MWH
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State Highway 58 Safety Improvements Scheme Assessment Report

Prepared for NZ Transport Agency

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QUALITY STATEMENT

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REVISION SCHEDULE

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1	22/11/13	Addition of Option 4	JP, DR	SM	PP	PP
2	4/03/14	Update following Road Safety Audit and Economic Peer Review	DR	JP	PP	PP

Executive Summary

The primary project objective is to reduce the number of deaths and serious injuries along State Highway 58 (SH58) by investing in cost effective treatments that promote a 'Safe System'; focusing on providing safer roads and roadsides, and safe speeds.

The project scope was to undertake a Scheme Assessment Report, building on a previous 2009 Project Feasibility Report, for the section of SH58 that runs between State Highway 2 (SH2) and the Pauatahanui Roundabout (approximate section length of 10km).

The project length has experienced a large number of high severity (fatal and serious) crashes in recent years. In the last five-year period from 2008 to 2012 there have been a total of 138 crashes, including two fatal and 13 serious injury crashes resulting in 15 deaths and serious injuries (DSi).

As a result of high severity crash density, this section of highway (and the rural entirety of SH58) is classified as a high-risk rural road.

Run off road and head on crashes comprised 70% of the reported crashes and 80% of the high severity crashes. Compared to national figures, this section of highway is overrepresented in high severity run off road crashes. The poor horizontal alignment (24 out of context curves), severe roadside hazards and narrow cross section all contribute to the high injury crash rate.

The NZTA requested that three options be considered for the full project length:

- **Option 1:** where 1.5m shoulders are provided throughout.
- **Option 2:** where 1.5m shoulders are provided throughout and where an additional 2.0 m of seal width is provided for the provision of a flush median.
- **Option 3**: where 1.5m shoulders are provided throughout and where an additional 2.0 m of seal width is provided for the provision of a wire rope median barrier.

In addition, this report considered the realignment of four out of context curve sites on SH58.

Based on the assessment undertaken, Option 2 was marginally the most economic option, achieving a BCR of 2.0 for the 40 year Economic Evaluation Manual analysis period. However Option 3 was considered the preferred option given the BCR was almost identical to Option 2, but favoured on the basis of providing central median barrier throughout (with consequential reduction in risk of high severity crashes).

As an extension to the initial SAR, the project scope was widened to optimise the original Option 3, creating Option 4. Option 4 included the removal of one of the high cost realignment sites, changes to a proposed intersection, and small overall reduction in project extents to the north. The project economics were also further refined and the Do-Minimum and Option speeds were set as 80km/h. Option 4 is estimated to cost $31.1m, yielding a BCR of 1.5.

It is recommended that NZTA undertake:

- Public consultation on the options (noting the need for co-ordination with the Petone to Grenada consultation phase).
- Engagement of a property consultant to validate and update property costs \ estimates to refine the project estimates.
- Further geotechnical testing as per the recommendations of the attached Preliminary Geotechnical Appraisal Report.
- A staging assessment to determine if and how the overall package of works could be delivered through block project funding given the current quantum of work is not expected to be financially viable as a single project, at least in the short to medium term.
- A detailed design of the preferred option (noting public consultation has not yet been undertaken which may influence the preferred option).

NZ Transport Agency

State Highway 58 Safety Improvements

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1 Introduction

1.1 Project Background

The NZTA has a long-term strategic plan for State Highway 58 (SH58) for the 20-year period 2009 to 2029. The SH58 Strategic Study prepared by MWH relates to the entire 15.1 km length of SH58, from the junction with SH2 at Manor Park in the Hutt Valley, to the junction with SH1 at Paremata.

Key aspects of the long-term strategic plan are outlined below.

- Transmission Gully, Petone to Grenada and the Grade Separation of the SH2/SH58 intersection are assumed to be complete by 2020;
- Based on these assumptions, SH58 will be retained as a two-lane two-way highway with the current passing lanes.
- The section between SH2 Manor Park and Moonshine Road will be managed as an 80 – 100km/h rural environment with a median barrier (and some provision for turning movements) considered in the long term.
- The section between Moonshine Road and Pauatahanui will also be managed as an 80-100 km/h rural environment with minor safety upgrades in the short term. Long term (15-20 years), this section could become a peri-urban environment and roundabouts for safety will be considered at the Moonshine Road and Flightys Road / Murphys Road intersections in conjunction with reducing the speed limit.
- The section between Pauatahanui and Postgate Drive will be managed as a 70km/h peri-urban section and the section from Postgate Drive to Paremata will be managed as a 50km/h urban highway with controlled access in the short term.
- Minor safety works will continue to be undertaken to address specific crash issues that arise during the study period.

1.1.1 Project Feasibility Report Recommendations

A Project Feasibility Report (PFR) was undertaken by MWH in 2009 as part of the SH58 Strategic Study to investigate the realignment of several out of context cures on SH58 between the SH2/SH58 intersection and Mount Cecil Road, in an effort to reduce the both the number and severity of crashes.

The project involved three substandard curve sites:

- **Site 1**: Includes a series of isolated reverse curves west of the intersection with Hugh Duncan Street;
- **Site 2**: Includes a series of tight reverse curves near Old Haywards Road at a point along the uphill passing lane; and
- **Site 3**: Includes a series of reverse curves and a broken back alignment from Mount Cecil Road to a point 650 m to the east.

The recommendations of the PFR are summarised below:

- It is recommended that funding be sought to undertake a Scheme Assessment Report for the realignment and widening of SH58 at Sites 2 and 3. The improvements would involve the realignment of the road geometry and widening to an acceptable standard. The benefit of this would be travel time savings and crash reduction savings.
- An alternative would be to abandon this project and consider a modification of the project investigated in SH58 – Haywards Hill Road to Moonshine Road Seal Widening and Median Barrier PFR, where only the out of context curves are widened. This would reduce the cost of the improvements as outlined in this report while potentially claiming many of the benefits.
- After considering the BCR of each project and the impact of both widening and realignment, the preferred option would be to realign and widen both Site 2 and Site 3, although the degree of realignment should be investigated further in the SAR stage.

1.1.2 Petone to Grenada PFR

As part of the Petone to Grenada investigation and reporting, a PFR is currently being undertaken to consider a number of improvements to SH58 from Haywards to Porirua. The outcomes of the PFR will be reported separately and is a separate commission to this SAR.

1.2 Objectives and Scope

The primary project objective is to reduce the number of deaths and serious injuries along SH58 by investing in cost effective treatments that promote a 'Safe System'; focusing on providing safer roads and roadsides, and safe speeds.

1.2.1 Project Scope

The scope of this project is the section of SH58 that runs between SH2 and the Pauatahanui Roundabout (section length of just under 10km)

The NZTA requested that three options be considered for the full project length:

- **Option 1:** where 1.5m shoulders are provided throughout.
- **Option 2:** where 1.5m shoulders are provided throughout and where an additional 2.0 m of seal width is provided for the provision of a flush median.
- **Option 3**: where 1.5m shoulders are provided throughout and where an additional 2.0 m of seal width is provided for the provision of a wire rope median barrier. The location of turnaround facilities will also be investigated.

In addition, this report will consider the realignment of four sections of SH58. Three of these are based on the projects described in the 2009 MWH PFR, outlined above. One option for realignment at each of the three sites is investigated.

A further site (herein described as Site 4), not included in the aforementioned PFR, is also investigated. For clarity the general location of Site 4 (also known as the washout/dropout section) is approximately RP SH58/0/3.40 to RP SH58/0/4.00.

2 Problem Description

The project length, from just west of the SH2/SH58 intersection to the Pauatahanui roundabout, has experienced a large number of high severity (fatal and serious) crashes in recent years. In the last five-year period from 2008 to 2012 there have been a total of 138 crashes, including two fatal and 13 serious injury crashes resulting in 15 deaths and serious injuries (DSi).

Run off road and head on crashes attributed to 70% of the reported crashes and 80% of the high severity crashes. Compared to national figures, this section of highway is overrepresented in high severity run off road crashes. A third of high severity crashes occurred in the wet, higher than the region's average of 28%.

As a result of high severity crash density, this section of highway (and the rural entirety of SH58) is classified as a high-risk rural road.

The key issues and deficiencies relating to the high crash rate and low 2.7 KiwiRAP star rating include:

- The project length contains 24 out of context curves, generally defined as rural curves with a radius less than 400 m and curve speeds 10 km/h lower than the approach speed. A number of these are in succession, creating tight reverse curves and broken-back[2] alignments, which reduce forward sight distance.
- The road has a high-speed environment of approximately 100 km/h[3]. The curves in question have curve advisory speeds between 65-75 km/h. Research has shown that curves requiring a reduction in speed of more than 15% from the surrounding speed environment are difficult for drivers to read and will increase the risk of loss of control crashes occurring.
- The SH58 carriageway is narrow, with 73% of shoulders along the 10 km section being below 1.5 m; reducing the recovery room for errant vehicles.
- 80% of the project length has moderate to severe (34%) roadside hazards, consisting of steep slopes, power poles and drop offs. The roadside hazards and narrow shoulders have resulted in approximately 61% of injury crashes involving a hit object (cliff, fence, tree etc.).
- Lack of continuous median barrier protection; there is a single 720 m section of wire rope barrier in the 10 km project length.
    - Research has shown that as traffic volumes exceed 6,000 AADT, the head on high severity crash rate exceeds the run off road crash rate[4]. As the project length has an AADT of 13,600, the head on crash risk is approximately 1.6 times greater than the run off road risk.
    - Therefore, although there have been few head-on crashes when compared to run off road crashes, the potential crash risk is high and this supports the provision of wire rope median barrier.

In summary, the poor horizontal alignment (out of context curves), roadside hazards and narrow cross section all contribute to the high injury crash risk.

[2] NZTA, SHGDM, Section 4, *"Two horizontal curves in the same direction, sometimes joined by a short straight, can form an unsightly alignment which is commonly known as a 'broken back' alignment".* These alignments are hazardous as drivers expect to have exited the curve when in reality they are required to negotiate the next curve almost immediately.

[3] Refer Section 4.2.4 for speed survey data.

[4] NZTA, High Risk Rural Roads Guide, Figure 3-6.

3 Site Description

The SH58 corridor is classified as a Regional Strategic highway[5], recognising its contribution to the social and economic wellbeing of the Wellington region, which provides an east-west link connecting SH2 Hutt Valley with SH1 Paremata.

3.1 Project Location and Highway Characteristics

The project length negotiates a series of hills from SH2 in the Hutt Valley (RP) 0/0.1), rising to Mount Cecil Road in Haywards Hill, through to the Pauatahanui village in the west (RP 0/9.8).

The carriageway consists of a standard two-way two-lane rural highway, but with two eastbound passing lanes and one westbound passing lane. The width of the highway is constrained in a number of locations due to the rolling/mountainous terrain. There are a series of high-speed horizontal and vertical curves. Several of the horizontal curves are out of context and have been posted with curve speed advisory signs of between 65 and 85 km/h.

The dominant land use adjacent to this stretch of road is rural, with the remainder being rural-residential, park reserve or industrial, such as two Transpower substations[6], Griffiths Drilling (on the former Downer EDi site), Winstone Dry Creek Quarry and a logging mill. Beyond the immediate neighbouring properties there is a greater focus on rural-lifestyle properties, and also includes commercial activities, such as BRANZ.

An outline of the study area is shown in Figure 3-1 below. A detailed location plan, showing the proposed realignment and widening extents, is attached in **Appendix A.**

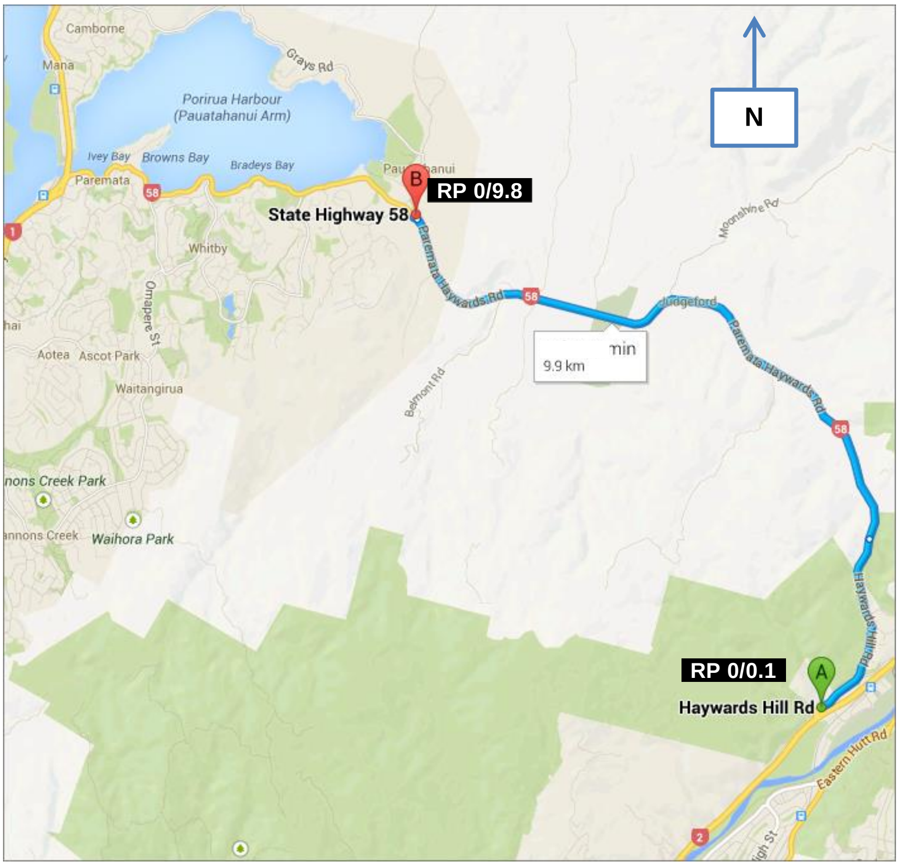

Figure 3-1: Study Extent

[5] NZTA, http://www.nzta.govt.nz/planning/process/doc/final-classification.pdf
[6] Located at Haywards and just east of the Pauatahanui roundabout.

Key highway features and constraints along the project length include:

- Highway Alignment
    - The current State Highway 58 length within the project area is characterised by significant vertical curvature, in additional to the curvilinear horizontal alignment. This is a direct result of the existing topography, with the road running through rolling and mountainous terrain.
    - The result of the topography on the SH58 road geometry is considerable with significant grades, 24 out of context curves and narrow shoulders that effect the operation of the road.
- Guardrail and Median Barriers
    - 760 m of wire rope median barrier from RP 0/1.515-2.275, installed in 2003.
    - Limited side protection in the form of W-section guardrail along the project length, with the KiwiRAP Assessment Tool (KAT) records showing guardrail present for 8% (LHS) and 11% (RHS). Installation of new guardrail has since occurred as part of the minor safety programme and these works are outlined in the recent and planned works section below.
- Passing and Overtaking
    - Three passing lanes;
        - 1.37 km westbound (increasing) uphill passing lane at Haywards, from RP 0/0.880-2.253 (excluding tapers).
        - Short 150 m eastbound (decreasing) passing lane on approach to Mt Cecil Road, from RP 0/3.183 to 3.337 (excluding tapers). Does not meet NZTA standards[7].
        - 1.23 km eastbound (decreasing) downhill passing lane, east of Moonshine Road, from RP 0/5.966-4.735 (excluding tapers).
    - 71% of the project length has no overtaking (double yellow lines and/or insufficient sight distance)
- Sites of Interest, Signage and Structures
    - Winstones Dry Creek Quarry – the private access is effectively a cross intersection with McDougall Grove (access at RP 0/0.30)
    - Transpower Haywards Substation – is located approximately 1 km west from the beginning of the study area, with private accesses at Kaitawa Street (RP 0/1.17) and Atiamuri Crescent (RP 0/1.33).
    - Griffiths Drilling and a logging mill just east of the Pauatahanui roundabout.
    - Variable Message Sign for westbound traffic at RP0/8.7 (approximately 1 km east of the Pauatahanui Roundabout)
- Property and Access
    - 12 local roads that are accessed via the state highway along the project length, refer Section 4.2 for further detail.
    - The highway is designated as a Limited Access Road (LAR) and the NZTA have over the past several years imposed conditions to restrict detrimental development on properties adjoining SH58.
    - In saying this, a number of private properties are accessed off the state highway, increasing in frequency on approach to semi-rural Judgeford and Pauatahanui.
- Future Land uses

[7] NZTA, Passing and Overtaking Guideline, short passing lanes are defined those between 600-800 m excluding tapers. For the purposes of this report, passing lanes less than 600 m have been considered deficient. http://www.nzta.govt.nz/resources/passing-overtaking-guidelines/docs/attachment-a-glossary.pdf.

- Transmission Gully (see section 9.4.1)
- Winstone Aggregates Cleanfill Site (see section 7.1)
- Pauatahanui-Judgeford Site (see section 9.4.2)
- Changes in designation (see section 9.1.1)

• Public Transport, Walking and Cycling

- Walking and cycling facilities in this area are limited, with no facility other than the road shoulder (of varying width).
- SH58 is part of the Greater Wellington's regional cycling network[8], with a number of mainly recreational cyclists using the route.
- Public transport along SH58 consists of limited number of bus services, with the majority of these services covering the Porirua to Pauatahanui section only; a single public service covers the entirety of SH58[9].
- The study length is also part of a school bus route servicing Pauatahanui School, with a bus stop at the SH58/Moonshine Road intersection. This bus stop has been observed as being very busy at peak times, with a number of buses and cars parked on the highway and Moonshine Road (refer **Appendix A** for photos).
- As part proposed Pauatahanui-Judgeford Site (see section 9.4.2) there will also be opportunities for walkway/cycleways along Pauatahanui Stream as the area is subdivided through the provision of Esplanade Reserves and/or Strips. Refer Appendix N for a map of the proposed transportation improvements of the Pauatahanui to Judgeford structure plan.

• Existing Structures

- The existing structures are outlined in the table below.

Table 3-1: Existing Structures

Existing Structure	RP Start	Length	Width
Dry Creek Quarry Culvert	0/0.33	10m	10m
Stock Subway Culvert	0/3.84	10m	8m
Pauatahanui Culvert No. 1	0/5.99	21m	14.6m
Pauth Stream Culvert No. 2	0/6.87	10.5m	7.3m
Golf Course Subway	0/6.92	11.5m	10.3m
Pauth Stream Culvert No. 3	0/7.45	12.8m	7.25m
Murphys Road Culvert	0/8.16	14m	10m
Pearce Bridge	0/8.36	13.3m	12m
Pauth Stream Bridge No. 7	0/8.97	15.9m	8.5m
Pauth Stream Bridge No. 7	0/8.97	18m	9.7m

8 Greater Wellington Regional Cycling Plan (2008), http://www.gw.govt.nz/assets/importedfiles/5938_CyclingPlan2wit_s11794.pdf
9 Metlink, #97, Polytech Link route, http://www.metlink.org.nz/info/network-map/

Recent and planned works affecting the project length include:

- Recently completed guardrail (Refer Appendix C for maps showing the sites and extent of works)
  - Section 1 – 0/0.35 – 0.63 Completed June 2013
  - Section 4 – Transpower (Haywards) barrier (lower) built Dec 2012
  - Section 5 – Transpower (Haywards) barrier (upper) built Jan 2013
  - Section 6 – 0/1.28 – 2.26 built July 2013
  - Section 7 – 0/2.45 – 2.95 built June 2013
  - Section 10 – 0/3.3 – 3.60 built May 2013
- Future Safety Works Investment Prioritisation Process (SWIPP) projects for 2013/14 include:
  - Culverts Upgrade: Prioritise worst culverts and install/construct traversable ends on the numerous non-traversable roadside culverts headwalls/ends.
  - Further guardrail installation: Approx. 700m of guardrail for hazard protection from Judd's farm to Britten's (0/3.7 to 0/4.4).
  - Speed limit review: Undertake speed surveys and Speed Limit NZ (SLNZ) surveys to support, or otherwise, speed limit changes.
  - Harris Road: the existing intersection has high risk turning movements due to the intersection being located on a crest and at the end of a passing lane.
    - All proposed options include widening and a right turn bay to limit conflict points.
  - Flightys/Murphy's Road: Widen the carriageway at the narrow crossroad intersection.
    - All the proposed options include widening of the carriageway through this intersection.
  - Signs and Marking: undertake sign and delineation improvements to improve quality and consistency.
  - Wire Rope Barrier extension: Extend the existing WRB from 0/2.2 to 0/2.3 to discourage 'U' turns.
  - Other planned work includes improvements to the Scour site (refer Section 3.1.1.4).

The project team has been in discussion with the Wellington State Highway Network Minor Safety team during option development to ensure that the recent and future works outlined above are considered and/or incorporated, as much as practicable, into the preferred option.

3.1.1 Proposed Realignment Sites

Four sites in particular have been identified as being inconsistent with the adjacent speed environment and have been investigated for realignment, these are outlined below.

3.1.1.1 Site 1 – East of Hugh Duncan Street (RP 0/0.574 to 1.064)

Both approaches to this site consist of high-speed straights and curves. Travelling west, the road is on an uphill grade entering into a tight left hand curve followed by a moderate right hand curve. A westbound passing lane develops immediately after this right hand curve, followed by a moderate left hand curve. The first left hand curve travelling west has a speed advisory sign of 75km/h with poor visibility through the curves due to a bank with high vegetation. The lack of sight distance reduces the driver's ability to read the transition between the tighter curves and increases the risk of a crash occurring. Figure 3-2 below shows the approach to the curve from the east.

Out of context curves along this site include:

- 147 m radius curve with a length of 150 m, left hand curve (RP0/0.61-0.76)
- 160 m radius curve with a length of 100 m, right hand curve (RP0/0.76-0.86)
- 233 m radius curve with a length of 100 m, left hand curve (RP0/0.93-1.03)

Other features include:

- Existing 1.4 km westbound uphill passing lane from RP 0/0.89 to RP 0/2.25 (excluding tapers)
- Approx. 50 m of drop off protection guardrail eastbound from RP 0/0.66 – 0.71.
- Intersection of Hugh Duncan Street and SH58 at RP 0/0.95, 250 ADT, stop controlled with a right turn bay and flush median provided.

Figure 3-2: Approach to Site 1 from the east (Increasing RP0/0.62)

3.1.1.2 Site 2 – East of Old Haywards Road (RP 0/1.128 to 1.470)

Both approaches to this site consist of high-speed straights. Travelling west, the road is relatively flat with a westbound passing lane and right turn bay for the Haywards Substation access. The road then steepens into an uphill grade and a medium left hand curve followed by a tight right hand curve. This arrangement could lead to vehicles accelerating at the passing lane to overtake vehicles at the beginning of the series of curves. This could lead to an increased risk of a crash occurring. The downhill approach transitions from a high-speed section with a steep downhill grade onto a tight left hand curve, posted at 65 km/h, which is out of context with the surrounding speed environment.

Out of context curves along this site include:

- 198 m radius curve with a length of 190 m, left hand curve (RP0/1.20-1.39)
- 100 m radius curve with a length of 100 m, right hand curve (RP0/1.42-1.52)

Other site features include:

- Existing 1.4 km westbound uphill passing lane from RP 0/0.89 to RP 0/2.25 (excluding tapers)
- Guardrail eastbound from RP 0/1.00 – 1.36
- Two Haywards Substation private access intersections with SH58 including:
    - Kaitawa Street (RP 0/1.17), existing RTB.
    - Atiamuri Crescent (RP 0/1.33), flush median.

Figure 3-3: Approach to the tight, uphill, right hand curve on Site 2 from the east (Increasing RP 0/1.42)

Section between Site 2 and Site 3

The approximately 1 km section of SH58 between Site 2 and Site 3 is not currently being investigated for realignment as part of this SAR. This section includes a westbound passing lane and wire rope median barrier for the majority of its length which was installed in 2003.

This section contains three out of context curves in a reverse curve arrangement, including one 75 km/h posted speed advisory for a 185 m radius curve right hand curve (75km/h advisory travelling westbound, 65km/h advisory eastbound) at RP 0/1.84-2.07. This 75 km/h curve is preceded by a medium, 400 m radius, left hand curve and followed by a tight, 200 m radius, left hand curve.

There have been a total of 22 crashes in the last 5 year period along this section, including both of the fatal crashes along the study length and two minor injury crashes. Both fatal crashes occurred on the out of context curves with radii less than 200 m.

- The fatal crashes involved:
  - A westbound van losing control while overtaking in heavy rain (worn tyres); and
  - A westbound motorcyclist colliding with a westbound van u-turning, visibility limited by curve.

Although highway realignment is not being considered between sites 2 and 3, cross section and delineation improvements (e.g. edgeline and centreline Audio-Tactile Profiled (ATP)) will be undertaken. It is considered that these treatments will reduce the crash risk. In saying this, it is recommended that the crash history be reviewed following the implementation of these measures to determine if future geometric improvements are required.

3.1.1.3 Site 3 – East of Mount Cecil Road (RP 0/2.411 to 3.00)

The approach to this site, heading west, enters a right hand curve approximately 200m after the termination of the uphill passing lane. It then enters a left hand curve followed by a short straight and a second left hand curve. This alignment is termed a 'broken back' which are hazardous as drivers expect to have exited the curve when in reality they are required to negotiate the next curve almost immediately.

This section of road has a reverse curve sign with a concealed exit (Mt. Cecil Road) on approach to the second left hand curve; however there is no supplementary curve speed advisory sign. It is likely that the speed reduction required for the out of context curves can be exacerbated by vehicles exiting the passing lanes at high speeds as the gradient becomes level at the crest of the hill.

Out of context curves along this site include:

- 216 m radius curve with a length of 100 m, left hand curve (Broken back) (RP 0/2.46-2.63)
- 270 m radius curve with a length of 160 m, left hand curve (Broken back) (RP 0/2.70-2.86)
- 250 m radius curve with a length of 190 m, right hand curve (RP 0/2.91-3.07)

Other site features include:

- Intersection of Mt. Cecil Road (no exit) and SH58 at RP 0/2.97, 20 ADT, Give Way controlled with right turn bay provision.

Figure 3-4: Approach to the short straight between the two left hand curves in the 'broken back' alignment heading west (Increasing RP 0/2.58)

3.1.1.4 Site 4 – East of Mount Cecil Road (RP 0/3.376 to 4.00)

The approach to this site from the east enters a medium left hand curve approximately 100 m west of the reverse curve signage (PW-20) with a (temporary) posted speed limit of 70 km/h. It then enters another tighter left hand curve, after an approximately 70 m short straight; as discussed in Site 3 above, this alignment is termed a 'broken back'. Immediately following this broken back curve is a medium right hand bend and vertical crest curve. The posted speed limit returns to 100 km/h upon exiting the right hand bend at RP 0/4.00

This section of highway also includes a scoured site / drop off at approx. RP 0/3.6 – 3.8, located on second left hand curve travelling west. The existing guardrail installation is 80m long and offers limited protection of the drop off and one power pole. The drop off has been undermined by a stream below, and with the slip crest only metres away from the guardrail, reducing the founding of the guardrail posts significantly. As a result, the guardrail is leaning away from the highway and it is likely the guardrail will not operate as intended.

Preliminary investigation and design for this site has been undertaken for an interim solution of cutting away part of the bank on eastern side of the highway to move the road away from the scour face. This interim solution is outside of the scope this Scheme Assessment Report (but is given due cognisance).

Out of context curves along this site include:

- 297 m radius curve with a length of 140 m, left hand curve (broken back) (RP 0/3.49-3.63)
- 156 m radius curve with a length of 70 m, left hand curve (broken back) (RP 0/3.69-3.76)
- 242 m radius curve with a length of 240 m, right hand curve (RP 0/3.80-4.04)

Figure 3-5: Approach to the existing 70 km/h 'temporary' signage and first curve in the 'broken back' alignment heading west (Increasing)

Figure 3-6: Approach to 'Washout' area and second curve in the 'broken back' alignment heading west (Increasing)

3.2 Services

The following services have been identified in the vicinity of the proposed project works, and may be impacted:

- Power: Underground and overhead cables;
- Water, sewer and stormwater lines;
- Water pipelines (including Greater Wellington Regional Council (GWRC) water pipelines);
- Sewer main pipeline and sewer lateral;
- Stormwater pipeline and swales;
- Telecommunications and services;
- Fibre optic duct;
- Telecommunications; and

- Vector gas.

Services of significant risk include the high-pressure GWRC water mains and telecommunications that both run alongside (and across) the highway for much of the project length. The concentration of services in the vicinity of the Haywards Substation will also need care during the detail design phase.

It is noted that by the time construction commences there may be additional services that may be impacted by the works.

Further detail is provided in the existing services plan located in **Appendix E**.

4 Collected Data

4.1 Topographical Survey

The initial scope of this SAR was limited to the consideration of three sites for realignment. As such the initial topographical survey data collection was undertaken in two specific parts.

Firstly, ground based topographical survey was undertaken of the three realignment sites which included the full road seal and any existing unsealed road shoulder. In combination with the ground based topographical survey, it was deemed appropriate to take further aerial (LiDAR) survey to capture the topography either side of the existing sealed road. It was necessary to gather this data aerially given the large and steep slope faces in places that would be affected by any proposals for realignment requiring significant cut or fill.

When the project scope was subsequently expanded to include a fourth site for realignment together with an improved cross section to be considered for the entire project extent, further survey data was required. A further aerial survey was then commissioned for the remaining length. Aerial survey was deemed appropriate given the project length and volume of data required for the full project extent (9.5km total). Whilst aerial survey does lack the detail of ground based survey, it is reasonably accurate and can be used for scheme stage design with confidence.

4.2 Traffic Data

4.2.1 Traffic Volumes

The telemetry traffic count site located at RP 0/9.1 on SH58 gives a 2012 AADT of 13,600 and a regression analysis of 1992 to 2012 traffic volumes gives a traffic growth rate of 1.7%, as shown in Figure 4-1 below. However, when considering the last ten year period, the growth rate is 0.6%.

A 1.5% growth rate has been adopted[10] to account for the following:

- An increase in traffic following completion of Transmission Gully[11];
- A minor increase due to future development in Judgeford and Pauatahanui (see section 9.4.2); and
- The likely decrease in traffic on SH58 if the Petone to Grenada link proceeds.

[10] Note a 1.5% growth rate was used for the original Options 1-3 only. Following receipt of Petone to Grenada Saturn Modelling results, the preferred option (Option 4) was updated to use 2021 and 2031 SATURN modelling outputs, with a traffic growth rate of 0.5% from 2013 to 2021 and model based growth rates from 2021 to 2041. Refer Section 11.3, Appendix B and Appendix L for further detail.

[11] Board of Inquiry, Transmission Gully, Statement of evidence (Tim Kelly), *"…an increase in daily volumes using SH58 between the Project and SH2 at Haywards of 18%. This increase is not sufficient to give rise to any significant deterioration in the efficiency or safety of this route. The NZTA has programmed a number of safety and capacity improvements to SH58, including the grade-separation of its intersection with SH2". "Traffic volumes on both sides of the Pauatahanui Inlet will be significantly reduced, by 25-30% on sections of SH58.* The full evidence is provided in the TG evidence of Tim Kelly, paragraphs 52 and 58 apply to SH58.http://www.nzta.govt.nz/projects/transmission-gully-application/docs/evidence-tim-kelly.pdf.

Sensitivity testing has also been undertaken to consider a 0.5% traffic growth future scenario, refer **Appendix L**.

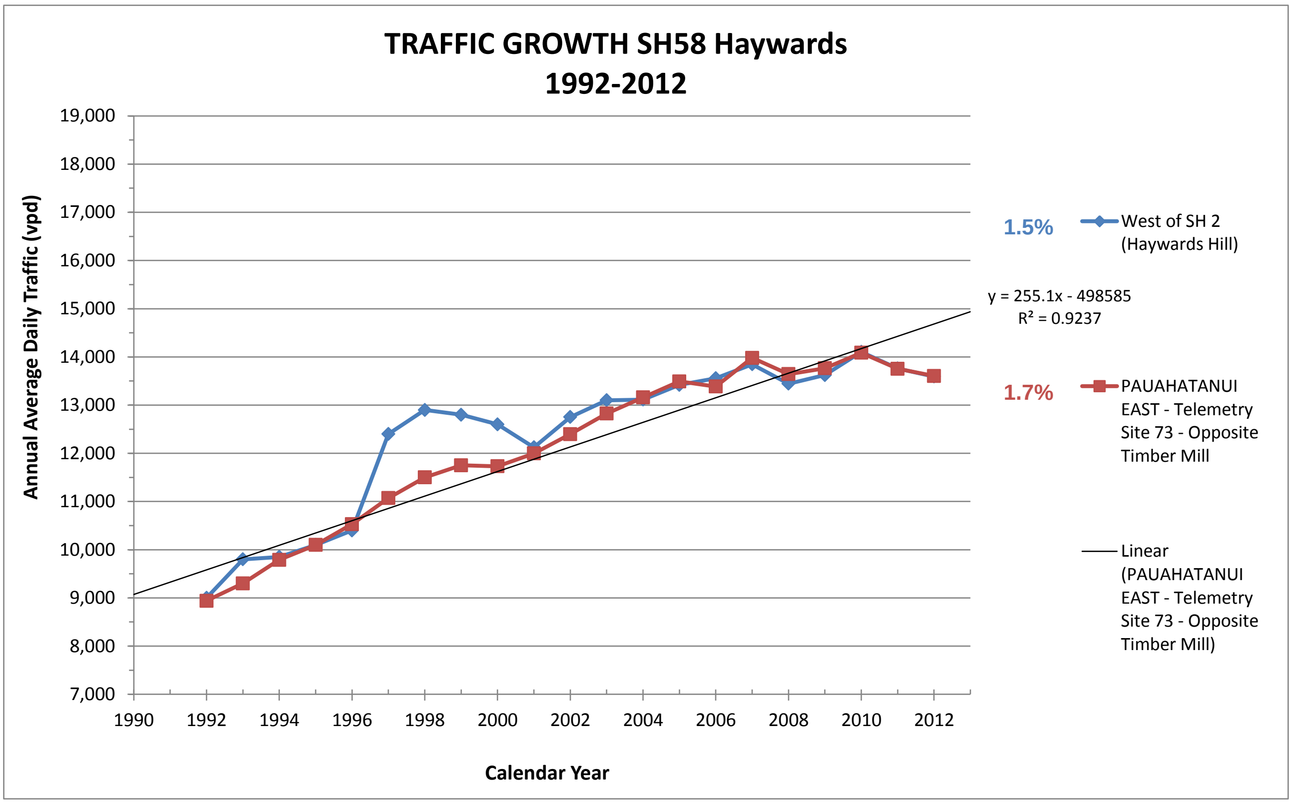

Figure 4-1: Haywards SH58 Traffic Growth 1992-2012

Table 4-1 below outlines the current traffic volumes of the nearest telemetry count site as well as the local roads located within the three sites.

Table 4-1: Current Traffic Volumes[12]

Location	Type	Volume
SH58 West of SH2 - Haywards Hill (RP 0/0.10)	Single Loop, continuous ID: 05800000	13,594 AADT (2012)
SH58 Pauatahanui East (RP 0/9.14)	Telemetry Site 73 ID: 05800009	13,605 AADT (2012)
Hebden Crescent (RP 0/0.03)	Local road count	453 ADT
McDougall Grove (RP 0/0.30)	Local road count	99 ADT
Hugh Duncan Street (RP 0/0.95)	Local road count	250 ADT
Kaitawa Street (RP 0/1.17)	Private Access	N/A – Substation Access
Atiamuri Crescent (RP 0/1.33)	Private Access	N/A – Substation Access

[12] SH58 volumes obtained via NZTA's Traffic Monitoring Systems (TMS), local road counts obtained via CAS (data sourced from RCA RAMM).

Location	Type	Volume
Old Haywards Road (RP 0/1.44)	Local road count	99 ADT
Mount Cecil Road (RP 0/2.99)	Local road count	20 ADT
Harris Road (RP 0/4.47)	Local road count	32 ADT (2009)
Moonshine Road (RP 0/6.32)	Local road count	576 ADT (2010) – low count compared to MWH short term pm peak survey (approx. 1,200 vph)
Mulhern Road (RP 0/7.31)	Local road count	255 ADT (2009)
Murphys Road /Flightys Road (RP 0/8.01)	Local road count	Murphys Road: 221 ADT (2010) Flightys Road: 488 ADT (2010)
Belmont Road (RP 0/8.37)	Local road count	121 ADT (2010)
Bradey Road (RP 0/9.32)	Local road count	124 ADT (2007)

4.2.2 Roadway Capacity

Traffic modelling[13] was undertaken as part of the SH58 Corridor Strategy Study (2009), with the results from Manor Park (SH2) to the Pauatahanui Roundabout outlined below.

- This section of SH58 is currently operating at LOS E during the weekday commuter peak periods, except for the sections with passing lanes which operate at LOS D. This is just below the assessed capacity[14].
- In 2029 (with Transmission Gully, Petone to Grenada and SH2/SH58 Grade Separation complete), the AM peak eastbound traffic volumes of approximately 1,250 vph will mean that some sections of the route will be operating at capacity. However, in all other situations LOS D or E can be expected.

Refer **Appendix B** for LoS graphs and 2012 directional peak hour flow graphs.

4.2.3 Traffic Composition

The 2012 traffic composition of the count site within the study area and the nearby telemetry site have been assessed with the results shown in Table 4-2 and Figure 4-2 below.

The vehicles classes currently recorded by telemetry sites (and classified surveys) are outlined below:

- Light vehicles (LV) are split into two length categories, up to 5.5 m (LV-I cars) and 5.5 m to 11 m (LV-II).
- Medium commercial vehicles (MCV) are calculated as 50% of the 5.5-11 m vehicles; these are included in the total number of heavy vehicles.
- Heavy commercial vehicles type I (HCV-I) with lengths between 11 m and 17 m.

[13] Note: the model included the following assumptions: SH2/SH58 Interchange and the Petone to Grenada projects complete by 2019 and in 2029 the above projects plus Transmission Gully.

[14] NZTA, SH58 Corridor Strategy (2009) states "The upper limit of LOS E has been chosen to reflect the capacity of the highway. Ideally, highway upgrades should occur prior to the traffic volumes in peak periods meeting this capacity figure; however, this often does not happen. The primary reason for this is affordability".

- Heavy commercial vehicles type II (HCV-II) are large vehicles with lengths greater than 17 m.
- Heavy vehicles are the sum of MCV, HCV-I and HCV-II.

Table 4-2: Telemetry Site Traffic Composition

Location	2012	Total	LV-I	LV-II	MCV	HCV-I	HCV-II	HVs (MCV, HCV)
West of SH2 (Haywards) RP 58/0	AADT (vpd)	13,594	12,754	122	416	215	87	718
	%	100%	94%	1%	3%	2%	1%	5%
SH58 Pauatahanui East RP 58/9	AADT (vpd)	13,605	12,607	427	427	82	62	571
	%	100%	93%	3%	3%	1%	0%	4%

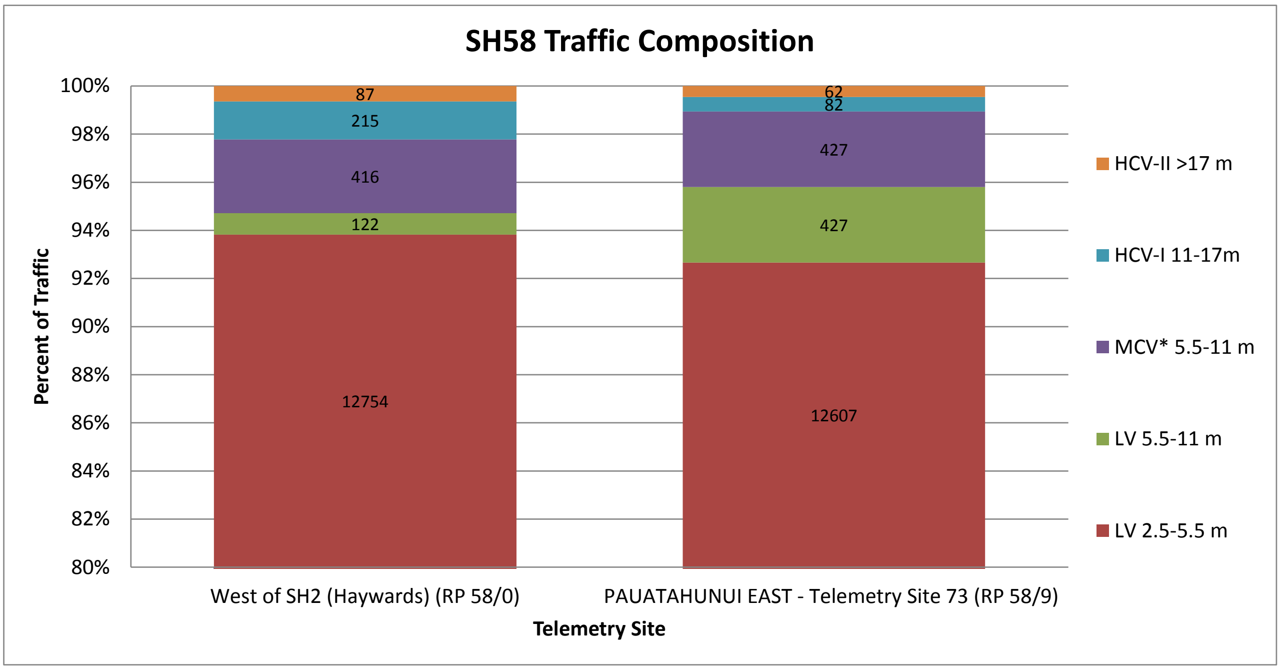

Figure 4-2: Count Site Traffic Composition

4.2.4 Travel Speed

Travel speed data has been collected using the following sources:

- Dual tube speed survey (NZTA/HTS, 2005) east of the Pauatahanui Roundabout (approx. RP 0/9.1 – near Telemetry site);
- Dual tube speed survey (TDG, 2011) near the proposed Winstones Clean Fill site, west of Mt. Cecil Road (approx. RP 0/3.22);
- Car following travel time surveys[15], July 2013, along the four proposed realignment sections (approx. RP0/0.5 to RP0/4.0); and

[15] These surveys involved following another vehicle, at approximately the same speed, along each of the four realignment sites and recording the travel time and distance travelled. This was repeated three to four times in each direction.

- Design speed estimates for the existing situation using geometric data[16]

The purpose of collecting and analysing the travel speed and travel time data is to verify the existing speed environment and validate the economic assumptions relating to travel time savings.

The results of the various surveys are outlined in Table 4-3, Table 4-4 and Figure 4-3 below.

Table 4-3: HTS and TDG Dual Tube Speed Surveys

Weekly	HTS Group (RP 0/9.1)				TDG (RP 0/3.1)	
	Increasing		Decreasing		Increasing	Decreasing
	April '05	August '05	April '05	August '05	Oct '11	Oct '11
Volume (vpd)	6,742	6,581	6,549	6,345	-	-
Mean speed (km/h)	90	91	88	88	92	91
85th %tile (km/h)	97.1	103.1	99.5	99.8	100	99

Table 4-4: Estimated Realignment Travel Speeds

Realignment Site	Car-following Speed Survey (km/h)			Design Speed Estimates (km/h)
	Westbound (Inc)	Eastbound (Dec)	Both Directions	Existing
1	77	81	79	70
2	72	82	78	80
3	86	85	86	85
4	84	82	83	82

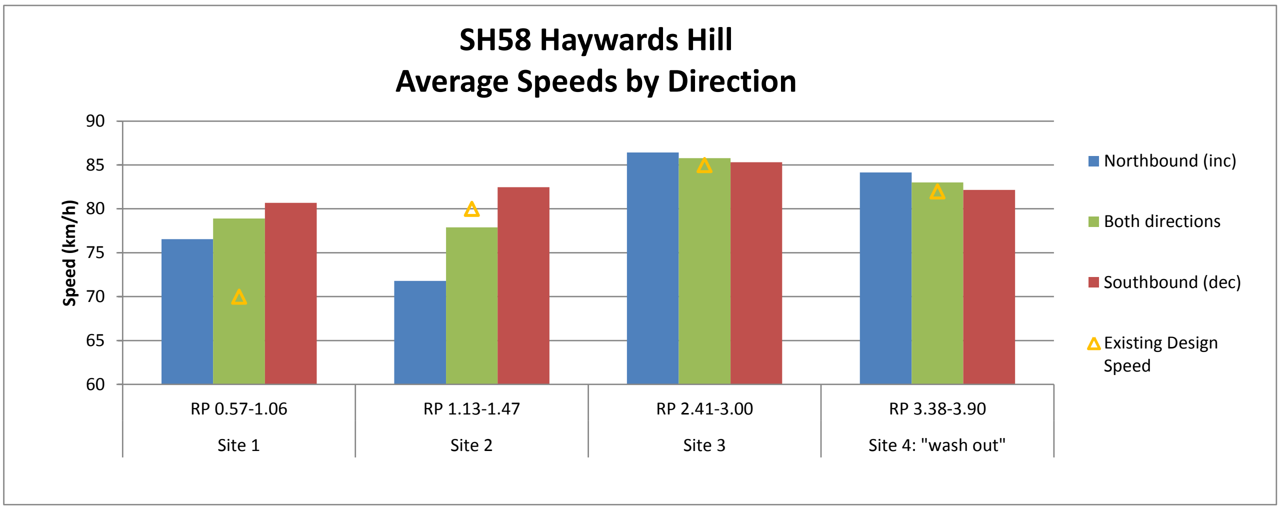

Figure 4-3: SH58 Realignment Site Average Speeds

As outlined Table 4-3, both the speed surveys conducted in April/August 2005 and October 2011 show similar results with a mean speed of 90 km/h and an 85th percentile speed of 100 km/h. In comparison,

[16] Note: Design speed estimates haves been calculated based on the current geometry (with a number of sites also containing multiple curves). LIDAR data has been used. Therefore, the results are only approximate. Refer Section 8.3.2.1 for the option design speed estimates.

the four realignment sites to the east (refer Table 4-4 and Figure 4-3) show much lower mean speeds. This is likely due to the spot speed surveys being located along relatively straight sections, in contrast to the average speeds surveys which were conducted along the curvilinear alignment of the realignment sites. Table 4-4 and Figure 4-3 show that site 1 and site 2 had the lowest average speeds of the four realignment sites from the car-following surveys undertaken; these trends correlate well with the existing design speed estimation (refer Figure 4-3, triangular symbols).

The observed travel speeds are similar or higher for all four sites when compared to the existing design speed estimates, this is not unsurprising due to the relatively high speed environment.

Further Traffic data, including graphs of AADT, peak hourly flows and speed survey data are detailed in **Appendix B**.

4.3 Crash History

4.3.1 Crash Data

A review of NZTA's CAS database over the five-year period 2008 to 2012 revealed a total of 138 crashes (15 high severity crashes resulting in 15 DSI) along the approximately 10 km project length, from RP 0/0.1 to RP 0/9.8.

The following tables provide a summary of the CAS output data for the study area:

Additional outputs from the CAS database are **Appendix C**.

Table 4-5: Annual Distribution of Crashes

Year	Fatal	Serious	Minor	Non-Injury	Total	DSi*
2008	-	2	4	8	**14**	**2**
2009	1	2	7	21	**31**	**3**
2010	1	1	9	19	**30**	**2**
2011	-	3	5	19	**27**	**3**
2012	-	5	9	22	**36**	**5**
Total	**2**	**13**	**34**	**89**	**138**	**15**

* Death and serious injury casualties

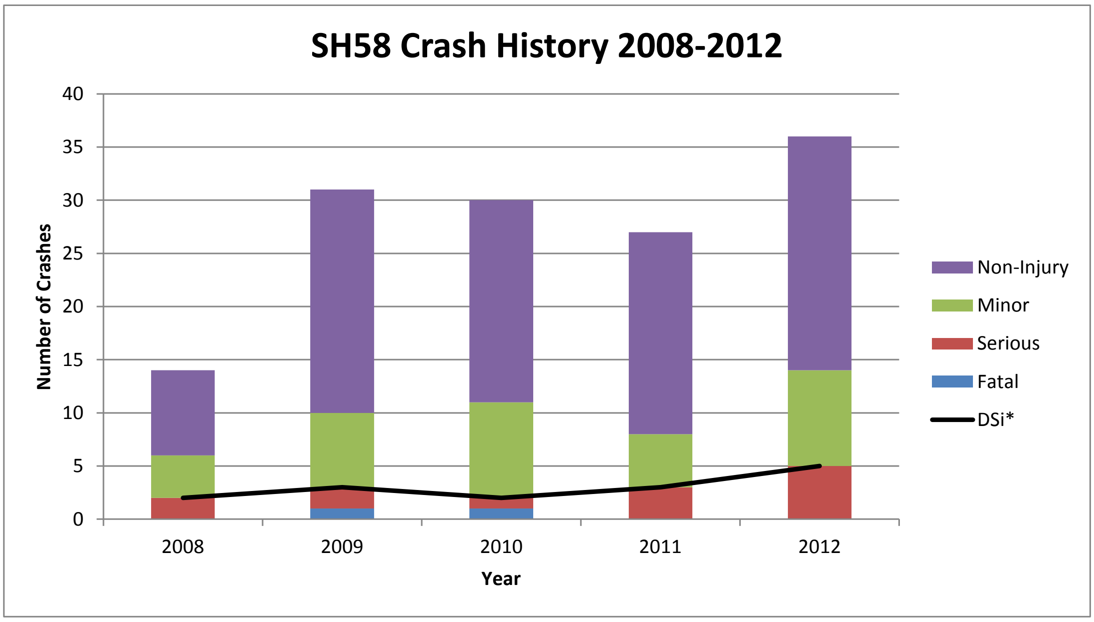

Figure 4-4: SH58 Crash History 2008-2012

Figure 4-4 above shows an increasing trend in deaths and serious injuries from 2010 onwards.

Table 4-6: CAS Crash Type

Crash Type	Number of Reported Crashes	% of Reported Crashes	% of Reported High Severity Crashes
Bend – Lost Control/Head On	76	55%	**40%**
Rear End / Obstruction	24	17%	**20%**
Straight Road Lost Control/Head On	15	11%	**27%**
Overtaking Crashes	14	10%	**13%**
Crossing / Turning	5	4%	**0%**
Miscellaneous Crashes	4	3%	**0%**
Pedestrian Crashes	0	0%	**0%**
Total	**138**	**100%**	**100%**

Table 4-7: Environmental Factors

	Wet/ Icy	Dry		Night	Day		Weekend (Fri 6:00PM to Monday 5:59AM)	Weekday
No.	73	65		33	105		49	89
%	**53%**	47%		24%	76%		36%	64%

The percentage of all crashes which occurred in the wet is very high at 53% (compared to the Wellington State Highway network average of approximately 30%).

Table 4-8 shows that of the 70 crashes occurring in the wet, 30% were injury crashes with 24% being high severity. Overall, 33% of the total fatal and serious crashes occurred in the wet, higher than the regional[17] average of 28%.

Table 4-8: Wet/Icy Crash Summary

Road Surface	Fatal	Serious	Minor	Non-injury	Total	% Injury	% of Total Injury	% High Severity	% of Total F+S
Dry	1	9	17	38	65	42%	55%	37%	67%
Wet	1	4	16	49	70	30%	43%	24%	33%
Icy	0	0	1	2	3	33%	2%	0%	0%
Total	**2**	**13**	**34**	**89**	**138**	**36%**	**100%**	**31%**	**100%**

[17] HRRRG, Wellington NMA is in the South-west North Island climate zone. It is noted however, that the HRRRG shows a higher value, proportion of rural road F&S injury crash occurring in the wet, of 36% for bend-lost/Head-on. As the majority of high severity crashes on this section are Bend/Lost control/head-on (40% - table 4-6), the 33% of high severity crashes occurring on this sections is not significantly high.

Table 4-9: Hit Object Crashes

Object Hit*	Number of Reported Crashes	% of Reported Crashes	Number of Reported High Severity Crashes	% High Severity	Number of Reported Injury Crash	% Injury
Fence	30	25%	2	7%	10	33%
Cliff/Bank	28	23%	2	7%	10	36%
Guard/guide rail & median barrier	15	13%	-	0%	1	7%
Tree	11	9%	1	9%	5	45%
Ditch	10	8%	-	0%	3	30%
Utility post/pole	10	8%	-	0%	6	60%
Overbank/Cliff	7	6%	-	0%	3	43%
Other	7	6%	1	14%	3	43%
Water/River	2	2%	1	50%	2	100%
Total	**120**	**100%**	**7**	**6%**	**43**	**36%**

*Note: Some crashes could have involved more than one object hit; 61% of the total number of injury crashes involved one or more objects hit (24% of the total number of injury crashes involved multiple hit objects).

Table 4-10: HRRRG Crash Type

Crash Type	Number of Reported Crashes	DSi	% of Reported Crashes	% of Reported High Severity Crashes
Run off Road	86	9	62%	60%
Head On	11	3	8%	20%
Intersection Crashes	15	1	11%	7%
Other	26	2	19%	13%
Total	**138**	**15**	**100%**	**100%**

Table 4-11: Crash Causation Factors of Reported Injury Crashes

Causation	Number of Reported Crash Causation Factors	Number of Reported Injury Crash Causation Factors	% High Severity
Poor handling	46	15	17%
Road factors	40	14	15%
Other (all remaining)	44	15	9%
Alcohol / drugs observed	14	8	29%
Too fast	41	15	7%
Poor observation	38	14	8%
Poor judgement	24	10	8%
Incorrect lanes/position	14	5	14%
Disabled /old / ill	4	4	50%
Failed to keep left	4	3	25%
Vehicle factors	15	2	7%
Weather (excl. animals)	6	2	17%
Enter/exit land use	7	2	0%
Failed to Give Way/Stop	5	2	0%
Fatigue	6	1	0%
Overtaking	5	1	0%

Road factors included:

- 85% (34 crashes) were due to “Slippery” conditions; 63% of due to rain or ice, 13% (5 crashes) due to oil/fuel and 6% due to surface bleeding/loose material.
- 5% (2 crashes) due to “Surface” conditions, with one of the crashes due to road maintenance.
- The remaining four of crashes were due to visibility limitations (three involving curves).

4.3.2 Crash Summary

A summary of the crashes on each of four realignment sites and the remaining midblock sections is outlined below.

- Midblock Sections (excluding the four realignment sections) – 93 recorded crashes (11 DSI)
    - Two fatal crashes, nine serious crashes, 21 minor injury crashes and 61 non-injury crashes.
    - The fatal crashes involved:
        - A westbound van losing control while overtaking in heavy rain (worn tyres); and
        - A westbound motorcyclist colliding with a westbound van u-turning, visibility limited by curve.
    - The serious crashes involved seven loss of control, one rear end and one overtaking crash.
    - 45% of crashes were bend loss of control/head-on, 20% Rear end/obstruction, 13% straight loss of control/head on, 13% overtaking, 5% crossing/turning and 4% miscellaneous.
    - When considering the three high risk rural roads guide (HRRRG) high severity crash types, run off road crashes account for 64% (54% nationally), head on 18% (21% nationally) and intersection 9% (13% nationally).
        - Compared to national figures, this section of highway is overrepresented in high severity run off road crashes.
    - 45% of the crashes occurred in wet/icy conditions, including one fatal, two serious, eight minor and 31 non-injury crashes.
- Site 1 RP 58/0/0.574 – 1.064: 12 recorded crashes (1 DSI)
    - One serious crash, three minor injury crashes and eight non-injury crashes.
    - The serious injury crash involved a motorcyclist travelling westbound losing control and colliding with the rear of a car that was travelling very slowly on a left hand curve.
    - The minor injury crashes involved:
        - An eastbound car travelling too fast when entering a corner, losing control when turning right and hitting a bank/tree;
        - A westbound SUV travelling too fast when entering a corner, swinging wide, and colliding head on with another vehicle; and
        - A westbound vehicle colliding with another vehicle when changing lanes to the left on a passing lane.
    - The non-injury crashes involved six bend loss of control/head on crashes, one u-turning crash and one rear-end crash.
    - 50% of the crashes occurred in dark (night/twilight) conditions, including one minor injury crash and five non-injury crashes.
    - 58% of the crashes occurred in wet conditions, including two minor injury crashes and five non-injury crashes.
- Site 2 RP 58/0/1.128 – 1.470: 5 recorded crashes (0 DSI)
    - No fatal or serious crashes, two minor injury crashes and three non-injury crashes.
    - The minor injury crashes involved:
        - A westbound van travelling too fast when entering a corner, losing control when turning left and hitting guardrail; and

        - A westbound SUV losing control when turning left on a curve and colliding with a cliff/bank.
    - 80% of the crashes occurred in wet or icy conditions, including both minor injury crashes.
    - 60% of the crashes occurred in dark (night/twilight) conditions, including one minor injury crash.
- Site 3 RP 58/0/2.411 – 3.000: 5 recorded crashes (0 DSI)
    - No fatal or serious crashes, two minor injury crashes and three non-injury crashes.
    - Both minor injury crashes occurred in wet conditions, with the driver entering the corner too fast; resulting in one loss of control while overtaking and one rear end crash.
    - The non-injury crashes involved two bend loss of control crashes and one rear-end crash.
    - 80% of the reported crashes occurred in wet conditions. However, only one non-injury crash occurred in dark conditions (20%).
- Site 4 RP 58/0/3.376 – 4.000: 23 recorded crashes (3 DSI)
    - Three serious crashes, six minor injury crashes and 14 non-injury crashes.
    - The serious injury crashes involved:
        - An eastbound van losing control turning right colliding with a fence, flipping down a bank and coming to rest in a small stream.
        - An eastbound car entering a corner too fast, losing control when turning and colliding with another car head on.
        - A westbound car losing control on a straight, crossing the centreline and colliding with two eastbound vehicles.
    - The three minor injury crashes were bend loss of control followed by hit object (cliff/bank, poles, and fence).
    - The non-injury crashes involved 12 bend loss of control, one head on and one rear-end crash.
    - 65% of reported crashes occurred in wet conditions, including two serious, three minor and 10 non-injury crashes.
    - 26% of crashes occurred in dark conditions, including one serious crash and two minor injury crashes.

4.3.3 Crash Risk

The project area has been assessed using both the High Risk Rural Roads Guide[18] (HRRRG) and the draft High Risk Intersections Guide[19] (HRIG). Refer **Appendix C** for crash risk calculations.

Based on published 2012 KiwiRAP risk maps, SH 58 from Porirua to SH 2 Upper Hutt has a low-medium personal risk (annual average fatal and serious injury crashes per 100 million vehicle km) and a high collective risk (annual average fatal and serious injury crashes per km). Due to the high collective risk (ranked 12th nationally), SH58 is classified as a high-risk rural road.

The calculated star rating for this section of SH58 is 2.7, resulting in a published KiwiRAP star rating of 2-star. This is below the NZTA's regional strategic aim "to achieve mostly 3-star KiwiRAP safety risk rating".

The crash risk for the project length is as follows:

- High collective risk (0.31 high severity crashes per km per year)

[18] High Risk Rural Roads Guide (HRRRG), NZTA, September 2011
[19] High Risk Intersection Guide (HRIG), NZTA, Draft March 2012

- Medium personal risk (6.12 high severity crashes per 100 million veh km)

Therefore this section is classified as a high-risk rural road with predominately a ‘Safer Corridors’ treatment strategy. In addition, due to the high volume of the route there is some justification for medium to high cost improvements under a ‘Safe System Transformation’ treatment strategy.

The treatment strategies support the proposed options[20] of providing roadside and centreline corridor improvements, in the form of shoulder widening, curve easing and median treatments.

Two intersections in the study area were identified with three or more injury crashes, Moonshine Road and Flightys/Murphys Road. Both intersections were analysed according to the HRIG, refer section 4.3.3.1 and 4.3.3.2 below.

4.3.3.1 Crash Risk: SH58/Moonshine Road Intersection

In terms of collective crash risk for the T intersection of SH58/Moonshine Road intersection, there are two methods of calculation:

- Reported F&S Crashes: Over the five year assessment period: there have been two F&S crashes reported within 250 m of the intersection, with two DSI.
- Estimated F&S Crashes: The second method involves the estimation of F&S crashes that have occurred at an intersection using all injury crashes that have occurred during the crash period. This method takes into account the crash movement type, intersection form and control, and collision speed on crash severity outcomes. The estimated collective crash risk is calculated at 0.7 F&S crashes for a 5-year period. This is presented in the table below:

Table 4-12: Estimation of F&S Collective Risk Using Severity Index SH58/Moonshine Road Intersection

Crash Type	Number of Reported Injury Crashes	Adjusted F&S crashes / All injury crashes[21]	Estimated Number of F&S Injury Crashes
Head-on (B Type)	1	0.35	0.35
Cornering (D Type)	1	0.27	0.27
Rear End (F Type)	1	0.08	0.08
Total	**3**		**0.70**

Therefore, according to HRIG[22] this intersection is considered ‘Low medium’ risk when quantifying collective risk.

When considering personal risk; a calculation is performed which considers the major and minor road traffic volumes to determine the product of flow to standardise the number of potential conflicts that could occur at an intersection. The SH58 / Moonshine intersection is calculated as having a personal risk value of 95. According to HRIG[23], this results in a ‘Medium’ personal risk level.

The Level of Safety Service (LoSS)[24] for this intersection has been calculated to be 7 which is category V[25] and demonstrates a poor safety performance on a five point scale, when compared to other intersections with similar characteristics.

Therefore although this intersection has not resulted in high-risk classification (based on collective and personal risk), the HRIG recommended safety improvement strategy is ‘Safety Management’. However,

[20] Refer Section 7 for option discussion
[21] HRIG, Table 8.10
[22] HRIG, Table 4-1
[23] HRIG, Table 4-2
[24] Level of Safety Service, as defined by HRIG, is a method of categorising the safety performance of an intersection compared to other intersections of that type.
[25] LoSS categories range from I (one) to V (five) where intersections classified as LoSS I have a safety performance that is better than other intersections of that type, in the same speed environment and with similar traffic flows. For intersections of Category V, the converse is true. Category V have LoSS values greater than 3.

due to the poor LoSS, further investigation and/or larger cost treatments may be justifiable on safety grounds.

4.3.3.2 Crash Risk: SH58 and Flightys/Murphys Road Intersection

In terms of collective crash risk for the crossroads intersection of SH58 and Flightys/Murphys Road, there are two methods of calculation:

For Collective Crash Risk:

- Reported F&S Crashes: Over the 5 year assessment period, there have been no F&S crashes.
- Estimated F&S Crashes: The estimated collective crash risk is calculated at 0.90 F&S crashes for a 5 year period. This is presented is the table below:

Table 4-13: Estimation of F&S Collective Risk Using Severity Index SH58 and Flightys/Murphys Road Intersection

Crash Type	Number of Reported Injury Crashes	Adjusted F&S crashes / All injury crashes	Estimated Number of F&S Injury Crashes
Cornering (D Type)	1	0.27	0.27
Loss Control Bend (G Type)	3	0.24	0.72
Total	**4**		**0.90**

Therefore, according to HRIG, using F&S injury estimation method the intersection is ‘Medium’ risk. The SH1 / SH57 intersection is calculated as having a personal risk value of 140, according to HRIG, this results in a ‘High’ personal risk level.

The Level of Safety Service (LoSS) for this intersection has been calculated to be 3.0 which is category V and demonstrates a poor safety performance on a five point scale, when compared to other intersections with similar characteristics.

This intersection has been classified as having a medium collective risk and a high personal risk, therefore this intersection is high-risk. The HRIG recommended safety improvement strategy is ‘Safe System Transformation Works’ or ‘Safety Management’.

4.3.4 Crash Rate

The site specific crash rate for each site has been compared to what would be expected as typical. The typical crash rate was found for each of the curves using the crash prediction model for mid-block crashes in the New Zealand Transport Agency’s Economic Evaluation Manual (EEM1).

4.3.4.1 Midblock

An analysis of the 2008 to 2012 crash data shows that 32 injury crashes occurred in the latest five year period (6.4 injury crashes per year). The typical crash rate was found to be 9.6 injury crashes per year based on predicted 2013 traffic flows. This indicates that the crash rate along this section of the road is lower than “typical” but also that a road with this alignment has the potential to cause more injury crashes.

Table 4-14: Midblock Crash Rate

Parameter	Injury Crashes per Year
Site Specific Crash Rate	6.4
Typical Crash Rate	8.7

4.3.4.2 Realignment Sites

An analysis of the 2008 to 2012 crash data shows that 17 injury crashes occurred in the latest five year period (3.4 injury crashes per year). The typical crash rate was found to be 2.8 injury crashes per year based on predicted 2013 traffic flows. This indicates that the crash rate along this section of the road is approximately 20% higher than expected.

Table 4-15: Realignment Crash Rate

Parameter	Injury Crashes per Year
Site Specific Crash Rate	3.4
Typical Crash Rate	2.8

4.3.5 Crash Context

Crashes occurring at, and on approach to, the intersection of State Highway 2 and State Highway 58 have been excluded from the analysis as this is the study area and will be addressed in the planned SH2/SH58 Grade Separation Project.

However, due to the proximity of the intersection to the start of the study area, the following comments have been made regarding the crash history:

- In the five year period from 2008 to 2012 there have been:
  - Seven loss of control crashes on the curve just west of the SH2/SH58 intersection, all occurring in wet conditions.
  - Four rear end crashes on approach to the signalised SH2/SH58 intersection, 25% occurring in wet conditions. 50% of these rear ends crashes are attributed to signals, with the remainder due to queuing.
- Since the intersection was resealed, with stone mastic asphalt (SMA) in late April 2012 up to RP 0/0.130:
  - There have been no loss of control on curve crashes on the SH58 approach to SH2 (excluding the SH2/58 intersection); and
  - There has been a single serious injury rear end queuing crash. The crash occurred due to an eastbound vehicle failing to stop and colliding with a stationary vehicle waiting at the signals. The severity of the crash is likely due to the elderly driver.
- Hebden Crescent (RP 0/0.04): intersection crossing/turning crashes excluded as the proposed treatments of this SAR (widening/curve realignment) will not have any effect on this section.

The crash data, including a collision diagram is **Appendix C**.

4.4 Summary of Preliminary Geotechnical Appraisal Report

Sh58 follows the side of a steeply incised valley cut down into greywacke bedrock. The existing road alignment has undertaken a combination of cuts into the western (true left, increasing RP) rock faces, and fill to right hand shoulders.

Whilst the existing rock cuttings are generally performing well; the shoulders to the right hand side are over-steep, and failing in several locations.

Our appraisal has highlighted the potential areas of concern or requiring specific detailed assessment and design. Generally at this stage, we recommend that cuttings to the left can adopt the existing cut angles as acceptable precedent for design, provided that appropriate catch benches are also included. Fills to the true right are likely to require significant structures or engineered fills in areas that have shown previous signs of instability. Significant detailed assessment and design would be required to undertake widening or realignment to the right side (increasing RP). There are a number of fills in natural gully landforms that will require culvert extension, and there are some instabilities on the gentled soil slopes to the left side, at RP 3.42-3.46, west of Mt Cecil Road that should be avoided. There is an existing scour site under active management to the west of this.

No specific geotechnical risks stand out for the proposal to add 1.5m of shoulder and up to 2m of additional seal width between SH2 and Pauatahanui Roundabout. In general, the potentials for risk may include minor shoulder construction less than 1.0m thick or cuttings less than 1.5m high (toe to crest). Detailed design would be required to confirm that the scale of general widening proposals meets with this assessment, but we do not consider there to be any untreatable risks as part of this work.

Our report includes a recommended testing schedule; Boreholes are recommended at the top of proposed cuttings to confirm ground conditions beyond the limits of conventional mechanical or hand tool methods, to provide detailed information on the existing geology and allow a rip-ability rating assessment to be undertaken. A combination of mechanically excavated test pits and pavement shoulder pit excavations are recommended, along with hand augers for field logging, sampling and in-situ strength testing. Face scrapes and detailed face mapping will also be undertaken within existing cut slopes next to the highway.

Some consenting may be required in advance of the investigations. Access outside of the road reserve may require land-entry agreements prior to undertaking the work. Temporary access tracks up to 120m long are required for some of the boreholes. Traffic management will be required for work affecting the highway.

5 Stakeholder Relationship Management and Consultation

Consultation with affected people and communities provides decision-makers with information that assists in making well-founded decisions. As well as providing information, consultation processes help project proponents understand community values and expectations.

The NZTA has a policy on consultation and communication of which the development of a consultation plan forms the basis. Under the LTMA, NZTA has a specific obligation to consult, particularly on any proposed activity likely to affect Māori land, or Māori historical, cultural or spiritual interests.

A number of principles that help define the meaning of good consultation include:

- Consulting as early as possible when the proposal is still flexible and issues raised by interested and affected persons can still be addressed;
- Being transparent about project aims and objectives;
- Keeping an open mind to people’s responses and to the benefits that might arise from consultation;
- Consultation is intended as an exchange of information and requires both the applicant and those consulted to put forward their points of view, and to listen to and consider other perspectives;
- While consultation is not an open-ended process, it should not be seen merely as a means to an end;
- Consultation may be on-going and may continue after approvals have been sought, and even after a decision has been made;
- Consultation does not necessarily mean that all parties have to agree to a proposal, although it is expected that all parties will make a genuine effort. While agreement may not be reached on all issues, points of difference will become clearer or more specific.

A Consultation Plan has been prepared for the project area and consultation will be undertaken in accordance with the plan. The purpose of the plan is to:

- Provide a documented process for intended engagement with the community, including the project context, the parties involved, and desired outcomes;
- Maximise effective and efficient engagement of community within generally tight time constraints;

- Provide the specifics of consultation to be undertaken, including timeframes;
- Help the project team to proactively manage risks to the project/project future from inappropriate or inadequate community engagement; and
- Help the project team to constructively manage community expectations.

Key stakeholders have been identified and consultation will commence at the appropriate time. Due to the consultation undertaken for the Petone to Grenada project, the NZTA has decided to defer the consultation for SH58 until the Petone to Grenada consultation is likely to be completed as this also includes consultation on the future of SH58.

When the SH58 SAR consultation is undertaken, a summary note will be provided as an Appendix to this report which will be used to inform the detailed design phase. It has been agreed with the client that, due to the late nature of the consultation, no further changes will be made to the SAR.

6 Options Description

As presented previously, the investigation is broken into two parts; realignment of the four specific sites and corridor treatment from SH2 to the Pauatahanui Roundabout.

6.1.1 Realignment

Site 1

This section of road has two curves both currently posted at 75km/h. The option is to realign the western curve and eastern curve to grant radii of 400m and 280m respectively. The eastern curve would retain an estimated design speed of 75km/h while the western curve would be increased to 90km/h. This realignment would reduce the demand on drivers and make it easier for them to read the required change in speed by ‘stepping’ the speed change. The design speed would also be increased on average throughout the section resulting in travel time saving.

Site 2

This section of road is currently posted at 65km/h on the western curve and 75km/h on the eastern curve. The option is to realign the western curve to grant a radius of 350m with an estimated design speed of 85km/h, This realignment would reduce the demand on drivers and make it easier for them to read the required change in speed. The design speed would also be increased throughout the section resulting in travel time savings.

Site 3

This section of road is currently posted at 75km/h in both directions. The option is to realign the western curve to grant a radius of 400m with an estimated design speed of 90km/h, the eastern curves would then be combined into one large radius curve removing the ‘broken back’ alignment to obtain a design speed of 90km/h. This realignment would reduce the demand on drivers and make it easier for them to read the required change in speed. The realignment would also improve sight distances at the intersection with Mount Cecil Road decreasing the risk of crashes occurring. The design speed would also be increased throughout the section resulting in travel time savings.

Site 4

A further site (herein described as Site 4), not included in the aforementioned PFR, will also be subject to realignment. For clarity the general location of the section in question is approximately RP SH58/0/3.40 to RP SH58/0/4.00. The existing site has poor horizontal geometry and is a combination of three curves of varying radii and transition lengths. This site is also characterised by stream scour on the eastern side of the road. Recently, a temporary speed restriction to 70km/h has been implemented due to the scour in close proximity to the seal. The realignment proposed will grant a radius of 400m with an estimated design speed of 90km/, resulting in travel time savings.

6.1.2 Enhanced Cross Section

In addition to the realignment discussed above, an improved cross section is also proposed for the entire route with three options investigated:

- **Option 1:** 3.5m traffic lanes, with 1.5m sealed shoulders
- **Option 2:** 3.5m traffic lanes, with 1.5m sealed shoulders and a 2m flush median
- **Option 3:** 3.5m traffic lanes, with 1.5m sealed shoulders, 2m median and provision of central median wire rope barrier

6.2 Option 1: Curve Realignment and Shoulder Widening

This option consists of shoulder widening to 1.5 m, with 3.5m traffic lanes to achieve a minimum seal width of 10 m, as shown in Figure 6-1 below. Refer **Appendix E** for typical guardrail, passing lane and right turn bay cross sections.

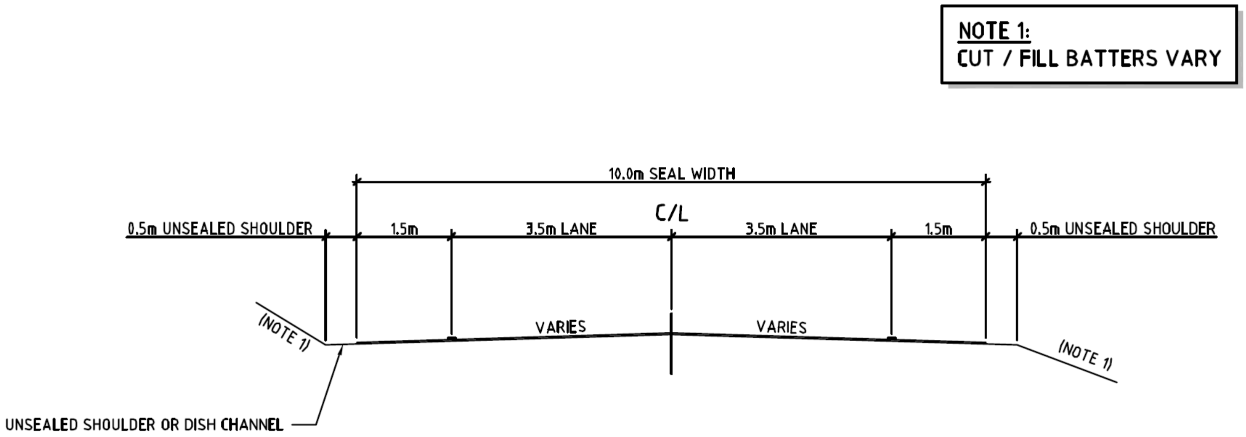

Figure 6-1: Option 1 Typical Cross section

Right turn bays have been provided for at intersections with associated flush median development. Where right turn bays are provided the flush median is developed to 2.5m width to provide a safe refuge area for vehicles waiting to turn right. The 2.5m flush median is also considered upstream of a local road intersection to provide for vehicles turning right out of the local road onto SH58.

Central median wire rope barrier is only provided to replace existing – west of the Transpower access between the westbound passing lane and eastbound carriageway (existing WRB from RP 0/1.515-2.275). However the flush median where the wire rope barrier is located is widened to 2.0m (whereas at present this is only approximately 1.5m wide)

The eastbound passing lane east of Moonshine Road (RP 0/5.966-4.735 – excl. tapers) is maintained. However the short substandard eastbound passing lane west of Mount Cecil Road (RP 0/3.183 to 3.337) is removed to provide access to the proposed cleanfill quarry site.

Edge protection is proposed at a number of locations through the project extents to protect against roadside hazards such as drop offs, cliff faces and (proposed) gabion basket retaining structures. Where guardrail is proposed, an additional 600mm widening is proposed to maintain the shoulder width of 1.5m. Due to topography and the propensity for runoff road / strike object type crashes, a considerable length of guardrail, approximately 6.4km (project length total), is proposed for hazard protection.

Additional curve and shoulder widening is also proposed in a number of locations for safety – either for geometric reasons to support movement around horizontal curves, or due to the density of residential accessways to assist with access and egress (generally between Harris Road and Moonshine Road, and between Mulhern Road and Murphys Road). Details are provided on the corresponding scheme plans.

Proposed delineation features, in addition to retaining the existing Raised Reflectorized Pavement Markers (RRPMs), include the installation of both edgeline and centreline Audio-Tactile Profiled (ATP) markings along the project length.

In addition, realignment is considered at all four horizontal curves as described in section 6.1.1. Where realignment has been proposed, radii reflective with the horizontal curves on the extent of the route are proposed for consistency and driver readability.

6.3 Option 2: Curve Realignment, Shoulder Widening and Flush Median

This option consists of carriageway widening to achieve 1.5 m shoulders, 3.5 m traffic lanes and a 2.0 m wide flush median, as shown in Figure 6-2 below. Refer **Appendix E** for typical guardrail, passing lane and right turn bay cross sections.

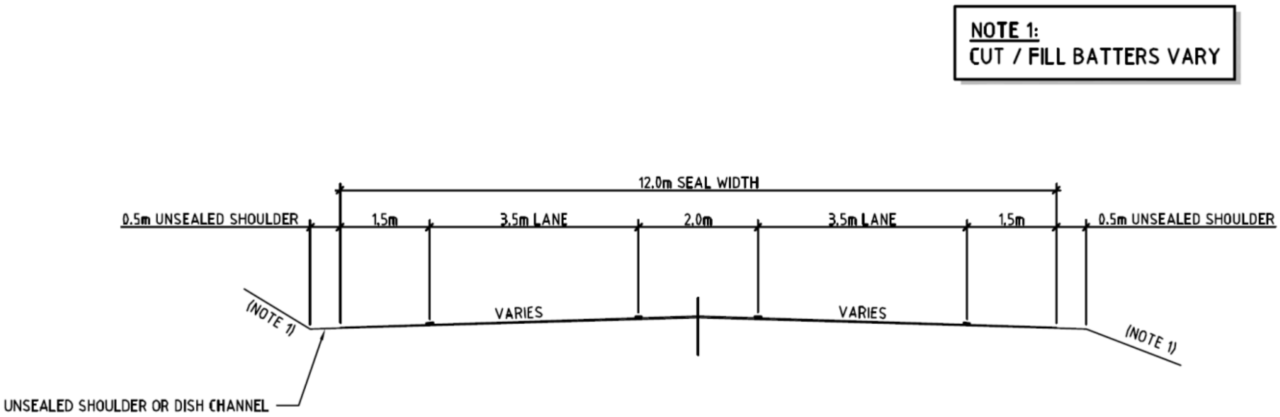

Figure 6-2: Option 2 Typical Cross section

The 2.0m flush median is provided throughout the entire project extent, increased to 2.5m width in proximity to local road intersections to provide for turning vehicles.

Central median wire rope barrier is only provided to replace existing – west of the Transpower access between the westbound passing lane and eastbound carriageway (existing WRB from RP 0/1.515-2.275).

The eastbound passing lane east of Moonshine Road (RP 0/5.966-4.735) is maintained. However the short substandard eastbound passing lane west of Mount Cecil Road (RP 0/3.183 to 3.337) is removed to provide access to the proposed cleanfill quarry site.

Edge protection is proposed at a number of locations through the project extents to protect against roadside hazards such as drop offs, cliff faces and (proposed) gabion basket retaining structures. Where guardrail is proposed, an additional 600mm widening is proposed to maintain the shoulder width of 1.5m. Due to topography and the propensity for runoff road / strike object type crashes, a considerable length of guardrail, approximately 6.6km (project length total), is proposed for hazard protection.

Additional curve and shoulder widening is also proposed in a number of locations for safety – either for geometric reasons to support movement around horizontal curves, or due to the density of residential accessways to assist with access and egress (generally between Harris Road and Moonshine Road, and between Mulhern Road and Murphys Road). Details are provided on the corresponding scheme plans.

Proposed delineation features, in addition to retaining the existing Raised Reflectorized Pavement Markers (RRPMs), include the installation of both edgeline and centreline Audio-Tactile Profiled (ATP) markings along the project length.

This option includes the realignment at the four sites as per Option 1. Where realignment has been proposed, radii reflective with the horizontal curves on the extent of the route are proposed for consistency and driver readability.

6.4 Option 3: Curve Realignment, Shoulder Widening and Wire Rope Median Barrier

In addition to including the four realignment sites of Option 1, this option consists of carriageway widening to achieve 1.5 m shoulders, 3.5 m traffic lanes and a 2.0 m wide median with wire rope barrier provision, as shown in Figure 6-3 below. Refer **Appendix E** for typical guardrail, passing lane and right turn bay cross sections.

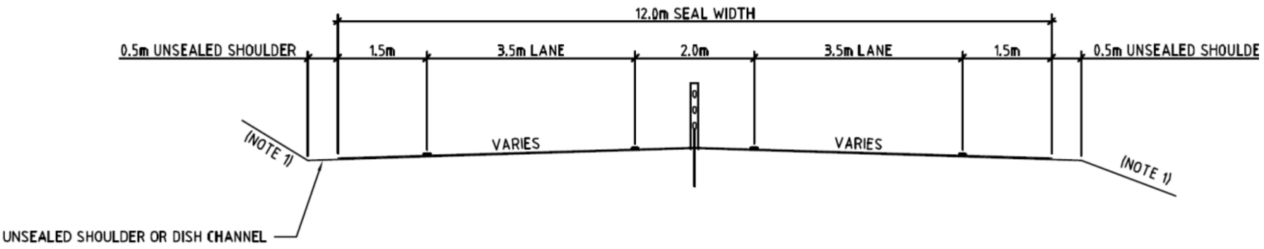

Figure 6-3: Option 3 Typical Cross section

This option is the same as Option 2 with the addition of a wire rope median barrier.

The provision of central median wire rope barrier protection has implications for movements at intersections. Decisions on how intersections have been treated in Option 3 has been based on the following; local road traffic volumes, crash history, crash potential (considered on the basis of geometry), existing and proposed strategic plans, and suitability of alternative turnaround locations, including diversion lengths.

The following table describes the proposals at each intersection:

Table 6-1: Option 3 – Intersection Access Arrangements

Location	RP	Proposed Treatment	Right Turn Alternatives	Comments
Hebden Crescent	0/0.03	No works, outside of treated area	N/A	Wire rope median barrier does not extend this far. Likely part of SH2/SH58.
McDougall Grove	0/0.30	No works, outside of treated area	N/A	Wire rope median barrier does not extend this far. Likely part of SH2/SH58.
Hugh Duncan Street	0/0.95	WRB broken to allow all movements, right turn bay provided	None required	Based on 250 ADT and no crashes
Kaitawa Street	0/1.17	WRB through intersection left in and out only (LILO)	U turn at Old Haywards Road for entry. For exit, turnaround at McDougall Grove Area	Substation Access. Transpower currently operate with LILO access.
Atiamuri Crescent	0/1.33	WRB through intersection left in and out only	U turn at Old Haywards Road for entry. For exit, turnaround at McDougall Grove Area	Substation Access Transpower currently operate with LILO access.
Old Haywards	0/1.44	WRB broken to allow right turn in only, right	Right turn entry provided for. For exit,	Right turn in to maintain access. Right turn out

Location	RP	Proposed Treatment	Right Turn Alternatives	Comments
Road / Substation access		turn bay provided	turnaround at McDougall Grove Area	prevented to avoid a merge on a passing lane on an uphill 9% grade. It is noted that the substation encourages no right turn out at present, recognising the high risk involved in turning vehicles joining the overtaking lane of a passing lane on a significant uphill grade
Mount Cecil Road	0/2.99	WRB broken to allow all movements, right turn bay provided	None required	Very low volumes 20 ADT and on apex of crest but zero crashes and difficult to provide alternatives
Proposed Cleanfill Site	0/3.10	WRB broken to allow all movements, right turn bay provided and left turn slip lane	None required	As per NZTA previously approved design.
Harris Road	0/4.47	WRB broken to allow right turn in only, right turn bay provided	Right turn entry provided for. For exit, turnaround at Moonshine Road	Low vehicle flows (32 ADT - 2009) however right turn in allowed to cater for business (business access would require relocation from SH58 onto Harris Road). Right turn out to passing lane removed.
Moonshine Road	0/6.32	Roundabout proposed to provide full access and turnaround facilities	None required	576 ADT (2010) – low count compared to MWH short term pm peak survey (approx. 1,200 vph)
Mulhern Road	0/7.31	WRB broken to allow all movements, right turn bay provided	None required	Reasonably high local road movements (255 ADT - 2009), no intersection crashes and acceptable visibility
Murphys Road /Flightys Road	0/8.01	WRB broken to allow all movements, right turn bays provided (for both)	None required	High vehicle numbers. However there are a number of intersection crashes here and it may be feasible to close this at detailed design stage with vehicles diverting to Pauatahanui and Moonshine roundabouts[26,27].
Belmont	0/8.37	WRB through	Right turn entry	Due to presence of horizontal

[26] PFRs were also undertaken by MWH in 2009 investigating a roundabout at Moonshine Road and Murphys/Flightys Road. Due to the negative BCR the recommendation was to revisit the both proposals at a later date.

[27] Pauatahanui Judgeford Structure Plan Technical Report (2012), Transport and Accessibility, "*The NZTA has indicatively planned to subsequently construct two roundabouts at the Flightys/Murphys Roads crossroads and at the Moonshine Hill Road Tee intersection in 15-20 years. However the preliminary assessment outlined above indicates that, depending on rise in SH58 traffic and associated level of acceptance of delays to side road traffic as well as the safety record, the roundabouts might be required earlier*".

Location	RP	Proposed Treatment	Right Turn Alternatives	Comments
Road		intersection left in and out only	turnaround at Moonshine Road. Right turn exit, turnaround at Pauatahanui roundabout	curves, allowing right turn in and out is not appropriate
Bradey Road	0/9.32	WRB broken to allow all movements	None required	124 ADT (2007), and good visibility and crash history

A key consideration for this scheme assessment has related to the provision of turning facilities where new central median wire rope barrier is proposed. Whilst some wire rope median barrier is proposed in both Options 1 and Option 2, this is replication of the existing wire rope barrier and results in no change to access.

In Option 3 however, where wire rope is proposed throughout the full project extents, the effect on access provision, either to intersections, or to direct frontage access onto SH58, is considerable.

A thorough assessment has been undertaken as to where the proposed wire rope barrier could be broken and the effect this would have directly on access. In addition, a key component of any proposal to prevent direct access is a consideration of alternative turning locations – in terms of the location, diversion length and safety (both in terms of actual crashes and also crash potential).

Whilst the proposals submitted are considered a good solution in terms of balancing access provision, safety and reasonable turnaround alternatives, it is accepted that there are other options that exist that may also offer suitable levels of access and could indeed be preferable to some of those affected. It is recognised that the provision of median barrier with the effect of limiting access and forcing vehicles to divert is a highly contentious and emotive issue for those affected.

Alternatives certainly exist in respect of which locations the wire rope is broken. For example a possible alternative option in providing a roundabout at the intersection of Murphys Road and Flightys Road[28] has been discussed previously and this would assist in providing vehicle turn around facilities.

A roundabout is proposed at Moonshine Road which also serves a purpose for both access but also acts as a vehicle turnaround for locations where access has been reduced to left in / left out only. The use of roundabouts as an intersection form certainly assists in providing safe turnaround facilities. However, the provision of new roundabouts has to be carefully considered as the access benefits are offset by the negative economic effect of a roundabout directly located on SH58 due to the delaying effect on all state highway traffic that ordinarily would not have been encountered.

In respect of the roundabout proposed at Moonshine Road under this option, the physical island diameter is shown at 40m as per Austroads standards – however further consideration should be given to the speed environment at detailed design stage as a smaller diameter may be warranted which is more in-keeping with the surrounding road environment.

Furthermore, it is noted that visibility for vehicles travelling east on Moonshine Road to the existing limit line is impeded by the left hand side embankment. With the provision of a roundabout there would be a requirement to improve sight distance by cutting away some of this bank and realigning part of Moonshine Road. The old section of road could then potentially be used to accommodate bus movements that currently stop around this intersection. Two vehicle accessway would also require relocation.

[28] It may be necessary to realign both Murphy's and Flightys Road so that the approaches to SH58 provide acceptable visibility for a roundabout. This is shown indicatively on the scheme drawings.

6.5 Alternatives

6.5.1 Reduced Speed Limit

A further option that could be considered either in isolation or as part of the tested project option would be for a speed reduction along all (or part of) the route, with roundabouts at Moonshine Road and Flightys/Murphys Road intersections.

A speed limit review is in the 2013/14 SWIPP (refer Section 3.1) and it is recommended for the NZTA to further investigate this option following the results of this review.

6.5.2 Standards Reduction

There may be benefit in considering a reduction of standards for the route – for example with the provision of a narrow central median in Option 2 & 3. Other opportunities exist such as removing the additional widening proposed at certain locations to facilitate access.

6.5.3 Addressing Wet Weather Crashes Only

Given the high proportion of crashes occurring in wet weather, then a further assessment could be warranted in respect of treating wet weather crashes.

6.5.4 Guardrail Only

Implementing guardrail only along the route could provide benefits given the high proportion of runoff road, object struck type of crashes. By protecting roadside hazards, the severity of crashes that do take place is likely to be reduced. Guardrail treatment could be combined with treating wet weather loss of control crashes which would be likely to realise even greater safety benefits.

6.5.5 Addressing Fatal and Serious Injury Crashes Only

Consideration may be given to treating only FSi crashes that take place within the project length.

7 Option Discussion

7.1 Proposed Cleanfill Intersection Options

It is noted that a resource consent application has been made[29] for a Cleanfill operation within the extent of this SAR. Significant consideration was given to the alternative access proposals for the Cleanfill site. Ultimately, an access location was deemed suitable, subject to detailed design, at approximately RP 0/3.22. The access as proposed by the submitted resource consent is shown in the figure below:

Figure 7-1: TDG Winstone Cleanfill Proposed Access

The location and operation of this access was considered in detail within the Transportation Assessment[30], including consultation with the NZ Transport Agency. However, this report further considers the available options for access treatment at this location to ensure the most appropriate and safe solution has been identified (for clarity, the actual access location at RP 0/3.22 has not be reconsidered).

7.1.1 TDG Access Proposal (Channelised Right Turn)

The access proposal included in the resource consent application provides for an at-grade intersection arrangement permitting all movements in and out of the facility. As shown in Figure 7-1 above for access, this is achieved through the provision of a eastbound right turn bay into the cleanfill site, together with a westbound left turn slip lane. For egress, vehicles will turn left from the site and continue westbound, whilst for right turning vehicles will be permitted, catered for by way of an acceleration lane, followed by a merge prior to Mount Cecil Road intersection.

This arrangement has been considered further as part of this investigation. Considered against current standards, there are certain aspects of the proposal that are non-compliant. Of particular note is the right turn out of the site for vehicles heading east. The concept design proposes a 150m acceleration

[29] To Greater Wellington Regional Council, Hutt City Council and Porirua City Council
[30] Winstones Cleanfill, Haywards Hill, SH58, Porirua, Transportation Assessment Report, July 2012, *Traffic Design Group*

lane length, which is all that is available due to site constraints, but significantly below desirable acceleration length.

It is fully acknowledged that this is a severely constrained environment and that, even in unconstrained locations, it can be extremely difficult to fully provide acceleration lanes for trucks to increase speeds to the free speed of through vehicles. Therefore a speed differential is generally accepted – ideally with the merge taking place by trucks travelling no less than 20km/h below the speed of though traffic.

The situation is exacerbated for right turning trucks due to the significant uphill grade (7.7%) that will be encountered. Austroads[31] provides an example of how difficult it can be to provide acceleration lane lengths for semi-trailers to accelerate from rest to a speed on upgrades and acknowledges this is rarely if ever feasible. It is also noted that vehicles exiting the cleanfill site will be un-laden.

A merge length of approximately 100m is proposed and this is compliant with Austroads standards (though Austroads does not convert for grade and noting a substandard acceleration length is proposed). It is also noted that forward visibility to the intersection for eastbound vehicles is approximately 300m, whilst forward visibility to the merge is around 450m.

In considering the suitability of this access proposal, consideration has been given to both the current standards and the practicalities of providing for access in such a constrained environment. The access into the site is considered reasonable for a deceleration lane for left turning vehicles (which does not quite meet the Austroads requirements of at least 200m+) but takes into account the preceding horizontal curve at Mount Cecil Road. The right turn into the site is also considered reasonable though it would require some modification to be in accordance with Austroads standards.

The major concern with this proposal is the acceleration lane length prior to the merge for eastbound HCVs exiting the cleanfill site. The issues with the merge length have been discussed in relation to the ability (or inability) of HCVs to accelerate to a speed that does not create unnecessary safety issues when attempting to merge. The speed of HCVs at the end of the acceleration lane as they begin to merge is stated in the resource consent variation as being approximately 60km/h. This would likely result in a speed differential of approximately 40km/h between merging HCVs and eastbound traffic. This is a significant speed differential.

Austroads recommends that where there is a significant speed differential at the merge between through traffic and merging HCVs, then consideration should be given to extending the acceleration lane. Where this is not possible then providing the acceleration length required for cars should be considered. In this instance providing the 435m acceleration lane for a car is not possible due to the proximity of the Mount Cecil Road intersection.

Another aspect of the proposal that could create some issues is the need for HCVs to turn into the eastbound acceleration which is located on the inside of the through traffic lane. This may be a difficult manoeuvre for HCVs to achieve without encroaching into the through traffic lane. Furthermore, this arrangement will also require HCVs to merge to the left at the termination of the acceleration lane.

Positively, by allowing all movements into the cleanfill site directly from the main access, detours and extra travel is removed (removing unnecessary exposure) and also avoids the need for alternative turnaround facilities elsewhere on the network.

7.1.2 Left In / Left Out Only

Another potential option for treating the proposed cleanfill access location would be to permit only left in and left out (LI/LO) movements. This could be achieved with the provision of physical central median and/or the provision of unbroken median barrier opposite the access.

From a safety perspective, and considering the access only in isolation, this access treatment would be positive by removing the conflicting movements directly at the intersection. That said, it is not appropriate to consider the location only in isolation as by not providing for all movements directly at the intersection there is the potential to relocate risks to other locations.

[31] Austroads Guide to Road Design Part 4A: Unsignalised and Signalised Intersection's Table 5.7

The information contained within the TDG Transportation Assessment suggests the daily mean vehicles accessing the site to be approximately 44 vehicles with 80% (35 vehicles) requiring a right turn out from the site. These HCV movements would need to be catered for along the route to allow for a turnaround. Realistically, such a facility if it could be designed safely would require a significant amount of land and flat and straight terrain for approach sight distance. Such facilities do not appear to exist either west or east of the proposed cleanfill access within a reasonable distance for detouring traffic (considered as 5km maximum round trip). Initial investigations suggest the first suitable turnaround facility, for vehicles wishing to go eastbound, could be at Moonshine Road by installing a roundabout. This is considered too distant to be acceptable. A further consideration would be the greater exposure to risk that the additional VKT[32] of the HCVs on the network creates, calculated as approximately 1,000km over a 5 day working week period.

For vehicles approaching the site from the west and forced to travel past the site to detour back, no suitable roundabout locations have been identified due to the curvilinear alignment and mountainous terrain.

7.1.3 Roundabout Intersection at Cleanfill Site

The provision of a roundabout intersection at the proposed Cleanfill site has been considered as a possible intersection arrangement to cater for all movements. In principle this intersection arrangement is a preferred choice for managing vehicle conflicts particularly in high speed environments and more reflective of the Safe System Philosophy.

However, in this situation a roundabout may not be suitable. Firstly the truck stopping sight distance (SSD) to the limit line of the roundabout is not achievable for westbound vehicles where, including the correction for negative grade, a SSD of 257m would be required (where it has been calculated using the design model that only 176m would be available). The eastbound approach to the roundabout can achieve Austroads sight distance requirements. Failing to provide adequate SSD for trucks is likely to result in greater crash risk at the intersection (with trucks overshooting the limit line).

The second major concern with the provision of a roundabout at the proposed cleanfill intersection is the disparity in approaching flows. The AADT for SH58 is approximately 13,500 vpd, whereas the daily flow for the cleanfill site is estimated at less than 100 vpd[33]. Such disproportionate flows on the SH58 approaches are likely to mean significant delay for vehicles exiting the proposed cleanfill site (this has not been modelled).

Of lesser concern but still worthy of note is the efficiency effect on SH58 through traffic by including a roundabout at this location. Clearly with such as significant number of vehicles using SH58 not wishing to access the proposed cleanfill site, there is a major effect on efficiency due to the delaying effect a roundabout would have on these vehicles.

The benefits of installing a roundabout at this location (ignoring the fact that a roundabout is unlikely to be feasible) would be in the facility providing for all movements into and out of the cleanfill site. This would therefore remove the requirements for HCV detours and negate the need for identifying alternative turning provisions.

7.1.4 Alternative Channelised Right Turn Intersection

A further option has been investigated that builds upon the original proposal in the resource consent for channelised right turn provision but modifies the arrangement. The alternative arrangement is similar to that of the resource consent proposal but differs in a number of ways.

The separation between the proposed cleanfill access and Mount Cecil Road is fixed at 250m which, with a fixed merge length of 100m for a 100km/h road results in a 150m fixed acceleration lane length. Therefore consideration has been given to the most appropriate means of using this length for accelerating right turning HCVs from the proposed cleanfill site. It is considered that right turning traffic should turn into an auxiliary acceleration lane to the left hand side of the eastbound through traffic. This has a number of benefits; the right turn out tracking for a 19m semi-trailer is not possible to contain fully within the RHS acceleration lane whereas a turn into a LHS acceleration lane could be accommodated.

[32] Vehicle Kilometres Travelled

[33] No overall figures are provided in the TPG report for total vehicles numbers. A mean volume of 44 trucks per day, so additional vehicles have been added, for staff and other movements, as a conservative assumption.

Also, the merge for HCVs would change to a merge to the right which would improve assist HCV drivers looking to their right as opposed to looking to the left and attempting to merge.

The 150m acceleration lane is below standard, however this is somewhat fixed following the submission of the resource consent and affected party approval provided by the NZ Transport Agency. Austroads recognises that providing acceleration lanes for semi-trailers is extremely difficult and impractical due to the lengths required. For upgrades the lengths requirements are substantially more onerous. The resource consent supporting documentation states that an un-laden truck turning out of the proposed cleanfill could accelerate to approximately 60km/h by the commencement of the merge zone. This assertion has been checked and is considered reasonable.

As previously mentioned in section 7.1.1, Austroads recommends that where there is a significant speed differential at the merge between through traffic and merging HCVs, then consideration should be given to extending the acceleration lane or providing a suitable acceleration lane to accommodate cars (435m) neither of which is possible in this instance due to site constraints.

Therefore one further sub-option for this layout would be a localised speed reduction to 80km/h. This would mean the merge occurs where through traffic (80km/h) and turning HCV traffic (60km/h) are within the Austroads approximation of acceptable speed differences of 20km/h.

The left turn slip into the site for westbound vehicles is reasonable – Austroads recommended around 202m for the slip (including taper and corrected for grade). Due to the crest vertical curve and merge for traffic turning right out of Mount Cecil Road, this has to be shortened slightly, though this is not envisaged to create adverse effects (indeed, it would be possible to widen out the radius of the exit curve).

This option also ensures that all movements into and out of the proposed cleanfill site are maintained which, positively, means that alternative turning facilities are not required and additional HCV kilometres are not unnecessarily added to the network.

7.1.5 Cleanfill Access Summary

The provision of an access to the cleanfill site is extremely difficult throughout much of SH58 due to the constrained environment of rolling to mountainous terrain, with significant vertical grade changes and challenging curvilinear road geometry. No one option investigated will comply fully with Austroads standards. Primarily this is because the location selected for the Winstones access is not ideal given the proximity of the Mount Cecil intersection and the existing vertical grade, though it is acknowledged that locating an access anywhere along SH58 is extremely difficult. It is noted that the desirable spacing between accessways and intersections on state highways carrying over 10,000 vpd is 500m[34] for this speed of road, whereas the separation achieved between Mount Cecil Road and the proposed cleanfill site is only 250m.

As a result of the access location at the proposed cleanfill site, the most favourable option for access is to maintain all movements directly into and out of the site by providing for a channelised right turn intersection. It is acknowledged that this option still does not comply with Austroads standards however it is considered to be a more appropriate and safer option than other options. This option (with 100km/h and 80km/h localised posted speed limit) would need to be considered further during detailed design and subject to fully safety audit procedures.

7.2 Guardrail

There are a number of sections of existing guardrail along the route. It is proposed to retain the vast majority of this guardrail, supplemented by additional sections where required to protect against road side hazards (approximately 6.5km in total, varying slightly between the options).

Existing guardrail will remain in-situ where possible and appropriate, to avoid unnecessary cost expenditure. It is however inevitable due to curve realignment and widening that sections will require relocation.

[34] Transit Planning Policy Manual 2007

7.3 Compliance with Standards

The primary objective for the project is to improve safety throughout the project length. However, given the road geometry is considerably substandard at present, it is not possible to meet all current road design standards whilst staying within the project scope. The current vertical and horizontal alignment is very poor in places at present and therefore to adhere to current standards would require significant sections of realignment, compromising deliverability and affordability.

Therefore, the project proposals and options testing has aimed to meet current standards wherever possible and to provide geometric upgrade where feasible and achievable. However, only four sections of true realignment are proposed[35] where the horizontal curvature has been eased significantly, together with improved road cross section for the project extent.

As there are limited works being considered to the horizontal and vertical geometry it is therefore inevitable that there will be considerable remaining sections of substandard alignment. This is understandable given the difficult topography through much of the project.

Nonetheless, it is considered appropriate to detail some of the design issues that have been contemplated. Further details are included with the Preliminary Design Philosophy Statement, refer Error! Reference source not found..

7.3.1 Horizontal Alignment

With the receipt of topographical information, it has be deemed appropriate to slightly refine the proposals for Option 1 & 2 from what was presented in the PFR to form a more consistent alignment, with similar design speeds and superelevation through each curve. Similarly, the realignment proposals for Site 3&4 have been selected on the basis of curve easing to provide a consent environment where speeds are relatable to preceding curves. This has resulted in many of the horizontal curves throughout this section of the project having design speeds in the range of 75-85 km/h and with horizontal curve radii of approximately 400m.

It is acknowledged that ordinarily, curves within the 300m-450m range are preferably avoided as studies have shown they can prove difficult for drivers to read the severity and therefore misjudging appropriate speeds for the alignment. However, given the existing alignment and variability between adjacent horizontal curves, it is considered that providing consistency between curves is a better solution. Furthermore, the mountainous topography through (and between) the realigned sections results in the perception of a constrained environment which will serve to control, vehicle speeds.

Furthermore, sight distance is constrained at a number of locations due to the obstructions (banks/vegetation/cliffs) on low radii horizontal curves and vertical crests. Along the four realignment sites, the average sight distance is less than 150 m in both directions; this is below the Austroads desirable minimum of 165[36] for rural roads.

Minimum intersection sight distance is currently met at all intersection except for Hugh Duncan Street (RP0/0.90), where the increasing (westbound) sight distance is less 125m.

7.3.2 Vertical Alignment

The current State Highway 58 length within the project area is characterised by significant vertical curvature, in additional to the curvilinear horizontal alignment. This is a direct result of the existing topography, with the road running through rolling and mountainous terrain.

The result of the existing terrain on the quality of the existing SH58 road geometry is considerable with significant grades that effect the operation of the road. With operating speeds of 100km/h, maximum grades of between 6-8% are recommended[37] for mountainous terrain. Presently a number of locations on SH58 are around or marginally above this threshold. It is not considered feasible or economic to attempt to address this substandard geometry as part of this Scheme Assessment given the magnitude

[35] Note there are a number of minor sections of realignment where the road centre line has been altered slightly to improve geometry or provide for road facilities (such as turnaround provisions)

[36] Austroads Guide to Road Design Part 3, Table 5.4, prior to correcting for grade.

[37] Austroads Guide to Road Design Part 3, Table 8.3

of works involved. However cognisance of the effect of grade, particularly on heavy vehicles and the resulting speed differentials has been undertaken.

For the most significant section of uphill grade, of over 9%, the uphill passing lane is retained to allow good overtaking opportunities particularly where heavy vehicles speed will reduce significantly over the course of the long vertical grade increase.

It is also recognised that the length of grades within the current road geometry are substandard, with lengths of grade over 6% longer than the recommended 300m. Again, it is not considered feasible or economic to attempt to rectify these terrain issues as part of this SAR, given significant works that would be required. However, attempts have been made to provide geometric improvements where possible, that whilst not fully meeting current standards, do provide a level of improvement to the existing situation.

The same is particularly true of K values for vertical curvature in terms of existing and what can reasonably be achieved. As only four sections are proposed for horizontal realignment, with the remaining lengths subject to an improved road cross section, then it is inevitable that many of the substandard K values for vertical curves remain. If a length is being realigned then attempts have been made to improve the associated vertical curve K value – there are 6 vertical crest curves within the four sections of realignment. Five of these have been improved in terms of vertical profile and one has been maintained.

Vertical alignment and other design issues are detailed in the Preliminary Design Philosophy Statement. The locations where vertical curves are (and will remain) deficient despite improvement have been assessed and display surprisingly few crashes. This is most likely as a result drivers attenuating their speed accordingly given the road profile. Therefore a key requirement for locations where the vertical alignment remains substandard is to ensure that vehicle speeds will not be increased. There are two sections subject to realignment where the K values remain substandard. The first is a 100m section immediately west of Hugh Duncan Street that is at the very end of the horizontal realignment for Site 1. Whilst the horizontal curve realignment for this 100m is almost negligible, it is possible that eastbound vehicles travelling from realignment Site 2 could be approaching at an increased speed. Therefore, the existing 75km/h curve advisory warning sign currently located here should be retained.

The second section subject to horizontal realignment where the vertical profile remains substandard is the western-most 150m of Site 3, at Mount Cecil Road. This is a significant crest at present that has been improved. The horizontal realignment is at the very extent of Site 3. The proposed options design speed could increase the existing design speed (and speeds observed by on site car following survey) potentially by 2-3km/h. The effect of a small increase in speed will be offset by the safety benefits of a wider sealed shoulder. Nevertheless, such issues should be considered further in detailed design.

For the project length west of realignment Section 4, where only an improved road cross section is proposed, then no changes are proposed to existing horizontal or vertical profile.

7.3.3 Cleanfill Access Location

The proposed access to the cleanfill site is discussed in greater detail in Section 7.1. The location of the access is considered fixed given this has received affected party approval from NZTA and is progressing through the consenting process. However it is acknowledged that this location is not ideal and accommodating the access is difficult.

7.3.4 Effect of Partial Upgrades

It is recognised that the existing alignment of SH58 is problematic and fails to meet current design standards in a variety of situations (described earlier). Generally, providing geometric or road cross section upgrades is beneficial and result in consequential safety improvements. However, it is noted that where a full upgrade is not undertaken, and only certain features are improved, then there is the risk that drivers misinterpret the road environment and fail to drive appropriately for the conditions. For example, providing an improved road corridor with wider and consistent road shoulders may be interpreted by drivers as to mean the overall road standard is higher than is actually the case. This can result in increased vehicle speeds (or potentially inattention) and could ultimately have a detrimental effect on safety.

Similarly, caution is required where the horizontal alignment is improved by providing improved curve radii in some locations, but not in others. This has been carefully assessed throughout to try and give a consistent feel for drivers with similar curve radii, superelevation and therefor design speed. Whilst this has generally been achieved, two low radius curves remain, east of the Mount Cecil Road intersection. These have not been subject to realignment and would not be considered as out of context, given the design speeds are within 3km/h of the adjacent curves (which are located in close proximity).

In summary, the realignment and cross section upgrades investigated as part of the SAR are considered reasonable and will result in an improved crash record – this is because the alignment will become consistent in terms of vertical and horizontal profile whilst maintaining the perception of a very constrained mountainous road environment. The improvements should actually serve to ease the existing curvature providing greater route consistency without significantly improving the overall road standard in isolated locations. Generally the route remains punctuated by substandard horizontal and vertical alignment and should be perceived as a relatively low standard by drivers. The enhanced cross section will provide for improved recovery and protection but again not fundamentally altering the driving environment (and by extension the perception drivers will have when using the road).

A further potential effect of partial upgrading can be crash migration. Given the proposed curve easing of the four sites serves to generally provide consistency and homogeneity across the entire route, crash migration is considered unlikely. The same is true of the enhanced cross section where the upgrade is project-wide.

7.4 Constructability

Given the existing topography adjacent to the existing road with high sided steep slope faces together with considerable drop offs, consideration of constructability will be required during the detailed design phase (and in engaging a physical works contractor).

In particular, it is noted that some of the earthworks required for cut batters necessary for realignment sections will be major. The effect of this will be to require substantial temporary traffic management (for a lengthy period) to construct.

The effect of temporary traffic control would inevitably be severe given the limited road space available, current high levels of usage and lack of an alternative route.

It is noted that SH58 does not enjoy many obvious locations where contractor facilities could be set up in order to undertake the physical works – for example, a location to store plant and materials and set up staff welfare facilities could be difficult given the existing constrained location, with the length between Hugh Duncan Street and Mount Cecil Road particularly difficult.

7.5 Property

A high level property assessment has been undertaken which considers the likely area, and value, of property to be acquired for each of the three options.

Land areas have been calculated using the scheme design drawings. Any earthworks have been included within the land requirement, whereas in reality minor grading / shaping work could potentially be undertaken with an entry agreement and approval of the land owner so not requiring property acquisition.

Land values have been based on a conservative estimate from previous investigation works in a similar location of $200,000 per hectare. This figure relates more to smaller lifestyle blocks and so is a conservative assumption across the entire route. In reality some of the land would be considered rural which is more likely to command land costs in the order of $60,000 to $100,000 per hectare. However a conservative property cost estimation at scheme stage is considered a viable approach, to be refined with the support of property consultants at detailed design.

Table 7-1: Property Estimates

Option Description	Calculated Land Requirement (m^2)	Estimated Land Acquisition Cost ($M)
Option 1: Curve Realignment and widening	10,000	0.20
Option 2: Curve Realignment, Widening and a 2m flush median	13,000	0.26
Option 3: Curve Realignment, widening and a wire rope median barrier	13,000	0.26

8 Option Evaluation

8.1 Cost Estimates

The expected and 95th percentile estimates for this project are detailed in the table below.

Table 8-1: Scheme Estimates

Option Description	Expected Estimate ($M)	95th Percentile Estimate ($M)
Option 1: Curve Realignment and widening	29.1	35.9
Option 2: Curve Realignment, widening and a 2m flush median	32.0	39.9
Option 3: Curve Realignment, widening and a wire rope median barrier	33.9	42.2

The cost estimates for the option have been calculated using the survey information available. Whilst the four sections of realignment are based on ground based topographical survey, the remaining lengths are reliant on aerial LiDAR survey data which has a greater risk of inaccuracy. That said, the data provided using aerial survey provides sufficiently detailed and accurate survey for a scheme stage assessment to give reasonable confidence in the design solution, and associated costs (and by extension, calculated BCR).

Of particular note in terms of the cost estimation undertaken is the effect on major structures[38]. No upgrade or widening to any of the existing structures (Refer Table 3-1) has been proposed within the cost estimation – instead it envisaged that any widening or median improvements would cease in advance of existing structures and recommence after the structure terminates. This is considered a reasonable approach at scheme assessment stage as widening of structures is not considered to be necessary or cost-effective. This may be revisited at detailed design should there be a desire to improve certain structures.

[38] An allowance for extending / relocating other stormwater drainage features, such as parallel and lateral drainage culverts, has been allowed for in the cost estimation as these are essential to the on-going operation of the road.

8.2 SIDRA Modelling

Intersection modelling was undertaking using SIDRA (version 6.012) in order to assess the impact of converting the existing T intersection at Moonshine Road into a roundabout, as part of Option 3 (refer Section 6.4 above).

Refer **Appendix K** for site layout details of both the existing T and roundabout option and SIDRA output tables.

Turning counts for the Moonshine Road intersection were obtained from a 2009 MWH survey, which was factored[39] to reflect 2013 time zero. A peak flow factor of 0.91 and peak flow period of 15-30 minutes[40] was adopted for the modelled peak periods based on the turning count survey. SIDRA default critical gap parameters were adopted.

Modelling was undertaken for the morning peak, inter-peak and evening peak periods for the years 2013, 2015 (end of construction), 2018, 2024, 2030, 2036 and 2042. The outputs for geometric delay, control delay and fuel consumption were extracted from the models and used in the economic evaluation (refer Section 8.3).

A summary of the SIDRA outputs for three of the modelled years are provided in Table 8-2 below.

Table 8-2: SIDRA Output Summary (1.5% growth)

Period	Demand Flow (vph)	Base (Existing T)			Roundabout (40m diameter, single circulating lanes, twin approach)		
		Total Delay (veh-hrs/hr)[41]	Fuel Use (L/hr)	Worst Approach Degree of Saturation (volume/ capacity) (95th%tile Queue in veh)	Total Delay (veh-hrs/hr)	Fuel Use (L/hr	Worst Approach Degree of Saturation (volume/ capacity) (95th%tile Queue in veh)
Morning Peak							
2015	1,970	2.1	138	0.6	8.8	147	0.6
2024	2,227	3.9	158	1.0 (3.0*)	10.0	167	0.7
2042	2,745	7.6	196	1.0 (4.2)	12.9	207	0.8 (16**)
Interpeak							
2015	629	0.2	47	0.2	2.7	51	0.2
2024	709	0.2	54	0.2	3.1	58	0.2
2042	874	0.3	66	0.2	3.8	71	0.2
Afternoon Peak							
2015	1,721	1.1	85	0.5	7.5	90	0.5
2024	1,948	2.8	98	1.0 (3.8)	8.5	102	0.5
2042	2,400	3.4	119	1.0 (3.4)	10.6	127	0.7

39 Based on 2009 SH58 Telemetry AADT and 2012 SH58 Telemetry AADT.

40 A Peak flow factor (PFF) of 0.91 was calculated from the average PFF for the AM, PM and IP. The peak flow period (PFP) was determined as 15 min for both the morning and afternoon peak, with a 30 min inter-peak.

41 Note: the geometric delay for the existing Moonshine road T junction is between 0.8-1.2 sec/veh, while the roundabout geometric delay is between 15.4-15.6 sec/veh due to the additional distance travelled; therefore the total delay for the roundabout is largely made up of geometric delay, whereas for the T-junction the delay is control delay/queuing.

*For Moonshine Road right turn approach. **For the Porirua (west) through approach.

The results show that, predictably, the roundabout option results in a significantly higher total delay. This is due to all SH58 traffic being required to slow down and negotiate the roundabout with a resulting increase in geometric delay leading to a reduction average speed. In contrast, with the existing T-Junction only the low volume movements (i.e. in and out of Moonshine Road) suffer from high delays.

The existing Moonshine Road intersection reaches capacity[42] (morning peak) between modelled periods 2018 and 2024, or likely within the next 10 year period. In contrast, the roundabout option will still operate in the 2042 AM peak with a LoS B and degree of saturation of 0.8.

However, because of the low side road flows compared to the state highway, the roundabout has increased travel time and fuel usage even in the future modelled years. An alternative that could be investigated is a slip lane or seagull roundabout configuration.

8.3 Economic Evaluation

8.3.1 Basis of Analysis

An economic evaluation has been carried out in accordance with the full procedures of the Economic Evaluation Manual Volume 1 (EEM1, July 2010). The realignment option was analysed against the Do minimum option. The inputs, assumptions, and results are described in the following sections.

The worksheets used for the economic evaluation are included in **Appendix L.**

The key assumptions for the economic evaluation are summarised in Table 8-9 below.

Table 8-3: Economic Analysis Assumptions

Option Description	
Time Zero	2013
Scheme Opening Year	2015
Construction Period	2014-2015
Base Date for Cost Estimates	2013
Discount Rate and Analysis Period	8% and 30 years 6% and 40 years (sensitivity test)

The following options were considered.

8.3.1.1 Do Minimum Option

The do minimum option is to continue annual and periodic maintenance of the existing road section as required. Future maintenance costs were based on the future works programme, noting that there are no significant pavement rehabilitation works planned along the study length.

In addition, the recent guardrail works have been included in the do-minimum.

8.3.1.2 Options

Three options have been considered at each site; discussed in Section 6 above and outlined below.

- **Option 1:** Curve realignment of four sites, 3.5m traffic lanes, 1.5m sealed shoulders and the retention of the existing Moonshine Road T intersection.

42 Degree of saturation of >0.9-1.0.

- **Option 2:** Curve realignment of four sites, 3.5m traffic lanes, 1.5m sealed shoulders, a 2m flush median and the retention of the existing Moonshine Road T intersection.
- **Option 3:** Curve realignment of four sites, 3.5m traffic lanes, 1.5m sealed shoulders, 2m median and provision of central median wire rope barrier. Proposed roundabout at Moonshine Road in addition to limiting right turning movements at intersections (refer Section 6.4).

8.3.2 Travel Time and Vehicle Operating Costs

For the purposes of Travel Time Cost (TTC) and Vehicle Operating Cost (VOC) analysis and option comparison, the study length was divided into the following sections:

- Curve Realignment: travel time costs and vehicle operating costs arising from the length of highway undergoing curve realignment have been assessed.
- Moonshine Road intersection: travel time and vehicle operating costs relating to the delays incurred from the existing Moonshine Road T junction and proposed roundabout (Option 3) have been assessed using SIDRA6.
- Wire Rope Barrier effects: Travel time and vehicle operating dis-benefits relating to the wire rope barrier (Option 3) have been assessed based on the additional delays introduced from turning restrictions.

8.3.2.1 Curve realignment

The curve realignment would result in a slightly shortened route at a higher design speed. This would provide a benefit to vehicles travelling on SH58.

The existing average travel speeds were obtained from on car-following surveys (refer Section 4.2.4 for further detail). As each site consisted of more than one curve the average speed over the entire series was calculated as a length weighted average. Travel times were then estimated given the measured distance.

For the proposed option, a design speed was estimated using geometric data including the radius of the curves and the curve superelevation. The option estimated speed was assumed as the option design speed plus 5 km/h. The traffic speeds for both the do-minimum and the option are shown in Table 8-4.

Table 8-4 : Estimated Vehicle Speeds

Realignment Site	Observed Existing Average Speed (km/h)	Option Estimated Speed (km/h)
Site 1	79	84
Site 2	78	92
Site 3	86	92
Site 4	83	87

Travel time costs were calculated using a rural strategic standard vehicle composition profile as per Table A4.3 in the EEM1. However, as shown in Table 8-5 below, the proportion of heavy vehicles for both count sites is less than half of the typical rural strategic mix contained in the EEM, the medium commercial proportions are similar, and the light vehicles proportions are larger. This deviation is likely due to the rolling/mountainous topography, highway alignment and limited travel demand generation on SH58 for heavy commercial vehicles.

Table 8-5: Telemetry Site Traffic Composition

Location	2012	Total	LV-I	LV-II	MCV	HCV-I	HCV-II	HVs (MCV, HCV)
SH58 Pauatahanui East (Telemetry) RP 58/9	AADT (vpd)	13,605	12,607	427	427	82	62	571
	%	100%	93%	3%	3%	1%	0%	4%
EEM Rural Strategic Mix	%	100%	78%	10%	4%	4%	4%	12%
EEM Urban Arterial Mix	%	100%	85%	10%	2%	1%	2%	5%

The table above also shows that SH58 has a similar distribution to the EEM's urban arterial mix; this is supported by the peak hour flow graphs showing significant morning and afternoon peaks (see **Appendix B)**. However, due to the existing 100 km/h rural speed limit and for consistency with previous work, the economic evaluation has used the rural strategic time values[43].

Vehicle operating costs and carbon dioxide costs would increase slightly with the higher speed of vehicles and decrease due to the shorter length when compared to the do-minimum. For this project, the reduction in length outweighs the speed increase, resulting in VOC and CO_2 savings.

In addition, road roughness improvements have been included in the assessment. This is based on the existing NAASRA weighted average wheel path value, calculated as 81 for the four realignment sites, which according to table A5.14 of the EEM, has a cost of $0.38/km for a rural strategic highway.

Carbon dioxide savings have been assessed as 4% of the vehicle operating cost saving, in accordance with the guidance in EEM.

8.3.2.2 Moonshine Road Intersection

As outlined in Section 8.2, a roundabout would add geometric delay for vehicles travelling straight through on SH58, increasing the distance they are required to travel (increased fuel) and reducing the speed of negotiation (increased delay), thereby resulting in dis-benefits.

For the purposes of this evaluation, the geometric delay, total control delay and fuel usage outputs were used to calculate the travel time costs and vehicle operating costs for the morning peak, inter-peak, afternoon peak period and weekend peak[44]. It has been assumed that the morning peak and afternoon peaks have a 1.5 hour duration (368 days per year), with the interpeak and weekend peak having 8 hours (interpeak 1960 days per year, weekend 911 days per year).

As above, travel time costs were calculated for the peak periods outlined above using a rural strategic standard vehicle composition profile as per Table A4.3 in the EEM1. An uncongested and congested value of time was also used to differentiate the geometric delay from queuing delay.

The vehicle operating costs have been derived from the SIDRA models from the fuel consumption in litres per hour. The fuel consumption was multiplied by a factor of 1.91 which is derived from Table A5.0 (a) of the EEM, which states that fuel and oil make up 52.3% of the total VOC component for Rural Strategic roads. A resource cost of $ 1.48 / L has been used to calculate the VOC, this is the subsumed

43 A sensitivity test has been undertaking using the urban strategic values of time, refer Appendix L.
44 Weekend flows were assumed as 90% of the surveyed inter-peak flows.

value used in EEM in deriving VOC. CO_2 cost emissions were calculated as approximately 3.1% of VOC[45].

The SIDRA models show that both the travel time costs and vehicle operating costs would be greater for the roundabout option than the do-minimum, resulting in dis-benefits.

8.3.2.3 Option 3: Wire Rope Median Barrier Dis-benefits

As outlined in Table 6-1 of Section 6.5, the provision of central median wire rope barrier protection has implications for movements at intersections and property accessways.

An assessment was carried out to determine both the additional distance travelled and additional travel time incurred from the restriction of right turning movements. The key assumptions of the assessment included:

- Side road AADTs were extracted from CAS/RAMM databases with values estimated where no records were available.
- An assumed 50% of traffic will be affected, i.e. 50% of traffic will be undertaking right in or right out movements.
- Existing side road right in or right out turning delays will be equivalent to the introduced right in/right out delays at the nearest intersection. This is based on the fact that traffic volumes along SH58 are consistent, resulting in similar side road gap acceptance. Left turn delays were assumed to be negligible.
- Where movements are restricted, distances were measured to the nearest intersection/ turnaround facility[46]. It is assumed that adequate seal width will be provided for the turning manoeuvres at key turnaround areas. Where appropriate additional manoeuvring time was added to account for u-turning movements.
- A 10.4 vpd trip generation rate for a dwelling in accordance with Appendix 5B of the NZTA's Planning and Policy Manual

There are five intersections, three large commercial accesses[47] and approximately 44 dwellings[48] which will be affected (i.e. restricted movements) by the provision of a wire rope median barrier along the project length.

Initial calculations have revealed that there will be approximately $105,000 of travel time dis-benefits, $129,000 of vehicle operating cost dis-benefits and $5,200 of CO_2 dis-benefits associated with the turning restrictions at intersections and property accesses. Carbon dioxide savings have been assessed as 4% of the vehicle operating cost saving, in accordance with the guidance in EEM.

[45] Based on a cost of $40 per tonne of CO2 (EEM), light and heavy vehicle tonnes/l values of 0.0022 and 0.0025 and 4% HV.
[46] With the exception of the logging mill and Griffiths yard, where it was assumed that the mainly heavy vehicles would use the nearby Pauatahanui and Moonshine roundabouts.

[47] Griffiths drilling yard, Pauatahanui logging mill and the Judgeford Golf Club.
[48] Estimate based on aerial.

8.3.2.4 Summary of Travel Time and Vehicle Operating Costs

Table 8-6 below provides a summary of the net present value travel time, VOC and CO_2 for each option costs for each option.

Table 8-6: NPV TTC, VOC and CO_2

Option Description	NPV Travel Time Costs ($M)	NPV VOC and CO_2
Option 1: Curve Realignment and widening	4.7	0.7
Option 2: Curve Realignment, widening and a 2m flush median	4.7	0.7
Option 3: Curve Realignment, widening and a wire rope median barrier (incl. roundabout)	-1.0	-1.5

8.3.3 Crash Benefits

The crash history along the section of SH58 considered for this project is sufficient to allow an accident-by-accident analysis. The analysis was performed on both the options and the Do-minimum using the principles found in the EEM.

The major movement/crash types and severity of crash were considered, and assigned an expected crash reduction value in accordance with the EEM and HRRRG. Refer **Appendix L** for the adopted values for each option.

For the purposes of crash analysis and option comparison, the study length was divided into the following sections:

- Curve Realignment: crashes located on the sections of highway undergoing realignment
- Midblock crashes: remaining crashes excluding Moonshine Road intersection.
- Moonshine Road intersection: crashes within a 250m radius of the intersection of SH58 and Moonshine Road.

As each of the options involved multiple treatments, and therefore multiple crash reduction factors, it is not appropriate to add all the crash reduction factors (CRF) together. Common practice is to multiply the crash modification factors[49] to estimate the combined effect of the treatments.

In addition, due to the number of treatments considered, which target the same crash type, the combined CRFs have been factored as following:

- A 2/3 reduction factor based on New Zealand research[50] where three or more CRFs target the same crash type and a reduction factor of 0.8 where two CRFs target the same crash type.

[49] Where a crash modification factor (CMF) is 1-(CRF/100). For example if two proposed treatments had 20% and 30% crash reduction factors respectively, the combined effect would be equal to 1 - (1-(20/100)) x (1-(30/100)). Which results in a combined CRF of 44%, compared to a 50% additive CRF.

[50] Turner, B. "Estimating the Safety Benefits when Using Multiple Road Engineering Treatments," Road Safety Risk Reporter, 11, June 2011) http://www.arrb.com.au/admin/file/content13/c6/RiskReporterIssue11.pdf. In the analysis, estimates from different approaches were compared with CMFs for actual combinations of treatments and it was found that the estimates consistently overestimated the true crash reductions. That discovery prompted his suggestion of a dampening factor of 2/3 as general rule.

8.3.3.1 Curve realignment and midblock

Method A: Accident by Accident analysis was undertaken for the do-minimum due to the high number of injury crashes in the five year period.

Method A was also used for the option of curve realignment and shoulder widening. While realignment is normally considered a fundamental change in the EEM, the proposed realignment in this project involves only a select number of curves along the route length. In addition, due to the challenging topographical constraints, the option curve radii are not considerably altered. Further, it is considered that post implementation of the options, the nature of the road alignment and crash types will not be significantly altered.

8.3.3.2 Moonshine Intersection

Method A: Accident by Accident analysis was undertaken for the do-minimum due to the high number of injury crashes in the five year period.

Method A was also used for Option 1 and Option 2 due to no fundamental change occurring, although the applicable benefits from each option (shoulder widening, ATP, flush median etc.) were considered. These were simplified to; 25% reduction for Option 1 and a 40% reduction for Option 2.

Method B, accident rate analysis, was used for Option 3, due to a change in intersection form to a roundabout. The crash cost for the roundabout was determined using the high speed roundabout injury crash model, (8) in the EEM. The crash rate for each approach was determined and summed to determine the total crash rate for the intersection.

8.3.3.3 Crash Migration

As discussed in Section 7.3.4, a potential effect of partial upgrading can be crash migration. Given the proposed curve easing of the four sites serves to generally provide consistency and homogeneity across the entire route crash migration is considered unlikely. The same is true of the enhanced cross section where the upgrade is project-wide.

In saying this, the 2/3 reduction factor applied to the combined CRF, as outlined in Section 8.3.3, is considered conservative and will likely account for the effects of any crash migration.

8.3.3.4 Summary of Crash Costs

Table 8-7 below provides a summary of the key crash reduction factors and crash costs each option.

Table 8-7: Crash Costs

Option Description	Key Combined CRF (Midblock)	NPV Crash Costs ($M)
Option 1: Curve Realignment, widening, ATP and guardrail	**Head-on**: 40% Injury **Loss of Control (off road)**:47% F+S, 43% Minor	29.2
Option 2: Curve Realignment, widening, ATP, guardrail and a 2m flush median	**Head-on**: 57% F+S, 51% Minor **Loss of Control (off road)**:51% F+S, 43% Minor	36.2
Option 3: Curve Realignment, widening, e/l ATP, guardrail and a WRB (incl. Rbt)	**Head-on**: 90% F+S, 30% Minor, 20% increase in non-injury crashes. **Loss of Control (off road)**:62% F+S, 44% Minor	43.7

8.3.3.5 Crash Risk

The options were assessed using the KiwiRAP Assessment Tool (KAT) to determine the effect of the options on KiwiRAP star rating. As the curve easing considered in the options is relatively minor we have adopted a conservative approach and not included it in the KAT modelling at this stage.

Table 8-8: KAT Option Assessment

Option	Extent Average Star Rating	Pub. Star Rating	30y DSi saved[51]	Average RPS	Average Run off Road RPS	Average Head On RPS	Average Intersection RPS
Do Min	2.78	2	-	12.0	8.2	12.4	0.2
1.5m Shoulder widening (SW)	2.85	2	5	11.2	7.7	11.8	0.2
Option 1: SW and guardrail (GR)**	3.11	3	24	9.2	4.4	11.8	0.2
Option 2: SW, GR, and flush median	Flush medians are not currently able to be modelled in KAT						
SW, WRB and no guardrail	3.33	3	38	7.8	6.9	0.0*	0.1
Option 3: SW, GR, WRB, RBT at Moonshine Rd	3.91	3	65	4.9	4.0	0.0*	0.1

*Note: the analysis did not account for the breaks in the median barrier. **Semi-rigid guardrail on KAT was placed on sections with severe roadside hazards (approximately 3.1km LHS 4.0km RHS); this is of a similar length as proposed by the options.

Table 8-8 above shows the following:

- Shoulder widening alone, without guardrail provision is not sufficient to achieve the Regional Strategic state highway objective of a 3-star KiwiRAP rating.
- A combination of guardrail across severe hazards and shoulder widening will be sufficient to achieve a 3 star published rating (i.e. Options 1 and 2).
- Option 3, including a WRB median treatment achieves a nearly 4-star calculated rating.
- Using a social cost value of $1.12M per DSI[52], the calculated annual crash cost for Option 3 was $2.55M (compared to approximately $2.25M in the conventional analysis). Using this value, the BCR for Option 3 decreases slightly from 1.2 to 1.1.

Therefore, all options considered are likely to increase the KiwiRAP star rating to a minimum of 3 stars at current traffic volumes. In order to ensure the 3-star rating is maintained in the medium to long term a wire rope barrier option is recommended.

8.3.4 Maintenance Costs

Do-Minimum
Future maintenance costs were based on the future works programme, noting that there are no significant pavement rehabilitation works planned along the study length.

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[51] Calculated according to Figure C-2, Appendix C of the HRRRG.

[52] Calculated using EEM 2010 A6.10 tables, 21% Fatal 79% Serious split.

Options

Option 1, 2 and 3 maintenance costs increase compared to the Do-minimum due to the extra seal width following shoulder widening and median treatments.

- Future annual maintenance costs based on annual chip seal maintenance of $0.12/m^2.
- Construction will include a full length 150mm overlay.
- Future periodic maintenance costs based on chip seal reseals of $5.50/m^2 and additional ATP (edgeline and centreline) maintenance of $25,000[53] per km at 8-year cycles (i.e. future year 10, 18 and 26).
- Additional maintenance costs to maintain any new structures have not been included.

In addition, wire rope barrier maintenance costs were assessed for Option 3 as follows.

- Average cost of repair per hit of $2,430 based on the 2011/12 and 2012/13 maintenance costs for the existing 0.76km of wire rope median barrier on SH58.
- Historical number of hits per year per km is 7.89. This has been factored by 0.8, on the basis that the existing wire rope barrier is higher risk (located on an out of context curve and near a passing lane.)
- Approximate length of new barrier (excluding existing) is 7.2 km.
- Expected number of hits per year is 46, resulting in an expected cost of repair per year of approximately $111,000.

The difference between the maintenance required for the current intersection and the maintenance required for a roundabout (Option 3) is not seen as significant and hence has not been included in the economic evaluation.

8.3.5 Benefit Cost Ratio Results

Both the initial BCR and subsequent incremental analysis show that Option 2 is the preferred option in economic terms.

Table 8-9: Economic Evaluation Summary

	Option 1: Curve R & shoulder widening	Option 2: Curve R, widening & flush median	Option 3: Curve R, widening & WRB
Costs ($M)			
NPV Capital Costs	26.6	29.2	30.9
NPV Maintenance Costs	-0.2	-0.1	1.1
NPV Total Costs	**26.4**	**29.1**	**32.1**
Benefits ($M)			
NPV Travel Time Costs	4.8	4.8	-1.0
NPV Vehicle Operating Costs & CO_2 Emissions	0.7	0.7	-1.5

[53] The Usability and Safety of Audio Tactile Profiled Road Markings, NZTA, The cost of ATP installation and maintenance, http://www.nzta.govt.nz/resources/research/reports/365/docs/365.pdf. It is noted that costs of ATP have since reduced, although the effect is insignificant due to discounting.

	Option 1: Curve R & shoulder widening	Option 2: Curve R, widening & flush median	Option 3: Curve R, widening & WRB
NPV Crash Costs	29.2	36.2	43.7
NPV Total Benefits	34.6	41.6	41.1
Benefit Cost Ratio	**1.3**	**1.4**	**1.3**
First Year Rate of Return	8%	8%	8%

8.3.6 Sensitivity Testing

Sensitivity testing was carried out for the following:

- Traffic Growth
  - 10 year growth (0.5% growth, instead of 1.5%)
  - 6% discount rate and 40 year analysis period at 0.5% growth
  - Refer **Appendix L** for future scenarios relating to Transmission Gully modelling results. In summary:
    - The time frames and assumptions relating to SH2/SH58 grade separation and Petone to Grenada have changed since the model was developed. It is noted that a review of the modelling and underlying assumptions of the TG model is being revisited as part of Petone to Grenada I&R.
    - Until this update occurs the future traffic growth is uncertain, therefore we have adopted growth rates of 0.5% and 1.5% which cover the likely scenarios, which can be updated once information becomes available.
- Discount Rate and Analysis period
  - 6% discount rate and 40 year analysis period
  - 6% discount rate and 30 year analysis period
- Costs:
  - Project Base Scheme Estimate
  - Project 95% tile Scheme Estimate
- Crash Benefits
  - Consideration of a single additional fatal head on crash and two serious injury loss of control crashes occurring on the midblock section.
- Urban arterial
  - Using urban arterial values (rather than rural strategic) of time due to both the traffic composition and daily flow profiles showing urban arterial trends (refer Section 8.3.2.1).

A summary of the sensitivity testing results for Option 2 is provided in Table 8-10 below. Refer **Appendix L** for full sensitivity analysis for all three options.

Table 8-10: Option 2 Sensitivity Testing

Option 2	Base Value	Base BCR	Sensitivity value	Sensitivity BCR
Analysis period and Discount Rate	30 Year, 8%, (1.5% growth)	1.4	40 years,6% (1.5% growth)	2.0
Traffic Growth	1.5%	1.4	0.5%	1.2
Crash History	Existing Crashes (2F,13S)	1.4	Additional 1F Head on, 2S LoC on the midblock. (3F,15S)	1.6
Construction Cost	Expected Estimate $32M	1.4	95th%tile Estimate $40M	1.1
Traffic Composition	Rural Strategic	1.4	Urban Arterial	1.4

The results show that using the upcoming EEM change to a 6% discount rate and 40 year analysis period increases the BCR to 2.0. The effect of three additional crashes also had a significant impact, increasing the BCR to 1.6.

If traffic growth continues at 0.5%, the BCR of Option 2 falls to 1.2 and 1.6 for a 30 year and 40 year analysis period respectively.

The analysis showed that there is little sensitivity in the BCR to altering the traffic composition values; this is due to the value of time changing in both the do-minimum and the option, resulting in a significantly lower total cost for TTC and VOC (for an urban arterial), but a similar net difference.

9 Resource Management Issues

The project must meet all statutory requirements. There are a number of documents (both statutory and non-statutory) that must be considered when planning for the state highway improvements. In particular, the requirements of the Resource Management Act, the Porirua City District Plan, Hutt City District Plan, the Upper Hutt District Plan and the Greater Wellington Regional plans will be assessed to ensure that the proposed project meets the plan provisions and follows the statutory process.

The social and environmental assessment is provided in **Appendix H**.

9.1 District Plan Provisions

The SH58 designation (and proposed works) is located within the boundaries of three territorial authorities, being Hutt City Council, Upper Hutt City Council and Porirua City Council. The overarching regional council is Greater Wellington (see section 9.2).

9.1.1 Designations

State Highway 58 is designated under the district plans of Porirua City Council (being K0404) and Hutt City Council (being TNZ4) as “state highway purposes”. Upgrades to the road within these designations do not require resource consent from the territorial authorities, but will require outline plans to indicate the scale of the proposed works within the designation. For any works outside of the designations, it is recommended to alter the designation where necessary to accommodate these works under s181 RMA. NZTA will be required to give notice (as a Notice of Requirement) to the Council of its requirement to alter the designation.

Upper Hutt City Council does not appear to have designated any part of SH58 within its boundary. This will need to be confirmed during the next stage of the planning process. An outline plan may not be required from this council, however resource consents (land use) may be necessary.

Other designations in the vicinity of the proposed safety improvements include the Haywards Transpower site in Lower Hutt (TPNZ 1, designated for 'electricity substation'), and two Wellington Regional Council designations just west of the Transpower site (both WRC 7, designated for 'Water supply pumping station').

9.1.2 Heritage, Archaeology, Cultural and Iwi Issues

There are two heritage buildings located close to the SH58 designation, both within the Porirua City boundary. These are the WWII American Camp marker and Community Hall (JB25, NZHPT class I), and St Joseph's Catholic Church (JA02, NZHPT class II).

The proposed works are unlikely to affect these buildings. It appears that there are no other heritage, archaeological, cultural or waahi tapu sites close to the SH58 designation.

9.2 Regional Plan Provisions

The scheme designs and final construction plans will determine what regional consents are required. Given that there is likely to be extensive earthworks associated with the formation of batter slopes, the following resource consents are likely to be required under the Greater Wellington Soil Plan, Freshwater Plan and Air Quality Plan:

- Land use consents for the placement/extension of structures in the riverbed;
- Bore permits for geotechnical investigation
- Stormwater discharges from bulk earthworks
- Soil and vegetation disturbance
- Discharge of contaminants to land and air from road construction.

It should be noted that the Pauatahanui Stream is mentioned in the list of streams which specifically require the avoidance of adverse effects, as well as being identified in the list of 'Water Bodies with Nationally Threatened Indigenous Fish Recorded'. Works in the Pauatahanui Stream are therefore likely to require consent under the Freshwater Plan as a Discretionary Activity.

Belmont Regional Park is located along a section of SH58 in the vicinity of the intersection of SH2. The park is managed by Greater Wellington Regional Council and recognises the ecological and cultural values in the area. Part of Belmont Regional Park provided a route between Wellington and Porirua harbours for Ngāti Toa Rangātira and the various Wellington based Taranaki iwi who retain mana whenua over these lands.

The Regional Parks Network Management Plan outlines how the park is managed and what future plans are proposed. Future plans for the park in the vicinity of the roading improvements include improving linkages of native ecology across SH58 towards Upper Hutt.

9.3 Other Provisions

Given that the proposed works may involve earthworks on river/stream banks, there is the potential to unearth Maori artefacts. It is likely that an Accidental Discovery Protocol will be required to be adopted; in the even that unknown sites or artefacts are discovered, an archaeological authority may be required.

9.4 Future Land Use Proposals

There are a number of proposed developments which may affect the capacity of SH58, and the type of traffic that is generated. Known proposed developments include the Winstones Cleanfill site (as discussed in Sections 7.1 and 7.3.3), Transmission Gully, and potential development resulting from the Pauatahanui-Judgeford Structure Plan.

9.4.1 Transmission Gully

For the purposes of this report, the Linden to MacKays (Transmission Gully) Roads of National Significance project is assumed to be completed by 2020. The current designation in the Porirua District Plan have been considered, and is unlikely to change significantly before construction.

The expressway crosses SH58 approximately where the project area starts for this report. The implications of the expressway being built include significant earthworks and disruptions to traffic. On completion, the road is likely to increase the volume of traffic traversing SH58, as discussed in section 0 of this report.

9.4.2 Pauatahanui-Judgeford Structure Plan

The Pauatahanui-Judgeford Structure Plan was developed by MWH, Urbanism Plus and Isthmus in May 2012, and is currently in the process of being adopted by the Porirua City Council. The implications of the plan change the zoning of some areas adjacent to SH58, and may result in land use changes such as additional lifestyle-residential, light-industrial and commercial activities.

Key features of the Structure Plan are as follows:

- **Rural Subdivision** - proposed changes to subdivision standards to allow rural lifestyle subdivision, which is linked to a requirement to re-vegetate or retire areas of land and which may include a requirement for a financial contribution towards the cost of replanting or retiring land on another site.
- **Pauatahanui Village** - review of existing zoning and limited rural residential development on the higher ground to the east of the village.
- **Judgeford Hamlet** – the possibility of a small hamlet-style development around the intersection of SH58 and Moonshine Road in Judgeford consisting of rural residential lots ranging in size from 3,000m2 to 2.5ha with a mix of light industry and one or two small convenience or craft shops.
- **Lanes Flat** - options for future development at Lanes Flat once construction of Transmission Gully Motorway is completed.
- **Logistics Hub** - the Judgeford area is highlighted as a “Possible long-term industrial/business growth area” in Porirua City Council’s Porirua Development Framework (2009). The intension is for it to be a cluster of transport, logistics and distribution enterprises managed by a commercially neutral legal body. Facilities would include warehouses, distribution centres, storage areas, offices, truck services, accommodation and catering services for drivers etc.

Refer **Appendix N** for a map of the proposed transportation improvements of the Pauatahanui to Judgeford structure plan. The plan assumed roundabouts at Moonshine Road and Flightys/Murphys Road would proceed in the long term as part of the NZTA’s SH58 Strategy; however, following the PFRs undertaken in 2009 it was recommended to defer construction and revisit the proposals in the future.

10 Risk

The risks to the project have been assessed using the General Approach as determined in the Risk Management Process Manual (AC/Man/1).

A risk register is contained in **Appendix G** that summarises the main risks currently known. The principal risks to the project are outlined in Table 10-1 below. A geotechnical risk register is also contained in **Appendix I.**

Table 10-1: Risk Summary

Phase	Risk	Description	Score	Category	Treatment
Project Property	Land Acquisition	Difficulty in acquiring land. Caused by obstructive landowner or excessive cost demands.	210	Cost - Minor Delay - Substantial	Consultation
Investigation and Reporting	Project objectives not achieved	Investigations indicate that constraints or conditions will not allow full achievement of project intentions and objectives (e.g. inadequate width for median barrier).	200	Cost - Major H&S - Medium	Design
	Construction cost changes significantly different from I&R	With no geotechnical testing, there is the chance that basic construction costs will be significantly underestimated. LiDAR data may also lead to inaccurate quantities estimates	120	Cost - Major	Cost Estimation
Design and Project Documentation	Appeals to Environment Court	Project taken to Environment Court	120	Delay - Major Cost - Minor	Statutory Planning & Consultation
	Consents not achieved	Consent not granted	80	Delay - Medium Cost - Minor	Statutory Planning - Early and pre-lodgement engagement with Council(s).
	Onerous consent conditions	Consent conditions impose substantial changes to project	80	Delay - Medium Cost - Minor	
MSQA, NZTA Managed Costs and Consent Monitoring fees	Excessive claims by contractor	Contractor may over-claim either in error or to front-load payments. Potential for loss if contractor declares bankruptcy (re SH4 Papatawa)	160	Cost - Medium	Supervision
	Funding rejected	Construction costs as tendered are in excess of anticipated, and project funding is declined.	120	Delay - Major	Estimates
	Contractor not adequately skilled for job.	Local terrain and working conditions will challenge contractors, hence need adequately skilled contractors for the work.	120	Cost - Major Delay - Medium	Tendering
	Pavement design.	under strength pavement design results in rutting/uneven road surface	80	Image - Medium Cost - Major	Peer review

11 Preferred Option

Option 2 is the best option economically, achieving a BCR of 1.4 for a 30 year analysis period (8% discount rate) and 2.0 for the 40 year analysis period (6 % discount rate). Option 2 has an assessment profile of HML.

However, as the BCRs of all of the options are almost identical, it is difficult to select a clear preferred option on economics alone. Given the overall step-change safety improvement that Option 3 offers in terms of providing comprehensive wire rope barrier and a consequential reduction in risk[54], this option was initially considered as the preferred option. However, it was recognised that there were opportunities to improve the overall scheme design by reducing or removing elements from this option without compromising the overall project viability. Furthermore, other project changes could be undertaken to optimise the project and maximise benefit realisation. By reducing project costs and maximising benefits, the value for money achieved by the project can be enhanced (resulting in a greater BCR and more worthwhile project).

The various elements considered for the optimisation of Option 3 (to become Option 4) are discussed below.

11.1 Option 4

11.1.1 Introduction

This option (Option 4) has been subsequently created as an update and optimisation of the original Option 3. It has been created on the basis of identifying any areas within the project extent that can be amended and would improve the efficiency of the overall scheme design.

This optimisation has been necessary for two purposes; firstly to ensure the project fits within a likely envelope of affordability, and secondly, to ensure a suitable level of economic efficiency and value for money.

The various project changes to Option 3 that have been undertaken to create Option 4 are discussed below, together with other aspects that were initially considered but not progressed.

11.1.2 Option Description

Generally, Option 4 consists of a number of curve realignments and the provision of an improved cross section throughout.

11.1.2.1 Do-Minimum

The do-minimum option speed for the project length was reduced from the current 100km/h posted speed limit, to 80km/h. This reduction was on the basis the NZTA staff advising that they are already planning to reduce the speed limit given the high risk nature of this section of SH58 and the poor crash history.

11.1.2.2 Site 1 Realignment

The realignment of the horizontal curve at Site 1 was investigated in greater detail given the significant volumes of cut that would result. The volumes of cut required through Site 1 were calculated as being close to 50,000 m^3 which equated to a considerable cost. Whether Site 1 could reasonably be adjusted or removed was therefore reconsidered.

In terms of safety, crashes at Site 1 are discussed in Section 4.3.2. In summary, the crashes through Site 1 include one serious, three minor and eight non-injury crashes with loss of control being a key factor in the majority of crashes. This is a concerning number of crashes and therefore it was deemed unreasonable to simply omit any improvements at this location.

[54] The 5 year crash record for SH58, which shows a large amount of high severity loss of control crashes, does not actually exhibit a significant number of head-on collisions. Nevertheless, it is recognised that due to the vertical and horizontal alignment that there is high risk of head-on collisions with resulting high severity injuries. This is backed up by the KiwiRAP crash risk analysis in Section 8.3.3.5.

Therefore, it was determined that the realignment through Site 1 would be omitted, but an improved cross section would be provided through the existing horizontal curve. The full Option 3 cross section of 0.5m drainage channel, 1.5m sealed shoulder, 3.5m traffic lane and 2m flush median was originally considered. However, this still resulted in large volumes of cut due to the significantly high and steep slope face abutting the existing edge of seal. Therefore, the central median was reduced further to a 1.5m width, which ultimately resulted in a significant saving in earthworks quantities (a reduction of 44%).

Whilst the reduction in median width is not considered ideal given a 2m median is preferred for barrier deflection purposes, a median width of 1.5m has on occasion been used elsewhere[55].

With Option 4, the curve radius has not been improved (and increased) and is below the generally accepted 200m minimum radius for the provision of wire rope barrier. However, alternative options exist and barrier protection could still be provided (such as W section barrier or specific wire rope barrier design that supports installation on smaller radius curves).

The implications of not realigning this section have been considered in terms of route regularity, the potential for inappropriate approach speeds or driver awareness given realignments further north and the implications for route and curve consistency. The realignment previously proposed through this section treated two curves and therefore these existing radii would now remain, with the southern curve being 180m radius, and the northern curve at 245m. The consistency of design speeds through adjacent curves has been assessed for both westbound and eastbound vehicles and is considered acceptable; with there being no greater than 10 km/h speed differential between adjacent curves. Nevertheless, it is noted that curves of 180m and 245m radii are low and, when considered with existing crash history and proliferation of loss of control type crashes through this section, other safety measures may be warranted at this location[56].

With the proposed speed for the do-minimum now considered at 80km/h with an option speed of 80km/h posted speed limit, the decision to omit the Site 1 realignment has been reconsidered. Whilst it is clearly acknowledged that realignment at this location would be positive, the omission of this section for realignment is considered acceptable in conjunction with the cross section improvements.

11.1.2.3 Moonshine Roundabout Proposal

A further optimisation that has been carried out concerns the proposed roundabout at Moonshine Road. Various changes to the original Option 3 design have been considered at this proposed roundabout. The need for a roundabout at this location has been documented earlier in this report, refer Section 6.4.

The roundabout that was initially proposed had a central island diameter of 40m, as per current Austroads standards for this speed of road (currently 100 km/h). Following further discussions it was agreed to consider a smaller diameter roundabout on the basis that the 40m diameter was of a very high standard of intersection provision, whereas the remainder of much of SH58 is not of the same high standard (even with the proposed improvements).

Therefore, a reduced diameter of 32m was considered. With a central island diameter of this size, heavy vehicles can still adequately track through the roundabout if intending to use the intersection as a turnaround (due to turning restrictions created by the median wire rope barrier in the vicinity).

The proposed design of the roundabout has also been amended. Providing a roundabout at this location creates significant dis-benefit for SH58 traffic as a result of the queuing and geometric delay created by providing a roundabout whereas the current intersection form of priority does not impede the free flow of state highway traffic. Therefore, whether any form of slip lane could be provided that would reduce the delay and dis-benefit effects of the proposed roundabout for state highway through traffic was considered.

55 1.5m (or narrower) median width has been used on a case by case basis in a number of locations in the Wellington region.

56 Options such as calcined bauxite surfacing may be warranted, though caution is advised given such measures risk losing effectiveness over time.

The following options were investigated to provide a westbound slip lane (noting that a eastbound slip is not possible due to the presence of Moonshine Road):

- Full slip: 150m radius: This would require a significant amount of land and would result in too short a merge length prior to the existing right hand curve west of the proposed roundabout.
- Additional roundabout through lane: where the westbound lane is uncontrolled and separated from the inner circulating traffic lane: This would not require significant land acquisition but when modelled provides no benefit due to the tight negotiation radius through the roundabout which still results in delay. In addition, there are safety concerns about this type of layout (where there is a lack of physical separation between the right turn out of Moonshine Road and the SH58 westbound traffic)
- 70 m slip lane radius: This would require 3 curves and is not considered a safe solution.
- Relocate proposed roundabout 50-60 m northwest and provide a 150 m radius slip lane. This is a better solution but would require significant land acquisition and without further design it is not clear whether suitable approach angles of all of the roundabout legs could be achieved.

In conclusion, no option for the roundabout slip has been identified as being wholly acceptable and, whilst the benefits of a slip are duly noted in reducing the dis-benefit for westbound state highway traffic, safety is of greater importance than efficiency in this situation. Therefore the slip lane has not been progressed.

Notwithstanding this, certain amendments have been undertaken to the roundabout to improve efficiency. Additional approach lanes have been added for both of the state highway approaches with two lanes proposed for through traffic (with one of the through traffic lanes operating as a turning lane also). The Moonshine Road approach will remain as one lane given low volumes.

11.1.2.4 Projects Northern Extent (Bradey Road)

The northern extent of the project was also reconsidered. Previously the northern extent was proposed to extend to just south of the Pauatahanui Roundabout. Given the extent of the proposals for Transmission Gully, the section of SH58 improvements between Bradey Road and Pauatahanui Roundabout have been removed.

Accordingly, 610m of the project has been removed with the revised project extent now ending immediately south of Bradey Road. The crash history for the removed extent has been considered and this section is considered low risk, with three non-injury crashes during the five year assessment period.

By reducing the project extent and removing this 610m length from the project, a reduction in the physical works costs can be achieved (without a significant reduction in the overall project objective or enhanced safety performance along the corridor).

11.1.2.5 Median Width

A further option that was considered during the option optimisation was the reduction of the median width throughout the entire project length from the proposed 2.0m down to 1.5m (noting the section through the area of the previous realignment Site 1 has been reduced to 1.5m median width as discussed in Section 11.1.2.2 above).

Reducing the median width for the entire project length would have consequential reductions in physical works cost due to the reduced corridor width which in turn would translate to savings on earthworks quantities and pavement construction. However, after careful consideration, a wholesale median width reduction was not pursued as it was deemed too great a compromise on the safety provision without a corresponding level of cost reduction.

11.2 Road Safety Audit

An external road safety audit was undertaken in December 2013 by Opus International Consultants. The final road safety audit, inclusive of the designer's response, the (NZTA) safety engineer and the client's decision are included in Appendix O. As such, only a summary of the key issues is provided here.

- Posted Speed: The Safety Audit Team (SAT) recommended that a posted speed reduction from 100km/h to 80km/h would be warranted. Whilst this as originally outside of the scope, it is understood that NZTA have now agreed to a speed reduction to this effect, in advance of, and separate from, the proposed improvements investigated and recommended within this SAR.
- Drainage Paths: SAT noted the potential for aquaplaning due to topography. The design philosophy statement has noted this being a potential issue and the safety audit decision is to consider drainage paths in detail design where median drainage or porous surfacing can be used to address surface water depth.
- Protection of street furniture: Existing power poles are proposed for undergrounding and significant trees will be considered further during detailed design.
- Hugh Duncan Intersection: The SAT raised concern about allowing right turns in and out of this intersection, suggesting U-turns should be considered in the subsequent design stages of the project. This will be considered further post consultation.
- Kaitawa Street / Transpower Access: Rationalisation of accesses (with regard to diversions and U-turning) will be undertaken during and after consultation, with the most appropriate solution implemented during detailed design.
- Curve No. 18: The SAT recommended additional guardrail at this location which is accepted.
- Moonshine Road Roundabout: The SAT recommended a number of amendments at this location. These included a second exit lane on the eastern exit and hatching at the head of the medians. The SAT also recognised the need to cater for buses (and associated pedestrian movements). The SAT comments have been accepted and the scheme design updated accordingly.
- Access to Golf Course: it was noted that the median wire rope barrier was not currently proposed to be broken at the gold course access which would likely result in significant numbers of U-turning vehicles at Mulhern Road. Further consideration of turnaround facilities will be made post-consultation.
- Flightys Road and Murphys Road: Further consideration of turnaround facilities at this location to be undertaken post-consultation.

11.3 Evaluation

11.3.1 Basis of Evaluation

The economic evaluation of Option 4 was carried out in accordance with modified full procedures of the Economic Evaluation Manual Volume 1 (EEM1, July 2010), with a 40 year analysis period, 6% discount rate and 2013 update factors applied[58].

The key inputs, assumptions, and results that differ from the original economic evaluation (Section 8.3) are described in the following sections.

The worksheets used for the economic evaluation are included in **Appendix L.**

[58] It is noted that the November 2013 EEM has recently been released; however, the economic evaluation was completed prior to November 2013.

Table 11-1: Economic Analysis Assumptions

Option Description	
Time Zero	July 2013
Scheme Opening Year	July 2015
Construction Period	2014-2015
Base Date for Cost Estimates	July 2013
Discount Rate and Analysis Period	6% and 40 years

As outlined in Section 11.1.2, the Do-Minimum option speed along the project length was updated from the current 100km/h posted speed limit, to a reduced 80km/h.

Updated strategic model outputs[59] were provided by Opus as part of the August 2013 draft Petone to Grenada link (P2G) SH58 Scoping Report. The model forecast traffic volumes for 2021 and 2031, which was run with and without P2G, was used for this evaluation. Refer Appendix B for a summary of the modelling results.

The Do-Minimum model assumes that both Transmission Gully and the P2G link are constructed by 2021. The Do-Minimum, if the P2G link is not constructed, was also considered as a sensitivity test.

As a result of changing the Do-Minimum speed to 80km/h[60], Option 4 has also been considered as having a posted speed limit of 80km/h[61].

11.3.2 Economic Peer Review

An external Economic Peer Review was undertaken in February 2014 by Opus International Consultants. The following sections outline the results of the updated economics implementing the changes as agreed by the peer reviewer and analyst. The Moonshine Road SIDRA model was also updated to reflect the Road Safety Audit recommendations outlined in 11.2.
The final economic peer review and analyst responses are included in Appendix P.

11.3.3 SIDRA Modelling

The SH58 Moonshine Roundabout SIDRA model, outlined in Section 8.2 above, was updated to account for the new strategic model outputs, geometric changes and efficiency improvements (outlined in Section 11.1.2 above). In addition, the model was updated to reflect the RSA comments outlined in Section 11.2.

Based on the SATURN modelling results, telemetry traffic data and turning survey counts, SIDRA modelling was undertaken for the morning peak, inter-peak and evening peak periods for the years 2013, 2021, 2031 and 2041. The outputs for geometric delay, control delay and fuel consumption were extracted from the models and used in the economic evaluation.

A summary of the SIDRA outputs for the afternoon peak of the future modelled years is provided in Table 11-2 below.

[59] Northern Wellington SATURN Model (NWSM)

[60] Note the benefits and dis-benefits of reducing the posted speed limit to 80 km/h have not been included in this analysis as this would be undertaken prior to the project commencing.

[61] Note: an option at 100 km/h was also evaluated; however, this was removed following the RSA due to safety concerns.

Refer **Appendix K** for site layout details of both the existing T and roundabout option and SIDRA output tables.

Table 11-2: SIDRA Output Summary (Option 4)

Period	Demand Flow (vph)[62]	Base (Existing T)			Roundabout (32m diameter, single circulating lanes, twin approach, twin exits, 80 km/h)		
		Total Delay (veh-hrs/hr)[63]	Fuel Use (L/hr)	Worst Approach Degree of Saturation (volume/ capacity)	Total Delay (veh-hrs/hr)	Fuel Use (L/hr)	Worst Approach Degree of Saturation (volume/ capacity)
Afternoon Peak							
2021	1,971	0.7	48	0.5	4.7	54	0.3
2031	2,275	1.2	56	0.6	5.4	62	0.4
2041	2,567	3.1	65	1.0[64]	6.2	71	0.4[65]

The results show that, predictably, the roundabout option results in a significantly higher total delay. This is due to all SH58 traffic being required to slow down and negotiate the roundabout with a resulting increase in geometric delay, leading to a reduction average speed. In contrast, with the existing T-Junction only the low volume movements (i.e. in and out of Moonshine Road) suffer from high delays[66].

The existing Moonshine Road intersection indicatively reaches capacity[67] (morning peak) between modelled periods 2031 and 2041. In contrast, the roundabout option will still operate in the 2041 PM peak with an overall LoS A and a degree of saturation of 0.4 (LoS B for the Moonshine Road approach).

However, because of the low side road flows compared to the state highway, the roundabout has increased travel time (approximately double) and marginally higher fuel usage even in the future modelled years.

SIDRA modelling was also undertaken for the scenario of the Petone to Grenada link not being constructed. The higher flows on SH58 do not result in capacity bottlenecks at the Moonshine Road roundabout in future years. However, the draft Opus SH58 Scoping Report showed that if the Petone to Grenada link is not constructed, the eastbound AM peak and westbound PM peak demands in 2021 and 2031 exceed link capacity.

Therefore investigations into capacity improvements for all of SH58 should be considered if the Petone to Grenada link is not progressed.

11.3.4 Travel Time and Vehicle Operating Costs

Section 8.3.2 outlines the methodology used in the original economic evaluation in detail. The evaluation of Option 4 and the updated Do-Minimum was similar with the following key changes:

[62] Note the demand flow for the roundabout option is slightly higher due the additional u-turning movements created by the wire rope median barrier.

[63] Note: the average geometric delay for the existing Moonshine road T junction is less than 1 sec/veh, while the roundabout geometric delay is about 8 sec/veh due to the additional distance travelled; therefore the total delay for the roundabout is largely made up of geometric delay, whereas for the T-junction the delay is control delay/queuing.

[64] 95th%ile queue of 4 vehicles on the Moonshine Road approach.

[65] 95th%ile queue of 3.7 vehicles on SH58 Hutt approach.

[66] Note the previous SIDRA analysis used an early version of SIDRA 6, this analysis used version 6.0.15.4263 which has resulted in differences in fuel usage and delay; however, the net differences between the existing and option remain similar.

[67] Degree of saturation of >0.9-1.0.

- Use of 2021 and 2031 SATURN modelling outputs, with a traffic growth rate of 0.5% from 2013 to 2021 and model based growth rates from 2021 to 2041.
- The Do-Minimum and Option 4 posted speed limit of 80 km/h.
- Removal of Site 1 travel time benefits and vehicle operating cost benefits.
- Use of updated Moonshine intersection SIDRA model outputs outlined in Section 11.3.3 (total delay, geometric delay and fuel use as input data)

Table 11-3 below provides a summary of the net present value travel time, VOC and CO_2 for Option 4.

Table 11-3: NPV TTC, VOC and CO_2 (40yr, 6%)

Option Description	NPV Travel Time Costs ($M)	NPV VOC and CO_2 ($M)
Option 4: 80km/h Curve Realignment, widening and a wire rope median barrier (incl. roundabout)	-1.5	-1.3

The results show that the travel time disbenefits of the roundabout at Moonshine Road outweigh the travel time savings from the curve realignment.

11.3.5 Crash Benefits

Section 8.3.3 outlines the methodology used in the original economic evaluation. The evaluation of Option 4 and the updated Do-Minimum was similar with the following key changes:

- Use of 2021 and 2031 SATURN modelling outputs, with a traffic growth rate of 0.5% from 2013 to 2021 and model based growth rates from 2021 to 2041.
- The Do-Minimum and Option 4 posted speed limit of 80 km/h.
- Removal of Site 1: Crash reduction percentages at this site were reduced from the higher curve realignment reduction percentages into the midblock crash reduction rates used for the remainder of the project.
- The removal of three non-injury crashes which occurred on SH58 northwest of Bradey Road (within the Transmission Gully designation).

In addition, the crash reduction factors were reviewed and additional sensitivity tests were carried out on the out on the factor applied to combinations of three or more crash reduction factors (refer Section 8.3.3).

The sensitivity tests included:

- Pessimistic: 50%
- Median (base): 67%[68]
- Optimistic: 80%

Table 11-4 below provides a summary of the key crash reduction factors and crash costs for both option speeds.

[68] Turner, B. "Estimating the Safety Benefits when Using Multiple Road Engineering Treatments," Road Safety Risk Reporter, 11, June 2011) http://www.arrb.com.au/admin/file/content13/c6/RiskReporterIssue11.pdf. In the analysis, estimates from different approaches were compared with CMFs for actual combinations of treatments and it was found that the estimates consistently overestimated the true crash reductions. That discovery prompted his suggestion of a dampening factor of 2/3 as general rule.

Table 11-4: Crash Costs (Median crash reduction, 40yr, 6%)

Option Description	Key Combined CRF (Midblock)	NPV Crash Costs Benefits ($M)
Option 4: 80 km/h Curve Realignment, widening, ATP and guardrail	**Head-on**: 90% F+S, 20% Minor, 20% increase in non-injury crashes. **Loss of Control (off road)**:62% F+S, 35% Minor, 30% non-injury	49

As the Do-Minimum was adopted as 80 km/h and the existing five year CAS crash history has been recorded at 100 km/h, the existing crash history was factored down based on HRRRG methodology[69] to if it had occurred at 80 km/h.

Following the recent October 2013 and February 2014 fatal crashes on SH58, the crash history was reviewed to gauge the effect of updating the five-year period from 2008-2012 to February 2009 - February 2014. However, 2008 contained two serious crashes which would be lost at the gain of two fatal crashes, with minor injury crashes and non-injury crashes remaining fairly similar. The net effect, due to the EEM's fatal/serious split was in the range of approximately 20-25% higher annual crash cost (2009-2014). This is provided in Section 11.3.7.1 as a sensitivity test.

11.3.6 Cost Estimates

The expected and 95th percentile estimates for this project are detailed in the table below.

Table 11-5: Scheme Estimates

Option Description	Expected Estimate ($M)	95th Percentile Estimate ($M)
Option 4: Curve Realignment, widening and a wire rope median barrier	31.1	38.6

The cost estimates for the option have been calculated using the survey information available. Whilst the three sections of realignment are based on ground based topographical survey, the remaining lengths are reliant on aerial LiDAR survey data which has a greater risk of inaccuracy. That said, the data provided using aerial survey provides sufficiently detailed and accurate survey for a scheme stage assessment to give reasonable confidence in the design solution, and associated costs (and by extension, calculated BCR).

Of particular note in terms of the cost estimation undertaken is the effect on major structures[71]. No upgrade or widening to any of the existing structures (Refer Table 3-1) has been proposed within the cost estimation – instead it envisaged that any widening or median improvements would cease in advance of existing structures and recommence after the structure terminates. This is considered a

[69] NZTA, High Risk Rural Roads Guide Figures 2-3: *Relationship between change of mean speed and causalities on rural roads* and Figure D-1: *Relationship between change in speed limit and change in mean speed*. A posted speed limit decrease of 20 km/h (100 km/h – 80 km/h) results in a 6% reduction in mean speed (Fig. D-1). This is turn results in a 25% reduction in fatal casualties, 18% reduction in serious casualties and 10% reduction in minor casualties (Fig. 2-3). These were converted from percent reduction in casualties into percent reduction in crashes using a weighted average of SH58 crashes (08-12) by HRRRG crash type (weighted factor of 1.16 DSI per crash). These converted crash reduction percentages were then applied to the existing five-year crash history (100 km/h) to estimate the 80 km/h crash history. This modified crash history was then used as the basis for Method A crash analysis.

[71] An allowance for extending / relocating other stormwater drainage features, such as parallel and lateral drainage culverts, has been allowed for in the cost estimation as these are essential to the on-going operation of the road.

reasonable approach at scheme assessment stage as widening of structures is not considered to be necessary or cost-effective. This may be revisited at detailed design should there be a desire to improve certain structures.

Refer **Appendix J** for the full Scheme Estimate.

The maintenance costs for Option 4 are similar to that of Option 3, refer Section 8.3.4, with updated quantities.

11.3.7 Benefit Cost Ratio

The calculated BCR for Option 4 is provided in the table below.

Table 11-6: Option 4 Benefit Cost Ratio

Option Speed	Analysis Period and Discount Rate	Crash Reduction	With P2G (2021)	
			BCR	Safety only BCR
80	40yr 6%	Median	1.5	1.6

11.3.7.1 Sensitivity Testing

A range of sensitivity tests were carried out for an option speed of 80 km/h, scenarios with and without the Petone to Grenada link, differing crash reduction assumptions, 95th percentile and base cost estimates, and both 30 and 40 year analysis periods. The results are summarised in the tables below.

Table 11-7: 40 year Sensitivity Testing (New EEM default)

Analysis Period and Discount rate	Variable/Comment	With P2G (2021)		Without P2G	
		BCR	Safety only BCR	BCR	Safety only BCR
40yr 6%	Crash Reduction: Pessimistic	1.3	1.4	1.7	1.7
40yr 6%	Crash Reduction: Median	1.5	1.6	1.9	1.9
40yr 6%	Crash Reduction: Optimistic	1.7	1.7	2.1	2.1
40yr 6%	Crash Reduction: Median crash reduction and the approximate effect of including the two recent fatal crashes	1.9	2.0	2.4	2.4
40yr 6%	95th Percentile Project Estimate	1.2	1.3	1.5	1.6
40yr 6%	Base Project Estimate	1.7	1.8	2.2	2.2

Table 11-8: 30 year Sensitivity Testing

Analysis Period and Discount Rate	Variable/Comment	With P2G (2021)		Without P2G	
		BCR	Safety only BCR	BCR	Safety only BCR
30yr 8%	Crash Reduction: Pessimistic	0.9	1.0	1.2	1.2

Analysis Period and Discount Rate	Variable/Comment	With P2G (2021)		Without P2G	
		BCR	Safety only BCR	BCR	Safety only BCR
30yr 8%	Crash Reduction: Median	1.1	1.2	1.3	1.4
30yr 8%	Crash Reduction: Optimistic	1.2	1.3	1.4	1.5

The tables show that the BCR generally lies in the 1.2 to 2.4 range, increasing slightly if only the safety benefits are considered, for a 40 year analysis period.

It is noted that the Petone to Grenada link is now unlikely to be completed until 2024. This would likely result in slightly higher BCRs since not proceeding with P2G has higher BCRs (as shown above, assuming no subsequent capacity improvements are required).

Refer Section 8.3.6 for the likely effect of other sensitivity tests.

11.4 Resource Management Issues

Option 4 presents no change to the resource management issues considered in Section 9 of this report, and therefore is not replicated again.

11.5 Assessment Profile

The Government Policy Statement on Land Transport Funding (GPS) requires the NZTA to consider a number of matters when evaluating projects. To assist in understanding how projects perform against these matters and hence what investment decisions to make, the NZTA utilises an assessment profile process.

The assessment profile is a three-part rating for an activity, rated as high, medium or low e.g. HMM, and representing the assessment for Strategic Fit, Effectiveness and Efficiency respectively. The table below outlines the option assessment profile[72] for SH58.

Table 11-9: SH58 Safety Improvements Assessment Profile

Option	Strategic Fit	Effectiveness	Efficiency	Profile
Option 4: Curve Realignment, widening and wire rope median barrier	High	Medium	Low	**HML**

11.5.1 Strategic Fit

The strategic fit factor is a measure of how an identified problem, issue or opportunity that is addressed by a proposed activity or combination of activities, aligns with the NZTA's strategic investment direction.

As this project is classified as a High Risk Rural Road, the Strategic Fit is **High**.

[72] NZTA Planning and Investment Knowledge Base, www.pikb.co.nz/assessment-framework

11.5.2 Effectiveness

The effectiveness factor considers the contribution that the proposed solution makes to achieving the potential identified in the strategic fit assessment and to the purpose of the Land Transport Management Act (LTMA).

A wide range of assessment factors are available for use in this effectiveness rating and these draw from the five LTMA areas outlined below:

- Economic Development
  - The option proposed is not expected to significantly affect Economic Development.
- Safety and Personal Security
  - The option provides a significant reduction in crash risk; refer Section 8.3 for further detail. In summary, the shoulder widening, ATP, guardrail, curve realignment and wire rope barrier all result in significant crash reductions for the main injury crash types of Loss of Control and Head on.
- Access and Mobility
  - The option provides travel time savings due to curve realignment and increased design speed.
  - The provision of wide shoulders will make this section of State Highway more accessible for cyclists who would otherwise not choose to cycle at this location due to the perceived safety risk of the existing narrow shoulders.
  - The installation of a Wire Rope Median Barrier will limit the accessibility of side roads and accessways along its length, with access restricted to at a number of intersections; however, this is slightly offset by a proposed roundabout at Moonshine Road intersection.
- Public Health
  - The overall effects on public health are expected to be neither positive nor negative. However, there will be a health improvement through physical activity to new cyclists who choose to cycle along this section of State Highway due to the improvement in shoulder width.
- Environmental sustainability
  - The Pauatahanui Stream in the vicinity of the works is considered a sensitive environment and the effects of sedimentation will need to be addressed, this affects all options.
  - There are no heritage, archaeological, cultural or waahi tapu sites close to the SH58 proposed works.

A number of other key criteria may need to be considered including integration, consideration of options and responsiveness.

As this project is part of the SH58 Strategic Study, provides a long term solution and delivers a significantly effective, measureable outcome (reduce DSi), it is recommended that an effectiveness factor of **Medium** is adopted. This is considered appropriate as the project will contribute positively to safety and is consistent with NZTA's strategies and plans.

A high rating was not adopted due to the project not making 'significant contributions to multiple GPS impacts'. While, this project significantly reduced deaths and serious injuries and 'makes a contribution to multiple GPS impacts' (medium effectiveness), it is not considered to have a significant effect on economic growth, easing congestion/freight (efficiency), transport mode choice or a reduction environmental effects.

11.5.3 Efficiency

The economic efficiency assessment considers how well the proposed solution maximises the value of what is produced from the resources used. This is primarily undertaken by the Benefit Cost Ratio.

The option investigated has a BCR of 1.5. Sensitivity testing shows the BCR has a range of 1.2-2.4 depending on the whether or not Petone to Grenada is constructed and whether the two recent fatal crashes are included in the analysis. Therefore the economic efficiency is **Low**, with sensitivity testing showing the economic efficiency ranges from low to medium.

12 Scheme Drawings

Scheme drawings are provided in **Appendix E.**

13 Conclusions and Recommendations

Of the original three options considered, the analysis confirmed that Option 2, which consisted of curve realignment, widening and a flush median, was economically viable and marginally better than Option 3 (in economic terms). While the wire rope barrier option had the largest crash benefits, a lack of adequate turning provision necessitates a roundabout at Moonshine Road intersection; resulting in dis-benefits. Option 3 was subsequently selected as the preferred option, favoured over Option 2 because of the overarching benefits of the median barrier. This was subsequently optimised (creating Option 4) in an attempt to reduce unnecessary (or less beneficial) expenditure and maximise benefits to deliver a better value for money project with a higher BCR.

Option 4 includes the removal of one of the high cost realignment sites, changes to a proposed intersection, and small overall reduction in project extent to the north. The project economics were also further refined. Option 4 achieves a BCR of 1.5, with sensitivity showing that the BCR ranges between 1.2 and 2.4.

The provision of the improvements considered in Option 4 will ameliorate the existing poor crash history. It is acknowledged that the overall physical works cost is high, primarily resulting from the challenging topography. Nevertheless, it has been demonstrated that a safety improvement project will be beneficial in terms of crash reduction and economic efficiency[73].

It is recommended that NZTA undertake:

- Public consultation on the options (noting the need for co-ordination with the Petone to Grenada consultation phase). The public consultation will be critical to inform the access arrangements given the effect of median wire rope barrier on turning movements and associated diversions.
- Engagement of a property consultant to validate and update property costs \ estimates to refine the project estimates.
- Further geotechnical testing as per the recommendations of the attached Preliminary Geotechnical Appraisal Report.
- A staging assessment to determine if and how the overall package of works could be delivered through block project funding given the current quantum of work is not expected to be financially viable as a single project, at least in the short to medium term. This assessment should also consider the effect and implications of the current proposal of undertaking the realignment and improvement of the scour site curve (Realignment Section 4 – Curve No. 16) in advance of the main SAR upgrade[74].
- A detailed design of the preferred option (noting public consultation has not yet been undertaken which may influence the preferred option).

[73] Since the commencement of this SAR, there have been two further fatal crashes on SH58, both in the vicinity of Realignment Section 4 – Curve No. 16. As such, it is likely that NZTA will expedite the proposed upgrade at this location, in advance of the main SAR upgrade. This specific location has also been investigated previously as a result of the proximity of the stream and potential scour effect that may be taking place and undermining the batter slopes supporting the pavement structure.

These two additional fatal crashes have not been considered in the full economic evaluation undertaken for the project, though a basic sensitivity test has been included as to their impact on the project economics, increasing the BCR to 1.9. It is noted that should Realignment Section 4 be undertaken in advance of the main SAR upgrade, there will be consequential effect on the remaining SAR project BCR. Similarly, if further crashes take place prior to detailed design being undertaken, the project BCR will also change (though this is the situation with any project through the investigation and design life cycle).

[74] The effect of a potential time lag in undertaking the Realignment Site 4 works and there being a delay prior to the remaining SAR upgrades is not considered problematic. Given the NZTA are now proposing to lower the posted speed on SH58 to 80km/h, the upgrade to this section in isolation would not result in an out of context curve (noting the upgrade should result in a design speed of 87km/h through the new realigned curve – and which could still be subject to an advisory travel speed).

APPENDICES

Appendix A	Location Plan and Photographs
Appendix B	Traffic Data
Appendix C	Crash Data
Appendix D	Design Philosophy Statement
Appendix E	Scheme Drawings
Appendix F	Pavement Design
Appendix G	Risk Register
Appendix H	Social and Environmental Management Form (PSF 13)
Appendix I	Preliminary Geotechnical Appraisal Report
Appendix J	Scheme Estimate
Appendix K	SIDRA Modelling
Appendix L	Economic Evaluation
Appendix M	SH58 Strategic Study
Appendix N	Pauatahanui Judgeford Structure Plan
Appendix O	Road Safety Audit
Appendix P	Economic Peer Review

Appendix A Location Plan and Photographs

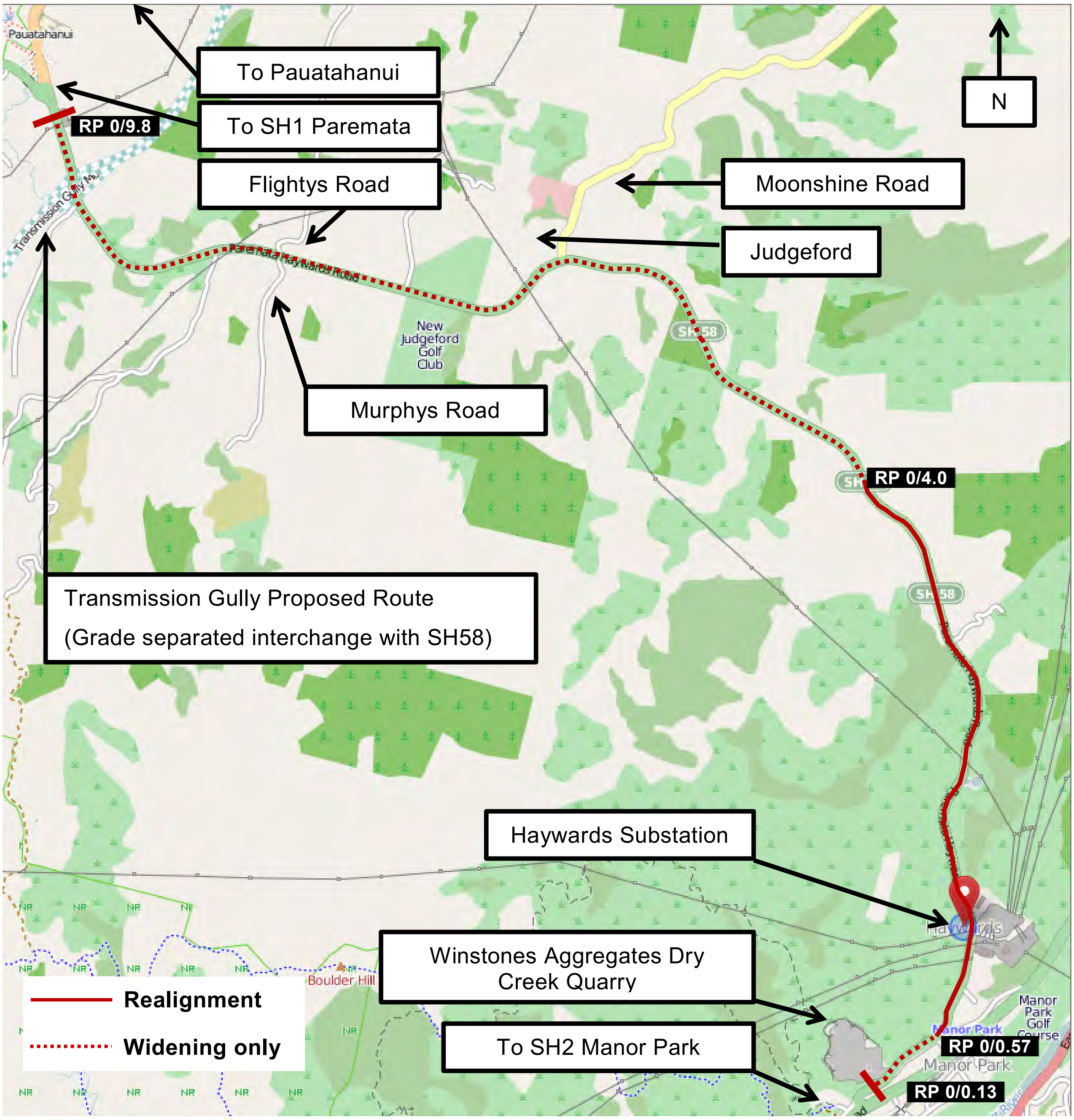


Figure 13-1: Location Plan

A.1 Photographs


Photo 1: Steep cliff bank, horizontal curve, limited sight distance, heading west


Photo 2: Narrow shoulders and out of context reverse curves, heading east

Photo 3: Existing wire rope barrier, heading east

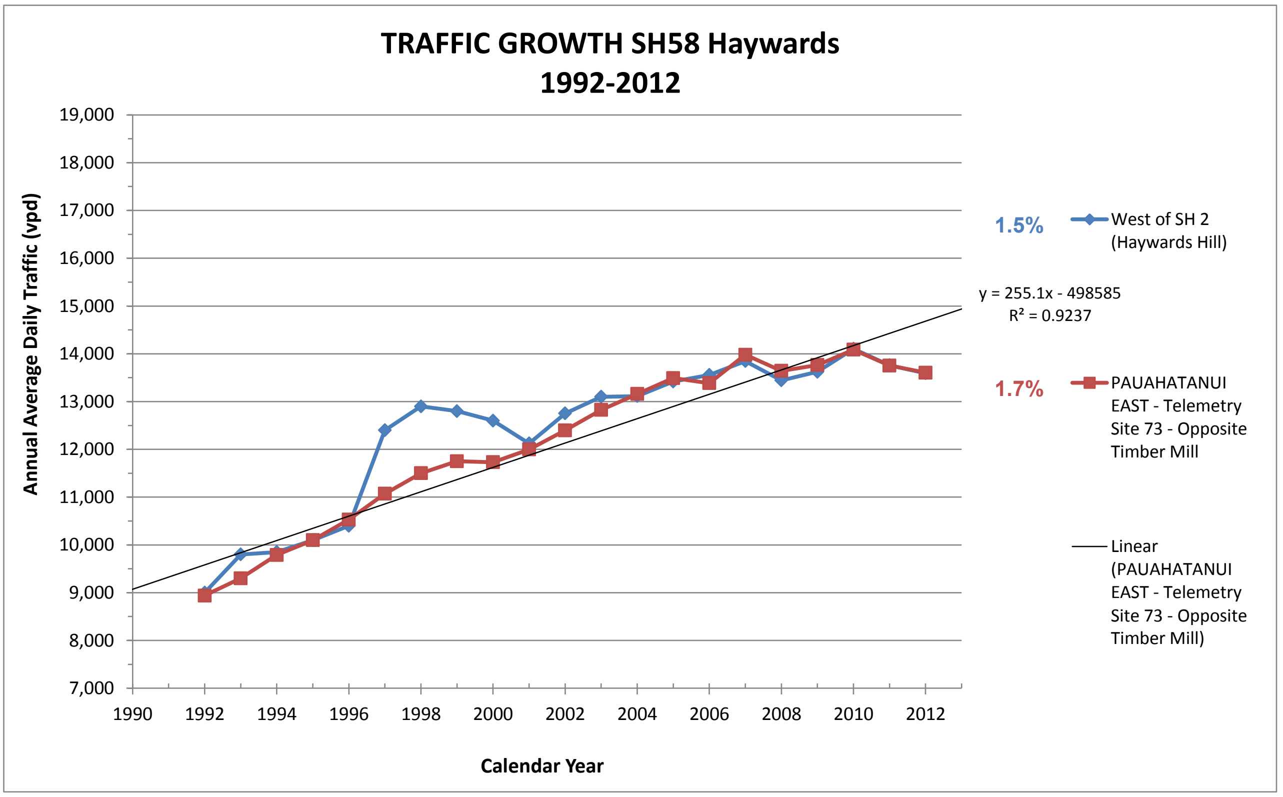
Photo 4: Haywards Substation Access and flush median, heading east

Photo 5: Moonshine Road Intersection: bus stop

Photo 6: Moonshine Road Intersection: bus stop

Appendix B Traffic Data

B.1 Traffic Growth



Traffic Data

WORKSHEET A2.4

1	Road section / movement	SH58 RP 0/9.14 Pauatahanui East (Telemetry Site 73)
2	Time Period	1992 to 2012

Year (3)	AADT or Average Volume (4)
1992	8,940
1993	9,300
1994	9,790
1995	10,100
1996	10,530
1997	11,070
1998	11,500
1999	11,750
2000	11,730
2001	11,997
2002	12,398
2003	12,825
2004	13,160
2005	13,491
2006	13,385
2007	13,980
2008	13,642
2009	13,766
2010	14,086
2011	13,753
2012	13,605

Telemetry Site 73

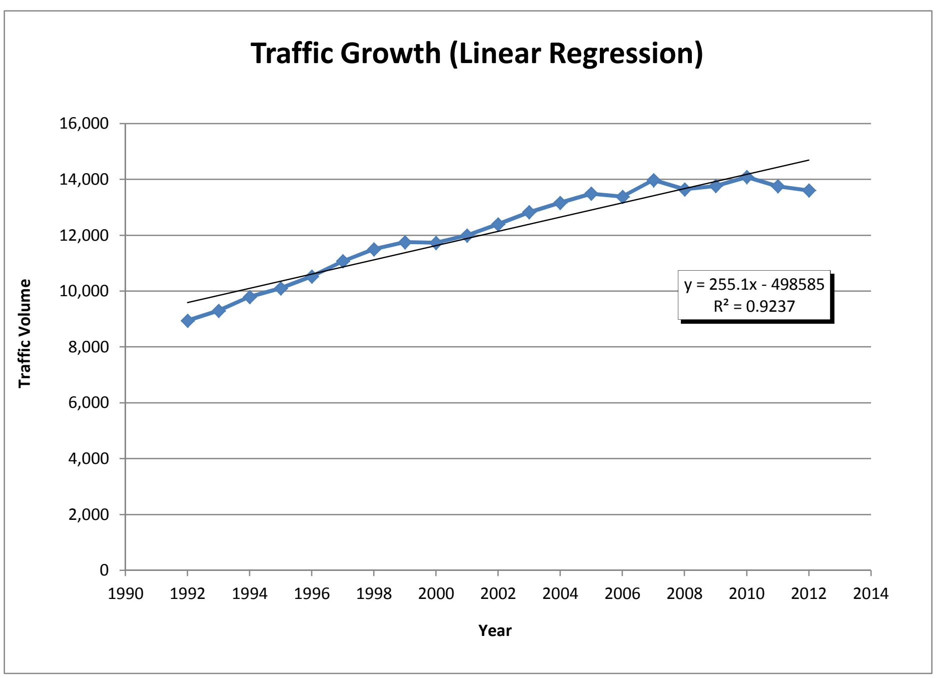
Traffic Count Location

Regression Output	
(5) Constant	-498,585
(6) X Coefficient	255.1
(7) R Squared	1.00

Calculated Values	
(8) Time Zero	2013
(9) Time Zero Traffic Volume (estimate)	14,939
(10) Calculated Growth Rate at Time Zero	1.5%

Adopted Values	
(8) Time Zero	2013
(9) Time Zero Traffic Volume (estimate)	**13,700**
(10) Adopted Growth Rate at Time Zero	1.5%

Note: assumes current trend continues, with resumption of growth in later years due to TG & future developement



B.2 Count Data

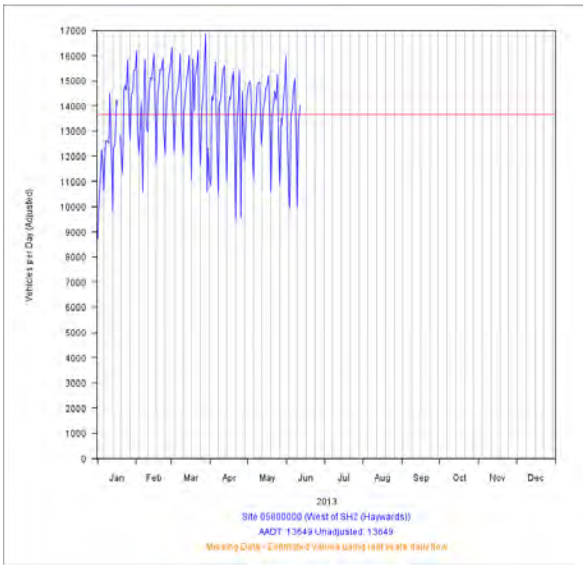


Figure 13-2: West of SH2 (Haywards) 2013 AADT

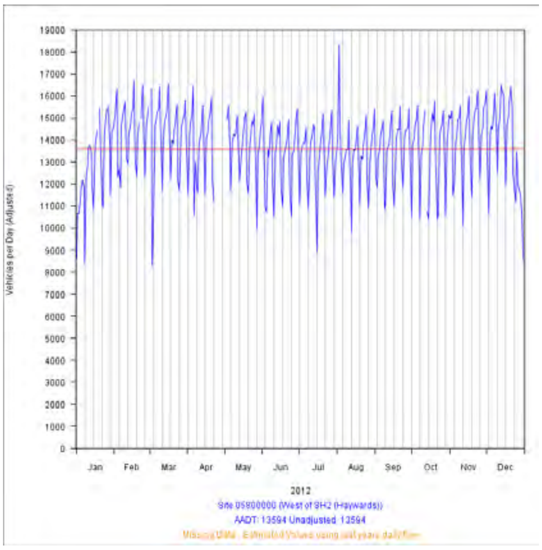


Figure 13-3: West of SH2 (Haywards) 2012 AADT

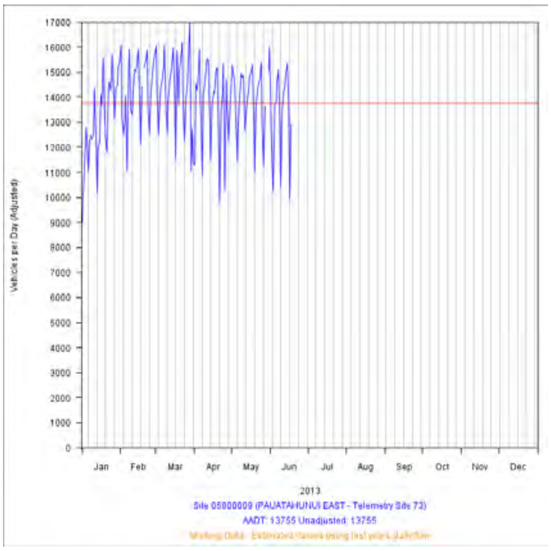


Figure 13-4: Pauatahanui East Telemetry Site 73 2013 AADT

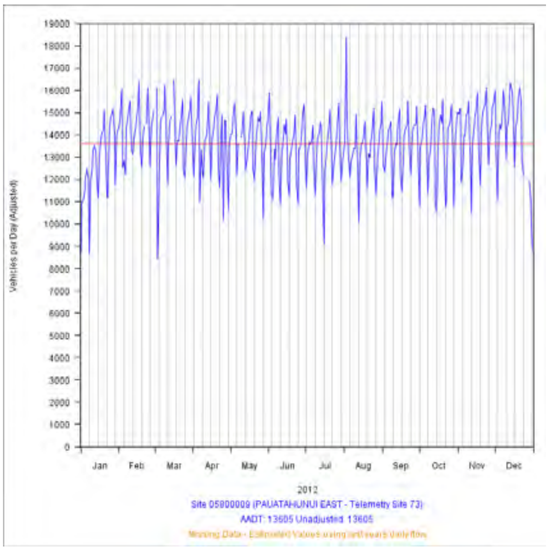


Figure 13-5: Pauatahanui East Telemetry Site 73 2012 AADT

B.3 Peak Hour Flow Data

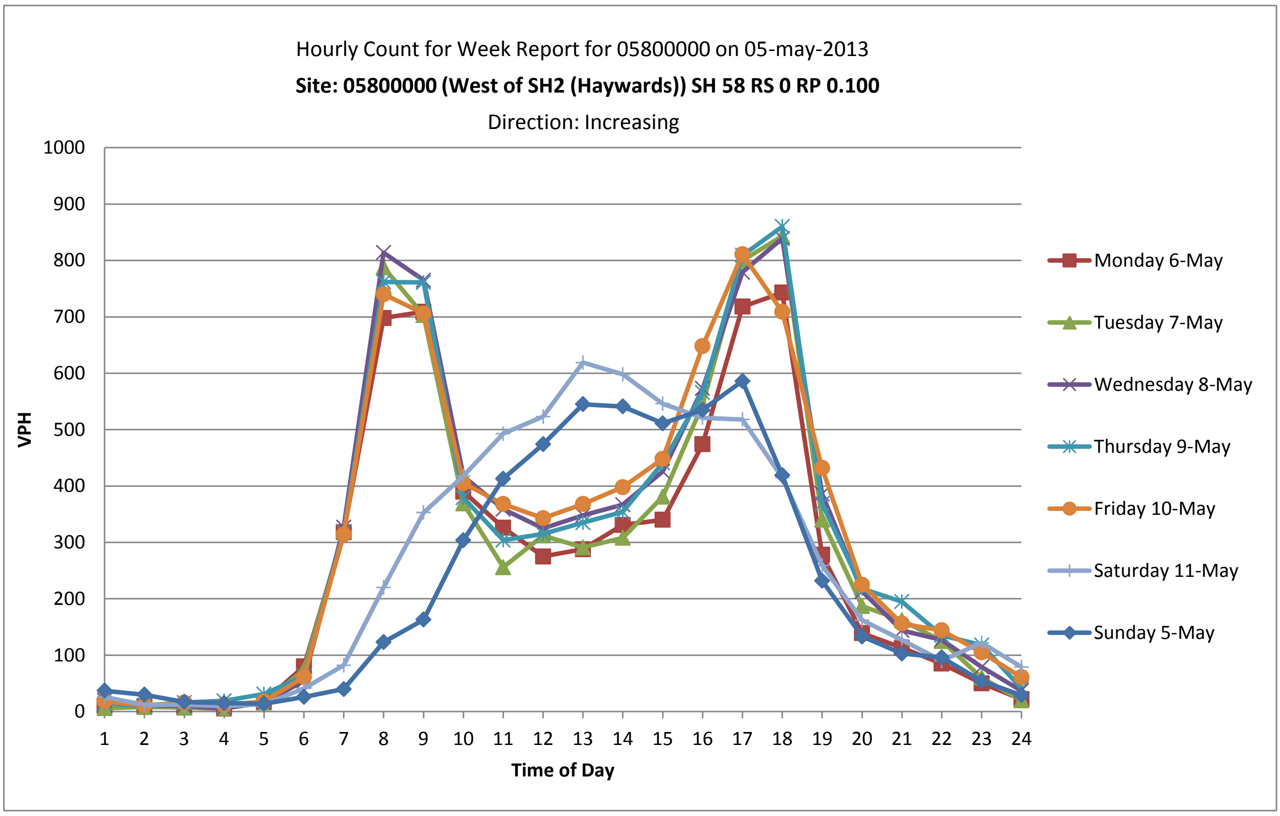


Figure 13-6: Hourly Count West of SH2 (Hayward) - Increasing

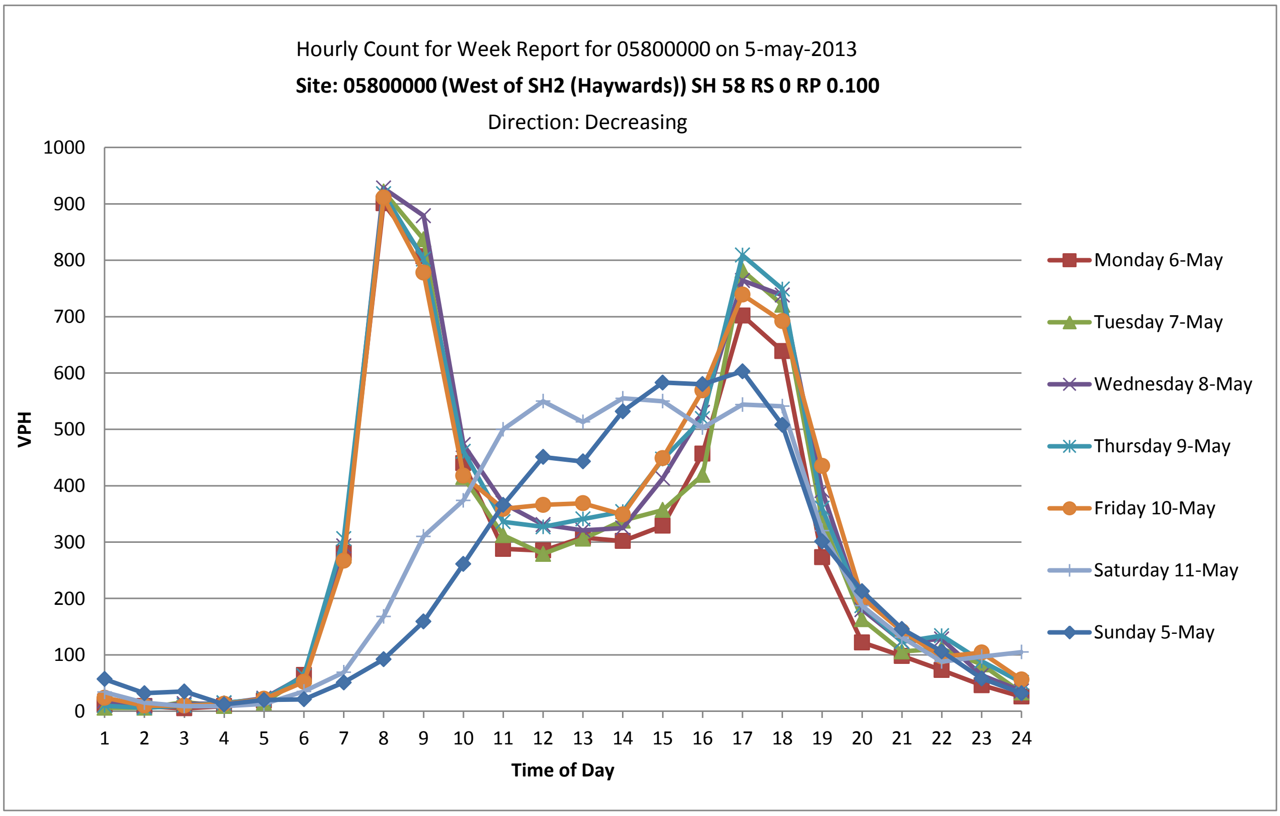


Figure 13-7: Hourly Count West of SH2 (Hayward) - Decreasing

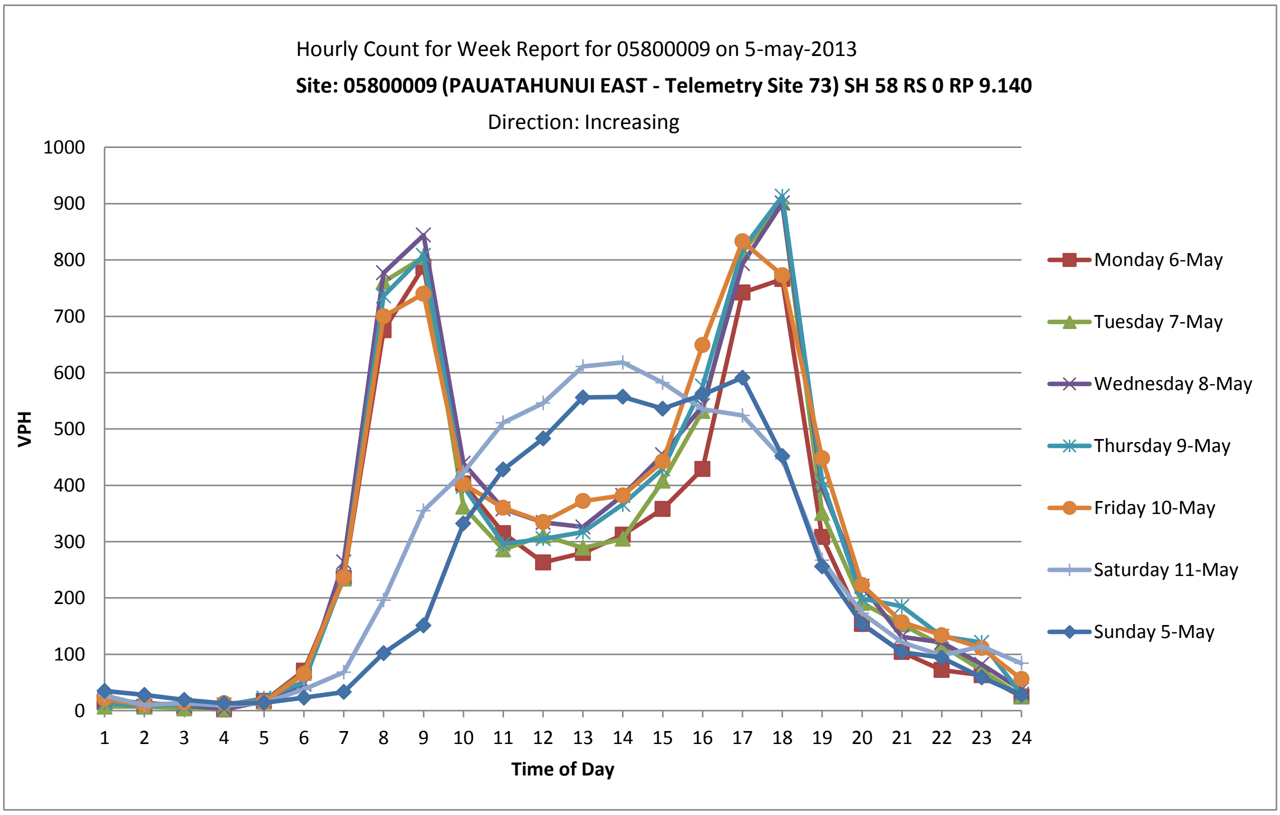


Figure 13-8: Hourly Count Pauatahanui Telemetry Site 73 - Increasing

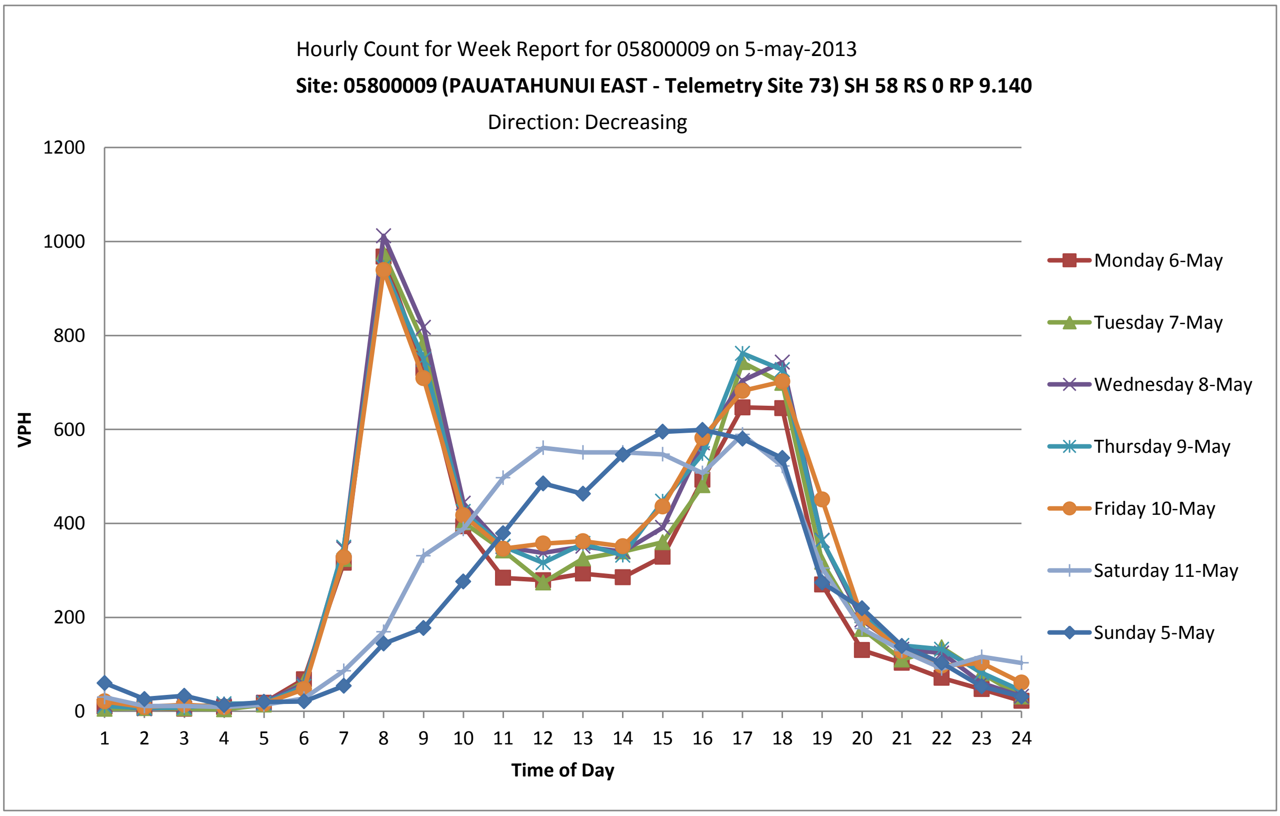


Figure 13-9: Hourly Count Pauatahanui Telemetry Site 73 – Decreasing

B.4 Highway Level of Service

Source: SH58 Strategic Study

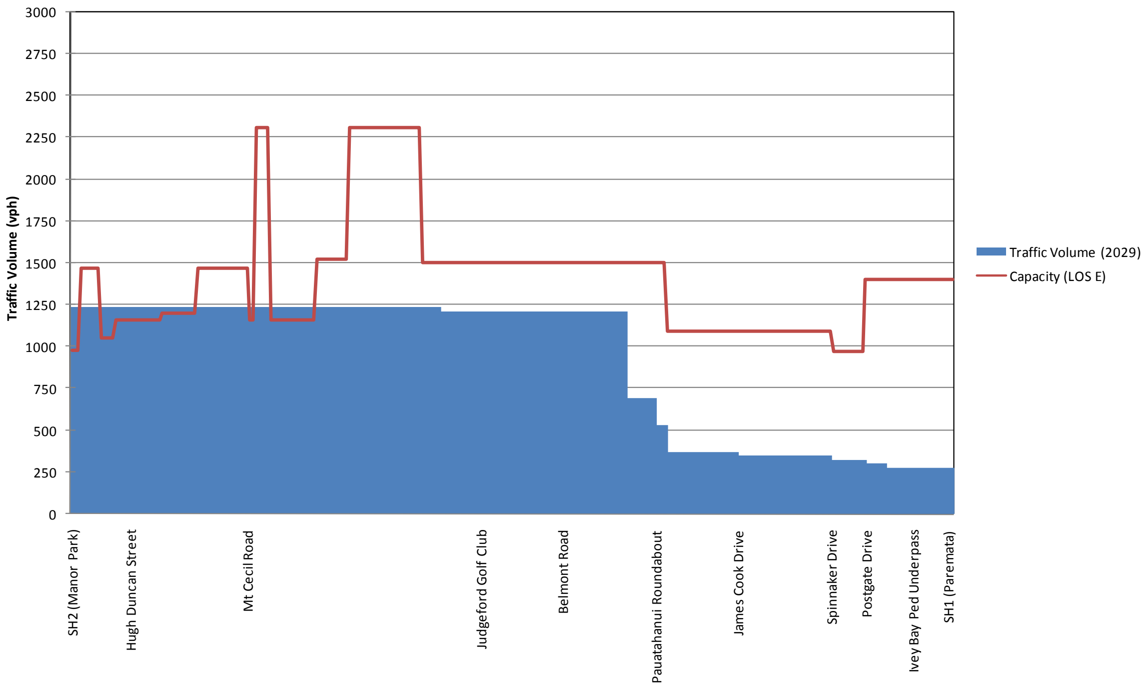


Figure 13-10: SH58 Eastbound Traffic Volumes – Predicted 2029 Weekday AM Peak

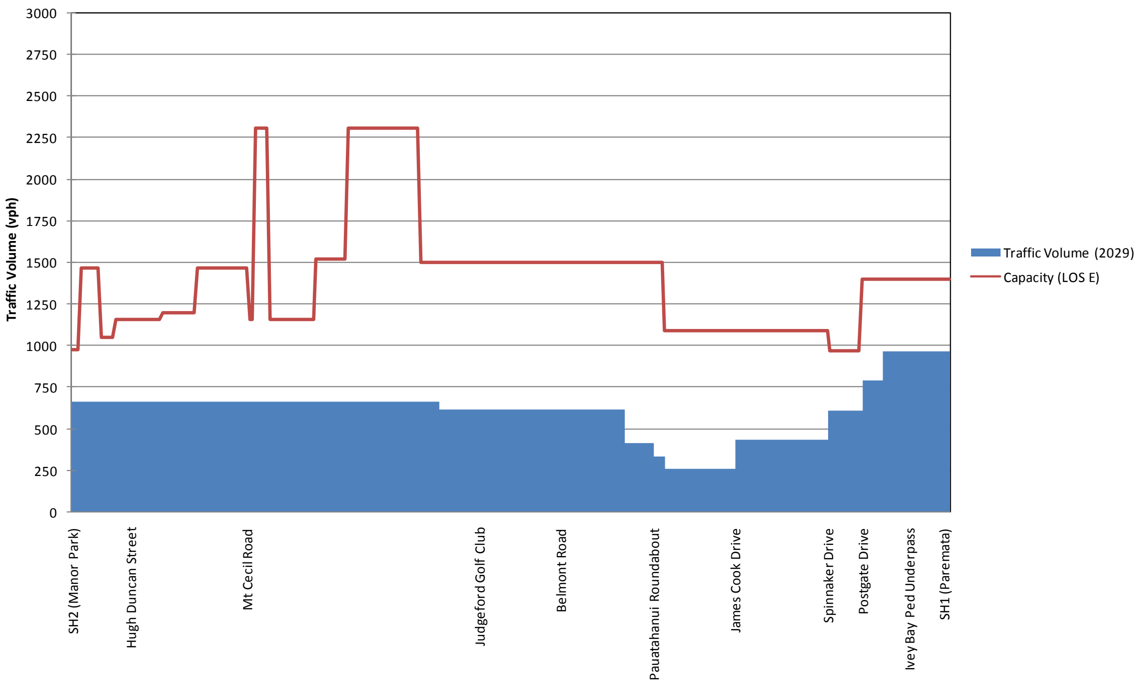


Figure 13-11: SH58 Eastbound Traffic Volumes – Predicted 2029 Weekday PM Peak

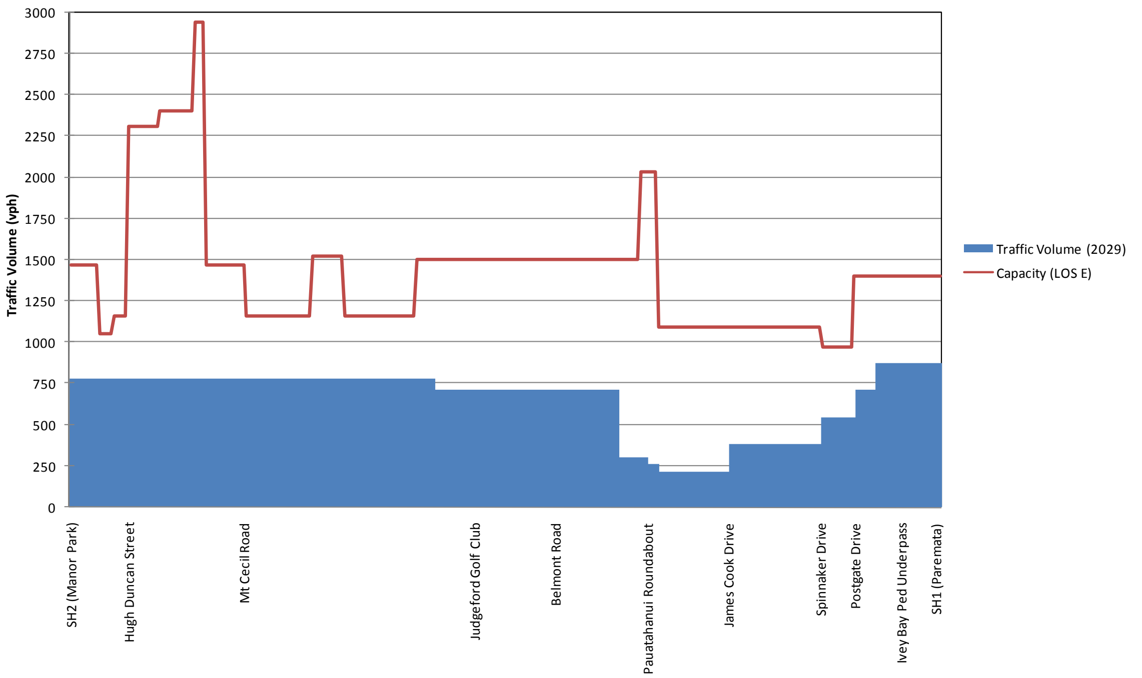


Figure 13-12: SH58 Westbound Traffic Volumes – Predicted 2029 Weekday AM Peak

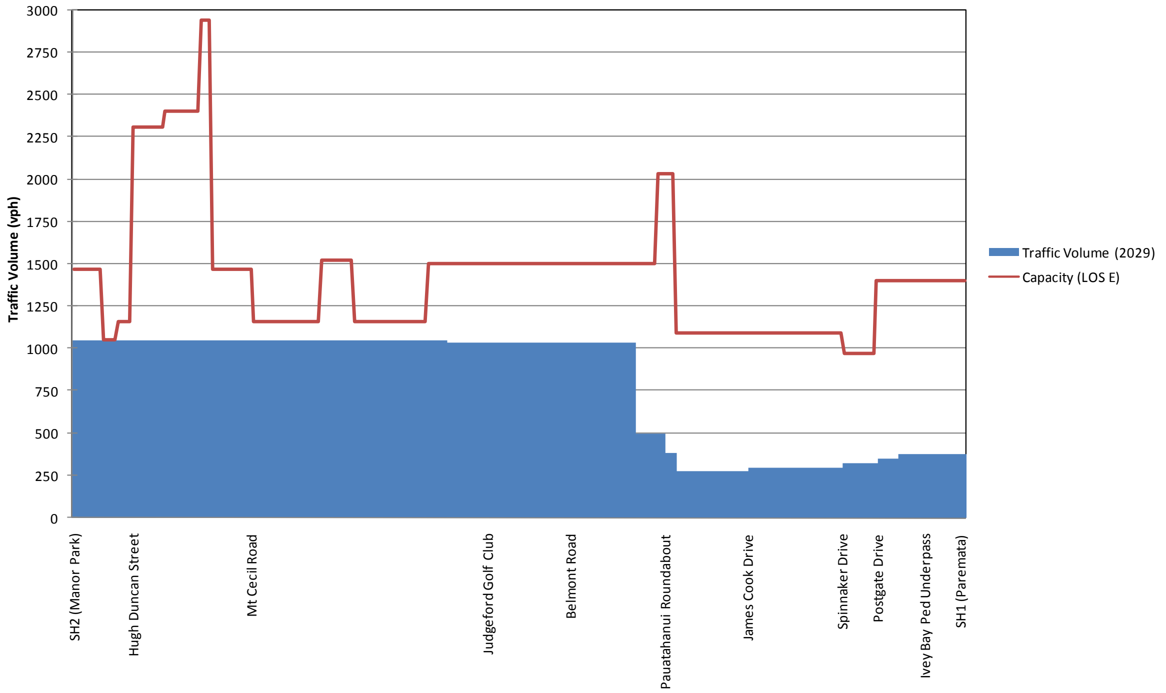


Figure 13-13: SH58 Westbound Traffic Volumes – Predicted 2029 Weekday PM Peak

B.5 Modelling Outputs

Source: Draft Opus SH58 Petone to Grenada PFR/Scoping Report

4 Traffic Demands

This section identifies the future traffic demands along SH58 and assesses the impact on efficiency.

4.1 Traffic Modelling

Modelling has been carried out using the Northern Wellington SATURN Model (NWSM) which has been recently updated to a base year of 2011 by SKM. Modelling in NWSM is carried out using traffic demand matrices extracted from the Wellington Strategic Transportation Model (WTSM) which is a four stage EMME model covering the whole Wellington region.

Table 4-1 gives an indication of the schemes which have been included in the do minimum modelling. The construction year is based on the latest construction schedule, this is subject to change. A number of schemes have only been included in WTSM as they fall outside the model area for NWSM but are still needed in WTSM for traffic demand forecasting purposes.

Table 4-1: Do Minimum Modelling Assumptions

Scheme	Construction Finish Year	2011	2021	2031
Airport to Mt Vic	2022	Not included	Included in WTSM Only	Included in WTSM Only
Wellington RoNS –Tunnel to Tunnel (Including Basin Reserve, ICB Improvements and Memorial Park Underpass)	2017	Not included	Included in WTSM Only	Included in WTSM Only
Terrace Tunnel Duplication	2024	Not included	Included in WTSM Only	Included in WTSM Only
Ngauranga to Aotea Quay	2021	Not included	Included	Included
Transmission Gully	2020	Not included	Included	Included
Mackays to Peka Peka	2018	Not included	Included in WTSM Only	Included in WTSM Only
Peka Peka to Ōtaki	2020	Not included	Included in WTSM Only	Included in WTSM Only
Ōtaki to Levin	2024	Not included	Not included	Included in WTSM Only
PT Improvements as per the Rail Plan[2]		Not included	Included in WTSM Only	Included in WTSM Only
SH2/ 58 grade separation		Not included	Included	Included
Uphill passing lane extension (SH58)		Not included	Included	Included

There are two do-minimums for this project one with and one without P2G. The Petone to Grenada link has been included in one of the do minimum models with the assumption it will be constructed before 2021.

Four models have been used to analyse the impacts on SH58 as described below:

[2] http://www.gw.govt.nz/assets/Transport/Public-transport/Docs/RegionalRailPlan.pdf

1. Do Minimum no P2G (Same used for the Do Minimum for the Petone to Grenada Scoping Report and as described in the table above)
2. Do Minimum with P2G (Same used for the Option for the Petone to Grenada Scoping Report but with P2G included)
3. Four laning no P2G (Same as model 1 with four laned SH58 from TG to SH2)
4. Four laning with P2G (Same as model 2 four laned SH58 from TG to SH2)

4.2 Forecast Future Year Traffic Volumes

Table 4-2, below shows the forecast AADT traffic volumes for the Do Minimum (model 2) scenario as predicted by the NWSM. Hourly volumes can be found in Appendix H.

Table 4-2: Do Minimum Forecast Traffic Volumes (AADT)

Location	Direction	2021	2031
SH58 East of TG	Eastbound	7580	8700
SH58 East of TG	Westbound	7190	8320
SH58 East of TG	**Both**	**14770**	**17020**
SH58 West of SH2	Eastbound	8330	9600
SH58 West of SH2	Westbound	7960	9140
SH58 West of SH2	**Both**	**16300**	**18740**

The NWSM Do Minimum has also been run without P2G in place (model 1). Table 4-3 shows the predicted traffic volumes. Without P2G, traffic volumes are significantly higher.

Table 4-3: Do Minimum Forecast Traffic Volumes – without P2G (AADT)

Location	Direction	2021	2031
SH58 East of TG	Eastbound	9780	11100
SH58 East of TG	Westbound	9770	11050
SH58 East of TG	**Both**	**19560**	**22150**
SH58 West of SH2	Eastbound	10510	11680
SH58 West of SH2	Westbound	10540	12080
SH58 West of SH2	**Both**	**21050**	**23760**

Appendix C Crash Data

Crash List: DCR_SH58

Overall Crash Statistics

Crash Severity	Number	%	Social cost ($m)
Fatal	2	1	9.45
Serious	13	9	11.13
Minor Injury	34	25	2.93
Non-injury	89	64	3.04
	138	100	26.54

Crash Numbers

Year	Fatal	Serious	Minor	Non-inj
2008	0	2	4	8
2009	1	2	7	21
2010	1	1	9	19
2011	0	3	5	19
2012	0	5	9	22
TOTAL	2	13	34	89
Percent	1	9	25	64

Note: Last 5 years of crashes shown

Overall Casualty Statistics

Injury Severity	Number	% all casualties
Death	2	3
Serious Injury	13	21
Minor Injury	48	76
	63	100

Casualty Numbers

Year	Fatal	Serious	Minor
2008	0	2	7
2009	1	2	10
2010	1	1	12
2011	0	3	6
2012	0	5	13
TOTAL	2	13	48
Percent	3	21	76

Note: Last 5 years of casualties shown

Crash Type and Cause Statistics

Crash Type	All crashes	% All crashes
Overtaking Crashes	14	10
Straight Road Lost Control/Head On	15	11
Bend - Lost Control/Head On	76	55
Rear End/Obstruction	24	17
Crossing/Turning	5	4
Pedestrian Crashes	0	0
Miscellaneous Crashes	4	3
TOTAL	138	100

Crash factors (*)	All crashes	% All crashes
Alcohol	14	10
Too fast	41	30
Failed Giveway/Stop	5	4
Failed Keep Left	4	3
Overtaking	5	4
Incorrect Lane/posn	14	10
Poor handling	46	33
Poor Observation	38	28
Poor judgement	24	17
Fatigue	6	4
Disabled/old/ill	4	3
Vehicle factors	15	11
Road factors	41	30
Weather	6	4
Other	10	7
TOTAL	273	198
Crashes with a:		
Driver factor	201	146
Environmental factor	47	34

(*) factors are counted once against a crash - ie two fatigued drivers count as one fatigue crash factor.

Note: Driver/vehicle factors are not available for non-injury crashes for Northland, Auckland, Waikato and Bay of Plenty before 2007. This will influence numbers and percentages.

Note: % represents the % of crashes in which the cause factor appears

Number of parties in crash	All crashes	% All crashes
Single party	84	61
Multiple party	54	39
TOTAL	138	100

Driver and Vehicle Statistics

Note: Driver information is not computerised for non-injury crashes

Drivers at fault or part fault in injury crashes

Age	Male	%	Female	%	Total	%
15-19	5	14	2	14	7	14
20-24	8	22	2	14	10	20
25-29	3	8	2	14	5	10
30-39	3	8	2	14	5	10
40-49	9	25	2	14	11	22
50-59	6	17	4	29	10	20
60-69	0	0	0	0	0	0
70+	2	6	0	0	2	4
TOTAL	36	100	14	100	50	100

Drivers at fault or part fault in injury crashes

Licence	Male	Female	Total	%
Full	27	7	34	67
Learner	2	1	3	6
Restricted	6	3	9	18
Never licensed	0	0	0	0
Disqualified	0	0	0	0
Overseas	0	1	1	2
Expired	0	2	2	4
Other/Unknown	1	1	2	4
TOTAL	36	15	51	100

Vehicles involved in injury crashes

	No.of vehicles	% Injury crashes
SUV	6	12
Car/Stn Wagon	48	67
Motor Cycle	9	16
Bicycle	2	4
Truck	1	2
Van Or Utility	13	27
TOTAL	79	128

Note: % represents the % of injury crashes in which the vehicle appears

Crash List: DCR_SH58

Road Environment Statistics

Road Type	Local road	%	State highway	%	Total	%
Urban	0	0	1	1	1	1
Open Road	0	0	137	99	137	99
TOTAL	0	0	138	100	138	100

Conditions	Injury	Non-injury	Total	%
Light/overcast	37	68	105	76
Dark/twilight	12	21	33	24
TOTAL	49	89	138	100

Conditions	Injury	Non-injury	Total	%
Dry	27	38	65	47
Wet	21	49	70	51
Ice/snow	1	2	3	2
TOTAL	49	89	138	100

Intersection/mid-block	All crashes	% All crashes
Intersection	16	12
Midblock	122	88
TOTAL	138	100

Objects Struck	Injury crashes	%	Non-injury crashes	%
Crashes w/obj.struck	30	61	61	69

Object Struck	Injury crashes	%	Non-injury crashes	%
Cliff Bank	10	20	18	20
Debris	0	0	1	1
Over Bank	3	6	4	4
Fence	10	20	20	22
Guard Rail	1	2	14	16
House Or Bldg	1	2	0	0
Traffic Island	1	2	0	0
Parked Vehicle	0	0	1	1
Post Or Pole	6	12	4	4
Traffic Sign	0	0	1	1
Tree	5	10	6	7
Ditch	3	6	7	8
Stray Animal	0	0	1	1
Other	1	2	0	0
Water/River	2	4	0	0
TOTAL	43		77	

Note: % represents the % of crashes in which the object is struck

Time Period Statistics

Day/Period	All crashes	% All crashes
Weekday	96	70
Weekend	42	30
TOTAL	138	100

Day/ Period	0000-0259	0300-0559	0600-0859	0900-1159	1200-1459	1500-1759	1800-2059	2100-2400	Total
Weekday	4	2	24	13	11	26	10	6	96
Weekend	1	2	2	7	10	12	4	3	41
TOTAL	5	4	26	20	21	38	14	9	137

Note: Weekend runs from 6 pm on Friday to 6 am on Monday

Day/ Period	0000-0259	0300-0559	0600-0859	0900-1159	1200-1459	1500-1759	1800-2059	2100-2400	Total
Mon	2	0	3	5	1	5	1	1	18
Tue	1	1	4	1	0	8	3	0	18
Wed	0	0	8	0	5	5	1	1	20
Thu	0	1	4	4	2	3	1	3	18
Fri	1	0	5	3	3	5	4	1	22
Sat	0	1	2	3	6	6	1	1	20
Sun	1	1	0	4	4	6	3	2	21
TOTAL	5	4	26	20	21	38	14	9	137

Month	Injury	%	Non-injury	%	Total	%
Jan	3	6	8	9	11	8
Feb	8	16	4	4	12	9
Mar	3	6	7	8	10	7
Apr	3	6	13	15	16	12
May	8	16	4	4	12	9
Jun	4	8	9	10	13	9
Jul	0	0	8	9	8	6
Aug	3	6	6	7	9	7
Sep	3	6	5	6	8	6
Oct	3	6	6	7	9	7
Nov	4	8	7	8	11	8
Dec	7	14	12	13	19	14
TOTAL	49	100	89	100	138	100

CRASH LIST DETAIL REPORT

Run on: 6 Jun 2013

Crash List: DCR_SH58 (138 crashes)

Total Injury Crashes:	49
Total Non-Injury Crashes:	89
	138

Crash Type	Number	%
Overtaking Crashes:	14	10
Straight Road Lost Control/Head On:	15	11
Bend - Lost Control/Head On:	76	55
Rear End/Obstruction:	24	17
Crossing/Turning:	5	4
Pedestrian Crashes:	0	0
Miscellaneous Crashes:	4	3
TOTAL:	138	100 %

Location	Local road	%	St.Highway	%	Total	%
Urban	0	0	1	1	1	1
Open road	0	0	137	99	137	99
TOTAL:	0	0	138	100	138	100 %

Intersection/Midblock	Number	%
Intersection:	16	12
MidBlock:	122	88
TOTAL:	138	100 %

Environmental Factors	Number	%
Light/Overcast Crashes:	105	76
Dark/Twilight Crashes:	33	24
TOTAL:	138	100 %
Wet/Ice:	73	53
Dry:	65	47
TOTAL:	138	100 %

Day/Period	Number	%
Weekday	96	70
Weekend	42	30
TOTAL:	138	100 %

Vehicles	Number	%
Car	132	72
Van/Ute	30	21
Truck	8	6
Bus	0	0
Motorcycle	11	7
Bicycle	2	1
TOTAL:	183	107 %

Note: Percentages represent the % of crashes in which the vehicle, cause or object appears.

Crash factors (*)	Number	%
Alcohol	14	10
Too fast	41	30
Failed Giveway/Stop	5	4
Failed Keep Left	4	3
Overtaking	5	4
Incorrect Lane/posn	14	10
Poor handling	46	33
Poor Observation	38	28
Poor judgement	24	17
Fatigue	6	4
Disabled/old/ill	4	3
Vehicle factors	15	11
Road factors	41	30
Weather	6	4
Other	10	7
TOTAL:	273	198 %
Crashes with a:		
Driver factor	201	146 %
Environmental factor	47	34 %

(*) factors are counted once against a crash - ie two fatigued drivers count as one fatigue crash factor.

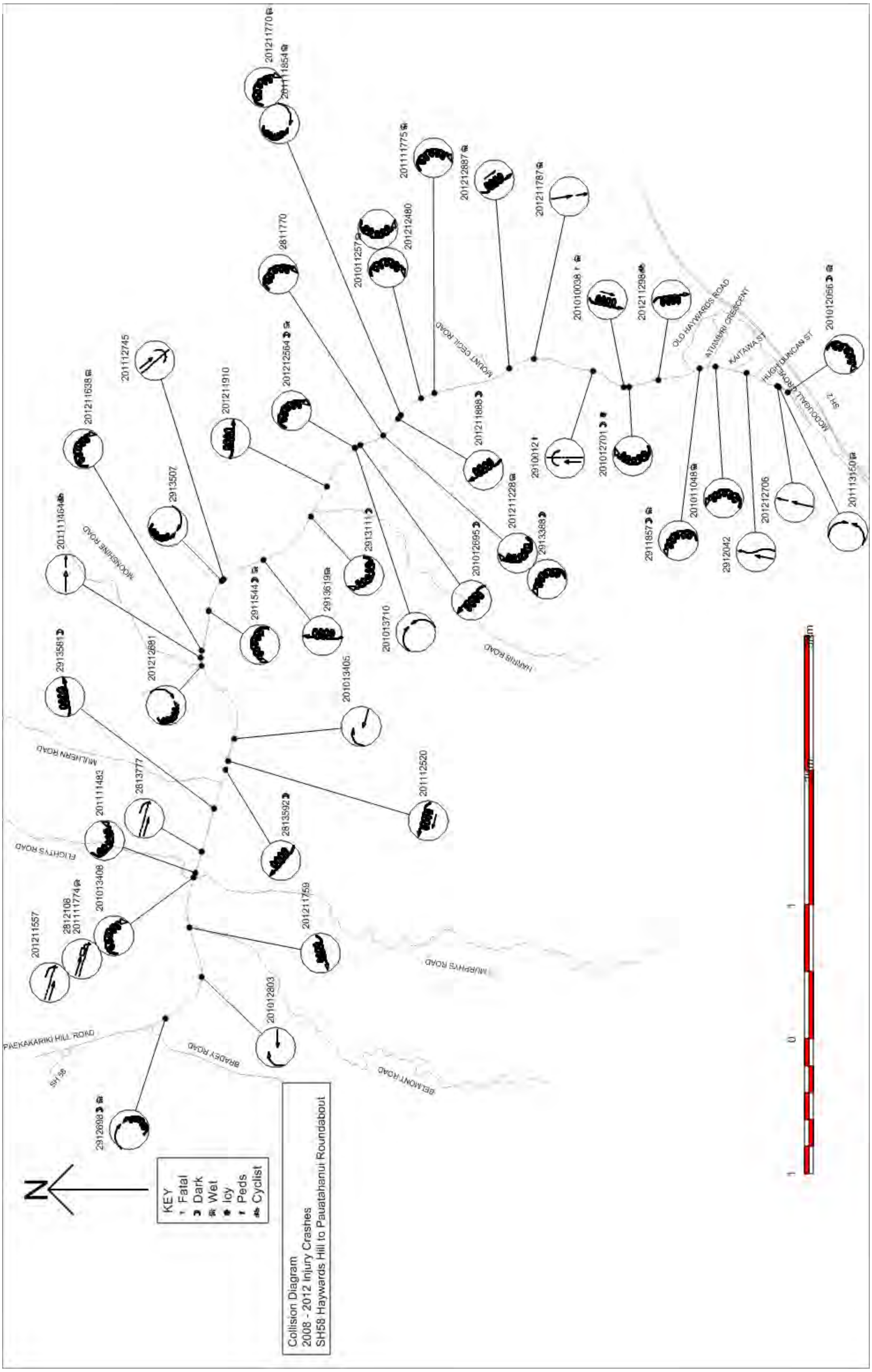
Note: Driver/vehicle factors are not available for non-injury crashes for Northland, Auckland, Waikato and Bay of Plenty before 2007. This will influence numbers and percentages.

Crashes with objects(s) struck 91 66 %

Object Struck	Number	%
Cliff Bank	28	20
Debris	1	1
Over Bank	7	5
Fence	30	22
Guard Rail	15	11
House Or Bldg	1	1
Traffic Island	1	1
Parked Vehicle	1	1
Post Or Pole	10	7
Traffic Sign	1	1
Tree	11	8
Ditch	10	7
Stray Animal	1	1
Other	1	1
Water/River	2	1
TOTAL:	120	88 %

Crash Numbers

Year	Fatal	Serious	Minor	Non-Inj
2008	0	2	4	8
2009	1	2	7	21
2010	1	1	9	19
2011	0	3	5	19
2012	0	5	9	22
TOTAL:	2	13	34	89


Collision Diagram
2008 - 2012 Injury Crashes
SH58 Haywards Hill to Pauatahanui Roundabout
KEY
Fatal
Dark
Wet
Icy
Peds
Cyclist
N
PAEKAKARIKI HILL ROAD
BRADEY ROAD
BELMONT ROAD
MURPHYS ROAD
FLIGHTYS ROAD
MULHERN ROAD
MOONSHINE ROAD
HARRIS ROAD
MOUNT CECIL ROAD
OLD HAYWARDS ROAD
ATIAWA CRESCENT
KAITAWA ST
HUGH DUNCAN ST
MCDOUGALL GROVE
SH 2
SH 58

High Risk Rural Roads Guide		Length	Vkt	FS Crashes	Value	Length	AADT	
	Personal Risk	9.8	2.450245	15	6.121836796	9.8	13700	0.00001825
	Collective Risk	9.8		15	0.306122449	0	0	0

High Risk Intersection Guide

Rural T-Junction

MOONSHINE ROAD

	TYPE	Adjusted FS Rate	Injury	Adjusted FS Rate
		<>M		
		<>N		
Overtaking/lane change	A	0.32	0	0
Head-on	B	0.35	1	0.35
Loss of control or off road (straight)	C	0.25	0	0
Cornering	D	0.27	1	0.27
Hit Object	E	0.31	0	0
Rear-end	F	0.08	1	0.08
Turning versus same direction	G	0.24	0	0
Crossing (no turning)	H	0.19	0	0
Crossing (turning)	J	0.28	0	0
Merging	K	0.26	0	0
Right turn against	L	0.29	0	0
Manoeuvring	M	0.28	0	0
Pedestrian crossing road	N	0.73	0	0
Pedestrian other	P	0.73	0	0
Misc	Q	0.5	0	0
Estimated FS Crashes/Collective Risk	Total		**3**	**0.7**
Actual FS Crashes				2
Collective Risk Band				**Low medium**
Qmajor				13753
Qminor				578
				576
	EEM high speed priority T junction model			1050493
Predicted Injury Crashes	B0	B1	B2	
Per year	0.000407	0.18	0.57	0.08
Personal Risk Metric				95
Personal Risk Band				**Medium**
Injury Crashes Per Year				0.60
LoSS Value				7
LoSS Band				**V**

High Risk Intersection Guide

Rural X roads

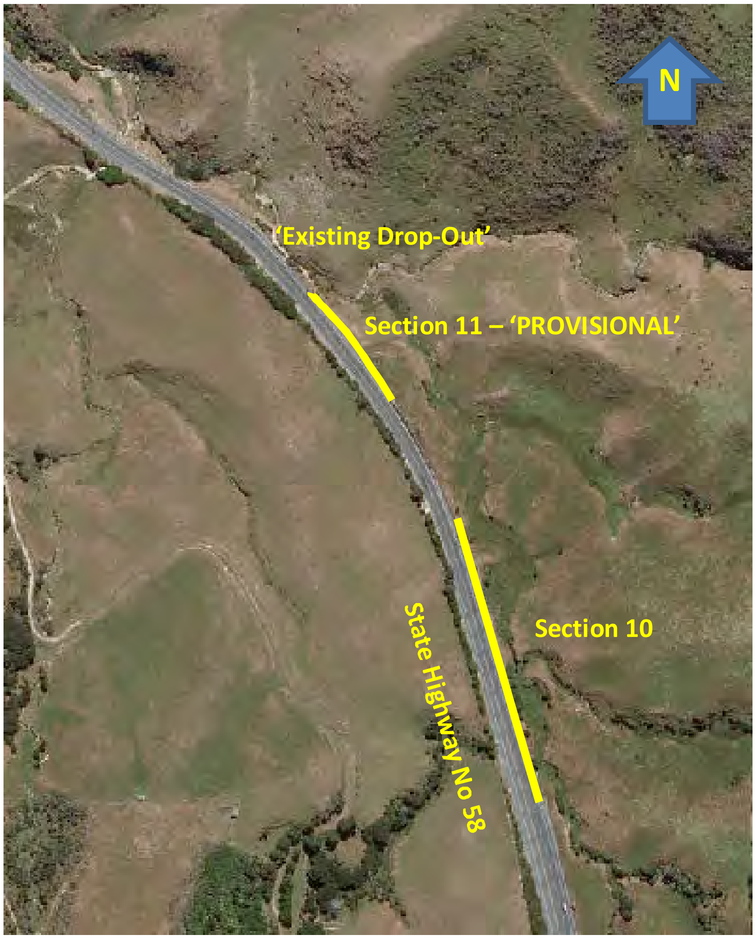
FLIGHTYS ROAD/ MURPHYS ROAD

	TYPE	Adjusted FS Rate	Injury	Adjusted FS Rate
		<>M		
	Rural T Junction	<>N		
Overtaking/lane change	A	0.32	0	0
Head-on	B	0.35	0	0
Loss of control or off road (straight)	C	0.25	0	0
Cornering	D	0.24	1	0.24
Hit Object	E	0.31	0	0
Rear-end	F	0.08	0	0
Turning versus same direction	G	0.22	3	0.66
Crossing (no turning)	H	0.34	0	0
Crossing (turning)	J	0.33	0	0
Merging	K	0.23	0	0
Right turn against	L	0.3	0	0
Manoeuvring	M	0.28	0	0
Pedestrian crossing road	N	0.73	0	0
Pedestrian other	P	0.73	0	0
Misc	Q	0.5	0	0
Estimated FS Crashes/Collective Risk	Total		**4**	0.9
Actual FS Crashes				**0**
Collective Risk Band				**Medium**
Qmajor				13753
Qminor				221
				392
	EEM high speed priority X road model			715120
Predicted Injury Crashes	B0	B1	B2	
Per year	0.000432	0.39	0.5	0.26
Personal Risk Metric				140
Personal Risk Band				**High**
Injury Crashes Per Year				0.8
LoSS Value				3.0
LoSS Band				**V**

703N - SH2Petone Bowl & SH 58 Safety Barriers – installation sites – Rev 3 – 13 May 2013

Mo
N
Section 7
State Highway No 58
Section 6
Hayward's Sub Station


N
Section 10
Mt Cecil Road
State Highway No 58
Section 7


N
'Existing Drop-Out'
Section 11 – 'PROVISIONAL'
Section 10
State Highway No 58

Key	First Street	Distance	D I R	Second street or landmark	Crash Number	Date DD/MM/YYYY	Day DDD	Time HHMM	Description of Events	Crash Factors (ENV = Environmental factors)	Road	Natural Light	Weather	Junction	Cntrl	Tot Inj F A T	S E R	M I N	Map Coordinates Easting	Northing
1	58/0/0.1	40	N	HEBDEN CRESCENT	201151771	05/04/2011	Tue	1659	SUV1 NBD on SH 58 lost control turning left, SUV1 hit Cliff Bank	SUV1 too fast entering corner, lost control when turning, new driver showed inexperience ENV: road slippery (rain)	Wet	Overcast	Light Rain	Unknown	Nil				1765445	5441760
2	58/0/0.1	100	N	SH 2	2811053	13/01/2008	Sun	1523	CAR1 WBD on SH 58 lost control turning right, CAR1 hit Traffic Island on right hand bend	CAR1 too fast entering corner, lost control due to road conditions ENV: road slippery (rain)	Wet	Overcast	Light Rain	Unknown	Nil		1	3	1765445	5441759
3	58/0/0.1	100	N	SH 2	2955798	06/11/2009	Fri	1010	VAN1 NBD on SH 58 hit rear end of CAR2 stop/slow for queue	VAN1 too fast at temporary speed limit, failed to notice roadworks signs ENV: road surface under construction or maintenance	Dry	Bright	Fine	Unknown	Nil				1765445	5441759
4	58/0/0.1	100	W	SH 2	201056475	11/10/2010	Mon	1145	SUV1 NBD on SH 58 lost control turning right, SUV1 hit Cliff Bank on right hand bend	SUV1 lost control due to road conditions ENV: road slippery (rain), heavy rain	Wet	Overcast	Heavy Rain	Unknown	Nil				1765445	5441759
5	58/0/0.1	100	W	SH 2	2853671	20/07/2008	Sun	1420	CAR1 NBD on SH 58 lost control turning right, CAR1 hit Cliff Bank on right hand bend	CAR1 lost control under heavy acceleration	Wet	Overcast	Light Rain	Unknown	Nil				1765445	5441759
6	58/0/0.14	80	N	HEBDEN CRESCENT	201150346	23/01/2011	Sun	1345	CAR1 WBD on SH 58 lost control turning right, CAR1 hit Cliff Bank on right hand bend	CAR1 lost control due to road conditions ENV: road slippery (oil/diesel/fuel)	Wet	Overcast	Light Rain	Unknown	Nil				1765480	5441778
7	58/0/0.15	150	W	SH 2	201012528	15/06/2010	Tue	1646	VAN1 WBD on SH 58 lost control turning right, VAN1 hit Cliff Bank on right hand bend	VAN1 lost control under heavy acceleration	Wet	Overcast	Light Rain	Unknown	Nil			1	1765489	5441783
8	58/0/0.2	200	W	SH 2	2813556	02/12/2008	Tue	0755	CAR1 NBD on SH 58 hit rear end of CAR2 stop/slow for queue	CAR1 failed to notice car slowing	Wet	Overcast	Light Rain	Unknown	Nil			1	1765533	5441806
9	58/0/0.359		I	MCDOUGALL GROVE	201056495	05/11/2010	Fri	1341	CAR1 NBD on SH 58 hit CAR2 U-turning from same direction of travel	CAR2 didnt see/look behind when changing lanes, position or direction	Dry	Bright	Fine	T Type Junction	Give Way Sign				1765643	5441917
10	58/0/0.359		I	MCDOUGALL GROVE	2950726	02/03/2009	Mon	1558	CAR1 NBD on SH 58 hit rear of CAR2 turning right from centre line	CAR1 failed to notice car slowing	Dry	Overcast	Fine	T Type Junction	Give Way Sign				1765643	5441917
11	58/0/0.359		I	MCDOUGALL GROVE	201051777	05/04/2010	Mon	1240	CAR1 NBD on SH 58 hit rear of CAR2 turning right from centre line	CAR1 failed to notice car slowing	Dry	Overcast	Fine	T Type Junction	Give Way Sign				1765643	5441917
12	58/0/0.359		I	MCDOUGALL GROVE	201155382	25/12/2011	Sun	1920	CAR1 NBD on SH 58 sideswiped by CAR2 turning left	CAR1 overtaking on left CAR2 turned left from near centre line, didnt see/look behind when changing lanes, position or direction, new driver showed inexperience	Dry	Bright	Fine	T Type Junction	Give Way Sign				1765643	5441917
13	58/0/0.639	280	N	MCDOUGALL GROVE	201152234	25/04/2011	Mon	1928	CAR1 SBD on SH 58 lost control turning right, CAR1 went Over Bank, Tree on right hand bend	CAR1 alcohol suspected, too fast entering corner, lost control when turning	Wet	Dark	Fine	Unknown	Nil				1765873	5442074
14	58/0/0.659	300	N	MCDOUGALL GROVE	201012056	11/06/2010	Fri	2118	CAR1 SBD on SH 58 lost control turning right, CAR1 hit Cliff Bank on right hand bend	CAR1 too fast entering corner, worn tread on tyre ENV: road slippery (rain)	Wet	Dark	Mist	Unknown	Nil			1	1765887	5442089
15	58/0/0.696	240	S	HUGH DUNCAN ST	201154716	04/11/2011	Fri	1046	CAR1 NBD on SH 58 lost control turning left, CAR1 hit Cliff Bank, Over Bank, Tree	CAR1 alcohol test below limit, lost control due to road conditions, new driver showed inexperience ENV: road slippery (rain)	Wet	Overcast	Fine	Unknown	Nil				1765910	5442119

Key	First Street	Distance D/I/R	Second street or landmark	Crash Number	Date DD/MM/YYYY	Day DDD	Time HHMM	Description of Events	Crash Factors (ENV = Environmental factors)	Road	Natural Light	Weather	Junction	Cntrl	Tot Inj FAT	Tot Inj SER	Tot Inj MIN	Map Coordinates Easting	Map Coordinates Northing
16	58/0/0.7 HAYWARDS HILL ROAD	700N	WESTERN HUTT ROAD	201254042	06/09/2012	Thu	2300	CAR1 NBD on SH 58 HAYWARDS HILL ROAD lost control turning left, CAR1 hit Cliff Bank	CAR1 too fast entering corner, stolen vehicle	Dry	Dark	Fine	Unknown	Nil				1765911	5442122
17	58/0/0.736	200S	HUGH DUNCAN ST	201113150	19/11/2011	Sat	0720	SUV1 NBD on SH 58 swinging wide hit CAR2 head on	SUV1 too fast entering corner, suddenly swerved to avoid vehicle, didnt see/look when visibility limited by roadside features	Wet	Overcast	Light Rain	Unknown	Nil			1	1765927	5442154
18	58/0/0.746	190S	HUGH DUNCAN ST	201212706	07/10/2012	Sun	1019	MOTOR CYCLE1 NBD on SH 58 hit rear end of CAR2 stopped/moving slowly	MOTOR CYCLE1 lost control, following too closely CAR2 travelling unreasonably slowly	Dry	Bright	Fine	Unknown	Nil		1		1765930	5442164
19	58/0/0.836	100S	HUGH DUNCAN ST	2956881	29/12/2009	Tue	0015	CAR1 SBD on SH 58 lost control turning right, CAR1 hit Guard Rail on right hand bend	CAR1 fatigue (drowsy, tired, fell asleep)	Wet	Dark	Light Rain	Unknown	Nil				1765957	5442249
20	HUGH DUNCAN ST	I	58/0/0.936	2956058	06/11/2009	Fri	0012	CAR1 EBD on HUGH DUNCAN ST hit parked veh, CAR1 hit Parked Vehicle	CAR1 alcohol test below limit, too fast entering corner, evading enforcement	Dry	Dark	Fine	T Type Junction	Nil				1766005	5442337
21	58/0/0.976	40E	HUGH DUNCAN ST	2955761	25/10/2009	Sun	1540	MOTOR CYCLE1 NBD on SH 58 lost control on curve and hit CAR2 head on	MOTOR CYCLE1 lost control avoiding another vehicle, did not see or look for other party until too late	Dry	Bright	Fine	Unknown	Nil				1766021	5442374
22	58/0/1	1000N	SH 2	2912042	01/06/2009	Mon	0910	CAR1 NBD on SH 58 changing lanes to left hit VEHB, CAR1 hit Post Or Pole	CAR1 too far left/right	Dry	Overcast	Fine	Unknown	Nil			1	1766028	5442396
23	58/0/1.016	80N	HUGH DUNCAN ST	201051895	15/05/2010	Sat	1724	CAR1 NBD on SH 58 lost control; went off road to right, CAR1 hit Guard Rail	CAR1 too fast for conditions	Wet	Dark	Light Rain	Unknown	Nil				1766032	5442412
24	58/0/1.036	100N	HUGH DUNCAN ST	2854626	08/08/2008	Fri	0830	SUV1 SBD on SH 58 hit VAN2 U-turning from same direction of travel	VAN2 didnt see/look behind when changing lanes, position or direction ENV: visibility limited by curve	Wet	Overcast	Heavy Rain	Unknown	Nil				1766036	5442432
25	58/0/1.236	300N	HUGH DUNCAN ST	201011048	23/01/2010	Sat	1215	VAN1 NBD on SH 58 lost control turning left, VAN1 hit Guard Rail	VAN1 too fast entering corner, lost control due to road conditions ENV: road slippery (rain)	Wet	Overcast	Light Rain	Unknown	Nil			1	1766076	5442627
26	58/0/1.336	400N	HUGH DUNCAN ST	201052050	17/05/2010	Mon	1625	MOTOR CYCLE1 NBD on SH 58 lost control but did not leave the road	MOTOR CYCLE1 lost control due to road conditions ENV: road slippery (oil/diesel/fuel)	Wet	Twilight	Light Rain	Unknown	Nil				1766068	5442726
27	58/0/1.356	40S	OLD HAYWARDS ROAD	2911857	08/05/2009	Fri	1853	SUV1 NBD on SH 58 lost control turning left, SUV1 hit Cliff Bank	SUV1 lost control when turning	Wet	Dark	Light Rain	Unknown	Nil			1	1766061	5442744
28	58/0/1.393 HAYWARDS HILL ROAD	100N	ATIAMURI CRESCENT	201253532	22/09/2012	Sat	1720	VAN1 SBD on SH 58 HAYWARDS HILL ROAD lost control turning right, VAN1 hit Fence on right hand bend	VAN1 lost control due to vehicle fault, suspension failure	Dry	Overcast	Fine	Unknown	Nil				1766044	5442777
29	58/0/1.456	60N	OLD HAYWARDS ROAD	2953109	24/06/2009	Wed	0630	CAR1 SBD on SH 58 lost control turning left, CAR1 hit Guard Rail	CAR1 lost control due to road conditions ENV: road slippery (frost or ice)	Ice/ Snow	Dark	Fine	Unknown	Nil				1766016	5442834
30	58/0/1.48	1480N	SH 2	2956414	02/12/2009	Wed	0728	SUV1 NBD on SH 58 lost control turning right, SUV1 hit Cliff Bank on right hand bend	SUV1 lost control, new driver showed inexperience, worn tread on tyre	Wet	Overcast	Fine	Unknown	Nil				1766009	5442856
31	58/0/1.576	640N	HUGH DUNCAN ST	201051947	30/04/2010	Fri	1624	VAN1 NBD on SH 58 lost control turning right, VAN1 hit Cliff Bank on right hand bend	VAN1 too fast entering corner, lost control due to road conditions ENV: road slippery (rain)	Wet	Overcast	Heavy Rain	Unknown	Nil				1765995	5442952

Key	First Street	Distance, D/I/R	Second street or landmark	Crash Number	Date DD/MM/YYYY	Day DDD	Time HHMM	Description of Events	Crash Factors (ENV = Environmental factors)	Road	Natural Light	Weather	Junction	Cntrl	Tot Inj FAT	Tot Inj SER	Tot Inj MIN	Map Coordinates Easting	Map Coordinates Northing
32	58/0/1.576	640N	HUGH DUNCAN ST	2957082	11/12/2009	Fri	0925	CAR1 NBD on SH 58 lost control while overtaking, CAR1 hit Traffic Sign	CAR1 too fast entering corner, lost control due to road conditions ENV: road slippery (rain)	Wet	Overcast	Heavy Rain	Unknown	Nil				1765995	5442952
33	58/0/1.596	200N	OLD HAYWARDS ROAD	201152188	15/04/2011	Fri	1920	CAR1 NBD on SH 58 lost control turning left, CAR1 hit Guard Rail	CAR1 lost control when turning ENV: road slippery (loose material on seal)	Wet	Dark	Light Rain	Unknown	Nil				1765992	5442971
34	58/0/1.676	280N	OLD HAYWARDS ROAD	201211298	18/02/2012	Sat	1018	CYCLIST1 (Age 53) SBD on SH 58 lost control but did not leave the road, CYCLIST1 hit Other	CYCLIST1 inattentive, obstruction on roadway	Dry	Bright	Fine	Unknown	Nil			1	1765980	5443051
35	58/0/1.706	770N	HUGH DUNCAN ST	201054160	03/08/2010	Tue	1736	load or trailer from TRUCK1 SBD on SH 58 hit CAR2 CAR2 hit Debris	TRUCK1 load not well secured or moved	Dry	Twilight	Fine	Unknown	Nil				1765976	5443080
36	58/0/1.706	770N	HUGH DUNCAN ST	201250023	01/01/2012	Sun	1512	CAR1 SBD on SH 58 lost control turning left, CAR1 hit Guard Rail	CAR1 lost control when turning, attention diverted ENV: slippery	Wet	Overcast	Light Rain	Unknown	Nil				1765976	5443080
37	58/0/1.8	1800W	SH 2	201251836	09/06/2012	Sat	1059	CAR1 SBD on SH 58 lost control turning right on right hand bend	CAR1 lost control while returning to seal from unsealed shoulder	Dry	Bright	Fine	Unknown	Nil				1765951	5443171
38	58/0/1.9	1900N	SH 2	201012701	14/06/2010	Mon	0628	CAR1 NBD on SH 58 lost control turning right, CAR1 hit Cliff Bank on right hand bend	CAR1 too fast entering corner, lost control due to road conditions ENV: road slippery (frost or ice)	Ice/ Snow	Dark	Fine	Unknown	Nil			1	1765927	5443267
39	58/0/1.92	1920N	SH 2	2950911	27/04/2009	Mon	0800	VAN1 NBD on SH 58 changing lanes/overtaking to right hit CAR2 CAR2 hit Guard Rail	VAN1 didnt see/look behind when changing lanes, position or direction	Wet	Overcast	Fine	Unknown	Nil				1765926	5443287
40	58/0/1.936	1000N	HUGH DUNCAN ST	201153588	03/08/2011	Wed	1720	CAR1 SBD on SH 58 changing lanes to left hit CAR2	CAR1 cut in after overtaking, inattentive	Dry	Overcast	Fine	Unknown	N/A				1765924	5443303
41	58/0/1.94	1940W	SH 2	201010038	24/03/2010	Wed	1231	VAN1 WBD on SH 58 lost control while overtaking, CAR2 hit Cliff Bank	VAN1 lost control due to vehicle fault, attention diverted by cell phone, worn tread on tyre ENV: road slippery (rain)	Wet	Overcast	Heavy Rain	Unknown	Nil	1		2	1765925	5443307
42	58/0/2 HAYWARDS HILL	2000N	WESTERN HUTT ROAD	201252011	05/06/2012	Tue	1535	CAR1 SBD on SH 58 HAYWARDS HILL lost control turning right, CAR1 hit Guard Rail on right hand bend	CAR1 too fast entering corner, failed to notice bend in road ENV: road slippery (rain)	Wet	Overcast	Fine	Unknown	Nil				1765943	5443364
43	58/0/2.053 HAYWARDS HILL ROAD	900S	MOUNT CECIL ROAD	201253565	05/10/2012	Fri	1415	CAR1 SBD on SH 58 HAYWARDS HILL ROAD lost control turning right, CAR1 hit Guard Rail, Tree on right hand bend	CAR1 lost control while returning to seal from unsealed shoulder, lost control end of seal	Dry	Overcast	Fine	Unknown	Nil				1765971	5443409
44	58/0/2.136	1200N	HUGH DUNCAN ST	201054312	14/07/2010	Wed	0716	VAN1 WBD on SH 58 lost control turning right, VAN1 hit Guard Rail on right hand bend	VAN1 lost control due to road conditions ENV: road slippery (frost or ice)	Ice/ Snow	Overcast	Fine	Unknown	Nil				1766021	5443475
45	58/0/2.153	800S	MOUNT CECIL ROAD	201152692	15/07/2011	Fri	0755	CAR1 NBD on SH 58 lost control turning left, CAR1 hit Cliff Bank, Guard Rail	CAR1 lost control when turning	Dry	Bright	Fine	Unknown	Nil				1766029	5443490
46	58/0/2.196	800N	OLD HAYWARDS ROAD	2951857	17/04/2009	Fri	0830	TRUCK1 NBD on SH 58 changing lanes to left hit CAR2	TRUCK1 misjudged speed of own vehicle	Dry	Bright	Fine	Unknown	Nil				1766043	5443530
47	58/0/2.196	800N	OLD HAYWARDS ROAD	2850780	07/02/2008	Thu	0740	CAR1 SBD on SH 58 lost control turning right, CAR1 hit Guard Rail on right hand bend	CAR1 alcohol test above limit or test refused, fatigue (drowsy, tired, fell asleep)	Dry	Bright	Fine	Unknown	Nil				1766043	5443530
48	58/0/2.203	750S	MOUNT CECIL ROAD	201152615	12/07/2011	Tue	1535	CAR1 SBD on SH 58 lost control turning right, CAR1 hit Guard Rail on right hand bend	CAR1 alcohol test above limit or test refused, lost control while returning to seal from unsealed shoulder	Dry	Overcast	Fine	Unknown	Nil				1766045	5443537

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49	58/0/2.203	750	S	MOUNT CECIL ROAD	2910012	05/02/2009	Thu	0954	MOTOR CYCLE1 NBD on SH 58 hit VAN2 U-turning from same direction of travel	MOTOR CYCLE1 alcohol not suspected, tested and -ve (MoT use only) VAN2 didnt see/look behind when changing lanes, position or direction, didnt see/look when visibility limited by roadside features ENV: visibility limited by curve	Dry	Bright	Fine	Unknown	Nil	1			1766045	5443537
50	58/0/2.216 HAYWARDS HILL	820	N	OLD HAYWARDS ROAD	201053065	17/06/2010	Thu	1145	CAR1 SBD on SH 58 HAYWARDS HILL lost control turning right, CAR1 hit Tree on right hand bend	CAR1 lost control due to road conditions ENV: road slippery (oil/diesel/fuel)	Wet	Overcast	Fine	Unknown	Nil				1766047	5443550
51	58/0/2.296	900	N	OLD HAYWARDS ROAD	201050767	12/02/2010	Fri	1530	CAR1 NBD on SH 58 lost control while overtaking, CAR1 hit Fence	CAR1 lost control when turning	Wet	Overcast	Heavy Rain	Unknown	Nil				1766060	5443629
52	58/0/2.553 HAYWARDS HILL ROAD	400	S	MOUNT CECIL ROAD	201254508	06/12/2012	Thu	1847	CAR1 SBD on SH 58 HAYWARDS HILL ROAD lost control turning right, CAR1 hit Tree on right hand bend	CAR1 too far left/right, lost control when turning	Wet	Overcast	Fine	Unknown	Nil				1766137	5443873
53	58/0/2.653	300	S	MOUNT CECIL ROAD	201050543	03/01/2010	Sun	2129	SUV1 SBD on SH 58 lost control turning right, SUV1 hit Fence, Post Or Pole, Ditch on right hand bend	SUV1 too far left/right, lost control, new driver showed inexperience	Wet	Dark	Heavy Rain	Unknown	Nil				1766133	5443972
54	58/0/2.653	300	S	MOUNT CECIL ROAD	201211787	14/05/2012	Mon	0907	CAR1 SBD on SH 58 hit rear end of CAR2 stopped/moving slowly	CAR1 too fast entering corner, following too closely, new driver showed inexperience CAR2 suddenly braked ENV: heavy rain	Wet	Overcast	Heavy Rain	Unknown	Nil			1	1766133	5443972
55	58/0/2.853	100	E	MOUNT CECIL ROAD	2850778	01/03/2008	Sat	1750	CAR1 WBD on SH 58 hit rear end of CAR2 stop/slow for queue	CAR1 too fast entering corner, misjudged speed of own vehicle ENV: heavy rain	Wet	Overcast	Heavy Rain	Unknown	Nil				1766064	5444156
56	58/0/2.853 HAYWARDS HILL ROAD	100	S	MOUNT CECIL ROAD	201212887	12/11/2012	Mon	0818	CAR1 SBD on SH 58 HAYWARDS HILL ROAD lost control while overtaking, CAR1 hit Post Or Pole, Tree, Ditch	CAR1 too fast entering corner, lost control due to road conditions, new driver showed inexperience	Wet	Overcast	Light Rain	Unknown	Nil			1	1766064	5444156
57	58/0/3.353	400	N	MOUNT CECIL ROAD	2956654	13/12/2009	Sun	1209	CAR1 NBD on SH 58 lost control; went off road to left, CAR1 hit Cliff Bank, Ditch	CAR1 too fast on straight, jack-knifed	Dry	Overcast	Fine	Unknown	Nil				1765904	5444622
58	58/0/3.448	1300	S	HARRIS ROAD	201111775	26/05/2011	Thu	1429	CAR1 SBD on SH 58 lost control turning right, CAR1 hit Fence, Post Or Pole on right hand bend	CAR1 alcohol test below limit, too fast for conditions, driving unfamiliar vehicle	Wet	Bright	Heavy Rain	Unknown	Nil			1	1765877	5444713
59	58/0/3.553	600	N	MOUNT CECIL ROAD	2850775	01/03/2008	Sat	1720	CAR1 EBD on SH 58 lost control turning right, CAR1 hit Cliff Bank on right hand bend	CAR1 too fast entering corner, lost control due to road conditions ENV: road slippery (rain), heavy rain	Wet	Overcast	Heavy Rain	Unknown	Nil				1765843	5444813
60	58/0/3.553	600	W	MOUNT CECIL ROAD	201011257	10/02/2010	Wed	1546	CAR1 SBD on SH 58 lost control turning right, CAR1 hit Fence on right hand bend	CAR1 lost control	Wet	Overcast	Light Rain	Unknown	Nil			1	1765843	5444813
61	58/0/3.553 HAYWARDS HILL	600	N	MOUNT CECIL ROAD	201152484	11/06/2011	Sat	1240	SUV1 SBD on SH 58 HAYWARDS HILL lost control turning right, SUV1 hit Fence, Post Or Pole on right hand bend	SUV1 lost control when turning, lost control while returning to seal from unsealed shoulder	Wet	Overcast	Fine	Unknown	Nil				1765843	5444813
62	58/0/3.553 HAYWARDS HILL ROAD	600	N	MOUNT CECIL ROAD	201212480	21/08/2012	Tue	1046	VAN1 SBD on SH 58 HAYWARDS HILL ROAD lost control turning left, VAN1 hit Cliff Bank	VAN1 too fast for conditions, lost control while returning to seal from unsealed shoulder	Dry	Bright	Fine	Unknown	Nil			1	1765843	5444813

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63	58/0/3.553 HAYWARDS HILL ROAD	600N	MOUNT CECIL ROAD	201254966	05/12/2012	Wed	1804	VAN1 SBD on SH 58 HAYWARDS HILL ROAD cutting corner hit SUV2 head on, VAN1 hit Cliff Bank	VAN1 too fast entering corner, cutting corner on bend	Wet	Overcast	Fine	Unknown	Nil		1765843	5444813
64	58/0/3.613	2680E	MOONSHINE ROAD	201250601	04/03/2012	Sun	1120	CAR1 EBD on SH 58 lost control turning right, CAR1 hit Fence on right hand bend	CAR1 too fast entering corner, lost control due to road conditions ENV: road slippery (rain)	Wet	Overcast	Light Rain	Unknown	Nil		1765811	5444863
65	58/0/3.653	700N	MOUNT CECIL ROAD	201151540	15/04/2011	Fri	1528	SUV1 SBD on SH 58 lost control turning right, SUV1 went Over Bank, Fence on right hand bend	SUV1 too fast entering corner, lost control due to road conditions ENV: road slippery (rain)	Wet	Overcast	Fine	Unknown	Nil		1765788	5444896
66	58/0/3.653	700N	MOUNT CECIL ROAD	201250828	22/01/2012	Sun	1633	CAR1 SBD on SH 58 lost control turning right, CAR1 hit Cliff Bank on right hand bend	CAR1 too fast entering corner, lost control when turning, inattentive	Dry	Bright	Fine	Unknown	Nil		1765788	5444896
67	58/0/3.653	700N	MOUNT CECIL ROAD	201052846	30/04/2010	Fri	1732	CAR1 SBD on SH 58 lost control turning right, CAR1 hit Fence on right hand bend	CAR1 too fast entering corner, failed to notice warning sign	Wet	Dark	Fine	Unknown	Nil		1765788	5444896
68	58/0/3.653 HAYWARDS HILL ROAD	700N	MOUNT CECIL ROAD	201252466	15/07/2012	Sun	2105	CAR1 SBD on SH 58 HAYWARDS HILL ROAD lost control turning right, CAR1 hit Fence, Ditch on right hand bend	CAR1 too fast for conditions, lost control when turning	Wet	Dark	Light Rain	Unknown	Nil		1765788	5444896
69	58/0/3.728 HAYWARDS HILL	1020E	HARRIS ROAD	201254654	19/12/2012	Wed	0752	TRUCK1 SBD on SH 58 HAYWARDS HILL lost control turning right, TRUCK1 hit Cliff Bank on right hand bend	TRUCK1 lost control due to road conditions ENV: road slippery (oil/diesel/fuel)	Wet	Overcast	Light Rain	Unknown	Nil		1765738	5444951
70	58/0/3.753	800N	MOUNT CECIL ROAD	201053253	21/07/2010	Wed	1305	CAR1 NBD on SH 58 hit rear end of CAR2 stop/slow for queue	CAR1 failed to notice car slowing, didnt see/look when visibility limited by roadside features ENV: visibility limited by curve	Dry	Overcast	Fine	Unknown	Nil		1765717	5444966
71	58/0/3.753	800N	MOUNT CECIL ROAD	201211770	02/05/2012	Wed	1448	VAN1 SBD on SH 58 lost control turning right, VAN1 hit Fence, Water/River on right hand bend	VAN1 lost control when turning, driving unfamiliar vehicle ENV: slippery	Wet	Overcast	Fine	Unknown	Nil	1	1765717	5444966
72	58/0/3.753	800N	MOUNT CECIL ROAD	201111854	16/04/2011	Sat	1415	CAR1 SBD on SH 58 lost control on curve and hit CAR2 head on	CAR1 too fast entering corner, lost control when turning, driver over-reacted ENV: road slippery (surface bleeding / defective), heavy rain	Wet	Overcast	Heavy Rain	Unknown	Nil	1	1765717	5444966
73	58/0/3.753	800W	MOUNT CECIL ROAD	201151415	16/04/2011	Sat	1216	VAN1 SBD on SH 58 lost control on curve and hit CAR2 head on, CAR3 hit Cliff Bank	VAN1 lost control under heavy braking, lost control due to road conditions ENV: road slippery (rain)	Wet	Overcast	Heavy Rain	Unknown	Nil		1765717	5444966
74	58/0/3.783 HAYWARDS HILL	830N	MOUNT CECIL ROAD	201211888	21/05/2012	Mon	0009	CAR1 NBD on SH 58 HAYWARDS HILL lost control; went off road to right	CAR1 alcohol test above limit or test refused, failed to keep left on straight	Dry	Dark	Fine	Unknown	Nil	1 2	1765692	5444982
75	58/0/3.793	2500E	MOONSHINE ROAD	2954972	01/03/2009	Sun	0001	CAR1 WBD on SH 58 lost control turning left, CAR1 hit Fence	CAR1 fatigue (drowsy, tired, fell asleep)	Dry	Dark	Fine	Unknown	Nil		1765684	5444987
76	58/0/3.953	1000N	MOUNT CECIL ROAD	2811770	10/04/2008	Thu	1135	CAR1 SBD on SH 58 lost control turning right, CAR1 went Over Bank, Fence on right hand bend	CAR1 swung wide on bend	Dry	Bright	Fine	Unknown	Nil	1	1765567	5445094
77	58/0/3.953	1000W	MOUNT CECIL ROAD	2913388	26/10/2009	Mon	0150	SUV1 NBD on SH 58 lost control turning left, SUV1 went Over Bank, Post Or Pole	SUV1 alcohol test above limit or test refused, new driver showed inexperience	Dry	Dark	Fine	Unknown	Nil	1	1765567	5445094

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78	58/0/3.953	1000W	MOUNT CECIL ROAD	201211228	07/02/2012	Tue	1945	SUV1 NBD on SH 58 lost control turning right, SUV1 hit Cliff Bank on right hand bend	SUV1 too fast entering corner, lost control when turning	Wet	Overcast	Light Rain	Unknown	Nil			1	1765567	5445094
79	58/0/3.953 HAYWARDS HILL	1000W	MOUNT CECIL ROAD	201155536	31/12/2011	Sat	2040	CAR1 EBD on SH 58 HAYWARDS HILL lost control on curve and hit CAR2 head on, CAR1 hit Cliff Bank	CAR1 too fast entering corner, lost control when turning, fatigue due to working long hours before driving CAR2 lost control under heavy braking	Wet	Twilight	Fine	Unknown	Nil				1765567	5445094
80	58/0/3.953 HAYWARDS HILL ROAD	1000N	MOUNT CECIL ROAD	201254485	16/12/2012	Sun	1137	CAR1 EBD on SH 58 HAYWARDS HILL ROAD lost control turning left, CAR1 went Over Bank, Fence, Post Or Pole	CAR1 alcohol test above limit or test refused, lost control when turning, attention diverted by cigarette etc	Dry	Bright	Fine	Unknown	Nil				1765567	5445094
81	58/0/4.143	2150S	MOONSHINE ROAD	201012695	25/02/2010	Thu	2330	MOTOR CYCLE1 NBD on SH 58 lost control; went off road to left	MOTOR CYCLE1 illness with no warning (eg heart attack)	Dry	Dark	Fine	Unknown	Nil		1		1765491	5445267
82	58/0/4.183	2110S	MOONSHINE ROAD	201013710	09/12/2010	Thu	1445	CAR1 NBD on SH 58 swinging wide hit CAR2 head on, CAR1 hit Fence, CAR2 hit Cliff Bank	CAR1 swung wide on bend	Dry	Bright	Fine	Unknown	Nil			1	1765475	5445304
83	58/0/4.188 HAYWARDS HILL ROAD	560S	HARRIS ROAD	201212564	21/08/2012	Tue	1734	CAR1 SBD on SH 58 HAYWARDS HILL ROAD lost control turning right, CAR1 hit Cliff Bank on right hand bend	CAR1 too fast entering corner, lost control due to road conditions ENV: road slippery (rain)	Wet	Twilight	Fine	Unknown	Nil			1	1765472	5445307
84	58/0/4.248	500E	HARRIS ROAD	2957096	05/11/2009	Thu	0341	VAN1 NBD on SH 58 lost control turning left, VAN1 hit Fence	VAN1 alcohol test above limit or test refused	Wet	Dark	Light Rain	Unknown	Nil				1765431	5445351
85	58/0/4.348 HAYWARDS HILL ROAD	400S	HARRIS ROAD	201253493	08/09/2012	Sat	0735	CAR1 SBD on SH 58 HAYWARDS HILL ROAD lost control turning right, CAR1 hit Cliff Bank, Fence on right hand bend	CAR1 too fast entering corner, lost control when turning	Wet	Overcast	Light Rain	Unknown	Nil				1765358	5445418
86	58/0/4.453	1500N	MOUNT CECIL ROAD	201056857	17/12/2010	Fri	0850	SUV1 SBD on SH 58 lost control turning right, SUV1 hit Fence on right hand bend	SUV1 too fast entering corner, lost control when turning ENV: road slippery (rain)	Wet	Overcast	Heavy Rain	Unknown	Nil				1765265	5445468
87	58/0/4.548 HAYWARDS HILL	200E	HARRIS ROAD	201211910	30/05/2012	Wed	1515	CAR1 EBD on SH 58 HAYWARDS HILL lost control; went off road to left, CAR1 hit Fence, Post Or Pole	CAR1 lost control, illness with no warning (eg heart attack)	Dry	Bright	Fine	Unknown	Nil			1	1765182	5445513
88	58/0/4.648	100E	HARRIS ROAD	2957127	18/08/2009	Tue	2025	CAR1 SBD on SH 58 lost control; went off road to left	CAR1 lost control	Wet	Dark	Heavy Rain	Unknown	Nil				1765095	5445562
89	58/0/4.723 HAYWARDS HILL ROAD	25S	HARRIS ROAD	201254305	26/10/2012	Fri	1400	VAN1 NBD on SH 58 HAYWARDS HILL ROAD changing lanes to left hit TRUCK2	VAN1 cut in after overtaking, emotionally upset/road rage TRUCK2 lost control under heavy braking, emotionally upset/road rage	Dry	Bright	Fine	Unknown	Nil				1765029	5445599
90	58/0/4.798	50N	HARRIS ROAD	2913111	01/10/2009	Thu	2120	CAR1 NBD on SH 58 lost control turning right, CAR1 hit Cliff Bank on right hand bend	CAR1 alcohol test above limit or test refused	Dry	Dark	Fine	Unknown	Nil		1		1764963	5445634
91	58/0/4.878	130W	HARRIS ROAD	201150550	02/03/2011	Wed	0700	CAR1 EBD on SH 58 lost control; went off road to left, CAR1 hit Fence, Post Or Pole	CAR1 lost control avoiding another vehicle, new driver showed inexperience	Wet	Overcast	Light Rain	Unknown	Nil				1764893	5445673

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92	58/0/4.948	200N	HARRIS ROAD	2851746	29/02/2008	Fri	1909	CAR1 NBD on SH 58 lost control turning right, CAR1 hit Guard Rail on right hand bend	CAR1 too fast entering corner, lost control due to vehicle fault	Dry	Overcast	Fine	Unknown	Nil				1764832	5445707
93	58/0/5.293	1000E	MOONSHINE ROAD	2913619	29/12/2009	Tue	0553	CAR1 WBD on SH 58 lost control; went off road to right, CAR1 hit Tree, Ditch	CAR1 alcohol test above limit or test refused, too fast for conditions, new driver showed inexperience	Wet	Overcast	Heavy Rain	Unknown	Nil			1	1764641	5445986
94	58/0/5.493	800E	MOONSHINE ROAD	201250850	01/04/2012	Sun		load or trailer from TRUCK1 SBD on SH 58	TRUCK1 lost control when turning, inattentive, load too heavy	Dry	Bright	Fine	Unknown	Nil				1764562	5446170
95	58/0/5.623 PAREMATA-HAYWARDS	670E	MOONSHINE ROAD	201112745	08/09/2011	Thu	1610	CAR1 EBD on SH 58 PAREMATA-HAYWARDS hit CAR2 U-turning from same direction of travel	CAR1 suddenly swerved to avoid vehicle CAR2 inattentive, didnt see/look behind when changing lanes, position or direction	Dry	Overcast	Fine	Unknown	Nil			2	1764495	5446280
96	58/0/5.643	650E	MOONSHINE ROAD	2913507	06/12/2009	Sun	1855	CAR1 SBD on SH 58 lost control on curve and hit CAR2 head on	CAR1 lost control due to road conditions ENV: road slippery (oil/diesel/fuel)	Dry	Overcast	Light Rain	Unknown	Nil			2	1764481	5446295
97	58/0/5.893	400S	MOONSHINE ROAD	2911544	04/02/2009	Wed	2225	CAR1 NBD on SH 58 lost control turning left, CAR1 hit House Or Bldg	CAR1 alcohol test above limit or test refused, attention diverted by cell phone, new driver showed inexperience	Wet	Dark	Fine	Unknown	Nil			1	1764258	5446391
98	58/0/6.193	100E	MOONSHINE ROAD	2951793	16/04/2009	Thu	0620	CAR1 EBD on SH 58 lost control turning right, CAR1 hit Fence, Ditch on right hand bend	CAR1 lost control while returning to seal from unsealed shoulder, fatigue (drowsy, tired, fell asleep)	Dry	Twilight	Fine	Unknown	Nil				1763963	5446443
99	58/0/6.193	100E	MOONSHINE ROAD	201211638	19/03/2012	Mon	1625	CAR1 EBD on SH 58 lost control turning right, CAR1 hit Fence, Tree on right hand bend	CAR1 too fast entering corner, lost control due to road conditions, new driver showed inexperience ENV: road slippery (rain)	Wet	Overcast	Light Rain	Unknown	Nil			1	1763963	5446443
100	58/0/6.193	100E	MOONSHINE ROAD	201053895	09/06/2010	Wed	0700	CAR1 EBD on SH 58 lost control turning right, CAR1 hit Fence on right hand bend	CAR1 too fast entering corner, lost control due to road conditions, attention diverted by cigarette etc ENV: road slippery (rain)	Wet	Overcast	Light Rain	Unknown	Nil				1763963	5446443
101	58/0/6.243	50E	MOONSHINE ROAD	201111464	01/02/2011	Tue	0752	SUV1 EBD on SH 58 hit rear end of CYCLIST2 (Age 37) stopped/moving slowly	SUV1 too far left/right, inattentive	Dry	Bright	Fine	Unknown	Nil		1		1763914	5446449
102	58/0/6.243	50E	MOONSHINE ROAD	201152923	10/07/2011	Sun	1630	CAR1 NBD on SH 58 lost control turning left, CAR1 hit Cliff Bank	CAR1 lost control due to road conditions ENV: road slippery (rain)	Wet	Overcast	Heavy Rain	Unknown	Nil				1763914	5446449
103	58/0/6.293	I	MOONSHINE ROAD	201056167	25/09/2010	Sat	1558	CAR1 WBD on SH 58 lost control turning left, CAR1 hit Fence	CAR1 lost control avoiding another vehicle SUV2 failed to give way at give way sign, misjudged speed etc of vehicle coming from another dirn with right of way	Dry	Overcast	Fine	T Type Junction	Give Way Sign				1763864	5446445
104	58/0/6.293	I	MOONSHINE ROAD	201155694	17/12/2011	Sat	0450	CAR1 WBD on SH 58 lost control turning left, CAR1 hit Fence	CAR1 alcohol test above limit or test refused, too fast entering corner, lost control when turning	Wet	Dark	Light Rain	T Type Junction	Give Way Sign				1763864	5446445
105	58/0/6.293	I	MOONSHINE ROAD	2953823	12/07/2009	Sun	0330	CAR1 WBD on SH 58 lost control turning left, CAR1 hit Fence	CAR1 alcohol test below limit, too fast entering corner, worn tread on tyre	Wet	Dark	Light Rain	T Type Junction	Give Way Sign				1763864	5446445
106	58/0/6.303 HAYWARDS HILL ROAD	10W	MOONSHINE ROAD	201212681	22/09/2012	Sat	1254	CAR1 EBD on SH 58 HAYWARDS HILL ROAD lost control on curve and hit VAN2 head on	CAR1 lost control, medical illness (not sudden eg flu), mental illness (eg depression)	Dry	Bright	Fine	T Type Junction	Give Way Sign		1	2	1763854	5446443

Key	First Street	Distance / D I R / Second street or landmark	Crash Number	Date DD/MM/YYYY	Day DDD	Time HHMM	Description of Events	Crash Factors (ENV = Environmental factors)	Road	Natural Light	Weather	Junction	Cntrl	Tot Inj F A T	Tot Inj S E R	Tot Inj M I N	Map Coordinates Easting	Map Coordinates Northing
107	58/0/6.693	400W MOONSHINE ROAD	2957068	05/11/2009	Thu	1540	CAR1 WBD on SH 58 lost control turning right on right hand bend	CAR1 lost control due to vehicle fault, wheel off	Dry	Bright	Fine	Unknown	Nil				1763558	5446199
108	58/0/6.915 HAYWARDS HILL ROAD	370E MULHERN ROAD	201252910	16/08/2012	Thu	1540	CAR1 WBD on SH 58 HAYWARDS HILL ROAD hit SUV2 turning right onto SH 58 HAYWARDS HILL ROAD from the left	SUV2 alcohol test below limit, failed to give way at driveway ENV: entering or leaving other non-commercial	Dry	Bright	Fine	Driveway	Nil				1763342	5446198
109	58/0/6.946	340E MULHERN ROAD	201013405	15/11/2010	Mon	1747	CAR1 WBD on SH 58 hit SUV2 turning right onto SH 58 from the left	SUV2 failed to give way at driveway, didnt see/look when visibility limited by roadside features ENV: visibility limited, entering or leaving other commercial	Dry	Bright	Fine	Driveway	Nil			1	1763314	5446205
110	58/0/6.963	670W MOONSHINE ROAD	201150161	12/01/2011	Wed	1735	CAR1 EBD on SH 58 hit rear of SUV2 turning right from centre line	CAR1 failed to notice car slowing, new driver showed inexperience, worn tread on tyre ENV: entering or leaving other commercial	Dry	Bright	Fine	Driveway	Nil				1763297	5446210
111	58/0/7.036	250E MULHERN ROAD	201056592	23/11/2010	Tue	0745	CAR1 WBD on SH 58 hit SUV2 headon on straight	CAR1 too far left/right, overtaking	Dry	Overcast	Fine	Unknown	Nil				1763227	5446229
112	58/0/7.063	770W MOONSHINE ROAD	201253824	25/10/2012	Thu	0715	load or trailer from TRUCK1 WBD on SH 58 hit CAR2	TRUCK1 load	Dry	Overcast	Fine	Unknown	Nil				1763200	5446237
113	58/0/7.086	200E MULHERN ROAD	2953285	18/05/2009	Mon	1000	CAR1 WBD on SH 58 hit rear end of CAR2 stopped/moving slowly	CAR1 following too closely	Wet	Overcast	Light Rain	Unknown	Nil				1763179	5446243
114	58/0/7.116 PAREMATA-HAYWARDS	170E MULHERN ROAD	201112520	29/05/2011	Sun	1424	MOTOR CYCLE1 WBD on SH 58 PAREMATA-HAYWARDS lost control while overtaking	MOTOR CYCLE1 alcohol test result unknown, lost control under heavy acceleration	Dry	Bright	Fine	Unknown	Nil		1		1763150	5446250
115	58/0/7.186	100E MULHERN ROAD	2813592	09/12/2008	Tue	2036	CAR1 WBD on SH 58 lost control; went off road to right, CAR1 hit Fence, Tree	CAR1 alcohol suspected, lost control	Dry	Dark	Fine	Unknown	Nil		1		1763082	5446269
116	58/0/7.436	150W MULHERN ROAD	201054981	06/10/2010	Wed	1750	TRUCK1 EBD on SH 58 hit VAN2 doing driveway manoeuvre	TRUCK1 following too closely, failed to notice car slowing ENV: entering or leaving other commercial	Dry	Bright	Fine	Unknown	Nil				1762842	5446338
117	58/0/7.486	200W MULHERN ROAD	2913581	14/12/2009	Mon	2355	CAR1 EBD on SH 58 lost control; went off road to left, CAR1 went Over Bank	CAR1 alcohol suspected, attention diverted by cell phone ENV: surface	Dry	Dark	Fine	Unknown	Nil			1	1762794	5446352
118	58/0/7.736	450W MULHERN ROAD	2853492	25/03/2008	Tue	1700	CAR2 turning right hit by oncoming CAR1 WBD on SH 58 CAR1 hit Fence	CAR2 failed to give way when turning to non-turning traffic, misjudged speed etc of vehicle coming from another dirn with right of way ENV: entering or leaving other commercial	Dry	Bright	Fine	Driveway	Nil				1762554	5446423
119	58/0/7.823	200E MURPHYS ROAD	2813777	21/11/2008	Fri	1846	MOTOR CYCLE1 EBD on SH 58 overtaking hit VAN2 turning right	MOTOR CYCLE1 misjudged intentions of another party VAN2 didnt see/look behind when changing lanes, position or direction	Dry	Overcast	Fine	Unknown	Nil			1	1762470	5446447
120	58/0/7.873	150E FLIGHTYS ROAD	201051269	28/01/2010	Thu	0730	CAR1 EBD on SH 58 hit rear end of CAR2 stop/slow for queue, CAR1 hit Ditch	CAR1 failed to notice car slowing, attention diverted by cigarette etc, attention diverted by driver dazzled by sun/lights CAR2 suddenly braked ENV: dazzling sun	Dry	Bright	Fine	Unknown	Nil				1762422	5446461
121	58/0/7.986	2000E PAEKAKARIKI HILL ROAD	201111483	16/02/2011	Wed	1430	VAN1 EBD on SH 58 lost control turning left, VAN1 hit Tree, Water/River	VAN1 fatigue due to lack of sleep	Dry	Overcast	Fine	Unknown	Nil			1	1762314	5446493

Key	First Street	Distance	D/I/R	Second street or landmark	Crash Number	Date DD/MM/YYYY	Day DDD	Time HHMM	Description of Events	Crash Factors (ENV = Environmental factors)	Road	Natural Light	Weather	Junction	Cntrl	Tot Inj FAT	Tot Inj SER	Tot Inj MIN	Easting	Northing
122	58/0/8.023		I	FLIGHTYS ROAD	201111774	04/05/2011	Wed	0832	CAR1 EBD on SH 58 hit rear of VAN2 turning right from centre line	CAR1 failed to notice car slowing, did not see or look for other party until too late	Wet	Overcast	Light Rain	X Type Junction	Stop Sign			1	1762279	5446505
123	58/0/8.023		I	FLIGHTYS ROAD	2812108	12/04/2008	Sat	1550	MOTOR CYCLE1 EBD on SH 58 hit rear of CAR2 turning right from centre line, MOTOR CYCLE1 hit Ditch	MOTOR CYCLE1 lost control avoiding another vehicle, following too closely	Dry	Bright	Fine	X Type Junction	Stop Sign			1	1762279	5446505
124	58/0/8.023		I	MURPHYS ROAD	2854295	29/06/2008	Sun	1125	VAN1 EBD on SH 58 hit rear end of VAN2 stop/slow for obstruction, VAN2 hit Ditch	VAN1 following too closely VAN2 windscreen or rear window misted/frosted	Wet	Overcast	Heavy Rain	X Type Junction	Stop Sign				1762279	5446505
125	58/0/8.023		I	MURPHYS ROAD	201013408	04/12/2010	Sat	1134	VAN1 EBD on SH 58 lost control turning right, VAN1 hit Fence, Post Or Pole on right hand bend	VAN1 illness with no warning (eg heart attack)	Dry	Bright	Fine	X Type Junction	Stop Sign			1	1762279	5446505
126	58/0/8.023		I	MURPHYS ROAD	201250021	15/01/2012	Sun	1530	CAR1 EBD on SH 58 hit rear of CAR2 turning right from centre line	CAR1 suddenly swerved to avoid vehicle, failed to notice car slowing, attention diverted by scenery or persons outside vehicle	Dry	Bright	Fine	X Type Junction	Stop Sign				1762279	5446505
127	58/0/8.023 HAYWARDS HILL		I	MURPHYS ROAD	201211557	26/03/2012	Mon	0958	CAR1 EBD on SH 58 HAYWARDS HILL overtaking hit TRUCK2 turning right, CAR1 hit Fence	CAR1 overtaking vehicle signaling right turn, suddenly swerved to avoid vehicle, attention diverted by other traffic	Dry	Bright	Fine	X Type Junction	Stop Sign			1	1762279	5446505
128	58/0/8.404	20	W	BELMONT ROAD	201211759	10/01/2012	Tue	1610	MOTOR CYCLE1 WBD on SH 58 lost control but did not leave the road	MOTOR CYCLE1 lost control, suddenly swerved to avoid object or for unknown reason	Dry	Bright	Fine	Unknown	Nil		1		1761906	5446534
129	58/0/8.764	380	W	BELMONT ROAD	2955241	12/09/2009	Sat	1400	VAN1 EBD on SH 58 lost control turning left	VAN1 lost control when turning, load	Wet	Overcast	Fine	Unknown	Nil				1761559	5446444
130	58/0/8.781	550	S	BRADEY ROAD	201151066	08/04/2011	Fri	0700	CAR1 EBD on SH 58 hit rear of CAR2 turning right from left side	CAR2 turned right from left side of road, didnt see/look behind when changing lanes, position or direction ENV: entering or leaving land use	Wet	Overcast	Fine	Driveway	Nil				1761541	5446443
131	58/0/8.784	400	W	BELMONT ROAD	2952402	20/02/2009	Fri	1520	CAR1 WBD on SH 58 lost control while overtaking, CAR1 hit Tree	CAR1 lost control due to road conditions ENV: road slippery (rain)	Wet	Overcast	Light Rain	Unknown	Nil				1761539	5446443
132	58/0/8.784	400	W	BELMONT ROAD	201012803	20/09/2010	Mon	1721	CAR1 WBD on SH 58 hit CAR2 turning right onto SH 58 from the left	CAR2 failed to give way at driveway, didnt see/look when required to give way to traffic from another direction ENV: entering or leaving other commercial	Dry	Bright	Fine	Driveway	Nil			2	1761539	5446443
133	58/0/9.131 HAYWARDS HILL ROAD	200	S	BRADEY ROAD	201252365	21/06/2012	Thu	1033	VAN1 NBD on SH 58 HAYWARDS HILL ROAD lost control; went off road to left, VAN1 hit Ditch	VAN1 inexperienced at towing trailer / other vehicle, load too heavy	Wet	Overcast	Light Rain	Unknown	Nil				1761278	5446647
134	58/0/9.213		A	PAUATAHANUI NO7 BR	2912698	19/08/2009	Wed	0654	CAR1 WBD on SH 58 lost control on curve and hit CAR2 head on	CAR1 too fast entering corner, lost control under heavy braking ENV: road slippery (rain)	Wet	Twilight	Light Rain	Unknown	Nil		1	2	1761235	5446716
135	58/0/9.331 HAYWARDS HILL		I	BRADEY ROAD	201152182	01/05/2011	Sun	1827	CAR1 NBD on SH 58 HAYWARDS HILL hit obstruction, CAR1 hit Stray Animal	ENV: farm animal straying	Wet	Dark	Fine	T Type Junction	Give Way Sign				1761173	5446817
136	58/0/9.586 HAYWARDS HILL ROAD	400	S	PAEKAKARIKI HILL ROAD	201254498	21/08/2012	Tue	0812	CAR1 SBD on SH 58 HAYWARDS HILL ROAD hit rear end of CAR2 stop/slow for queue	CAR1 following too closely, failed to notice car slowing ENV: road slippery (rain)	Wet	Overcast	Light Rain	Unknown	Nil				1761121	5447065

Key	First Street Distance	D I R	Second street or landmark	Crash Number	Date DD/MM/YYYY	Day DDD	Time HHMM	Description of Events	Crash Factors (ENV = Environmental factors)	Road	Natural Light	Weather	Junction	Cntrl	Tot Inj F S M A E I T R N	Map Coordinates Easting	Northing
137	58/0/9.679 HAYWARDS HILL ROAD	300S	PAEKAKARIKI HILL ROAD	201252147	27/06/2012	Wed	1254	load or trailer from VAN1 NBD on SH 58 HAYWARDS HILL ROAD	VAN1 lost control, new driver showed inexperience, load too heavy	Dry	Bright	Fine	Unknown	Nil		1761095	5447155
138	58/0/9.783	500E	JOSEPH BANKS DRIVE	2950102	03/01/2009	Sat	2150	CAR1 NBD on SH 58 lost control turning left, CAR1 hit Guard Rail	CAR1 too fast entering corner, new driver showed inexperience	Dry	Dark	Fine	Unknown	Nil		1761066	5447255

Key	First Street	DIR Distance	Second street or landmark	Crash Number	Date DD/MM/YYYY	Day DDD	Time HHMM	MVMT	VN VVV T 1 234	Factors and Roles (A is for vehicle 1, B is for veh 2 etc)	OBJECT	CURVE	WET NESS	LIGHT	WTHER	JUNCT	CNTRL	MARK	SPDLMT	Total Inj FAT	Total Inj SER	Total Inj MIN	PED age	CYC age	Map Coordinates	
1	58/0/0.1	40N	HEBDEN CRESCENT	201151771	05/04/2011	Tue	1659	DB	4N1	111A 131A 402A 801	C	M	W	O	L		N	R	100						1765445	5441760
2	58/0/0.1	100N	SH 2	2811053	13/01/2008	Sun	1523	DA	CW1C	111A 135A 801	I	E	W	O	L		N	R	100		1	3			1765445	5441759
3	58/0/0.1	100N	SH 2	2955798	06/11/2009	Fri	1010	FD	VN1C4	116A 339A 817		E	D	B	F		N	C	100						1765445	5441759
4	58/0/0.1	100W	SH 2	201056475	11/10/2010	Mon	1145	DA	4N1	135A 801 901	C	M	W	O	H		N	P	100						1765445	5441759
5	58/0/0.1	100W	SH 2	2853671	20/07/2008	Sun	1420	DA	CN1	133A	C	M	W	O	L		N	C	100						1765445	5441759
6	58/0/0.14	80N	HEBDEN CRESCENT	201150346	23/01/2011	Sun	1345	DA	CW1	135A 806	C	M	W	O	L		N	R	100						1765480	5441778
7	58/0/0.15	150W	SH 2	201012528	15/06/2010	Tue	1646	DA	VW1	133A	C	M	W	O	L		N	R	100			1			1765489	5441783
8	58/0/0.2	200W	SH 2	2813556	02/12/2008	Tue	0755	FD	CN1C	331A		R	W	O	L		N	C	100			1			1765533	5441806
9	58/0/0.359	I	MCDOUGALL GROVE	201056495	05/11/2010	Fri	1341	MC	CN1C	372B		E	D	B	F	T	G	L	100						1765643	5441917
10	58/0/0.359	I	MCDOUGALL GROVE	2950726	02/03/2009	Mon	1558	GD	CN1C	331A		E	D	O	F	T	G	L	100						1765643	5441917
11	58/0/0.359	I	MCDOUGALL GROVE	201051777	05/04/2010	Mon	1240	GD	CN1C	331A		E	D	O	F	T	G	C	100						1765643	5441917
12	58/0/0.359	I	MCDOUGALL GROVE	201155382	25/12/2011	Sun	1920	GB	CN1C	158A 175B 372B 402B		E	D	B	F	T	G	C	100						1765643	5441917
13	58/0/0.639	280N	MCDOUGALL GROVE	201152234	25/04/2011	Mon	1928	DA	CS1	101A 111A 131A	ET	E	W	DN	F		N	L	100						1765873	5442074
14	58/0/0.659	300N	MCDOUGALL GROVE	201012056	11/06/2010	Fri	2118	DA	CS1	111A 632A 801	C	S	W	DO	M		N	C	100			1			1765887	5442089
15	58/0/0.696	240S	HUGH DUNCAN ST	201154716	04/11/2011	Fri	1046	DB	CN1	102A 135A 402A 801	CET	M	W	O	F		N	C	100						1765910	5442119
16	58/0/0.7 HAYWARDS HILL ROAD	700N	WESTERN HUTT ROAD	201254042	06/09/2012	Thu	2300	DB	CN1	111A 517A	C	E	D	DO	F		N	C	100						1765911	5442122
17	58/0/0.736	200S	HUGH DUNCAN ST	201113150	19/11/2011	Sat	0720	BC	4N1CCV	111A 197A 378A		M	W	O	L		N	L	100			1			1765927	5442154
18	58/0/0.746	190S	HUGH DUNCAN ST	201212706	07/10/2012	Sun	1019	FA	MN1C	130A 181A 182B		M	D	B	F		N	L	100		1				1765930	5442164
19	58/0/0.836	100S	HUGH DUNCAN ST	2956881	29/12/2009	Tue	0015	DA	CS1	410A	G	M	W	DN	L		N	N	100						1765957	5442249
20	HUGH DUNCAN ST	I	58/0/0.936	2956058	06/11/2009	Fri	0012	EA	CE1C	102A 111A 514A	M	R	D	DO	F	T	N	N	050						1766005	5442337
21	58/0/0.976	40E	HUGH DUNCAN ST	2955761	25/10/2009	Sun	1540	BF	MN1C	137A 370A		M	D	B	F		N	L	100						1766021	5442374
22	58/0/1	1000N	SH 2	2912042	01/06/2009	Mon	0910	AC	CN1	129A	P	R	D	O	F		N	C	100			1			1766028	5442396
23	58/0/1.016	80N	HUGH DUNCAN ST	201051895	15/05/2010	Sat	1724	CC	CN1	110A	G	R	W	DN	L		N	C	100						1766032	5442412
24	58/0/1.036	100N	HUGH DUNCAN ST	2854626	08/08/2008	Fri	0830	MC	4S1V	372B 831		M	W	O	H		N	L	100						1766036	5442432
25	58/0/1.236	300N	HUGH DUNCAN ST	201011048	23/01/2010	Sat	1215	DB	VN1M	111A 135A 801	G	E	W	O	L		N	C	100			1			1766076	5442627
26	58/0/1.336	400N	HUGH DUNCAN ST	201052050	17/05/2010	Mon	1625	CA	MN1	135A 806		E	W	TF	L		N	R	100						1766068	5442726
27	58/0/1.356	40S	OLD HAYWARDS ROAD	2911857	08/05/2009	Fri	1853	DB	4N1	131A	C	E	W	DN	L		N	L	100			1			1766061	5442744
28	58/0/1.393 HAYWARDS HILL ROAD	100N	ATIAMURI CRESCENT	201253532	22/09/2012	Sat	1720	DA	VS1	136A 662A	F	E	D	O	F		N	C	100						1766044	5442777
29	58/0/1.456	60N	OLD HAYWARDS ROAD	2953109	24/06/2009	Wed	0630	DB	CS1	135A 802	G	M	I	DN	F		N	R	100						1766016	5442834
30	58/0/1.48	1480N	SH 2	2956414	02/12/2009	Wed	0728	DA	4N1	130A 402A 632A	C	E	W	O	F		N	C	100						1766009	5442856
31	58/0/1.576	640N	HUGH DUNCAN ST	201051947	30/04/2010	Fri	1624	DA	VN1	111A 135A 801	C	E	W	O	H		N	C	100						1765995	5442952
32	58/0/1.576	640N	HUGH DUNCAN ST	2957082	11/12/2009	Fri	0925	AD	CN1	111A 135A 801	S	M	W	O	H		N	C	100						1765995	5442952
33	58/0/1.596	200N	OLD HAYWARDS ROAD	201152188	15/04/2011	Fri	1920	DB	CN1	131A 804	G	E	W	DN	L		N	R	100						1765992	5442971
34	58/0/1.676	280N	OLD HAYWARDS ROAD	201211298	18/02/2012	Sat	1018	CA	SS1	330A 341A	X	R	D	B	F		N	C	080			1		53	1765980	5443051
35	58/0/1.706	770N	HUGH DUNCAN ST	201054160	03/08/2010	Tue	1736	QG	TS1C	682A	D	M	D	TO	F		N	C	100						1765976	5443080
36	58/0/1.706	770N	HUGH DUNCAN ST	201250023	01/01/2012	Sun	1512	DB	CS1	131A 350A 800	G	E	W	O	L		N	C	100						1765976	5443080
37	58/0/1.8	1800W	SH 2	201251836	09/06/2012	Sat	1059	DA	CS1	134A		E	D	B	F		N	C	100						1765951	5443171

Key	First Street	Distance	DIR	Second street or landmark	Crash Number	Date DD/MM/YYYY	Day DDD	Time HHMM	MVMT / DRVR (M VN VVV / T 1 234)	Factors and Roles (A is for vehicle 1, B is for veh 2 etc)	OBJECT	CURVE	WETNES	LIGHT	WETHER	JUNCT	CONTRL	MARKS	SPDLMT	Total Inj FAT	Total Inj SER	Total Inj MIN	PED Age	CYC Age	Map Coordinates	
38	58/0/1.9	1900	N	SH 2	201012701	14/06/2010	Mon	0628	DA CN1	111A 135A 802	C	M	I	DN	F		N	C	100			1			1765927	5443267
39	58/0/1.92	1920	N	SH 2	2950911	27/04/2009	Mon	0800	AA VN1C	372A	G	M	W	O	F		N	C	100						1765926	5443287
40	58/0/1.936	1000	N	HUGH DUNCAN ST	201153588	03/08/2011	Wed	1720	AC CS1C	159A 330A		E	D	O	F			C	080						1765924	5443303
41	58/0/1.94	1940	W	SH 2	201010038	24/03/2010	Wed	1231	AD VW1C	136A 359A 632A 801	C	M	W	O	H		N	R	100	1		2			1765925	5443307
42	58/0/2 HAYWARDS HILL	2000	N	WESTERN HUTT ROAD	201252011	05/06/2012	Tue	1535	DA CS1	111A 332A 801	G	E	W	O	F		N	R	100						1765943	5443364
43	58/0/2.053 HAYWARDS HILL ROAD	900	S	MOUNT CECIL ROAD	201253565	05/10/2012	Fri	1415	DA CS1	134A 139A	GT	E	D	O	F		N	C	100						1765971	5443409
44	58/0/2.136	1200	N	HUGH DUNCAN ST	201054312	14/07/2010	Wed	0716	DA VW1	135A 802	G	M	I	O	F		N	C	100						1766021	5443475
45	58/0/2.153	800	S	MOUNT CECIL ROAD	201152692	15/07/2011	Fri	0755	DB CN1	131A	CG	E	D	B	F		N	R	100						1766029	5443490
46	58/0/2.196	800	N	OLD HAYWARDS ROAD	2951857	17/04/2009	Fri	0830	AC TN1C	386A		E	D	B	F		N	C	100						1766043	5443530
47	58/0/2.196	800	N	OLD HAYWARDS ROAD	2850780	07/02/2008	Thu	0740	DA CS1	103A 410A	G	E	D	B	F		N	R	100						1766043	5443530
48	58/0/2.203	750	S	MOUNT CECIL ROAD	201152615	12/07/2011	Tue	1535	DA CS1	103A 134A	G	E	D	O	F		N	R	100						1766045	5443537
49	58/0/2.203	750	S	MOUNT CECIL ROAD	2910012	05/02/2009	Thu	0954	MC MN1V	106A 372B 378B 831		M	D	B	F		N	L	100	1					1766045	5443537
50	58/0/2.216 HAYWARDS HILL	820	N	OLD HAYWARDS ROAD	201053065	17/06/2010	Thu	1145	DA CS1	135A 806	T	E	W	O	F		N	C	100						1766047	5443550
51	58/0/2.296	900	N	OLD HAYWARDS ROAD	201050767	12/02/2010	Fri	1530	AD CN1	131A	F	E	W	O	H		N	C	100						1766060	5443629
52	58/0/2.553 HAYWARDS HILL ROAD	400	S	MOUNT CECIL ROAD	201254508	06/12/2012	Thu	1847	DA CS1	129A 131A	T	E	W	O	F		N	R	100						1766137	5443873
53	58/0/2.653	300	S	MOUNT CECIL ROAD	201050543	03/01/2010	Sun	2129	DA 4S1	129A 130A 402A	FPV	E	W	DN	H		N	C	100						1766133	5443972
54	58/0/2.653	300	S	MOUNT CECIL ROAD	201211787	14/05/2012	Mon	0907	FA CS1C	111A 181A 402A 191B 901		S	W	O	H		N	L	100			1			1766133	5443972
55	58/0/2.853	100	E	MOUNT CECIL ROAD	2850778	01/03/2008	Sat	1750	FD CW1C	111A 386A 901		M	W	O	H		N	L	100						1766064	5444156
56	58/0/2.853 HAYWARDS HILL ROAD	100	S	MOUNT CECIL ROAD	201212887	12/11/2012	Mon	0818	AD CS1	111A 135A 402A	PTV	E	W	O	L		N	L	100			1			1766064	5444156
57	58/0/3.353	400	N	MOUNT CECIL ROAD	2956654	13/12/2009	Sun	1209	CB CN1	112A 615A	CV	R	D	O	F		N	L	100						1765904	5444622
58	58/0/3.448	1300	S	HARRIS ROAD	201111775	26/05/2011	Thu	1429	DA CS1	102A 110A 403A	FP	E	W	B	H		N	L	100			1			1765877	5444713
59	58/0/3.553	600	N	MOUNT CECIL ROAD	2850775	01/03/2008	Sat	1720	DA CE1	111A 135A 801 901	C	E	W	O	H		N	P	100						1765843	5444813
60	58/0/3.553	600	W	MOUNT CECIL ROAD	201011257	10/02/2010	Wed	1546	DA CS1	130A	F	E	W	O	L		N	L	100			1			1765843	5444813
61	58/0/3.553 HAYWARDS HILL	600	N	MOUNT CECIL ROAD	201152484	11/06/2011	Sat	1240	DA 4S1	131A 134A	FP	M	W	O	F		N	C	100						1765843	5444813
62	58/0/3.553 HAYWARDS HILL ROAD	600	N	MOUNT CECIL ROAD	201212480	21/08/2012	Tue	1046	DB VS1	110A 134A	C	M	D	B	F		N	C	080			1			1765843	5444813
63	58/0/3.553 HAYWARDS HILL ROAD	600	N	MOUNT CECIL ROAD	201254966	05/12/2012	Wed	1804	BB VS14	111A 123A	C	M	W	O	F		N	L	100						1765843	5444813
64	58/0/3.613	2680	E	MOONSHINE ROAD	201250601	04/03/2012	Sun	1120	DA CE1	111A 135A 801	F	E	W	O	L		N	L	100						1765811	5444863
65	58/0/3.653	700	N	MOUNT CECIL ROAD	201151540	15/04/2011	Fri	1528	DA 4S1	111A 135A 801	EF	M	W	O	F		N	L	100						1765788	5444896
66	58/0/3.653	700	N	MOUNT CECIL ROAD	201250828	22/01/2012	Sun	1633	DA CS1	111A 131A 330A	C	M	D	B	F		N	N	100						1765788	5444896
67	58/0/3.653	700	N	MOUNT CECIL ROAD	201052846	30/04/2010	Fri	1732	DA CS1	111A 337A	F	M	W	DN	F		N	L	100						1765788	5444896
68	58/0/3.653 HAYWARDS HILL ROAD	700	N	MOUNT CECIL ROAD	201252466	15/07/2012	Sun	2105	DA CS1	110A 131A	FV	M	W	DN	L		N	L	100						1765788	5444896
69	58/0/3.728 HAYWARDS HILL	1020	E	HARRIS ROAD	201254654	19/12/2012	Wed	0752	DA TS1	135A 806	C	M	W	O	L		N	L	100						1765738	5444951
70	58/0/3.753	800	N	MOUNT CECIL ROAD	201053253	21/07/2010	Wed	1305	FD CN1C	331A 378A 831		E	D	O	F		N	C	100						1765717	5444966
71	58/0/3.753	800	N	MOUNT CECIL ROAD	201211770	02/05/2012	Wed	1448	DA VS1	131A 403A 800	FZ	E	W	O	F		N	C	100		1				1765717	5444966
72	58/0/3.753	800	N	MOUNT CECIL ROAD	201111854	16/04/2011	Sat	1415	BF CS1CVC	111A 131A 407A 809 901		E	W	O	H		N	L	100		1				1765717	5444966
73	58/0/3.753	800	W	MOUNT CECIL ROAD	201151415	16/04/2011	Sat	1216	BF VS1CC	132A 135A 801	C	M	W	O	H		N	L	100						1765717	5444966
74	58/0/3.783 HAYWARDS HILL	830	N	MOUNT CECIL ROAD	201211888	21/05/2012	Mon	0009	CC CN1CC	103A 125A		R	D	DN	F		N	C	100		1	2			1765692	5444982

Key	First Street	Distance DIR	Second street or landmark	Crash Number	Date DD/MM/YYYY	Day DDD	Time HHMM	MVMT	DRVR / VVV	Factors and Roles (A is for vehicle 1, B is for veh 2 etc)	OBJECT	CURVE	WET	LIGHT	WTHR	JUNCT	CNTRL	MARKS	SPDLMT	Total Inj FAT	SER	MIN	PED age	CYC age	Map Coordinates X	Map Coordinates Y
75	58/0/3.793	2500E	MOONSHINE ROAD	2954972	01/03/2009	Sun	0001	DB	CW1	410A	F	E	D	DN	F		N	C	100						1765684	5444987
76	58/0/3.953	1000N	MOUNT CECIL ROAD	2811770	10/04/2008	Thu	1135	DA	CS1	121A	EF	E	D	B	F		N	L	100			1			1765567	5445094
77	58/0/3.953	1000W	MOUNT CECIL ROAD	2913388	26/10/2009	Mon	0150	DB	4N1	103A 402A	EP	E	D	DN	F		N	C	100			1			1765567	5445094
78	58/0/3.953	1000W	MOUNT CECIL ROAD	201211228	07/02/2012	Tue	1945	DA	4N1	111A 131A	C	M	W	O	L		N	C	100			1			1765567	5445094
79	58/0/3.953 HAYWARDS HILL	1000W	MOUNT CECIL ROAD	201155536	31/12/2011	Sat	2040	BF	CE1C	111A 131A 414A 132B	C	M	W	TN	F		N	L	100						1765567	5445094
80	58/0/3.953 HAYWARDS HILL ROAD	1000N	MOUNT CECIL ROAD	201254485	16/12/2012	Sun	1137	DB	CE1	103A 131A 358A	EFP	E	D	B	F		N	L	100						1765567	5445094
81	58/0/4.143	2150S	MOONSHINE ROAD	201012695	25/02/2010	Thu	2330	CB	MN1	501A		R	D	DN	F		N	L	100		1				1765491	5445267
82	58/0/4.183	2110S	MOONSHINE ROAD	201013710	09/12/2010	Thu	1445	BC	CN1C	121A	FC	E	D	B	F		N	C	100			1			1765475	5445304
83	58/0/4.188 HAYWARDS HILL ROAD	560S	HARRIS ROAD	201212564	21/08/2012	Tue	1734	DA	CS1C	111A 135A 801	C	M	W	TF	F		N	L	100			1			1765472	5445307
84	58/0/4.248	500E	HARRIS ROAD	2957096	05/11/2009	Thu	0341	DB	VN1	103A	F	E	W	DN	L		N	L	100						1765431	5445351
85	58/0/4.348 HAYWARDS HILL ROAD	400S	HARRIS ROAD	201253493	08/09/2012	Sat	0735	DA	CS1	111A 131A	CF	E	W	O	L		N	L	100						1765358	5445418
86	58/0/4.453	1500N	MOUNT CECIL ROAD	201056857	17/12/2010	Fri	0850	DA	4S1	111A 131A 801	F	E	W	O	H		N	C	100						1765265	5445468
87	58/0/4.548 HAYWARDS HILL	200E	HARRIS ROAD	201211910	30/05/2012	Wed	1515	CB	CE1	130A 501A	FP	R	D	B	F		N	L	100			1			1765182	5445513
88	58/0/4.648	100E	HARRIS ROAD	2957127	18/08/2009	Tue	2025	CB	CS1	130A		R	W	DN	H		N	C	100						1765095	5445562
89	58/0/4.723 HAYWARDS HILL ROAD	25S	HARRIS ROAD	201254305	26/10/2012	Fri	1400	AC	VN1T	159A 357A 132B 357B		R	D	B	F		N	N	100						1765029	5445599
90	58/0/4.798	50N	HARRIS ROAD	2913111	01/10/2009	Thu	2120	DA	CN1	103A	C	E	D	DN	F		N	L	100		1				1764963	5445634
91	58/0/4.878	130W	HARRIS ROAD	201150550	02/03/2011	Wed	0700	CB	CE1	137A 402A	FP	R	W	O	L		N	L	100						1764893	5445673
92	58/0/4.948	200N	HARRIS ROAD	2851746	29/02/2008	Fri	1909	DA	CN1	111A 136A	G	M	D	O	F		N	C	100						1764832	5445707
93	58/0/5.293	1000E	MOONSHINE ROAD	2913619	29/12/2009	Tue	0553	CC	CW1	103A 110A 402A	TV	R	W	O	H		N	L	100			1			1764641	5445986
94	58/0/5.493	800E	MOONSHINE ROAD	201250850	01/04/2012	Sun		QG	TS1	131A 330A 687A		E	D	B	F		N	C	100						1764562	5446170
95	58/0/5.623 PAREMATA-HAYWARDS	670E	MOONSHINE ROAD	201112745	08/09/2011	Thu	1610	MC	CE1C	197A 330B 372B		M	D	O	F		N	C	100			2			1764495	5446280
96	58/0/5.643	650E	MOONSHINE ROAD	2913507	06/12/2009	Sun	1855	BF	CS1C	135A 806		E	D	O	L		N	L	100			2			1764481	5446295
97	58/0/5.893	400S	MOONSHINE ROAD	2911544	04/02/2009	Wed	2225	DB	CN1	103A 359A 402A	H	M	W	DN	F		N	L	100			1			1764258	5446391
98	58/0/6.193	100E	MOONSHINE ROAD	2951793	16/04/2009	Thu	0620	DA	CE1	134A 410A	FV	E	D	TF	F		N	C	100						1763963	5446443
99	58/0/6.193	100E	MOONSHINE ROAD	201211638	19/03/2012	Mon	1625	DA	CE1	111A 135A 402A 801	FT	E	W	O	L		N	L	100			1			1763963	5446443
100	58/0/6.193	100E	MOONSHINE ROAD	201053895	09/06/2010	Wed	0700	DA	CE1	111A 135A 358A 801	F	E	W	O	L		N	L	100						1763963	5446443
101	58/0/6.243	50E	MOONSHINE ROAD	201111464	01/02/2011	Tue	0752	FA	4E1S	129A 330A		E	D	B	F		N	C	100		1			37	1763914	5446449
102	58/0/6.243	50E	MOONSHINE ROAD	201152923	10/07/2011	Sun	1630	DB	CN1	135A 801	C	E	W	O	H		N	L	100						1763914	5446449
103	58/0/6.293	I	MOONSHINE ROAD	201056167	25/09/2010	Sat	1558	DB	CW14	137A 302B 382B	F	M	D	O	F	T	G	P	100						1763864	5446445
104	58/0/6.293	I	MOONSHINE ROAD	201155694	17/12/2011	Sat	0450	DB	CW1	103A 111A 131A	F	E	W	DO	L	T	G	P	100						1763864	5446445
105	58/0/6.293	I	MOONSHINE ROAD	2953823	12/07/2009	Sun	0330	DB	CW1	102A 111A 632A	F	E	W	DN	L	T	G	L	100						1763864	5446445
106	58/0/6.303 HAYWARDS HILL ROAD	10W	MOONSHINE ROAD	201212681	22/09/2012	Sat	1254	BF	CE1V	130A 504A 505A		E	D	B	F	T	G	C	100		1	2			1763854	5446443
107	58/0/6.693	400W	MOONSHINE ROAD	2957068	05/11/2009	Thu	1540	DA	CW1	136A 668A		M	D	B	F		N	C	100						1763558	5446199
108	58/0/6.915 HAYWARDS HILL ROAD	370E	MULHERN ROAD	201252910	16/08/2012	Thu	1540	JA	CW14	102B 308B 930		R	D	B	F	D	N	C	100						1763342	5446198
109	58/0/6.946	340E	MULHERN ROAD	201013405	15/11/2010	Mon	1747	JA	CW14	308B 378B 830 927		R	D	B	F	D	N	C	100			1			1763314	5446205
110	58/0/6.963	670W	MOONSHINE ROAD	201150161	12/01/2011	Wed	1735	GD	CE14	331A 402A 632A 927		R	D	B	F	D	N	C	100						1763297	5446210
111	58/0/7.036	250E	MULHERN ROAD	201056592	23/11/2010	Tue	0745	BA	CW14	129A 150A		R	D	O	F		N	N	080						1763227	5446229

Key	First Street	DIR Distance	Second street or landmark	Crash Number	Date DD/MM/YYYY	Day DDD	Time HHMM	MVMT	DRVN 1 234	Factors and Roles (A is for vehicle 1, B is for veh 2 etc)	OBJECT	CURVE	WETNES	LIGHT	WTHER	JUNCT	CNTRL	MARKS	SPDLMT	Total Inj FAT	SER	MIN	PED Age	CYC Age	Map Coordinates	
112	58/0/7.063	770W	MOONSHINE ROAD	201253824	25/10/2012	Thu	0715	QG	TW1C	680A		R	D	O	F		N	C	100						1763200	5446237
113	58/0/7.086	200E	MULHERN ROAD	2953285	18/05/2009	Mon	1000	FA	CW1C	181A		R	W	O	L		N	N	100						1763179	5446243
114	58/0/7.116 PAREMATA-HAYWARDS	170E	MULHERN ROAD	201112520	29/05/2011	Sun	1424	AD	MW1	104A 133A		R	D	B	F		N	L	100		1				1763150	5446250
115	58/0/7.186	100E	MULHERN ROAD	2813592	09/12/2008	Tue	2036	CC	CW1	101A 130A	FT	R	D	DN	F		N	C	100		1				1763082	5446269
116	58/0/7.436	150W	MULHERN ROAD	201054981	06/10/2010	Wed	1750	MD	TE1V	181A 331A 927		R	D	B	F		N	C	100						1762842	5446338
117	58/0/7.486	200W	MULHERN ROAD	2913581	14/12/2009	Mon	2355	CB	CE1	101A 359A 810	E	R	D	DN	F		N	C	100			1			1762794	5446352
118	58/0/7.736	450W	MULHERN ROAD	2853492	25/03/2008	Tue	1700	LB	CW1CC	303B 382B 927	F	R	D	B	F	D	N	L	100						1762554	5446423
119	58/0/7.823	200E	MURPHYS ROAD	2813777	21/11/2008	Fri	1846	GE	ME1VM	387A 372B		R	D	O	F		N	C	100			1			1762470	5446447
120	58/0/7.873	150E	FLIGHTYS ROAD	201051269	28/01/2010	Thu	0730	FD	CE1C	331A 358A 363A 191B 902	V	R	D	B	F		N	C	100						1762422	5446461
121	58/0/7.986	2000E	PAEKAKARIKI HILL ROAD	201111483	16/02/2011	Wed	1430	DB	VE1	412A	TZ	E	D	O	F		N	C	100			1			1762314	5446493
122	58/0/8.023	I	FLIGHTYS ROAD	201111774	04/05/2011	Wed	0832	GD	CE1V	331A 370A		R	W	O	L	X	S	C	100			1			1762279	5446505
123	58/0/8.023	I	FLIGHTYS ROAD	2812108	12/04/2008	Sat	1550	GD	ME1C	137A 181A	V	R	D	B	F	X	S	R	100			1			1762279	5446505
124	58/0/8.023	I	MURPHYS ROAD	2854295	29/06/2008	Sun	1125	FO	VE1V	181A 645B	V	R	W	O	H	X	S	C	100						1762279	5446505
125	58/0/8.023	I	MURPHYS ROAD	201013408	04/12/2010	Sat	1134	DA	VE1	501A	FP	R	D	B	F	X	S	C	100			1			1762279	5446505
126	58/0/8.023	I	MURPHYS ROAD	201250021	15/01/2012	Sun	1530	GD	CE1C	197A 331A 352A		R	D	B	F	X	S	C	100						1762279	5446505
127	58/0/8.023 HAYWARDS HILL	I	MURPHYS ROAD	201211557	26/03/2012	Mon	0958	GE	CE1T	160A 197A 353A	F	R	D	B	F	X	S	C	100			1			1762279	5446505
128	58/0/8.404	20W	BELMONT ROAD	201211759	10/01/2012	Tue	1610	CA	MW1	130A 198A		R	D	B	F		N	C	100		1				1761906	5446534
129	58/0/8.764	380W	BELMONT ROAD	2955241	12/09/2009	Sat	1400	DB	VE1	131A 680A		E	W	O	F		N	C	100						1761559	5446444
130	58/0/8.781	550S	BRADEY ROAD	201151066	08/04/2011	Fri	0700	GC	CE1C	174B 372B 920		M	W	O	F	D	N	C	100						1761541	5446443
131	58/0/8.784	400W	BELMONT ROAD	2952402	20/02/2009	Fri	1520	AD	CW1	135A 801	T	E	W	O	L		N	C	100						1761539	5446443
132	58/0/8.784	400W	BELMONT ROAD	201012803	20/09/2010	Mon	1721	JA	CW1C	308B 375B 927		E	D	B	F	D	N	C	100			2			1761539	5446443
133	58/0/9.131 HAYWARDS HILL ROAD	200S	BRADEY ROAD	201252365	21/06/2012	Thu	1033	CB	VN1	406A 687A	V	R	W	O	L		N	C	100						1761278	5446647
134	58/0/9.213	A	PAUATAHANUI NO7 BR	2912698	19/08/2009	Wed	0654	BF	CW1CC	111A 132A 801		E	W	TN	L		N	C	100		1	2			1761235	5446716
135	58/0/9.331 HAYWARDS HILL	I	BRADEY ROAD	201152182	01/05/2011	Sun	1827	EC	CN1	912	W	R	W	DF	F	T	G	C	100						1761173	5446817
136	58/0/9.586 HAYWARDS HILL ROAD	400S	PAEKAKARIKI HILL ROAD	201254498	21/08/2012	Tue	0812	FD	CS1CV	181A 331A 801		R	W	O	L		N	C	100						1761121	5447065
137	58/0/9.679 HAYWARDS HILL ROAD	300S	PAEKAKARIKI HILL ROAD	201252147	27/06/2012	Wed	1254	QG	VN1	130A 402A 687A		R	D	B	F		N	C	100						1761095	5447155
138	58/0/9.783	500E	JOSEPH BANKS DRIVE	2950102	03/01/2009	Sat	2150	DB	CN1	111A 402A	G	M	D	DN	F		N	L	080						1761066	5447255

Appendix D Design Philosophy Statement

Design Speed

The current posted legal speed of the road is 100km/h. The design speed of the road is considered as 100km/h, this is on the basis of the following data:

- Traffic survey data:
  - HTS Group Survey Data, 2005: Two surveys showing (combined directional) 100.1km/h & 99.6km/h 85 percentile speeds
  - TDG Traffic Survey Data, 2011: Two surveys showing (combined directional) 97.5km/h & 99.5km/h
- Car following verification surveys

A number of existing advisory curve speeds are also in operation throughout the project length.

It is however noted that a substantial length of the project area is substandard and inadequate to support a 100km/h design speed. However, the scope of work for this SAR investigation did not include consideration of a lowering of the posted speed[75].

Horizontal Alignment

The scope includes the realignment of four horizontal curves. The first 3 curves were considered as part of the 2009 PFR report and a fourth location was added to the investigation. The intention was to generally follow the recommendations of the 2009 PFR for Sites 1 & 2, and to optimise Site 3 following collection of topographical data. The additional site, Site 4, was also to be optimised.

Using topographical survey data, Sites 1 & 2 have been refined form the PFR recommendations to form a better more consistent alignment, with similar design speeds and superelevation through each curve. Similarly, the realignment proposals for Site 3&4 have been selected on the basis of curve easing to provide a consent environment where speeds are relatable to preceding curves. This has resulted in most of the horizontal curves throughout this section of the project having design speeds in the range of 75-85 km/h and with horizontal curve radii of approximately 400m.

Approximate horizontal curve data is provide below from Station 0000 to Station 4000 (the sections subject to, and between, the proposed horizontal realignment). Note that this is approximate as there are changes between the 3 different options considered (curve data is provided on the preliminary design plans).

Curve Number	Realigned?	Station (start of circular curve)	Radius (m)	Circular Arc Length (m)	Superelevation (%)
1	-	40	50	55	3
2	-	220	150	50	4
3	-	350	280	75	5
4	Yes	620	200	90	6
5	Yes	790	400	55	5
6	Yes	940	800	65	5
7	Yes	1180	400	195	5
8	Yes	1450	400	40	5

[75] Toward the end of the SAR investigation phase, the NZTA have confirmed they are likely to pursue a lowering of the posted speed from 100km/h to 80km/h (as a result of the crash record and specifically two further fatal crashes having occurred).

Curve Number	Realigned?	Station (start of circular curve)	Radius (m)	Circular Arc Length (m)	Superelevation (%)
9	-	1730	400	40	5
10	-	1880	185	130	6
11	-	2140	205	70	6
12	-	2330	750	55	5
13	Yes	2460	405	365	5
14	-	2930	400	120	5
15	-	N/A*	1350	N/A*	N/A*
16	Yes	3500	400	205	5
17	-	3860	310		5

*Considered as a straight due to large radius

It is acknowledged that ordinarily, curves within the 300m-450m range are preferably avoided as studies have shown they can prove difficult for drivers to read the severity and therefore misjudging appropriate speeds for the However, given the existing alignment and variability between adjacent horizontal curves, it is considered that providing consistency between curves is a better solution. Furthermore, the mountainous topography through (and between) the realigned sections results in the perception of a constrained environment which will serve to control, vehicle speeds.

Stopping Sight Distance
Insufficient widening on the inside of corners is an existing issue that should be further considered at the detailed design stage to provide additional widening (particularly for left hand curves to meet SSD requirements for the design speed of 100km/h and deceleration rate on 0.26. The improved cross section would nevertheless provide improvements in respect of SSD but a more thorough assessment of all locations within the project length at detailed design stage.

Vertical Alignment
The current State Highway 58 length within the project area is characterised by significant vertical curvature, in additional to the curvilinear horizontal alignment. This is a direct result of the existing topography, with the road running through rolling and mountainous terrain.

The result of the topography on the SH58 road geometry is considerable with significant grades that effect the operation of the road.

With operating speeds of 100km/h, maximum grades of between 6-8% are recommended[76] for mountainous terrain. Numerous locations on SH58 are around or marginally above this threshold. It is not considered feasible or economic to attempt to address this substandard geometry as part of this Scheme Assessment given the magnitude of works involved.

For the most significant section of uphill grade, of over 9%, the uphill passing lane is retained to allow good overtaking opportunities particularly where heavy vehicles speed will reduce significantly over the course of the long vertical grade increase.

It is also recognised that the length of grades within the current road geometry are substandard, with lengths of grade over 6% longer than the recommended 300m.

The same is particularly true of K values for vertical curvature in terms of existing and achieved. As only four sections are proposed for horizontal realignment, with the remaining lengths subject to an improved road cross section, then it is inevitable that many of the substandard K values for vertical curves remain.

[76] Austroads Guide to Road Design Part 3, Table 8.3

Where possible and if the section is being realigned then attempts have been made to improve the associated vertical curve K value – however a number of substandard vertical curves remain within the realignment sections.

The vertical curves within the full extent of the realignment (Stn 330 to Stn 4000) have been assessed. There are six crests within this length and as part of the proposed improvements, five of these crest have been improved and one has been maintained.

However, despite this improvement, a number of vertical curves still do not meet the Normal Design Domain requirements, due to existing topography. It is not considered feasible or realistic to fully realign the vertical geometry throughout this length as it would be cost prohibitive due to the existing mountainous terrain (as well as being significantly outside the scope of this investigation). Regardless of the improvements in vertical geometry that these proposals achieve, it is considered important to also contemplate Extended Design Domain (EDD) Parameters.

The use of EDD is considered appropriate for SH58 given this is an existing road upgrade in a constrained location. Furthermore, the use of EDD is stated as being appropriate for 'realignment of a few geometric elements on existing roads in constrained locations'[77].

The minimum crest curve (K value) for sealed roads for the truck-day base case has been used as the appropriate EDD parameter to determine suitability for truck movements.

A reaction time of 2.5 seconds has been used, whilst a design speed of 90km/h has been selected on the basis of the geometry from RP0/0.574 to RP0/0/4.000 being mountainous and therefore trucks being likely to be travelling below the overall 85th percentile speeds of other vehicles. A 90km/h 85th percentile speed of trucks is supported by traffic count information assessed which demonstrated HCV 85th percentile speeds as (combined directions) 88km/h and 91km/h[78]. It is also worth noting that these speeds were taken on the slightly flatter terrain where speeds are more likely to be higher than through the more mountainous topography. A coefficient of deceleration of 0.29 has been used in the calculations.

An eye height of 2.4m has been used with an object height of 0.8m as per Austroads standards[79]. The standard K value (S<L) is provided as 24.9 in Austroads. However, as a result of the significant roadway grade, SSD has been calculated based on the roadway grade, and truck deceleration for all crest curves (for both approach directions). The SSD for every location has then be used (along with algebraic grade change) to calculate the minimum value of K for both scenarios; where sight distance is less than the length of the vertical curve and vice-versa. The figures are provided below:

			Option1		Option 2		Option3	
Crest Number	Approx. Station	Existing K Value	Min. Calculated K Value		Min. Calculated K Value		Min. Calculated K Value	
			Required	Achieved	Required	Achieved	Required	Achieved
1	950-1060	13	29.0	13	29.6	13	25.0	18
2	1330-1560	29	31.4	33	30.9	29	23.5	42
3	2040-2240	16	26.5	19	26.8	20	27.6	20.6

77 Austroads Guide to Road Design, Part 3, Appendix A

78 TDG Transportation Assessment for Winstones Cleanfill Site, July 2012

79 Austroads Guide to Road Design, Part 3, Appendix A, Table A17

			Option1		Option 2		Option3	
Crest Number	**Approx. Station**	**Existing K Value**	**Min. Calculated K Value**		**Min. Calculated K Value**		**Min. Calculated K Value**	
4	2380-2580	16	24.5	70	26.6	72	26.6	71
5	2870-3020	7	27.8	20.2	26.4	21	27.1	20
6	3470-3570	5	29.9	71	29.9	71	24.8	71

In addition to the K Value information contained above, the following should be noted:

Crest 1: This is already a significant vertical crest existing, at the end of a long length of significant uphill (westbound) grade of over 8%. This crest is within the end portion of the realignment of Site 1.

Crest 2: This is an existing crest at the end of another significant uphill (westbound) grade of almost 10%. Part of the crest is outside of the realignment length.

Crest 3: This long crest is outside of any realignment and existing

Crest 4: This existing crest is very minor. This crest is almost entirely contained with the realignment of Site 3.

Crest 5: This crest is existing and is significant with the intersection of Mount Cecil Road sitting at the approximate crown position. The crest is the result of the relatively flat grade followed by a significant downhill (Westbound) grade. The achieved K value has been improved in all options but remains low.

Crest 6: This is a long gentle crest that adequately meets standards.

A further assessment has also been undertaken which considers the minimum EDD K values for sealed roads for the Norm-Day Base Case. A coefficient of deceleration of 0.46 has been used based on wet road conditions. The best achievable scenario for 100km/h design speed requires the use of an eye height of 1.1m, an object height of 1.25m and a reaction time of 2.0 seconds.

The required minimum K values are presented below (adjusted for grade):

			Option1		Option 2		Option3	
Crest Number	**Approx. Station**	**Existing K Value**	**Min. Calculated K Value**		**Min. Calculated K Value**		**Min. Calculated K Value**	
			Required	Achieved	Required	Achieved	Required	Achieved
1	950-1060	12	22.1	12.9	22.3	12	22.3	18
2	1330-1560	29	23.1	33	22.9	29	23.4	42
3	2040-2240	16	20.9	19	21	20	21	20.6
4	2380-2580	16	21	70	21	72	21.4	71

			Option1		Option 2		Option3	
Crest Number	**Approx. Station**	**Existing K Value**	**Min. Calculated K Value**		**Min. Calculated K Value**		**Min. Calculated K Value**	
5	2870-3020	7	21.6	20.2	21.6	21	21.2	20
6	3470-3570	5	22.5	71	22.5	71	22.5	71

These K values are less onerous than those required for the 90km/h truck scenario.

Using the 90km/h truck minimum K values, further analysis has been undertaken as to the requirements and practicality of undertaking the physical works required to achieving the minimum K values for Crest 1, 3 and 5.

				Work Required to Achieve Min K*		
Option Number	**Crest Number**	**Min. Calculated K Value**		**Reprofile Entire Vertical Curve (Station)**		**Earthworks Details**
		Achieved	Required	Start	End	
Option 1	1	29.0	12.9	900	1100	Approximately 1m cut depth at high point
	3	26.5	19	2030	2270	Approximately 0.8m cut depth at high point
	5	27.8	20.2	2850	3040	0.5m cut at high point plus fill lengths
Option 2	1	29.6	12	900	1100	Approximately 1.1m cut depth at high point
	3	26.8	20	2010	2270	Approximately 0.9m cut depth at high point
	5	26.4	21	2860	3060	0.5m cut at high point plus fill lengths
Option 3	1	25.0	18	920	1100	Approximately 0.7m cut depth at high point
	3	27.6	20.6	2010	2240	Approximately 0.8m cut depth at high point
	5	27.1	20	2850	3060	0.6m cut at high point plus fill lengths

*Re-profiling the existing pavement by cutting would also have consequential effects for services and require relocating / protection

It should also be noted that all 3 of the non-complying crests (Crests 1, 3 and 5) are existing crest curves that do not comply with current standards (and the vertical profile is maintained or improved through the works proposed in this investigation). Crests 1 and 5 are within sections of realignment (either entirely or partially) and are being improved with the proposed works, though still do not meet EDD requirements. Crest 3 is not being realigned and therefore the existing non-compliant K value is maintained. A design exception will be required for crests 1, 3 and 5.

Warp Rate

The warp rates for curve superelevation development and removal are also substandard, both existing and in proposed locations. Ordinarily, a maximum of 2.5% / sec would be adopted. In the realignment sections 2, 3 and 4, it has been possible to keep the warp rate below 2.5% / second. However for the first section of realignment (Section 1), warp rates of up to 3.5% / second have been used – these are necessary because the realignment in Section 1 includes a number of curves turning in different directions and in close proximity to each other and so it is necessary to develop and remove superelevation more rapidly. Warp rates are generally in the range of 2.0% to 3.1% throughout and between the realigned sections.

For the project length west of realignment Section 4, where only an improved road cross section is proposed, then no changes are proposed to existing warp rates.

Aquaplaning

Throughout the project extent, it is noted there is an existing issue with potential aquaplaning. This is as a result of the existing curvilinear alignment with many curves that warp the superelevation close to the falling grade which results in some long flow lines and water flow depth issues. Detailed design will need to further consider adjusting the warp rate where possible or by other means of water conveyance (such as drainage provision or porous surfacing where necessary).

Cross Section

For all options the cross section is proposed as 3.5m traffic lanes and 1.5m sealed shoulders. There is an additional 0.5m unsealed shoulder (or dished channel where required) provided.

Lighting

No street lighting is currently provided throughout the project length and none is proposed.

Delineation

Raised Reflectorized Pavement Markers (RRPMs) are used now throughout SH58 for centre line and edge line delineation. It is proposed that the use of RRPMS would be retained.

Audio-Tactile Profiled (ATP) markings are currently not used extensively on SH58, with approximately 1.7 km of existing centreline ATP and no edgeline ATP. It is proposed that the edge lines would make use of longitudinal ATP markings given the propensity for runoff road crashes. Centre line ATP would also be beneficial where no median barrier is proposed.

Design Exception Requirements

As discussed above, vertical crests 1, 3 and 5 will require a design exception as they do not meet minimum EDD requirements. Given the project scope is horizontal curve realignment to improve safety, this is considered reasonable. Furthermore, it is important to recognise that the road cross section and horizontal geometry has been improved to current standards and the vertical geometry on two of the three non-compliant vertical curves has also been improved. It is recognised that significantly improving certain aspects of road design whilst others remain substandard can have a negative consequence for safety as drivers misinterpret the road environment. However in this instance, it is considered that the road design is still sufficiently constrained by the curvilinear and mountainous environment that drivers will be able to interpret the geometry and drive appropriately without the risk of expecting.

Option 4 Update

A number of updates have been proposed as part of the optimisation of Option 3 to create Option 4. These changes are discussed in the main body of the report in section 11.1.2 with expansion here.

The design for Option 4 has been based upon the original 'desired' design speed (and posted speed) of 100km/h (acknowledging that the current alignment is substandard in multiple locations where no realignment is proposed), but recognising the NZTA wish to expedite a posted speed reduction across the entire project length to 80km/h. The effect of this intended speed reduction on the design has not been considered in detail but generally would lower some of the design requirements (for example the K value vertical crest curve requirements would be reduced). Based on the final decision for the design speed, this should be considered further at detailed design.

Option 4 has removed Realignment Site 1 (Stn 580-1060) from the project, on the basis of the challenging topography through this section and associated high cost of earthworks. The effect of this removal has been considered in terms of the adjacent curves to ensure an out of context curve is not created, where vehicle speeds on adjacent curves are disparate. The design speeds have been confirmed as being no greater than 10km/h difference through adjacent curves around the now removed section of Realignment Site 1. The improved cross section will enhance safety through these curves though careful signposting of advisory speeds will be required at detailed design stage, and other measures, such as high friction surfacing may be warranted through this set of curves now Site 1 is no longer proposed for realignment.

A substandard vertical crest curve exists between Stn 950-1060 which will not be altered with the Opt 4 proposals (discussed above for Options 1-3). This vertical curve is existing and would require significant re-profiling to improve.

The design changes at Moonshine Road and at the projects northern extent have been considered in detail within the main body of the report and are therefore not subject to further commentary in this DPS.

As with Options 1-3 potential aquaplaning issues will require consideration during the detailed design of stormwater facilities. Superelevation warp rates will also be further considered given the complex topography and the need to develop and remove superelevation through horizontal curves in close proximity.

The design of the proposed cleanfill access (Stn 3220) will also need to be revised (or removed) at detailed design as the current design shown is indicative only based upon the proposals previously supplied to NZ Transport Agency as part of the cleanfill site development proposals (and affected party approval granted). It is understood that this proposal was not issued the necessary resource consents though this decision may still be subject to challenge.

Appendix E Scheme Drawings

Provided separately.

Appendix F Pavement Design

F.1 Design Report

Below is the concept pavement design for the four sites on SH58. We have undertaken a desktop study of the RAMM data of the 4 sites to establish sensible assumptions for scheme design purposes;

Background

The NZTA has requested MWH to undertake a scheme design for State Highway 58. The work involves realigning the horizontal curves on 4 lengths and the approximately RP's are as follows; RP 0/0.535 to RP0/1.046, RP 0/0.975 to RP0/1.630, RP 0/2.255 to RP0/3.380 and RP 0/3.400 to RP0/4.000

Each site will include two options

- Option 1 – 3.5m traffic lanes, with 1.5m sealed shoulders
- Option 2 – 3.5m traffic lanes, with 1.5m sealed shoulders and a 2m flush median

Topography of the site

The four sites consist of a series of tight reverse curves with an uphill gradient.

Geotechnical Investigation

A Preliminary Geotechnical Appraisal Report was undertaken. The appraisal was visual only stated the following *'The existing pavement is performing well. Pavement test pits and RAMM historical data will confirm the nature of the existing construction and this should form a precedent for proposed pavement works'.*

As there has not been any pavement test pits undertaken, we have used historical RAMM data for this design. To proceed to detail design further geotechnical investigation is needed to confirm ground conditions and the CBR of the subgrade.

Historical RAMM data - Desktop Assessment

Below is the data from RAMM of the existing pavement for the four sites.

Site 1 SH58 RP 0/0.535 to RP 0/1.046

- Average skid resistance – left lane 0.49 and right lane 0.48 – These are acceptable levels so no surfacing renewal is required as yet
- Average roughness –80 NASSRA
- Average rutting – left lane 6.7mm and right lane 5.9mm – Not bad since it is under 10mm
- Existing surfacing – two coat chip seal
- Basecourse thickness – 150mm

Site 2 SH58 RP 0/0.975 to RP 0/1.630

- Average skid resistance –left lane 0.48 and right lane 0.50
- Average roughness – 101 NASSRA (comments in RAMM state that road works were there at the time of survey).

- Average rutting –right lane 5.88mm and left lane 6.48mm
- Existing surfacing – Two coat chip seal for majority of the site apart from two patch repairs that have Stone Mastic Asphalt surfacing at RP 0/1085 – 1180 and RP 0/1475-1085
- Basecourse thickness – 140mm – 150mm

Site 3 SH58 RP 0/2.250 to RP 0/3.380

- Average skid resistance – left lane 0.49 and right lane 0.45
- Average roughness – 73 NASSRA
- Average rutting – left lane 4.03mm and right lane 4.5mm
- Existing surfacing - Two coat chip seal
- Basecourse thickness – 140mm

Site 4 SH58 RP 0/3.400 to RP 0/4.00

- Average skid resistance – left lane 0.46 and right lane 0.45
- Average roughness – 77 NASSRA
- Average rutting – left lane 4.3mm and right lane 4.98mm
- Existing surfacing – Two coat chip seal
- Basecourse thickness – 140mm

FWD data 2011

- The average deflection for all four sites was 0.52 mm – This indicates a strong overall pavement structure

The above data indicates the pavement for all four sites is still performing well and because of this the pavement design will be based on existing. However the thickness of the granular material will be increased to 2.5 times the size to ensure compaction is met. RAMM data had no record of the CBR although from existing test results of other projects undertaken in the vicinity and the low deflections from the FWD testing carried out in 2011 a CBR of 10% will be assumed for the scheme assessment design.

Pavement Design

Below is the concept pavement design for SH58. The option that has been investigated is an unbound granular pavement with a chip seal surfacing. The minimum subgrade CBR shall not be less than 10% for this state highway given the 25 year design traffic of 5.3 million ESA.

For all four sites the proposed schematic pavement design is as follows:

Unbound Granular Material

- Excavate 330mm to subgrade.
- Test Subgrade to ensure a CBR of 10% is met.
- Place 170mm of AP65

- Place 160mm of AP40 M/4
- Place grade 3 and 5 two coat chip seal

Considerations for Pavement Widening

- Further consideration should be given to the existing pavement when widening as discussed in section 8.3 of the NZ Supplement 2007 to Austroads Pavement Design Guide. This states the potential risks of only excavating the existing shoulder and bringing the new pavement up to level can result in discontinuity of materials and layer performance in the area of the interface between the old and the new pavement. The discontinuity can be attributed to a number of factors, most notably; segregation of the new aggregate, reduced layer stiffness as a result of removing the lateral restraint provide by the shoulder and difficulties associated with compacting layers with a narrow or irregular shape. This risk should be considered when undertaking detail design and the design shall allow for modifying the upper materials to half or full width of the carriage way to a depth of at least 200mm. Step construction will be necessary to reduce failures at the interface.

Design assumptions:

- Design traffic 25 years = 5.3 x 10^6ESA
- Growth rate is 1.5%
- Combined AADT 13,600 and Heavies 5%
- Design subgrade CBR 10.0%
- Source Materials for the new Subbase and Basecourse shall comply with TNZ M/4 and TNZ M/3 Notes
- It is recommended that Subsoil drainage is installed approximately 650mm deep and to be in accordance with F/2

Design Standards:

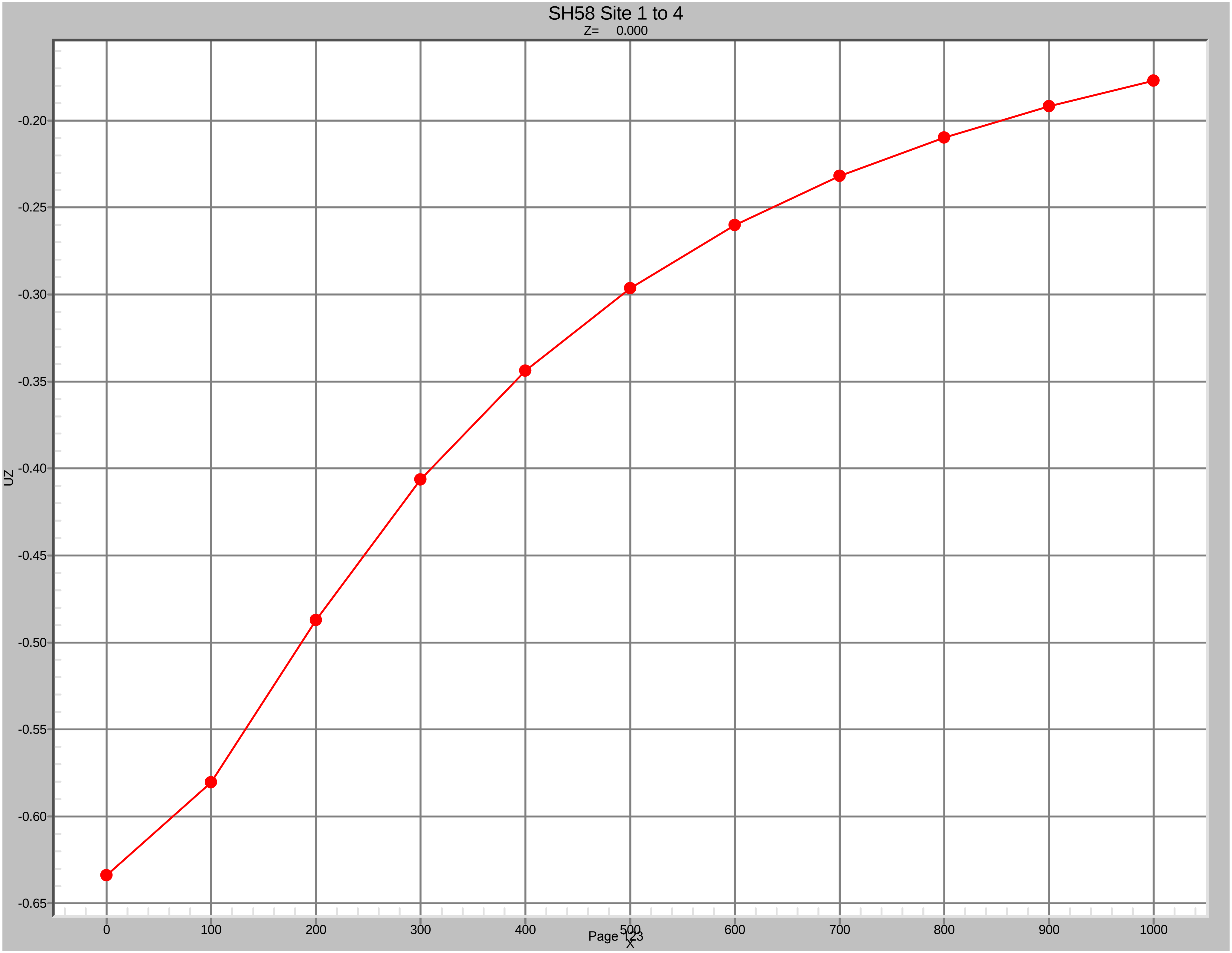
- Austroads Pavement Technology Part 2: Pavement Structural Design 2008
- NZ Supplement 2007 to Austroads Pavement Design Guide
- Circly 5 Pavement Analysis and Design Programme

Potential Risks

- The in-situ CBR may be less than 10% this could affect the design depth as weaker subgrades will require thicker pavement
- Quality of materials/construction is not in accordance with NZTA specifications.
- Further testing will need to be undertaken to confirm the CBR assumption of 10% or above.

F.2 Background Data and Circly Output

```
CIRCLY Version 5.0s (15 February 2012)

Job Title: SH58 Site 1 to 4

Damage Factor Calculation

Assumed number of damage pulses per movement:
   One pulse per axle (i.e. use NROWS)

Traffic Spectrum Details:

   ID: SH58 Title: SH58 Traffic

   Load   Load          Movements
    No.   ID
    1     ESA75-Full    5.27E+06

Details of Load Groups:

   Load   Load        Load        Load             Radius    Pressure/    Exponent
    No.   ID          Category    Type                       Ref. stress
    1     ESA75-Full  SA750-Full  Vertical Force     92.1     0.75          0.00

   Load Locations:
   Location   Load        Gear          X          Y      Scaling     Theta
    No.       ID          No.                             Factor
    1         ESA75-Full   1          -165.0        0.0   1.00E+00      0.00
    2         ESA75-Full   1           165.0        0.0   1.00E+00      0.00
    3         ESA75-Full   1          1635.0        0.0   1.00E+00      0.00
    4         ESA75-Full   1          1965.0        0.0   1.00E+00      0.00

Layout of result points on horizontal plane:
   Xmin:  0   Xmax:  1000   Xdel:  100
   Y:     0

Details of Layered System:

   ID: SH58 Site1 Title: SH58 Site 1 - 4

   Layer  Lower    Material     Isotropy   Modulus    P.Ratio
    No.   i/face   ID                      (or Ev)    (or vvh)  F          Eh          vh
    1     rough    Gran_500     Aniso.     5.00E+02   0.35      3.70E+02   2.50E+02   0.35
    2     rough    Sub_CBR10    Aniso.     1.00E+02   0.40      6.90E+01   5.00E+01   0.40

   Performance Relationships:
   Layer  Location Performance  Component  Perform.   Perform.  Traffic
    No.            ID                      Constant   Exponent  Multiplier
    2     top      Sub_2004     EZZ         0.009300    7.000     1.200

   Reliability Factors: Not Used.

   Details of Layers to be sublayered:
   Layer no.  1:  Austroads (2004) sublayering

Results:

   Layer  Thickness  Material     Load          Critical       CDF
    No.              ID           ID            Strain
    1      330.00    Gran_500                    n/a           n/a
    2        0.00    Sub_CBR10    ESA75-Full     8.58E-04      3.61E-01
```



SH58 Site 1 to 4
Z= 0.000
UZ
-0.20
-0.25
-0.30
-0.35
-0.40
-0.45
-0.50
-0.55
-0.60
-0.65
0
100
200
300
400
500
600
700
800
900
1000
X

Appendix G Risk Register

RISK FILE

SH58 Haywards Substation Curve Realignment

Prepared for NZ Transport Agency

3 July 2013

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REVISION SCHEDULE

Rev No	Date	Description	Signature or Typed Name (documentation on file). Prepared by	Checked by	Reviewed by	Approved by

NZ Transport Agency

SH58 Haywards Substation Curve Realignment

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1 Introduction

This report covers risk management for the Investigation and Reporting Phase of the SH58 Haywards Substation Curve Realignment Investigation. It is prepared generally in accordance with Minimum Standard Z/44 – Risk Management.

1.1 Risk File Status

This version of the Risk File is issued at approximately 25% of the I&R completion. At this stage, it only includes the initial project risk register, which is derived and updated from the risk register issued with the PFR.

The status is one of a live document during the contract period, and will be updated in line with NZTA requirements.

1.2 Intended Status

Z/44 requires the risk file to include:

a. Risk register
b. Risk review minutes
c. Risk adjusted programmes
d. Risk analysis data
e. Contract close out risk report.

The remaining sections, currently not covered by this report, will be updated as the project progresses.

2 Risk Register

The project risk register has been developed using the following criteria. It is noted that, according to Z/44, the consultant and NZTA need to consider and agree on the thresholds in use.

2.1 Consequence Criteria

2.1.1 Cost Consequence

The following cost-impact criteria and terminology have been used. The criteria are based on considering the project capital cost of approximately $20M:

- 100 - Catastrophic – cost implications > $10M
- 70 - Substantial – between $5M - $10M
- 40 - Major - $2.5M - $5M
- 10 - Medium - $1M - $2.5M
- 1 - Minor – up to $1M

The cost scoring system can be modified, after agreement.

2.1.2 Delay Consequence

The following cost-impact criteria and terminology have been used. The criteria are based on considering the project will progress from I&R to D&PD to MS&QA with only minimal delays for normal processing. Delay risk is considered to impact on the ideal timeline.

- 100 - Catastrophic – delays > 5 years
- 70 - Substantial – between 1 year and 5 years
- 40 - Major – 6 months to 1 year
- 10 - Medium – 2 months to 6 months
- 1 - Minor – up to 2 months.

The delay/delivery scoring system can be modified, after agreement.

2.1.3 Other Consequences

Consequences relating to Stakeholders, Public/Needs, Legal/Compliance, Health, Safety and Environmental are considered as per Z/44 page 14 – noting however that the rating scale uses Minor to Catastrophic (as above), rather than Very Low to Very High as per Z/44. Scales can be modified in later versions of the register.

2.2 Likelihood Criteria

Likelihood criteria are developed directly from Z/44, in terms of likelihood or frequency of event, however the terminology still refers to Rare, Unusual, Unlikely, Quite Common, Likely – as per the previous AC/Man/1 Risk Manual.

2.3 Risk Scoring

Projects are given a risk score based on Consequence x Likelihood (as per AC/Man/1), and subsequently their score can range from 1 to 500 – the higher the score the greater the severity. The Register also includes a Probability Impact Grid (PIG) scoring, as per Z/44 p16, and the projects have been ranked, within phases, in accordance with the PIG

2.4 Risk Owner

The MWH Project Manager – Jamie Povall – is identified as the risk owner for the I&R activities, and for the property phase activities that are being undertaken during I&R.

Where some risks are appropriate to later Phases, NZTA have been identified with risk ownership.

2.5 Risk Treatments and Mitigations

Where there are currently project actions that are attempting to address, mitigate or treat risks, they are given a Treatment Status – Live (L). For live treatments, this risk register also includes the name of the MWH person who currently responsible for the actions.

Where some risks in later phases have mitigation actions that can be, and are being worked on now, they are also given a Live status.

A number of risks have no mitigation/treatment actions being undertaken currently, so their treatments status is considered inactive (I). Regular risk register review will identify any future actions necessary to start mitigation actions.

SH58 Haywards Substation Curves Realignment

Activity	SH58 Haywards Substation Curves Realignment
Contract No.	630PN
Date	Jul-13

Analysts Name(s)	Alix Newman
Reviewers Name(s)	
Sources of Information	PFR Register, I&R development team

Phase	No.	Name	Description	Status	Threat / Opp	Existing Controls	Consequence Description	Consequence Rating (C)	Likelihood Description	Likelihood Rating (L)	Score = C x L[1]	Risk Treatment/Mitigation Actions	P.I.G	Risk Owner/ Organisation	Treatment Action Owner	Treatment Status	Date Raised	Date Updated
Project Property																		
	A1	Land acquisition problem	Difficulty in aquiring land. Caused by obstructive landowner or excessive cost demands.	L	T	RMA and PWA acquisition processes	Cost - Minor: Land purchase costs higher than anticipated. Delay - Substantial: Construction delay may be 18mnth if using PWA	70	Unlikely	3	210	Consultation - Engage landowners as early as possible to understand consequence and likelihood status.	19	Povall - MWH	Povall - MWH	L	30-Sep-09	3-Jul-13
	A2	Extent of land reqd underestimated	Updated design requires additional land subsequent to initial NoR and cost estimates	L	T	RMA and PWA acquisition processes	Cost - Minor: Only small land areas likely Delay - Medium: Estimate maximum delay of 6 months	10	Unusual	2	20	Design - Allow adequate flexibility within designation footprint to accommodate minor design changes; designate only after thorough review of design	10	Povall - MWH	Povall - MWH	L	30-Sep-09	3-Jul-13
Investigation and Reporting																		
	B8	Project objectives not achieved	Investigations indicate that constraints or conditions will not allow full achievement of project intentions and objectives (e.g. inadequate width for median barrier).	L	T	Standards review processes	Cost - Major: Potential operational efficiency costs from sub-standard design. H&S - Medium: Compromise on safety standards may have higher injury rate.	40	Likely	5	200	Design - Maximum accommodation of safety in design, and efficiency of traffic flow.	18	Povall - MWH	Povall - MWH	L	3-Jul-13	3-Jul-13
	B7	Construction cost changes significantly different from I&R	With no geotechnical testing, there is the chance that basic construction costs will be significantly underestimated. LiDAR data may also lead to inaccurate quantities estimates	L	T	Cost estimate tolerance schedules	Cost - Major: D&PD and construction costs very high	40	Unlikely	3	120	Cost Estimation - Custom application of estimate bounds (FE/OE/SE…)	15	Povall - MWH	Povall - MWH	L	3-Jul-13	3-Jul-13
	C3a	Change in scope of works	Change during I&R delays delivery of agreed timeframe	L	T	Variation processes	Cost - Minor: Additional I&R fees Delay - Minor: Anticipated maximum delay 2 months	10	Unlikely	3	30	Client Liaison - Maintain a high level of dialogue with the client, regularly pointing out issues & risks	10	Povall - MWH	Povall - MWH	L	30-Sep-09	3-Jul-13
	B3	Incomplete consultation	Stakeholders respond that they are not adequately consulted	L	T	Consultation Plan.	Delay - Minor: Delay to delivery of SAR for additional consultation actions	1	Unlikely	3	3	Consultation - Ensure engage all landowners, record engagements.	5	Povall - MWH	Povall - MWH	L	30-Sep-09	3-Jul-13
Design and Project Documentation																		
	B4	Appeals to Environment Court	Project taken to Environment Court	L	T	n/a	Delay - Major: consider possibly up to a year for completion of process. Cost - Minor: small cost relative to project	40	Unlikely	3	120	Statutory Planning & Consultation - Early, and pre-lodgement engagement with Council(s) and engagement with stakeholders to reassess risk.	15	NZTA - D&PD Consultant		I	30-Sep-09	3-Jul-13
	B6a	Cost rates	Rates increase over and above current escalation	L	T	Cost estimate tolerance schedules	Cost - Medium: Depending on market at time of tendering - considered up to $2.5M difference in price is Med risk	10	Quite Common	4	40	Cost Estimation - Follow Cost Estimation Procedures to analyses expected and 95%ile costs and update rates. Peer Review.	12	NZTA - D&PD Consultant	Povall - MWH	L	30-Sep-09	3-Jul-13
	B1	Consents not achieved	Consent not granted	L	T	n/a	Delay - Medium: Est up to 6 months for re-design and resubmission. Cost - Minor: Relatively low cost for rework	40	Unusual	2	80	Statutory Planning - Early, and pre-lodgement engagement with Council(s).	11	NZTA - D&PD Consultant	Povall - MWH	L	30-Sep-09	3-Jul-13
	B2	Onerous consent conditions	Consent conditions impose substantial changes to project	L	T	n/a	Delay - Medium: Est up to 6 months for re-design and resubmission. Cost - Minor: Relatively low cost for rework	40	Unusual	2	80	Statutory Planning - Early, and pre-lodgement engagement with Council(s) and good recommendations for conditions in AEE applications	11	NZTA - D&PD Consultant		I	30-Sep-09	3-Jul-13
	C1	Errors in contract documents	Items missing or incorrectly stated in contract documents impacting on quantities and costs	L	T	NZS 3910 and Contract form	Cost - Medium: May use contingency quickly or add some cost.	10	Unlikely	3	30	Contract Preparation - Follow correct procedures for preparing and collating contract documents. Check and review	10	NZTA - D&PD Consultant		I	30-Sep-09	3-Jul-13
	C3b	Change in scope of works	Change during D&PD delays delivery of agreed timeframe	L	T	Variation processes	Cost - Minor: Additional D&PD fees Delay - Minor: Anticipated maximum delay 2 months	10	Unlikely	3	30	Client Liaison - Maintain a high level of dialogue with the client, regularly pointing out issues & risks	10	NZTA - D&PD Consultant		I	30-Sep-09	3-Jul-13
	C4	Safety Audit	Proposed works are not safe to deliver, design standards not met	L	T	Standards review processes	Cost - Minor: Re-design of some element.	1	Likely	5	5	Design - Design to standards as much as possible (see risk B8). Respond as appropriate to safety audit issues raise.	9	NZTA - D&PD Consultant		I	30-Sep-09	3-Jul-13
	B5	Designation rejected	Designation not granted, requiring rework and resubmission	L	T	n/a	Delay - Major: consider possibly up to a year for reapplication and process. Cost - Minor: small cost relative to	40	Rare	1	40	Statutory Planning - Early, and pre-lodgement engagement with Council(s).	4	NZTA - D&PD Consultant		I	30-Sep-09	3-Jul-13

SH58 Haywards Substation Curves Realignment

Activity	**SH58 Haywards Substation Curves Realignment**
Contract No.	**630PN**
Date	**Jul-13**

Analysts Name(s)	**Alix Newman**
Reviewers Name(s)	
Sources of Information	**PFR Register, I&R development team**

Phase	No.	Name	Description	Status	Threat / Opp	Existing Controls	Consequence		Likelihood		Score	Risk Treatment/Mitigation Actions	P.I.G	Risk Owner/ Organisation	Treatment Action Owner	Treatment Status	Date Raised	Date Updated
							Description	Rating (C)	Description	Rating (L)	= C x L[1]							
MSQA, NZTA																		
NZTA Managed Costs	1a	Excessive claims by contractor	Contractor may over-claim either in error or to front-load payments. Potential for loss if contractor declares bankruptcy (re SH4 Papatawa)	E	T	Constract supervision, measure and value processes.	Cost - Medium: Overall may be excessive payments to contractor.	40	Quite Common	4	**160**	Supervision: Peer Review design and keep good relationship with contractor. Robust measure and value/claims process	17	NZTA - MS&QA Consultant		I	30-Sep-09	3-Jul-13
	1c	Funding rejected	Construction costs as tendered are in excess of anticpated, and project funding is declined.	E	T	n/a	Delay - Major: Could see protracted delay (consider up to a year)	40	Unlikely	3	**120**	Estimates: Check and review of estimates and rates during design using most up-to-date information.	15	NZTA - MS&QA Consultant		I	30-Sep-09	3-Jul-13
	1d	Conctractor not adequately skilled for job.	Local terrain and working conditions will challenge contractors, hence need adequately skilled contractors for the work.	E	T	Pre-qualification and tendering process criteria	Cost - Major: Poor construction capability could cost (est max $5M) Delay - Medium: Consider maximum delay of up to 6 months to resolve contractor capabilites	40	Unlikely	3	**120**	Tendering - Use contractor prequalification and ensure Non-price tendering attributes cover track record work in similar environments	15	NZTA - MS&QA Consultant		I	3-Jul-13	3-Jul-13
	B6b	Cost rates	Tender response rates are increased over and above current escalation	E	T	Cost estimate tolerance schedules	Cost - Medium: Depending on market at time of tendering - considered up to $2.5M difference in price is Med risk	10	Quite Common	4	**40**	Cost Estimation - Follow Cost Estimation Procedures to analyses expected and 95%ile costs and update rates. Peer Review.	12	NZTA - MS&QA Consultant		I	30-Sep-09	3-Jul-13
	1b	Issues raised that cause redesign	Construction activity may encounter conditions that require some elements to be redesigned	E	T	n/a	Cost - Minor Delay - Minor: Consider maximum delay of 2 months.	1	Quite Common	4	**4**	Supervision: On-site review of issues and analysis by all parties before re-design agreed. Contractor to re-programme.	7	NZTA - MS&QA Consultant		I	30-Sep-09	3-Jul-13
Environmental Compliance	2a	Failure to comply with consent conditions on site	The contractor's practices on site have caused a breach of consent conditions	E	T	Consent compliance checks	Image - Medium: Possibly regional media. Environment - Medium: Possible impact on regional park values Delays - Minor: Unlikely to affect progress of project	10	Unusual	2	**20**	Supervision - Ensure supervision checks consent condition compliance.	6	NZTA - MS&QA Consultant		I	30-Sep-09	3-Jul-13
	2b	Finding items of archaelogical interest	Finding items of archaelogical interest	E	T	Accidental discovery protocols	Delays - Medium	10	Rare	1	**10**	Consult with local iwi & obtain HPT approval first	2	NZTA - MS&QA Consultant		I	30-Sep-09	3-Jul-13
Earthworks	3a	Geotech conditions	Inaccuracies in current geotechnical knowledge of site with actual conditions	E	T	n/a	Cost - Medium	10	Quite Common	4	**40**	Further geotech investigation needed	12	NZTA - MS&QA Consultant		I	30-Sep-09	3-Jul-13
	3c	Soft material in earthworks footprint	Soft material in earthworks footprint greater than anticipated	E	T	n/a	Cost - Medium	10	Quite Common	4	**40**	Further geotech investigation needed	12	NZTA - MS&QA Consultant		I	30-Sep-09	3-Jul-13
	3d	Additional earthworks required	Current cost estimate/design does not allow for adequate earthworks	E	T	n/a	Cost - Medium	10	Quite Common	4	**40**	Site Survey needed	12	NZTA - MS&QA Consultant		I	30-Sep-09	3-Jul-13
	3b	Large proportion of rock	Larger proportion of rock material than envisaged	E	T	n/a	Cost - Medium	10	Unlikely	3	**30**	Further geotech investigation needed	10	NZTA - MS&QA Consultant		I	30-Sep-09	3-Jul-13
Ground Improvements	4a	Contaminated land encountered	Contaminated land encountered	E	T	n/a	Cost - Medium	10	Rare	1	**10**	Further investigation needed	2	NZTA - MS&QA Consultant		I	30-Sep-09	3-Jul-13
Drainage	5a	n/a	n/a								**0**					I	30-Sep-09	3-Jul-13
Pavement and Surfacing	6a	Poor pavement design.	Poor pavement design results in rutting/uneven road surface	E	T	n/a	Image - Medium Cost - Major	40	Unusual	2	**80**	Peer review design	10	NZTA - MS&QA Consultant		I	30-Sep-09	3-Jul-13
	6b	Underslippage of existing road	Underslippage of existing road	E	T	n/a	Delays - Medium Cost - Medium	10	Unusual	2	**20**	Further geotech investigation needed	6	NZTA - MS&QA Consultant		I	30-Sep-09	3-Jul-13
Traffic Services	9a	n/a	n/a	n/a							**0**					I	30-Sep-09	3-Jul-13
Service Relocations	10a	Unknown/unrecorded services found	Unknown/unrecorded services found that cause re-design	E	T	n/a	Delays - Minor Cost - Minor	1	Unusual	2	**2**	Further investigation needed	3	NZTA - MS&QA Consultant		I	30-Sep-09	3-Jul-13
Traffic Management and Temporary	12a	Major delays during works	Major delays during works	E	T	n/a	Image - Medium Delays - Medium Cost - Minor	10	Unusual	2	**20**	Peer review design and Constant dialogue with client and contractor	6	NZTA - MS&QA Consultant		I	30-Sep-09	3-Jul-13
CLOSED RISKS																		
D&PD Phase	C2	Change in personnel	Change in design personnel	C	T	n/a					**0**	Closed - not considered a relevant risk at 3 Jul 13 update.					30-Sep-09	3-Jul-13
MS&QA Phase																	30-Sep-09	
Preliminary and General	13a	Lack of adequate supervision by contractor	Lack of adequate supervision by contractor	C	T	n/a					**0**	Closed - not clearly understood as risk at 3 Jul 13 update.					30-Sep-09	3-Jul-13
Bridges	7a	Bridges built and then collapse	Bridges built and then collapse	C	T	n/a					**0**	Closed - no current intentions for bridges on the project, as of 3 July review					30-Sep-09	3-Jul-13
Retaining Walls	8a	Retaining wall build and then collapse	Retaining wall build and then collapse	C	T	n/a					**0**	Closed - no current intentions for retaining walls on the project, as of 3 July review					30-Sep-09	3-Jul-13
Traffic Management and Temporary Works	12c	Vandalism of TM equipment	Vandalism of TM equipment results in lane closure traffic signals not working	C	T	n/a					**0**	Closed - not considered a relevant risk at 3 July review. Falls within standard site security processes, where there are some.					30-Sep-09	3-Jul-13
Landscaping & urban design	11a	Newly planted trees/shrubs destroyed	Storm event destroys newly planted trees/shrubs	C	T	n/a					**0**	Closed - not considered a relevant risk at 3 July review.					30-Sep-09	3-Jul-13

Appendix H Social and Environmental Management Form (PSF 13)

Option Description:

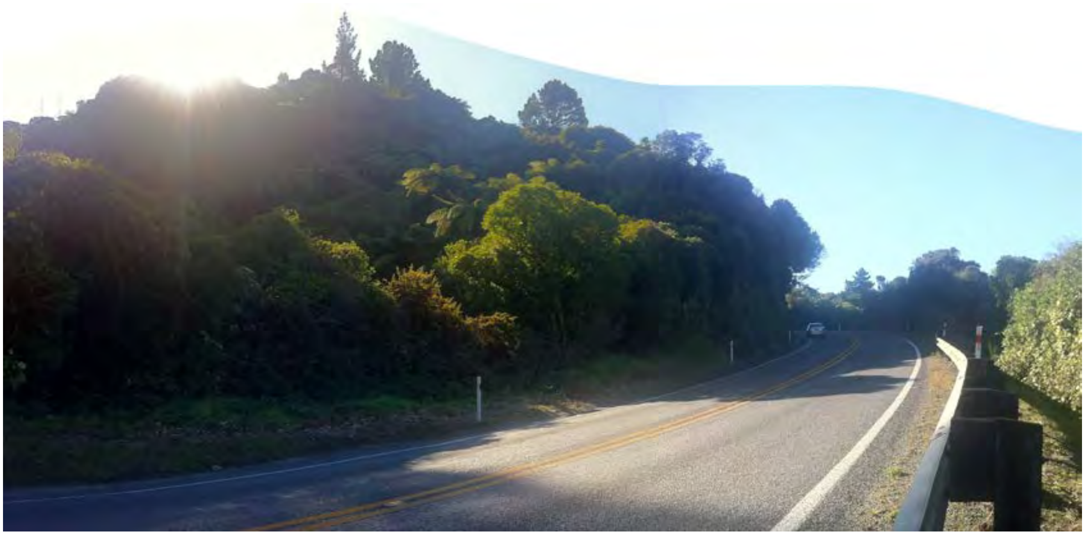
Social and Environmental Screen			Social and Environmental Assessment	Note to be completed following consultation	
Issue	**Effects**	**Degree of Effect**	**Requirements**	**Addressing Effects and meeting requirements**	
Social and environmental issues	*Describe the potential social and environmental effects of the option, including where the option may improve social and environmental outcomes*	*High / Medium / Low / N/A*	*List all legal requirements and relevant Transit social and environmental objectives*	*List actions to be taken to meet specific social and environmental requirements and objectives and address all effects identified. Include an estimated cost.*	
				Specific Actions	*Estimated Cost ($)*
Noise *e.g. .construction noise, traffic noise, maintenance noise, presence of sensitive receivers (homes, schools, hospitals)*	The noise effects of the project will be determined when further details on the design are available. Where necessary, a resource consent may be required. As part of the resource consent application an assessment of effects on the environment will be prepared.	N/A	**Resource consent / designation conditions details:** **Specific NZTA objectives details:** Planning Policy Manual and Environmental Plan, relevant guidelines **Other details:**		
Air Quality *e.g. dust, air pollution, greenhouse gas emissions, odour*	The air quality effects of the project will be determined when further details on the design are available. Where necessary, a resource consent may be required. As part of the resource consent application an assessment of effects on the environment will be prepared.	N/A	**Resource consent / designation conditions details:** **Specific NZTA objectives details:** Planning Policy Manual and Environmental Plan, relevant guidelines **Other details:**		
Water resources *E.g. sedimentation, contaminants in road run-off, climate change impacts (sea level rise and changing rainfall patterns), impacts on sensitive water bodies, changing hydrological cycles and water flow patterns.*	The water resources effects of the project will be determined when further details on the design are available. Where necessary, a resource consent may be required. As part of the resource consent application an assessment of effects on the environment will be prepared. The Pauatahanui Stream in the vicinity of the works is considered a sensitive environment and the effects of sedimentation will need to be addressed.	High	**Resource consent / designation conditions details:** **Specific NZTA objectives details:** Planning Policy Manual and Environmental Plan, relevant guidelines **Other details:**		
Erosion and sediment control *e.g. soil slips, landslides, water erosion (raindrop, sheet, rill gully, tunnel, channel) and wind erosion (dust)*	The effects of the project will be determined when further details on the design are available. Where necessary, a resource consent may be required. As part of the resource consent application an assessment of effects on the environment will be prepared. The Pauatahanui Stream in the vicinity of the works is considered a sensitive environment and the effects of sedimentation will need to be addressed.	High	**Resource consent / designation conditions details:** **Specific NZTA objectives details:** Planning Policy Manual and Environmental Plan, Regional Council Stormwater Guidelines **Other details:**		
Social responsibility *e.g. social, severance, social interaction, connectivity*	The effects of the project will be determined when further details on the design are available. Where necessary, a resource consent may be required. As part of the resource consent application an assessment of effects on the environment will be prepared.	N/A	**Resource consent / designation conditions details:** **Specific NZTA objectives details:** Planning Policy Manual and Environmental Plan, relevant guidelines **Other details:**		

Option Description:					
Social and Environmental Screen			Social and Environmental Assessment Note to be completed following consultation		
Issue	**Effects**	**Degree of Effect**	**Requirements**	**Addressing Effects and meeting requirements**	
Social and environmental issues	*Describe the potential social and environmental effects of the option, including where the option may improve social and environmental outcomes*	*High / Medium / Low / N/A*	*List all legal requirements and relevant Transit social and environmental objectives*	*List actions to be taken to meet specific social and environmental requirements and objectives and address all effects identified. Include an estimated cost.*	
Culture and Heritage *e.g. waahi tapu and Statements of identified Maori interests, archaeological sites, historic buildings, places, trees and special features*	The effects of the project will be determined when further details on the design are available. Where necessary, a resource consent may be required. As part of the resource consent application an assessment of effects on the environment will be prepared. The discovery of artefacts will be covered under the agreed discovery protocols.	N/A	**Resource consent / designation conditions details:** **Specific NZTA objectives details:** Planning Policy Manual and Environmental Plan, relevant guidelines **Other details:**		
Ecological resources *e.g. significant vegetation, fauna passage, habitat protection, special trees, reinstatement of vegetation, slope stabilisation, use of low-growth vegetation to reduce maintenance costs*	The effects of the project will be determined when further details on the design are available. Where necessary, a resource consent may be required. As part of the resource consent application an assessment of effects on the environment will be prepared. The Pauatahanui Stream in the vicinity of the works is considered a sensitive environment and the effects of sedimentation will need to be addressed.	High	**Resource consent / designation conditions details:** **Specific NZTA objectives details:** Planning Policy Manual and Environmental Plan, relevant guidelines **Other details:**		
Spill response and contamination *e.g. spills from vehicle accidents, onsite storage of fuels, excavations of contaminated soils/clean fill*	The effects of the project will be determined when further details on the design are available. Where necessary, a resource consent may be required. As part of the resource consent application an assessment of effects on the environment will be prepared.	Low	**Resource consent / designation conditions details:** **Specific NZTA objectives details:** Planning Policy Manual and Environmental Plan, relevant guidelines **Other details:**		
Resource efficiency *E.g. in situ pavement recycling, energy efficiency, initiatives to reduce waste to landfill, use of local materials.*	Tender requirements should address resource efficiency outcomes.	N/A	**Resource consent / designation conditions details:** **Specific NZTA objectives details:** Planning Policy Manual and Environmental Plan, relevant guidelines **Other details:**		
Climate change: *Adaptation and mitigation e.g. sea level rise, greenhouse gas emissions, increase incidence of flooding and coastal storms*	The effects of climate change on the project will be determined when further details on the design are available. These will be addressed should there be bridge or culvert proposals.	N/A	**Resource consent / designation conditions details:** **Specific NZTA objectives details:** Planning Policy Manual and Environmental Plan, relevant guidelines **Other details:**		
Visual quality *e.g. landscaping, retaining walls, noise walls, views from roads neighbouring properties*	The effects on the visual quality of the project will be determined when further details on the design are available. Where necessary, a resource consent may be required. As part of the resource consent application an assessment of effects on the environment will	N/A	**Resource consent / designation conditions details:** **Specific NZTA objectives details:** Planning Policy Manual and Environmental Plan, relevant guidelines **Other details:**		

Option Description:					
Social and Environmental Screen			Social and Environmental Assessment Note to be completed following consultation		
Issue	**Effects**	**Degree of Effect**	**Requirements**	**Addressing Effects and meeting requirements**	
Social and environmental issues	*Describe the potential social and environmental effects of the option, including where the option may improve social and environmental outcomes*	*High / Medium / Low / N/A*	*List all legal requirements and relevant Transit social and environmental objectives*	*List actions to be taken to meet specific social and environmental requirements and objectives and address all effects identified. Include an estimated cost.*	
	be prepared.				
Vibration *E.g. construction and maintenance vibration, pavement surface, heavy traffic vibration, presence of sensitive receivers including historic buildings and features.*	The vibration effects of the project will be determined when further details on the design are available. Where necessary, a resource consent may be required. As part of the resource consent application an assessment of effects on the environment will be prepared.	N/A	**Resource consent / designation conditions details:** **Specific NZTA objectives details:** Planning Policy Manual and Environmental Plan, relevant guidelines **Other details:**		
Land use and transport integration *E.g. integration of land use and development with transport networks, reverse sensitivity, access management.*	The effects on land use and transport integration of the project will be determined when further details on the design are available. Where necessary, a resource consent may be required. As part of the resource consent application an assessment of effects on the environment will be prepared.	N/A	**Resource consent / designation conditions details:** **Specific NZTA objectives details:** Planning Policy Manual and Environmental Plan, relevant guidelines **Other details:**		
Urban design *E.g. context sensitive design, including aesthetics of structures (refer PSG/12 for guidance).*	The urban design effects of the project will be determined when further details on the design are available. Where necessary, a resource consent may be required. As part of the resource consent application an assessment of effects on the environment will be prepared.	N/A	**Resource consent / designation conditions details:** **Specific NZTA objectives details:** Planning Policy Manual and Environmental Plan, relevant guidelines **Other details:**		
Public Health *e.g. stress to individuals and community, personal security, cycling and walking opportunities*	The public health effects of the project will be determined when further details on the design are available. Current proposals do not make additional provision for cycling and walking opportunities.	N/A	**Resource consent / designation conditions details:** **Specific NZTA objectives details:** Planning Policy Manual and Environmental Plan, relevant guidelines **Other details:**		
Cycling infrastructure *e.g. on highway cycle lanes, segregated cycle path adjacent to SH, links into local cycling network*	The effects of the project on cycling infrastructure will be determined when further details on the design are available. Current proposals do not make additional provision for cycling opportunities.	N/A	**Resource consent / designation conditions details:** **Specific NZTA objectives details:** Planning Policy Manual and Environmental Plan, relevant guidelines **Other details:**		
Cycle crossing facilities *e.g. shared cycle/pedestrian crossing at traffic signals, widened traffic island to accommodate cyclists where cycle route crosses SH, dropped crossings*	The effects of the project on cycle crossing facilities will be determined when further details on the design are available.	N/A	**Resource consent / designation conditions details:** **Specific NZTA objectives details:** Planning Policy Manual and Environmental Plan, relevant guidelines **Other details:**		
Walking infrastructure	The effects of the project on walking infrastructure will be determined when further	N/A	**Resource consent / designation conditions details:**		

Option Description:					
Social and Environmental Screen			Social and Environmental Assessment *Note to be completed following consultation*		
Issue	**Effects**	**Degree of Effect**	**Requirements**	**Addressing Effects and meeting requirements**	
Social and environmental issues	*Describe the potential social and environmental effects of the option, including where the option may improve social and environmental outcomes*	*High / Medium / Low / N/A*	*List all legal requirements and relevant Transit social and environmental objectives*	*List actions to be taken to meet specific social and environmental requirements and objectives and address all effects identified. Include an estimated cost.*	
e.g. new or widened footway, connections to local road footways	details on the design are available. It is noted that current proposals do not make provision for walking opportunities given that the road is narrow and winding. Proposals for the expansion of the walking tracks at the Belmont Regional Park are noted.		**Specific NZTA objectives details:** Planning Policy Manual and Environmental Plan, relevant guidelines **Other details:**		
Pedestrian crossing facilities *e.g. signalised crossings, traffic islands, dropped crossings, pedestrian desire lines*	The effects of the project on pedestrian crossing facilities will be determined when further details on the design are available. It is noted that the existing road is generally characterised by a rural environment with little pedestrian activity.	N/A	**Resource consent / designation conditions details:** **Specific NZTA objectives details:** Planning Policy Manual and Environmental Plan, relevant guidelines **Other details:**		
Bus related Infrastructure *e.g. bus laybys, hardstandings, buildouts into carriageway at bus stop*	The effects of the project on bus related infrastructure particularly that relating to school bus shelters, will be determined when further details on the design are available.	N/A	**Resource consent / designation conditions details:** **Specific NZTA objectives details:** Planning Policy Manual and Environmental Plan, relevant guidelines **Other details:**		
Priority lanes *e.g. potential to include bus, freight, HOV or HOT lane either through the reallocation of existing roadspace or new construction to make certain modes more efficient and widen travel choice*	No priority bus lanes are envisaged for the project given the nature of the environment and the status of the highway.	N/A	**Resource consent / designation conditions details:** **Specific NZTA objectives details:** Planning Policy Manual and Environmental Plan, relevant guidelines **Other details:**		
Traffic management *e.g. potential for ITS, variable message signing, variable speed management, ramp signalling*	Traffic management will be determined when further details on the design and construction methodology are available.	High	**Resource consent / designation conditions details:** **Specific NZTA objectives details:** Planning Policy Manual and Environmental Plan, relevant guidelines **Other details:**		

Appendix I Preliminary Geotechnical Appraisal Report



SH58 Haywards Curves
Preliminary Geotechnical Appraisal Report

QUALITY ASSURANCE STATEMENT

PREPARED BY	CHECKED BY
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NZ TRANSPORT AGENCY

SH58 Haywards Curves
Preliminary Geotechnical Appraisal Report

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LIST OF FIGURES

1 Introduction

The New Zealand Transport Agency (NZTA) has engaged MWH NZ Ltd (MWH) to prepare a preliminary geotechnical appraisal report (PGAR) for the realignment of several out of context curves on State Highway 58 (SH58) between State Highway 2 and Mount Cecil Road, to the northeast of Wellington, as located in Figure 1-1.

The exit to SH58 is located off SH2 between Lower Hutt and Upper Hutt.

1.1 Location

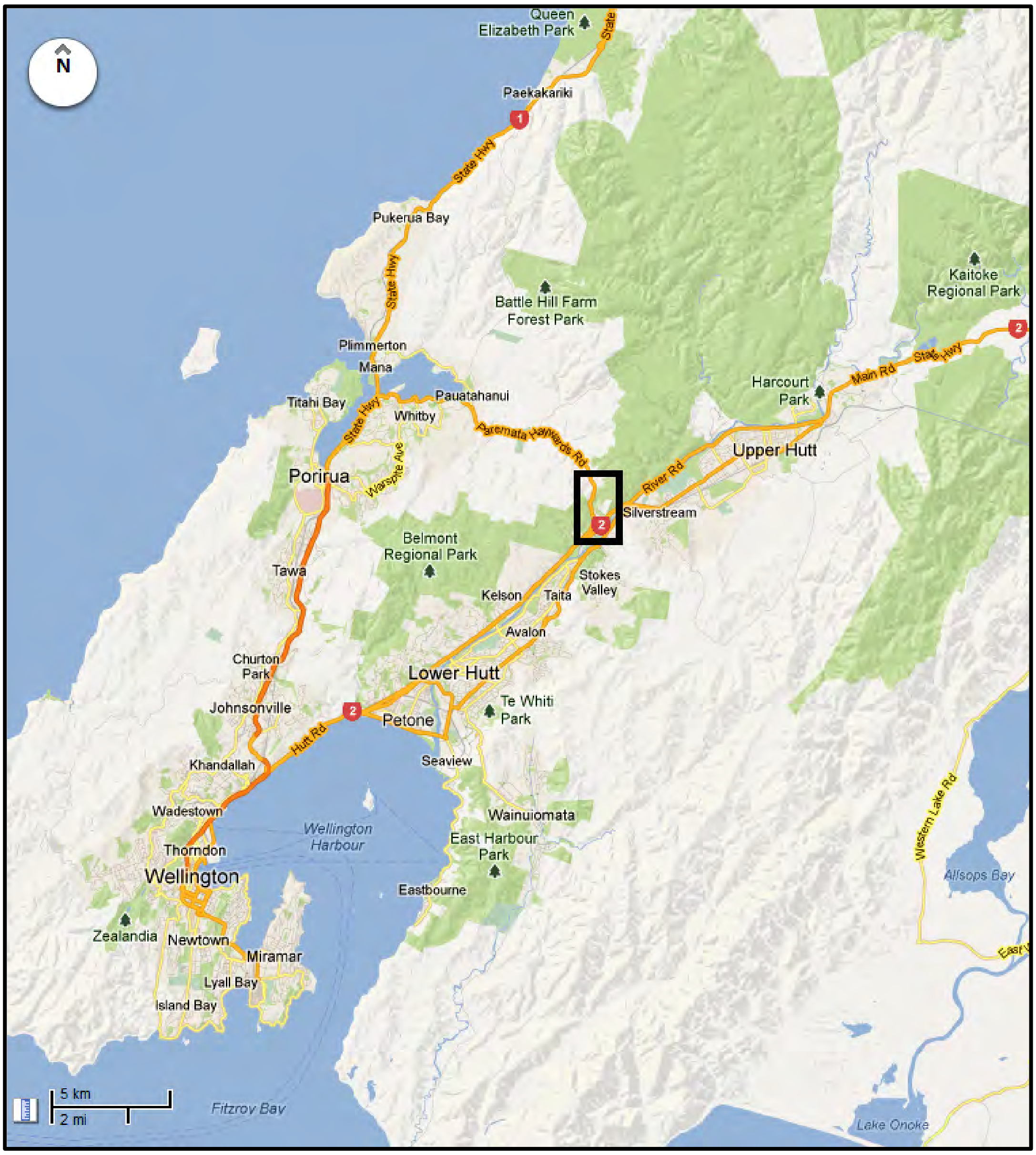


Figure 1-1 : Location Plan (Google Maps not to scale)

1.2 Proposed Works

The project involves several substandard curves on SH58, located on Figure 1-2, which are:

- Site 1: This site is the most southerly, nearest SH2. Includes a series of isolated reverse curves west of the intersection with Hugh Duncan Street, and east of the junction with McDougall Grove.
- Site 2: Includes a series of tight reverse curves near Old Haywards Road at a point along the uphill passing lane.
- Site 3: Includes a series of reverse curves and a broken back alignment from Mount Cecil Road to a point 650 m to the south.
- Site 4: This site is the most northerly of the set. Includes a series of reverse curves from 250m north of Mount Cecil Road to a point 650 m further to the north.

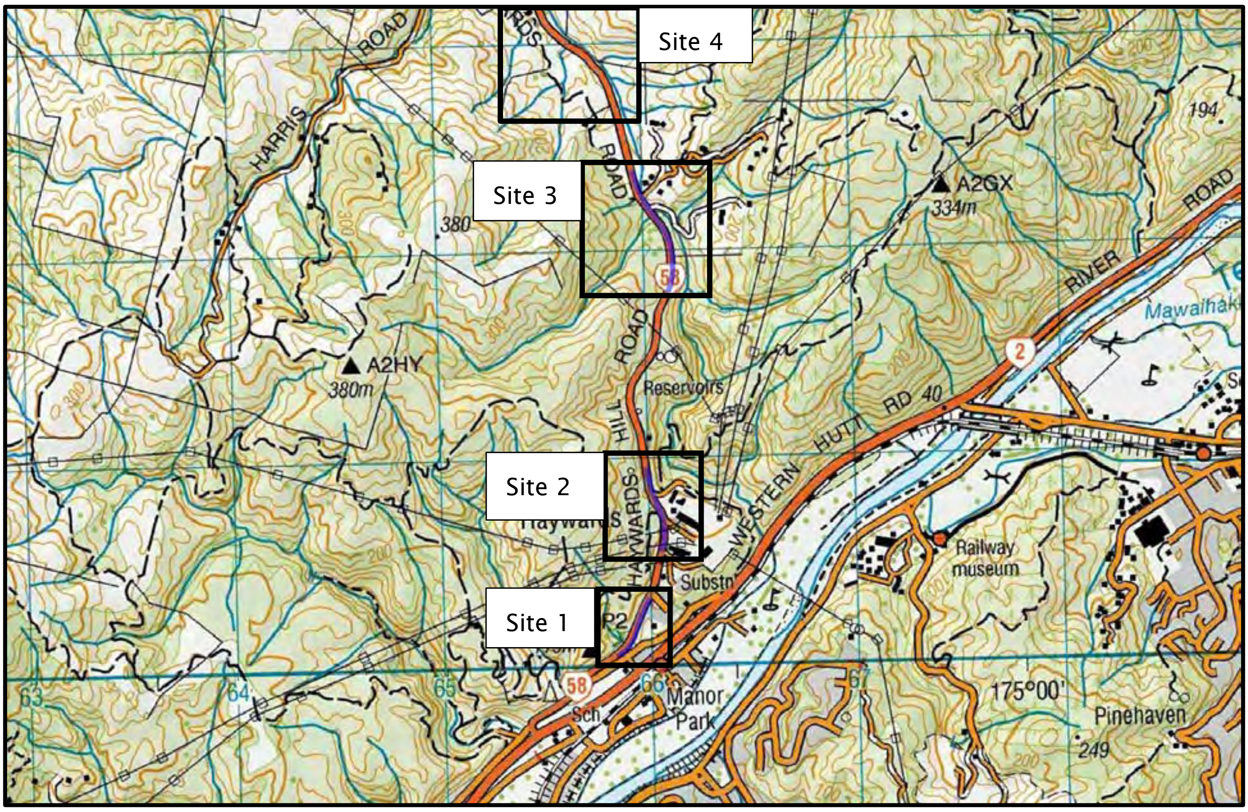


Figure 1-2 : Site Location Plan (LINZ's 1:50,000 / Topo50 not to Scale, north up page)

In addition, there are proposals over the entire length from SH2 through to the Pauatahanui Roundabout (approximately 10km length) to provide an additional 1.5m of shoulder and up to 2m of additional seal width for median.

1.3 Scope of Report

The scope of this PGAR is to outline any potential geotechnical issues that may arise and can be resolved during the Scheme Assessment Report (SAR) phase. The PGAR consists of the following:

- Site walkover and desk study
- Identification of likely geotechnical risks
- Preparation of recommended geotechnical testing to be executed as part of the Scheme Assessment investigations

2 Walkover Inspection

Lee Paterson (MWH Senior Geotechnical Engineer) visited the site on 14 May 2013and on 18 June 2013 to undertake a walkover inspection. No intrusive ground testing was undertaken. This appraisal was visual-only.

The existing highway has been cut from the left hand (western) hillside, with fills constructed across streams and gullies. Shoulder construction on the true right hand (eastern) side is soft in places, with significant scour holes and slumping / movement of shoulder material at several locations.

Existing cuttings to the left side are performing well and provide excellent precedence for the future design of cuttings in these locations.

The walkover appraisal highlighted several areas of potential risk that require specific attention. The following sections provide a breakdown of the potential elements that need to be addressed as part of the investigation and detailed design at each site.

The key to the associated figures for each site is as follows:

- Dark Blue Band: Proposed extent of realignment
- Light Blue: existing mapped streams
- Yellow: Cadastral Property Boundaries
- Pink: Item as Described

2.1 Site 1

1. RP 0.45-0.65, Steep cut face to LHS initially 70 degrees up to 10m high, then approximately 60m to the top of the ridge line at approximately 55°, cut in massive slightly weathered jointed greywacke
2. RP 0.665 - Gully crossing LHS
3. RP 0.640-0.690 - Movement of shoulder fill behind existing crash barriers at RHS
4. RP 0.68-0.84, Steep cut face to LHS approximately 10m standing at 70°, cut in massive slightly weathered jointed greywacke
5. RP 0.750 - Flume and gully to be avoided at RHS
6. RP 0.805 - Slumping of soft shoulder at RHS

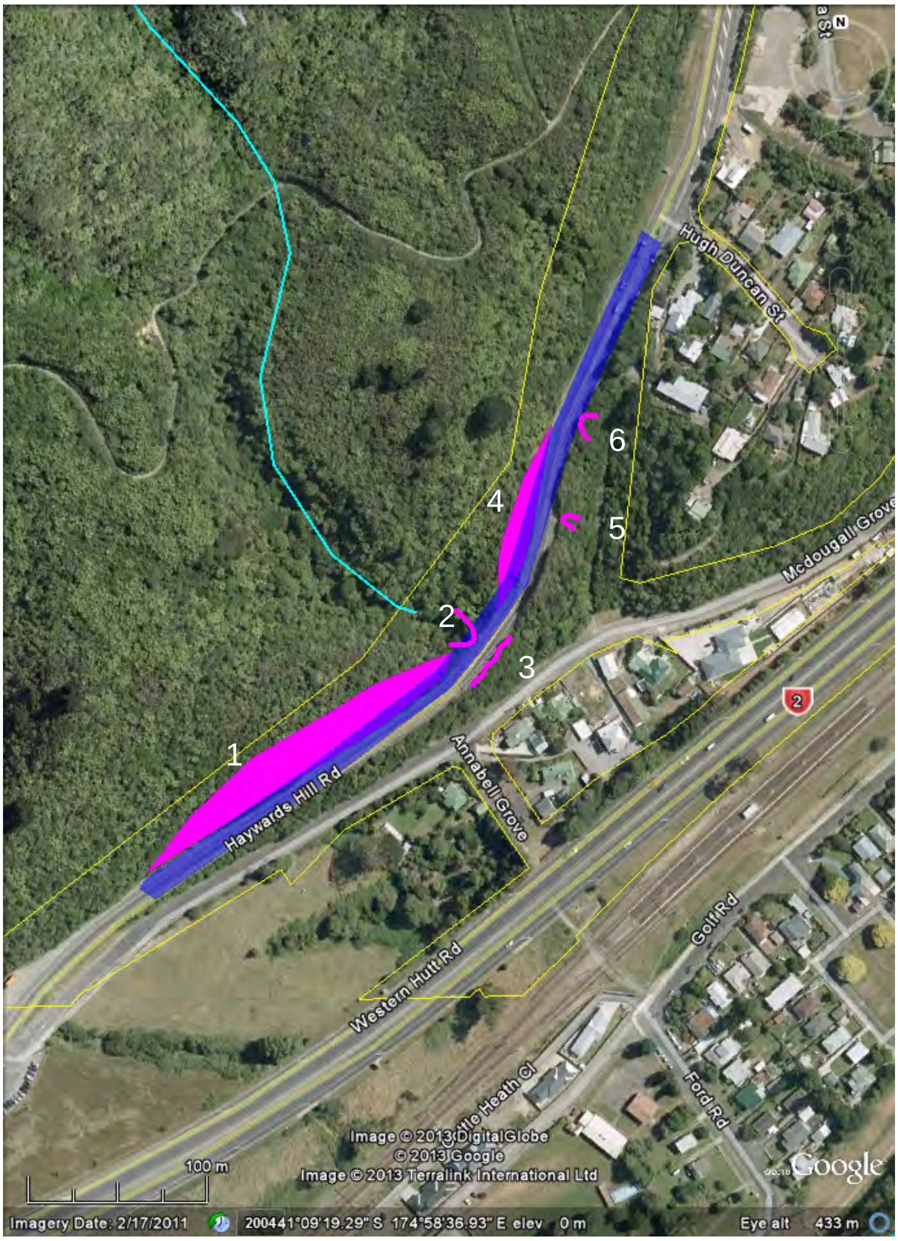


Figure 2-1 : Site 1 Marked Google Earth aerial showing risk locations

2.2 Site 2

1. RP 1.2-1.4 - Cutting to LHS approximately 6m high will affect access track to water tanks
2. RP 1.5 – Deeply incised erosion gully to RHS

Figure 2-2 : Site 2 Marked Google Earth aerial showing risk locations

2.3 Site 3

1. RP 2.68 - Gully hole and fill LHS
2. RP 2.6-2.72 - Soft shoulder fill RHS
3. RP 2.85 - Gully hole and fill LHS
4. RP 2.83-2.86 - Soft shoulder fill RHS
5. RP 2.5-2.8 - 4m cut Loess over massive greywacke LHS
6. RP RHS 2.96 - Fill to deep roadside channel

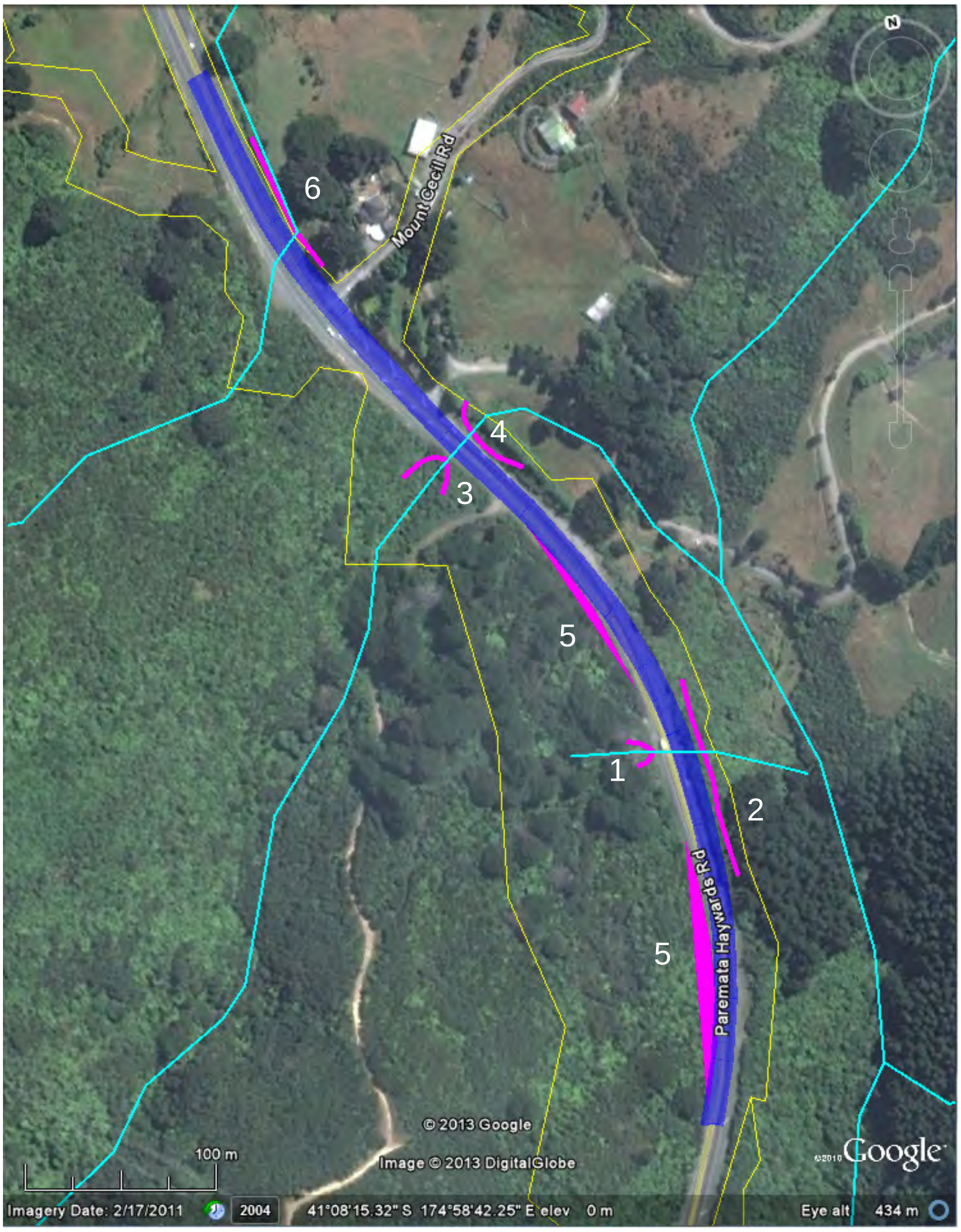


Figure 2-3 : Site 3 Marked Google Earth aerial showing risk locations

2.4 Site 4

1. RP 3.35 – Recent gabion wall RHS
2. RP 3.42-3.46 – Bowl-shaped landslide scarp LHS
3. RP 3.45-3.55 – Failing shoulder RHS
4. RP 3.51-3.8 – Existing hard flat area (opportunity?) RHS
5. RP 3.62-3.76 – 7m+ massive fractured greywacke LHS
6. RP 3.68-3.71 – Scour Site Failure RHS
7. RP 3.795 – Existing culvert structure concrete flume
8. RP 3.8-3.87 - 3m+ massive fractured greywacke LHS
9. RP 3.910 – Steep drop down to creek RHS
10. RP 3.910-3.915 – Assorted old retaining structures on steep slopes RHS

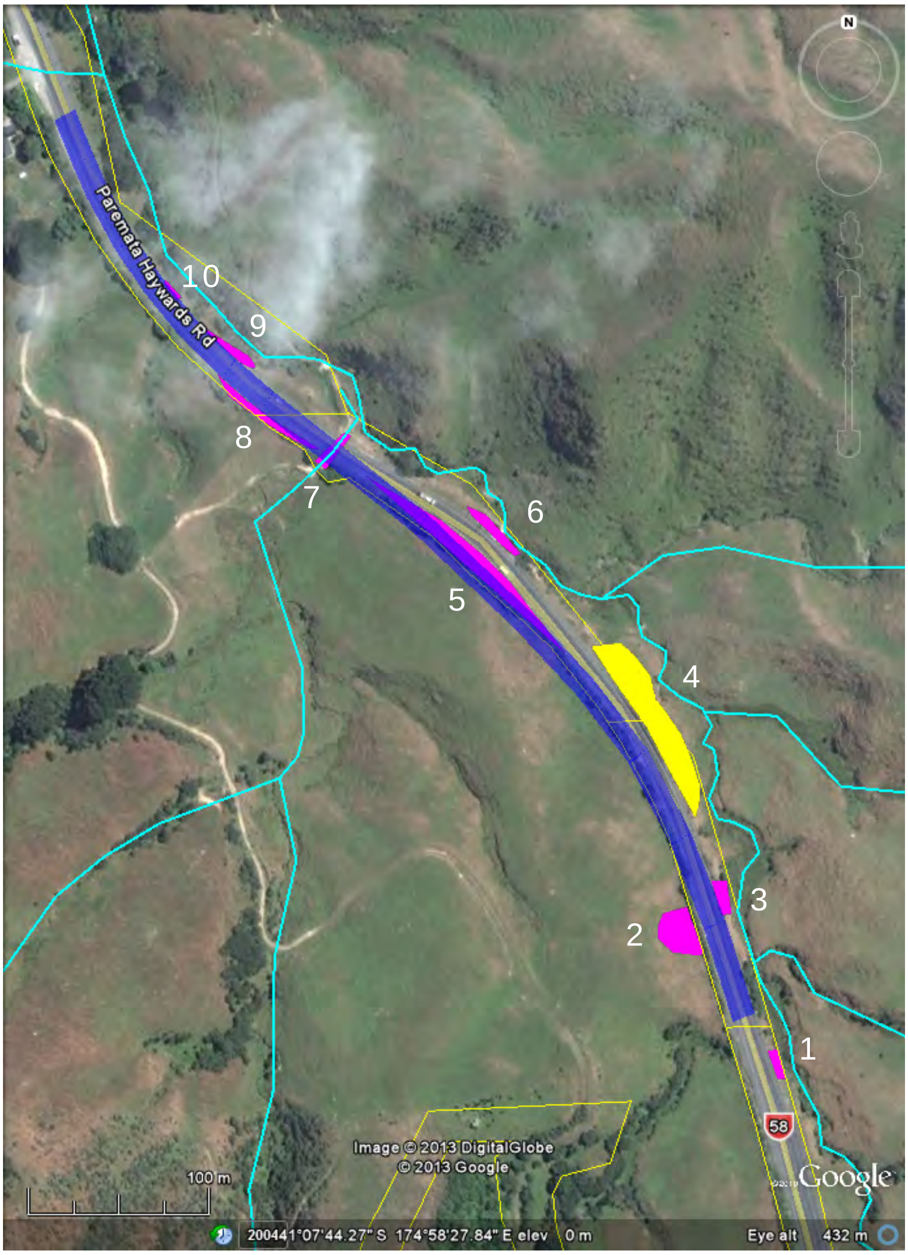


Figure 2-4 : Site 4 Marked Google Earth aerial showing risk locations

2.5 General Widening from SH2 to Pauatahanui Roundabout

No specific geotechnical risks stand out along this section. In general, the potentials for risk may include:

1. Minor shoulder construction less than 1.0m thick, and not at the crests of any significant slopes
2. Minor cuttings less than 1.5m high (toe to crest) and table drain construction

Detailed design would be required to confirm that the scale of general widening proposals meets with this assessment, but we do not consider there to be any untreatable risks as part of this work.

2.6 Geotechnical Risk Assessment

A qualitative risk assessment was undertaken using the General Approach identified in the Transit New Zealand Risk Management Process Manual, 2004, which is based on the risk management process and definitions presented in AS/NZS 4360: 2004.

Each risk site was given a unique identifying number (the RP location), and is detailed in the Risk Register attached in Appendix C.

3 Regional Geology

Site geology is indicated on the GNS Science 1:250,000 geological map 10, dated 2000, as Rakaia terrane of the Torlesse Group; being grey sandstone-mudstone sequences with poorly bedded sandstone (Tt). Colloquially this group is called greywacke.

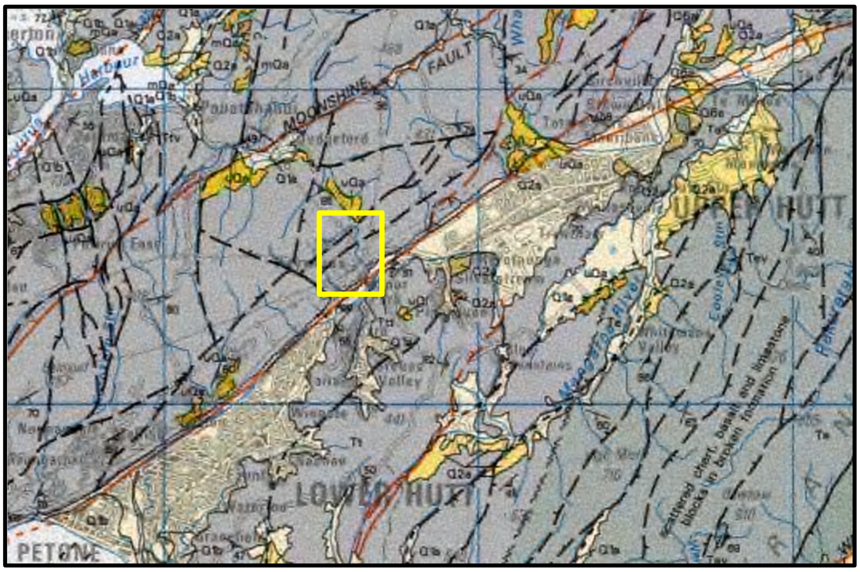


Figure 3-1 : Excerpt GNS Science 1:250,000 geological map 10 (Not to Scale) – Site location in Yellow

3.1 Seismicity

The Wellington region is considered to have a significant seismic risk within New Zealand.

The main active faults noted in the GNS Science 'New Zealand Active Faults Database', and quantified within the IGNS Probabilistic Seismic Hazard Assessment of NZ (2000/53), and GNS Science Consultancy Report 2008/92 (G H McVery, U Destegul). These are the Moonshine Fault to the northwest, and the Wellington Fault to the southeast, within 1km of sites 1 and 2 shown in red on Figure 3-1

- The Moonshine Fault has an established recurrence interval of 11,000 years with an estimated earthquake magnitude of 7.1 (Richter Scale)
- The Wellington Fault has a recurrence interval of less than 650-700 years; the last event was during last millennium; it has a “medium” slip rate and is anticipated to have a moderate single-event displacement with an estimated earthquake magnitude of 7.3-7.6 (Richter Scale)

4 Geotechnical Issues

4.1 Cut Slope Stability

Cuttings into the Greywacke bedrock are clean, show no signs of fretting or failures, and appear to be standing well; at angles up to 70° in places.

Cuttings into the loess overburden are performing well, at angles up to 45° and heights up to 3m. Minor erosion and slumping has occurred and small silt trap fences have been installed in places to prevent debris washed off the face from entering the water table.

The existing cut slopes provide good precedence for design of future cuttings.

New cuttings in the greywacke face should be capable of supporting slope angles of 0.5H:1V (64°), where the rock is only slightly weathered and where there are no significant unfavourable defects. Cuttings higher than 9m will require benching to provide safe construction and serviceability access and reduce any potential fall height for debris. This would be subject to detailed rock mass assessment following the investigation phase.

New cuttings in the loess overburden should be capable of supporting angles of 1:1 (45°) up to 3m high, provided that no springs or uncontrolled surface water is allowed to pass over the face. Crest drainage and hydro-seed re-vegetation of cut faces should provide serviceable slopes.

4.2 Fill Slope Stability

In many locations, the right hand side of the highway has been filled as part of construction across minor water courses. This fill material and some of the natural overburden shows signs of softening and movement.

Investigations should focus on confirming the depth of any softer soils in the gullies as well as in proposed fill locations prior to detailed design of any fill-supporting structures. It is likely that long sideling fills or retaining structures would be required to widen the road to the right side.

4.3 Storm water

Existing storm water controls appear to be performing well, and no significant additional measures are required. However; there are some locations where uncontrolled discharge of storm water has resulted in steep scour slopes to the right side of the highway. Construction details should seek to control discharges, or restrict them to locations with solid bedrock underlying geology.

4.4 Pavement Design

The existing pavement is performing well. Pavement test pits and RAMM historical data will confirm the nature of the existing construction, and this should form a precedent for proposed pavement works.

5 Proposed Site Investigations

5.1 Site investigation methodology

The proposed site investigations are indicated on the attached site plans Appendix A:Site Investigation Location Plans, and attached in the tender schedule Appendix B:Testing Schedule and consist of the following:

- Borehole investigations
- Test pit excavation with hand held shear vane testing, and Scala penetrometers
- Hand auger testing with hand held shear vane and Scala penetrometer testing
- Pavement pit investigations with hand held shear vane and Scala penetrometer testing
- Shoulder pit investigation with hand held shear vane and Scala penetrometer testing
- Detailed rock-mass mapping of existing cut faces, with cut-face scraping.

Borehole investigations have been recommended to confirm ground conditions where investigation depths are beyond the limits of conventional hand auger investigation and where test pit excavations may be too destructive i.e. within the road carriageway. The boreholes have the ability to core through pavement materials and extract in-situ samples

Test Pits will be undertaken for field logging and in-situ strength testing and to observe subgrade and structure of sub-soils, Test Pit and Shoulder Pit excavations will also provide adequate sampling for laboratory testing and may indicate temporary wall stability for any storm water structures. The tests will also help to identify and classify potential weak or fill soils if encountered.

Hand Augers will be undertaken for field logging and in-situ strength testing.

Pavement pits will be undertaken within the pavement surface to provide confirmation of existing subgrade materials and adequate sampling for laboratory testing including pavement modifications.

Shoulder pits will be undertaken outside the pavement within subgrade soils where road widening is likely to be undertaken. The shoulder pits will provide adequate testing and sampling of subgrades including laboratory testing where required.

Detailed face mapping will be undertaken within existing cut slopes. Associated traffic management will be required for this work.

Access outside of the Property boundaries for the highway may require land-entry agreements prior to undertaking the work.

5.2 Laboratory Testing Methodology

Samples obtained from the site investigations will be tested by an IANZ accredited laboratory. The following laboratory tests will be undertaken;

Classification of cut material for fill suitability

- Atterberg Limits
- Particle Size Distribution tests (PSD)
- NZ Standard Compaction tests

Classification of subgrade for pavement Design

- Water Contents
- PI Subgrade Aggregate (TNZ/M4)
- Soaked CBR Tests (natural) Standard Compaction

Atterberg limits will be undertaken on representative samples across the site for classification of sub-soils. These can be incorporated into ground models for cut and fill designs and will determine how sub-soils are likely to behave under variable conditions. The PI sub-grade, and soaked CBR testing will confirm current status of existing pavement materials and subgrade quality.

5.3 Site 1

Hand tool or excavator investigations should be undertaken in the gullies, shoulders and further down the slopes in the potential fill locations to confirm the depth of soft superficial soils and allow estimates for the required foundation depth of and proposed structures or fill to this edge.

Detailed rock structure mapping should be undertaken of the greywacke exposure between RP 0.45-0.65 and 0.68-0.84, to allow slope stability assessments to be undertaken and ripability assessments to be made. Traffic management will be required to undertake this work safely.

Two Boreholes; one 25m deep and one 75m deep from the top of the existing cuttings would provide detailed information on the existing geology and allow a ripability rating assessment to be undertaken; however; these boreholes require two access tracks, approximately 125m each.

5.4 Site 2

If any fill structures are proposed to the right hand side, then these will require investigation with hand tool / excavator investigations.

Excavated investigations of the left cutting would be sufficient to assess the geology and depth of superficial soils in the proposed cut zone.

5.5 Site 3

Hand tool or excavator investigations should be undertaken in the gullies, right hand side shoulders and further down the slopes in the potential fill locations to confirm the depth of soft superficial soils and allow estimates for the required foundation depth of and proposed structures or fill to this edge.

Excavated investigations of the cuttings to the left side would be sufficient to assess the geology and depth of superficial soils in the proposed cut zone.

5.6 Site 4

Hand tool or excavator investigations should be undertaken along the right hand side shoulders and further down the slopes in any potential fill locations to confirm the depth of soft superficial soils and allow estimates for the required foundation depth of and proposed structures or fill to this edge.

Excavated investigations of the cuttings to the left side would be sufficient to assess the geology and depth of superficial soils in the proposed cut zone.

Old landslip features are present that can be investigated with mechanically excavated trial pits to confirm the nature of materials in this location.

One 25m deep borehole into the hillside at the top of the existing cutting would provide detailed information on the existing geology and allow a ripability rating assessment to be undertaken; this could be readily accessed from existing tracks and paths through this land

5.7 General Widening

A combination of Pavement Pits / Shoulder pits, and test pits should be undertaken.

Pavement pits should be undertaken on the edge of the pavement formation where road widening is proposed. Shoulder pits should be undertaken to confirm that shoulder construction is adequate to take final traffic loading. Test pits should be taken off the sealed pavement.

Scala DCP testing should confirm readings from ground level to 1.5m depth below existing ground level. Bulk samples will be taken and tested for Plasticity Index and soaked CBR. This will provide confirmation of existing subgrade materials.

We recommend that an allowance be made for pavement / shoulder pits throughout the scheme at approximately 300m spacing; ideally widening should focus on one side at a time, and this testing provision assumes this. Should widening be proposed to both sides at the same chainage, then additional testing will be warranted.

6 Limitations

This report has been prepared for NZTA in accordance with the generally accepted practices and standards in use at the time it was prepared. MWH accepts no liability to any third party who relies on this report.

The information contained in this report is accurate to the best of our knowledge at the time of issue.

MWH NZ has made no independent verification of this information beyond the agreed scope set out in the report.

The interpretations as to the likely subsurface conditions contained in this report are based on site observations and existing information described in this report. No site investigations have been undertaken by MWH NZ Ltd at this stage.

Actual ground conditions encountered may vary from the predicted subsurface conditions. For example, subsurface groundwater conditions often change seasonally and over time. No warranty is expressed or implied that the actual conditions encountered will conform exactly to the conditions described herein,

Where conditions encountered at the site differ from those inferred in this report MWH NZ should be notified of such changes, and should be given an opportunity to review the report recommendations made in this report in light of any further information,

This report does not purport to describe all the site characteristics and properties. Subsurface conditions and testing relevant to construction works must be undertaken and assessed by any contractors as necessary for their own purposes.

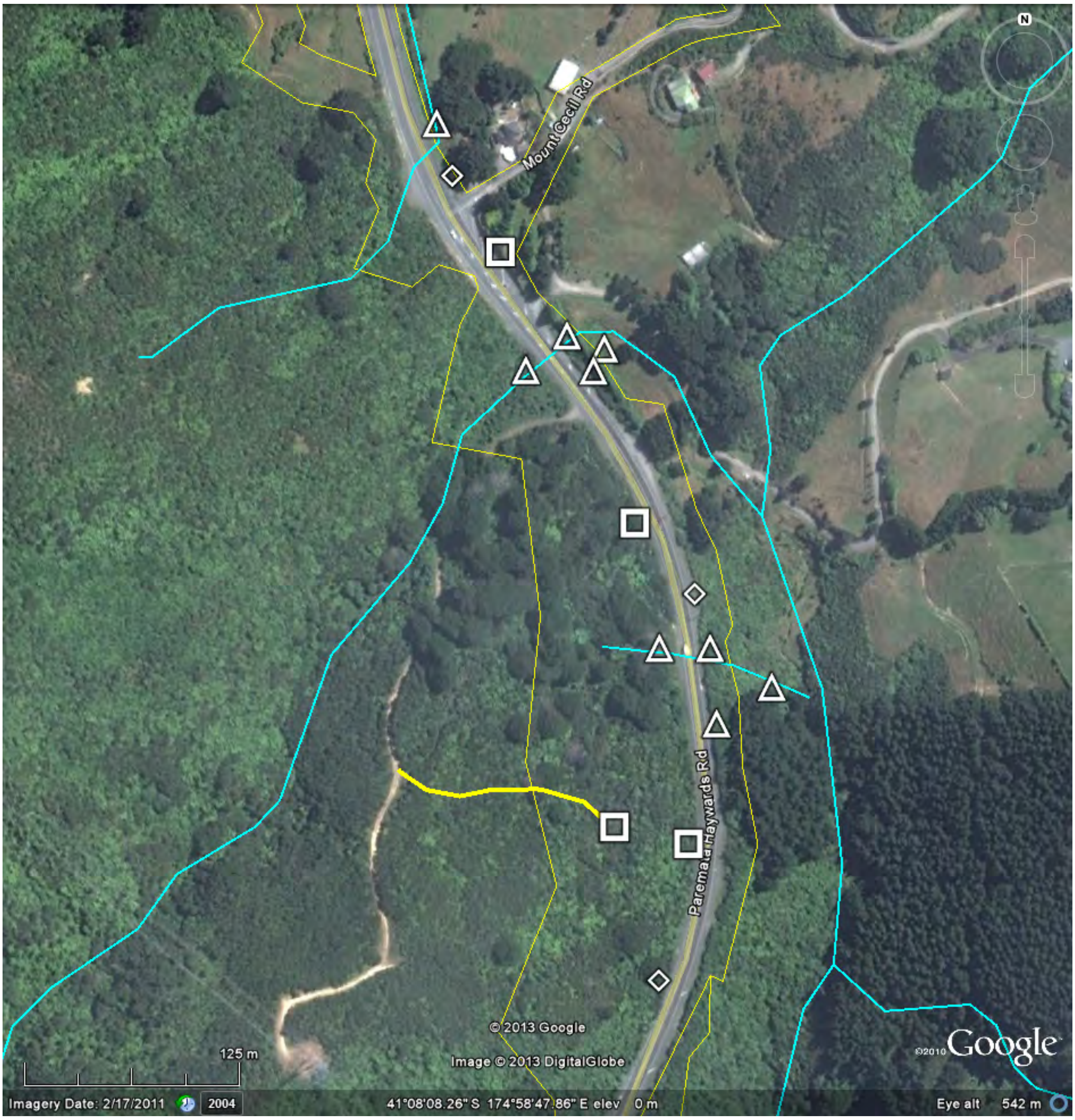
Appendix A: Site Investigation Location Plans

Site 1

Note: access track required for one Borehole


Old Haywards Rd
Haywards Hill Rd
© 2013 Google
Image © 2013 Terralink International Ltd
75 m
Imagery Date: 2/19/2008
2004
41°08'57.10" S 174°58'47.23" E elev 0 m
Eye alt 326 m
Google

Site 2



Site 3
Note: access track required for one trial pit

Site 4
Note: existing access available to borehole

Appendix B: Testing Schedule

Item	Description	Quantity	unit	Rate	Sum
	Scala and Hand Auger				
1.1	Scala Penetrometer (3m max)	27	ea		
1.2	Hand Auger Excavation (3m max)	19	ea		
1.3	Sample for laboratory testing	13			
	Pavement / Shoulder Test Pit				
2.1	Test Pit Excavation (500mm deep)	23	ea		
2.2	Density (field NDM)		PS		
2.3	Scala Penetrometer (2m max)	23	ea		
2.4	Shear vane (Pilcon single test)	23	ea		
2.5	Sample for Laboratory Testing	23	ea		
	Lab Testing (I)				
3.1	Water Content – Natural	28	ea		
3.2	Plasticity Index Subgrade Aggregate (TNZ/M4)	28	ea		
3.3	CBR Test – Natural or Optimum	28	ea		
	Investigation Test Pit				
4.1	Excavation (4m maximum)	19	ea		
4.2	Access Track (<200m)	1	sum		
4.3	Density (field) NDM		PS		
4.4	Sample for Laboratory Testing	19	ea		
4.5	Shear vane (Pilcon single test)	30	ea		
	Lab Testing (II)				
5.1	NZ Standard Compaction Test		PS		
5.2	Atterberg Limits		PS		
5.3	Grading hydrometer		PS		
5.4	Grading (Particle Sieve Analysis) wet		PS		
	Borehole				
7.1	Drilling rig establishment	1	ea		
7.2	Access Track (<200m)	2	sum		
7.3	Drilling rig set-up at borehole	3	ea		
7.4	Core recovery - Soil	15	m		
7.5	Standard Penetration Test		ea		
7.6	Core recovery - Rock	110	m		
7.7	Miscellaneous				
7.8	Standpipe Piezometer (2 per hole)	250	m		
7.9	Log and Photograph Core	125	m		
	Miscellaneous				
8.1	Factual Report	1	ea		
8.2	Geotechnical Assessment Report	1	ea		

Appendix C: Geotechnical Risk Register

SH58: Haywards Hill to Paramata Road

Geotechnical Risk Register (Sites listed in order of increasing RP distances i.e. south to north)

Activity	Risk Register from Transit NZ Risk Management Process Manual (2004)	Analysts Name(s)	Lee Paterson
Contract No.	80501811 NZTA	Reviewers Name(s)	Paul Wopereis
Date	27/06/2013	Sources of Information	Site Walkover, Reports, Air Photos, Google Earth

RP I.D.(km)		LHS / RHS	Description	Risk Status	Threat or Opportunity	Existing Controls	Consequence		Likelihood		Score = C x L[1]	Threat Category*	Treatment Plan Summary
From	To						Description	Rating (C)	Description	Rating (L)			
			START: RP0										
0.450	0.65	LHS	Existing Cutting 70degrees and 10 high - rockfall or failure risk	L	T		Minor	10	Unusual	2	**20**	**Low**	
0.66	0.67	LHS / RHS	Gully crossing, pavement failure in fill	L	T		Minor	10	Unusual	2	**20**	**Low**	
0.64	0.690	RHS	Movement / Failure of slope behind crash barriers underway	L	T		Minor	10	Common	5	**50**	**Moderate**	Failure not yet threatenning pavement, but guard rail effectivenes a concern, - construct retaining structure or retreat
0.680	0.84	LHS	Existing Cutting 70degrees and 10 high - rockfall or failure risk	L	T		Minor	10	Unusual	2	**20**	**Low**	
0.75	0.75	RHS	Flume and gully to be avoided - oversteep eroded slope	L	T		Minor	10	Unlikely	3	**30**	**Moderate**	stormwater discharges will need controlled and scour anticipated
0.805	0,845	RHS	Slumping of soft shoulder at RHS	L	T		Minor	10	Common	4	**40**	**Moderate**	Failing shoulder - avoid surcharging and retain if worsens
1.2	1.4	LHS	Cutting to LHS supporting access track to water tanks and further uphill would be disruptive in the event of failure	L	T		Medium	40	Unusual	2	**80**	**High**	Construction activity must ensure inout from access users and ensure access
1.5	1.505	RHS	Deeply incised erosion gully	L	T		Minor	10	Unlikely	3	**30**	**Moderate**	stormwater discharges will need controlled and scour anticipated. Tall structure would be required to construct road over this point
RP 2.68		LHS	Gully hole and fill	L	T		Minor	10	Unusual	2	**20**	**Low**	
2.6	2.72	RHS	Soft shoulder fill	L	T		Minor	10	Common	5	**50**	**Moderate**	Requires Structures through fill if supporting new road
2.85		LHS	Gully hole and fill	L	T		Minor	10	Unusual	2	**20**	**Low**	
2.83	2.86	RHS	Soft shoulder fill	L	T		Minor	10	Common	5	**50**	**Moderate**	Requires Structures through fill if supporting new road
2.5	2.8	LHS	4m cut Loess over massive greywacke	L	T		Minor	10	Unusual	2	**20**	**Low**	
2.96		RHS	Fill to deep roadside channel	L	T		Minor	10	Common	5	**50**	**Moderate**	Requires piping watercourse if covered
3.35	3.355	RHS	Recent gabion wall	L	T		Minor	10	Common	5	**50**	**Moderate**	avoid surcharging
3.42	3.46	LHS	Bowl-shaped landslide scarp. Potential to Mobilise it again or something similar adjacent	L	T		Medium	40	Unusual	2	**80**	**High**	Realign Away or retreat
3.45	3.55	RHS	Failing shoulder	L	T		Minor	10	Common	5	**50**	**Moderate**	Failure not yet threatenning pavement, but guard rail effectivenes a concern, - construct retaining structure or retreat
3.51	3.800	RHS	Existing hard flat area (opportunity?)	L	O		Minor	10	Common	5	**50**	**Moderate**	Large enough to offer relief for alignment?
3.620	3.760	LHS	7m+ massive fractured greywacke	L	T		Minor	10	Unusual	2	**20**	**Low**	
3.680	3.710	RHS	Scour Site Failure	L	T		Medium	40	Common	4	**160**	**Very High**	Realign Away or Treat
3.795		LHS / RHS	Existing culvert structure concrete flume	L	T		Minor	10	Common	5	**50**	**Moderate**	Construction over this section would require broad solution
3.800	3.870	LHS	3m+ massive fractured greywacke	L	T		Minor	10	Unusual	2	**20**	**Low**	
3.910	3.930	RHS	Steep drop down to creek	L	T		Minor	10	Common	5	**50**	**Moderate**	Any widenning this side would require a significant tall structure
3.910	3.915	RHS	Assorted old retaining structures on steep slopes	L	T		Minor	10	Common	5	**50**	**Moderate**	Failure not yet threatenning pavement, but guard rail effectivenes a concern, - construct retaining structure or retreat

Appendix J Scheme Estimate

Project Estimate - Form C

Project Name: SH58 Haywards Substation Curves
Option 1

SE

Scheme Estimate

Item	Description		Base Estimate	Contingency	Funding Risk
A	**Nett Project Property Cost**		**200,000**	**30,000**	**50,000**
	Investigation and Reporting				
	- Consultancy Fees		**Nil**	**Nil**	**Nil**
	- NZTA-Managed Costs		**Nil**	**Nil**	**Nil**
B	**Total Investigation and Reporting**		**Nil**	**Nil**	**Nil**
	Design and Project Documentation				
	- Consultancy Fees		**1,183,213**	**177,480**	**295,800**
	- NZTA-Managed Costs		**0**	**0**	**0**
C	**Total Design and Project Documentation**		**1,183,213**	**177,480**	**295,800**
	Construction				
	MSQA				
	- Consultancy Fees		**1,263,734**	**189,560**	**315,900**
	- NZTA-Managed Costs		**0**	**0**	**0**
	- Consent Monitoring Fees		**0**	**0**	**0**
	Sub Total Base MSQA		**1,263,734**	**189,560**	**315,900**
	Physical Works				
D1	Environmental Compliance		1,845,793	276,900	461,400
D2	Earthworks		3,116,250	779,100	1,308,800
D3	Ground Improvements		0	0	0
D4	Drainage		1,999,410	299,900	499,900
D5	Pavement and Surfacing		3,706,915	556,000	926,700
D6	Bridges / Structures		0	0	0
D7	Retaining Walls		76,650	11,500	19,200
D8	Traffic Services		1,379,990	207,000	345,000
D9	Service Relocations		5,705,565	855,800	1,426,400
D10	Landscaping		530,000	79,500	132,500
D11	Traffic Management and Temporary Works		1,606,403	241,000	401,600
D12	Preliminary and General		2,400,000	360,000	600,000
D13	Extraordinary Construction Costs		0	0	0
	Sub Total Base Physical Works		**22,366,975**	**3,666,700**	**6,121,500**
D	**Total Construction & MSQA**		**23,630,709**	**3,856,260**	**6,437,400**
E	**Project Base Estimate**	**(A+B+C+D)**	**25,013,922**		
F	**Contingency** (Assessed / Analysed)		**(A+B+C+D)**	**4,063,740**	
G	**Project Expected Estimate**		**(E+F)**	**29,077,662**	
	Project Property Cost Expected Estimate			**230,000**	
	Investigation and Reporting Expected Estimate			**Nil**	
	Design and Project Documentation Expected Estimate			**1,360,693**	
	Construction Expected Estimate			**27,486,969**	
H	**Funding Risk** (Assessed / Analysed)			**(A+B+C+D)**	**6,783,200**
I	**95th Percentile Project Estimate**			**(G+H)**	**35,860,862**
	Project Property Cost 95th Percentile Estimate				**280,000**
	Investigation and Reporting 95th Percentile Estimate				**Nil**
	Design and Project Documentation 95th Percentile Estimate				**1,656,493**
	Construction 95th Percentile Estimate				**33,924,369**

Base Date of Estimate	**1 Jul 2013**	**Cost Index**
Estimate prepared by:	**Nigel Lister**	**Signed**
Estimate internal peer review by:		**Signed**
Estimate external peer review by:		**Signed**
Estimate approved by NZTA Project Manager:		**Signed**

Note: (1) These estimates are exclusive of escalation and GST.
(2) I&R Project Phase Estimates are set to Nil as these are now sunk costs.

Project Estimate - Form C

Project Name: SH58 Haywards Substation Curves
Option 2

SE

Scheme Estimate

Item	Description	Base Estimate	Contingency	Funding Risk
A	**Nett Project Property Cost**	260,000	39,000	65,000
	Investigation and Reporting			
	- Consultancy Fees	Nil	Nil	Nil
	- NZTA-Managed Costs	Nil	Nil	Nil
B	**Total Investigation and Reporting**	Nil	Nil	Nil
	Design and Project Documentation			
	- Consultancy Fees	1,288,313	193,250	322,100
	- NZTA-Managed Costs	0	0	0
C	**Total Design and Project Documentation**	1,288,313	193,250	322,100
	Construction			
	MSQA			
	- Consultancy Fees	1,375,986	206,400	344,000
	- NZTA-Managed Costs	0	0	0
	- Consent Monitoring Fees	0	0	0
	Sub Total Base MSQA	1,375,986	206,400	344,000
	Physical Works			
D1	Environmental Compliance	1,845,793	276,900	461,400
D2	Earthworks	4,192,000	1,257,600	2,096,000
D3	Ground Improvements	0	0	0
D4	Drainage	2,117,220	317,600	529,300
D5	Pavement and Surfacing	4,195,565	629,300	1,048,900
D6	Bridges / Structures	0	0	0
D7	Retaining Walls	121,900	18,300	30,500
D8	Traffic Services	1,439,290	215,900	359,800
D9	Service Relocations	5,705,565	855,800	1,426,400
D10	Landscaping	530,000	79,500	132,500
D11	Traffic Management and Temporary Works	1,606,403	241,000	401,600
D12	Preliminary and General	2,600,000	390,000	650,000
D13	Extraordinary Construction Costs	0	0	0
	Sub Total Base Physical Works	24,353,735	4,281,900	7,136,400
D	**Total Construction & MSQA**	25,729,721	4,488,300	7,480,400
E	**Project Base Estimate** (A+B+C+D)	27,278,034		
F	**Contingency** (Assessed / Analysed) (A+B+C+D)		4,720,550	
G	**Project Expected Estimate** (E+F)		31,998,584	
	Project Property Cost Expected Estimate		299,000	
	Investigation and Reporting Expected Estimate		Nil	
	Design and Project Documentation Expected Estimate		1,481,563	
	Construction Expected Estimate		30,218,021	
H	**Funding Risk** (Assessed / Analysed) (A+B+C+D)			7,867,500
I	**95th Percentile Project Estimate** (G+H)			39,866,084
	Project Property Cost 95th Percentile Estimate			364,000
	Investigation and Reporting 95th Percentile Estimate			Nil
	Design and Project Documentation 95th Percentile Estimate			1,803,663
	Construction 95th Percentile Estimate			37,698,421

Base Date of Estimate	**1 Jul 2013**	**Cost Index**
Estimate prepared by:	**Nigel Lister**	**Signed**
Estimate internal peer review by:		**Signed**
Estimate external peer review by:		**Signed**
Estimate approved by NZTA Project Manager:		**Signed**

Note: (1) These estimates are exclusive of escalation and GST.
(2) I&R Project Phase Estimates are set to Nil as these are now sunk costs.

Project Estimate - Form C

Project Name: SH58 Haywards Substation Curves Option 3

SE

Scheme Estimate

Item	Description	Base Estimate	Contingency	Funding Risk
A	**Nett Project Property Cost**	**260,000**	**39,000**	**65,000**
	Investigation and Reporting			
	- Consultancy Fees	**Nil**	**Nil**	**Nil**
	- NZTA-Managed Costs	**Nil**	**Nil**	**Nil**
B	**Total Investigation and Reporting**	**Nil**	**Nil**	**Nil**
	Design and Project Documentation			
	- Consultancy Fees	**1,363,415**	**204,510**	**340,900**
	- NZTA-Managed Costs	**0**	**0**	**0**
C	**Total Design and Project Documentation**	**1,363,415**	**204,510**	**340,900**
	Construction			
	MSQA			
	- Consultancy Fees	**1,456,199**	**218,430**	**364,000**
	- NZTA-Managed Costs	**0**	**0**	**0**
	- Consent Monitoring Fees	**0**	**0**	**0**
	Sub Total Base MSQA	**1,456,199**	**218,430**	**364,000**
	Physical Works			
D1	Environmental Compliance	1,845,793	276,900	461,400
D2	Earthworks	4,613,250	1,384,000	2,306,600
D3	Ground Improvements	0	0	0
D4	Drainage	2,133,330	320,000	533,300
D5	Pavement and Surfacing	4,355,505	653,300	1,088,900
D6	Bridges / Structures	0	0	0
D7	Retaining Walls	121,900	18,300	30,500
D8	Traffic Services	2,111,690	316,800	527,900
D9	Service Relocations	5,705,565	855,800	1,426,400
D10	Landscaping	530,000	79,500	132,500
D11	Traffic Management and Temporary Works	1,606,403	241,000	401,600
D12	Preliminary and General	2,750,000	412,500	687,500
D13	Extraordinary Construction Costs	0	0	0
	Sub Total Base Physical Works	**25,773,435**	**4,558,100**	**7,596,600**
D	**Total Construction & MSQA**	**27,229,634**	**4,776,530**	**7,960,600**
E	**Project Base Estimate** (A+B+C+D)	**28,853,049**		
F	**Contingency** (Assessed / Analysed) **(A+B+C+D)**		**5,020,040**	
G	**Project Expected Estimate** **(E+F)**		**33,873,089**	
	Project Property Cost Expected Estimate		**299,000**	
	Investigation and Reporting Expected Estimate		**Nil**	
	Design and Project Documentation Expected Estimate		**1,567,925**	
	Construction Expected Estimate		**32,006,164**	
H	**Funding Risk** (Assessed / Analysed) **(A+B+C+D)**			**8,366,500**
I	**95th Percentile Project Estimate** **(G+H)**			**42,239,589**
	Project Property Cost 95th Percentile Estimate			**364,000**
	Investigation and Reporting 95th Percentile Estimate			**Nil**
	Design and Project Documentation 95th Percentile Estimate			**1,908,825**
	Construction 95th Percentile Estimate			**39,966,764**

Base Date of Estimate	**1 Jul 2013**	**Cost Index**
Estimate prepared by:	**Nigel Lister**	**Signed**
Estimate internal peer review by:		**Signed**
Estimate external peer review by:		**Signed**
Estimate approved by NZTA Project Manager:		**Signed**

Note: (1) These estimates are exclusive of escalation and GST.
(2) I&R Project Phase Estimates are set to Nil as these are now sunk costs.

Project Estimate - Form C

Project Name: SH58 Safety Improvements
Option 4

SE

Scheme Estimate

Item	Description	Base Estimate	Contingency	Funding Risk
A	**Nett Project Property Cost**	380,000	57,000	95,000
	Investigation and Reporting			
	- Consultancy Fees	Nil	Nil	Nil
	- NZTA-Managed Costs	Nil	Nil	Nil
B	**Total Investigation and Reporting**	Nil	Nil	Nil
	Design and Project Documentation			
	- Consultancy Fees	1,249,036	187,360	312,300
	- NZTA-Managed Costs	0	0	0
C	**Total Design and Project Documentation**	1,249,036	187,360	312,300
	Construction			
	MSQA			
	- Consultancy Fees	1,334,036	200,110	333,500
	- NZTA-Managed Costs	0	0	0
	- Consent Monitoring Fees	0	0	0
	Sub Total Base MSQA	1,334,036	200,110	333,500
	Physical Works			
D1	Environmental Compliance	1,768,075	265,200	442,000
D2	Earthworks	3,413,858	1,024,200	1,706,900
D3	Ground Improvements	0	0	0
D4	Drainage	2,198,260	329,700	549,600
D5	Pavement and Surfacing	4,023,025	603,500	1,005,800
D6	Bridges / Structures	0	0	0
D7	Retaining Walls	121,900	18,300	30,500
D8	Traffic Services	2,052,050	307,800	513,000
D9	Service Relocations	5,465,330	819,800	1,366,300
D10	Landscaping	530,000	79,500	132,500
D11	Traffic Management and Temporary Works	1,538,765	230,800	384,700
D12	Preliminary and General	2,500,000	375,000	625,000
D13	Extraordinary Construction Costs	0	0	0
	Sub Total Base Physical Works	23,611,263	4,053,800	6,756,300
D	**Total Construction & MSQA**	24,945,299	4,253,910	7,089,800
E	**Project Base Estimate** (A+B+C+D)	26,574,335		
F	**Contingency** (Assessed / Analysed) (A+B+C+D)		4,498,270	
G	**Project Expected Estimate** (E+F)		31,072,605	
	Project Property Cost Expected Estimate		437,000	
	Investigation and Reporting Expected Estimate		Nil	
	Design and Project Documentation Expected Estimate		1,436,396	
	Construction Expected Estimate		29,199,209	
H	**Funding Risk** (Assessed / Analysed) (A+B+C+D)			7,497,100
I	**95th Percentile Project Estimate** (G+H)			38,569,705
	Project Property Cost 95th Percentile Estimate			532,000
	Investigation and Reporting 95th Percentile Estimate			Nil
	Design and Project Documentation 95th Percentile Estimate			1,748,696
	Construction 95th Percentile Estimate			36,289,009

Base Date of Estimate	1 Jul 2013	Cost Index
Estimate prepared by:	Nigel Lister	Signed
Estimate internal peer review by:	Jamie Povall	Signed
Estimate external peer review by:		Signed
Estimate approved by NZTA Project Manager:		Signed

Note: (1) These estimates are exclusive of escalation and GST.
(2) I&R Project Phase Estimates are set to Nil as these are now sunk costs.

Appendix K SIDRA Modelling

K.1 Layout Diagrams

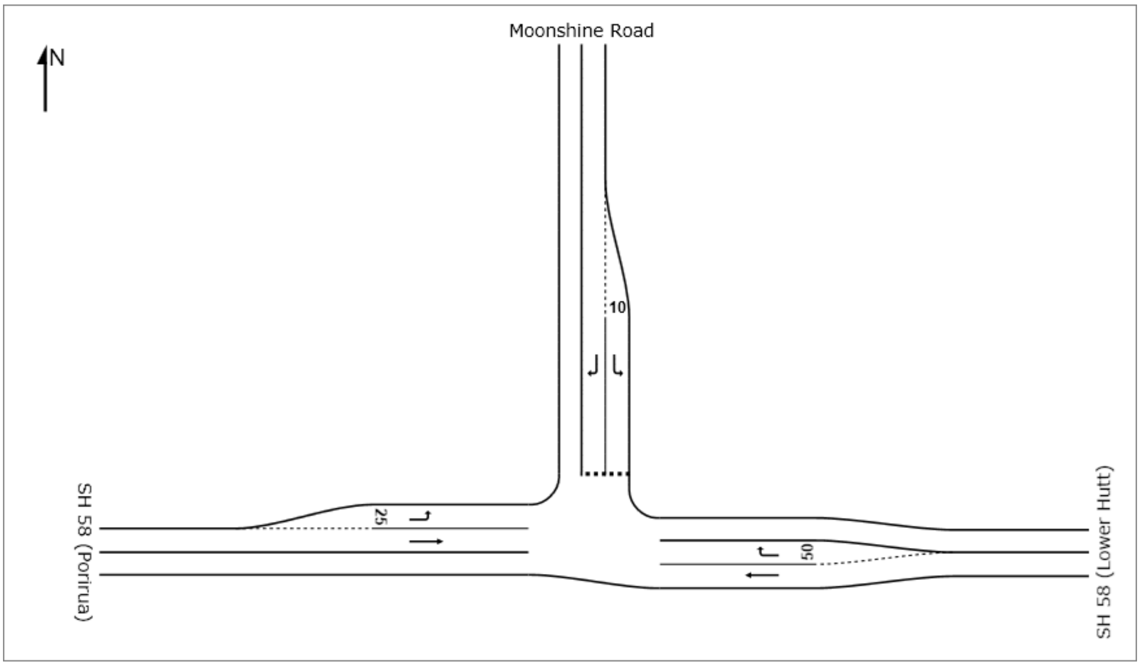


Figure 13-14: Moonshine Road Existing T Intersection Layout (as modelled)

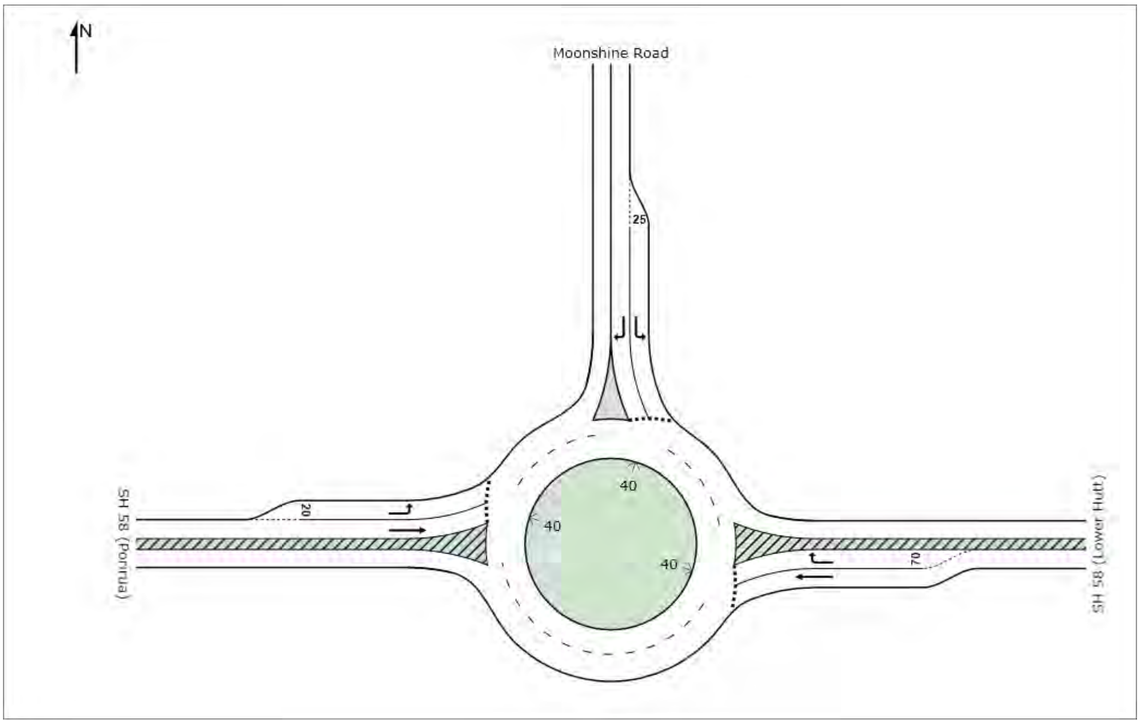


Figure 13-15: Moonshine Road Roundabout Layout

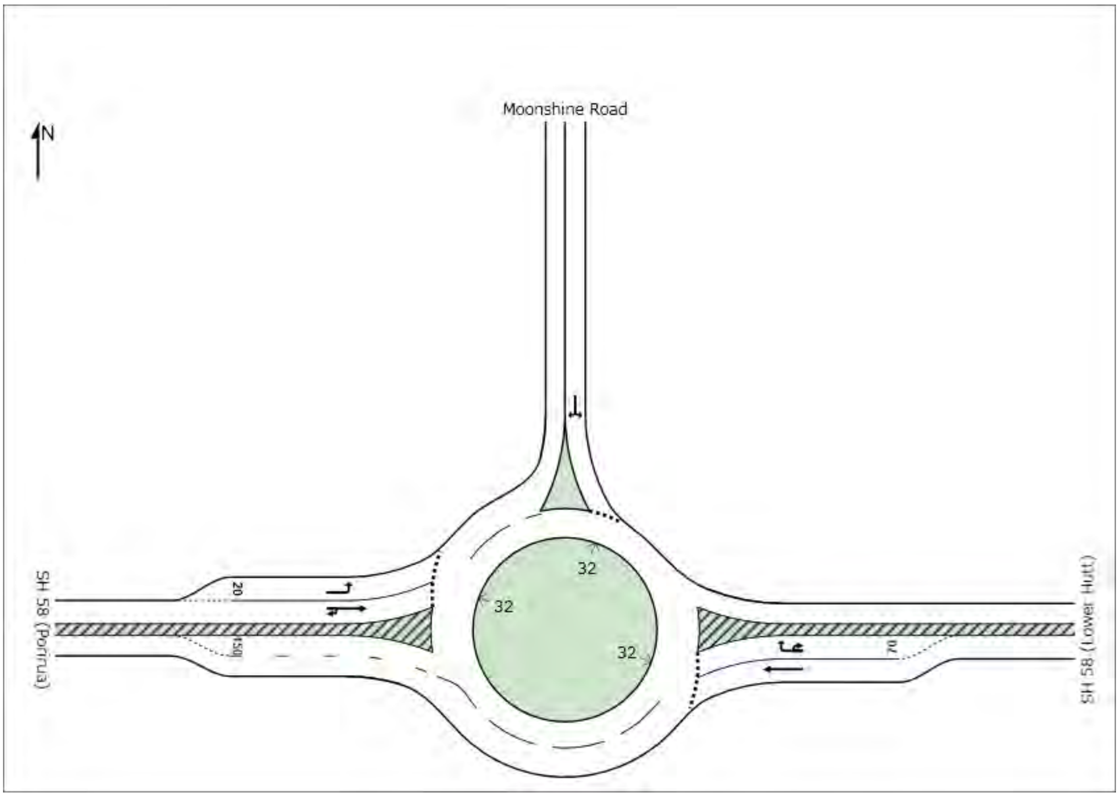


Figure 13-16: Moonshine Road Roundabout Layout (Option 4)

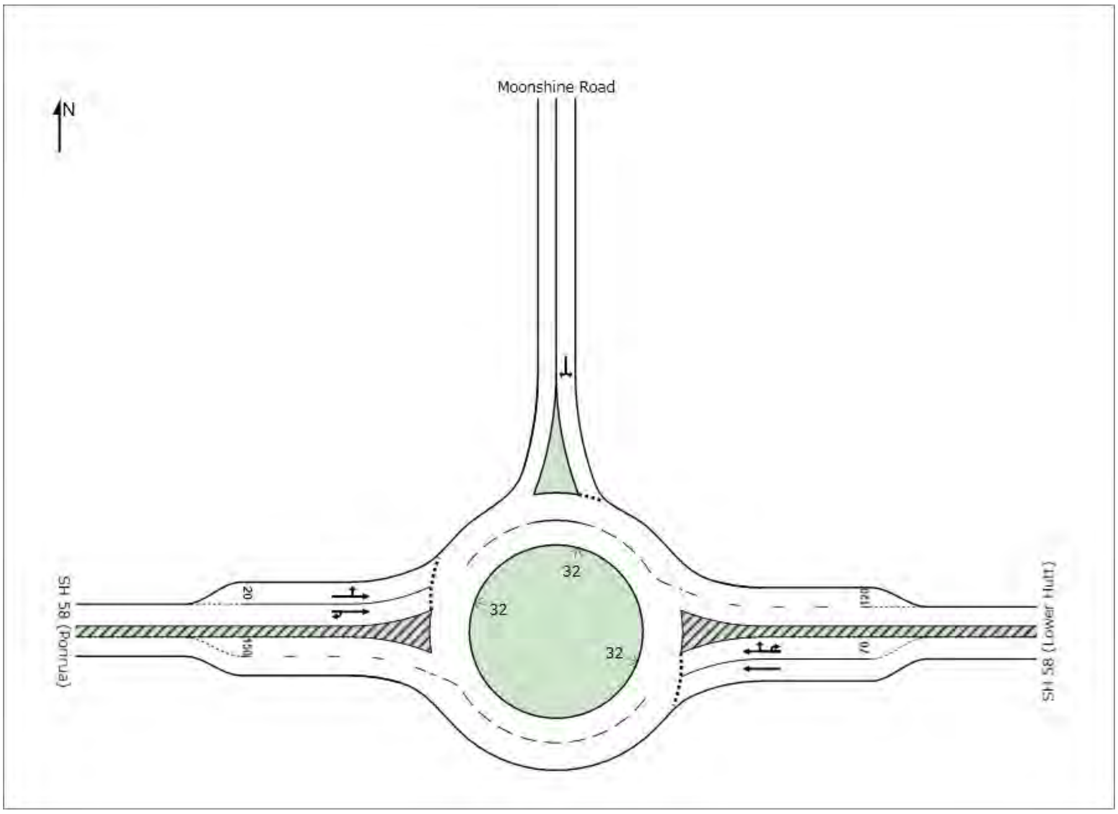


Figure 13-17: Moonshine Road Roundabout Layout (Final Option 4 – Road Safety Audit Update)

K.2 SIDRA Outputs

SIDRA6 RESULTS

1.50%	Do Min (T junction) Scenario 1.5% Growth	Time Period	Demand Flows (veh/h)	Deg. Of Sat	Total control delay veh-h/h)	Average Geometric delay (veh sec)	Average Travel Time (s)	Total Fuel Consumption (l/h)
	Base 2013	AM	1,913	0.547	1.81	1.2	47.5	134.1
		IP	611	0.157	0.22	1.1	45.4	46.1
		PM	1,673	0.452	0.99	0.8	46.2	82.4
	Base 2015	AM	1,970	0.568	2.08	1.2	47.9	138.3
		IP	627	0.161	0.22	1.1	45.4	47.4
		PM	1,721	0.489	1.14	0.8	46.5	84.9
	Base 2018	AM	2,056	0.800	2.82	1.2	49.0	144.9
		IP	655	0.168	0.24	1.1	45.4	49.5
		PM	1,798	0.622	1.46	0.8	47.0	89.0
	Base 2024	AM	2,227	1.000	3.93	1.2	50.3	157.7
		IP	709	0.182	0.25	1.1	45.4	53.6
		PM	1,948	1.000	2.8	0.8	49.2	97.8
	Base 2030	AM	2,400	1.000	5.41	1.2	52.0	171.1
		IP	764	0.196	0.28	1.1	45.4	57.7
		PM	2,098	1.000	2.79	0.8	48.8	104.8
	Base 2036	AM	2,573	1.000	7.74	1.2	54.6	185.0
		IP	819	0.211	0.31	1.1	45.4	61.9
		PM	2,248	1.000	2.8	0.8	48.4	112.0
	Base 2042	AM	2,745	1.007	7.63	1.2	53.6	195.8
		IP	874	0.224	0.34	1.1	45.5	66.0
		PM	2,400	1.000	3.4	0.8	48.1	119.1
	Option 3 (Roundabout) Scenario 1.5% Growth	**Time Period**	**Demand Flows (veh/h)**	**Deg. Of Sat (rbt =0.85)**	**Total control delay veh-h/h)**	**Average Geometric delay (veh sec)**	**Average Travel Time (s)**	**Total Fuel Consumption (l/h)**
	Option 2013	AM	1,913	0.562	8.5	15.6	57.4	142.9
		IP	611	0.156	2.64	15.5	56.0	49.4
		PM	1,673	0.467	7.27	15.4	56.8	87.7
	Option 2015	AM	1,970	0.579	8.77	15.6	57.5	147.2
		IP	627	0.161	2.71	15.5	56.1	50.8
		PM	1,721	0.481	7.48	15.4	56.8	90.3
	Option 2018	AM	2,056	0.605	9.18	15.6	57.6	153.7
		IP	655	0.167	2.83	15.5	56.1	53.0
		PM	1,798	0.503	7.83	15.4	56.9	94.3
	Option 2024	AM	2,227	0.658	10.02	15.6	57.9	166.7
		IP	709	0.182	3.06	15.5	56.1	57.5
		PM	1,948	0.547	8.51	15.4	57.0	102.3
	Option 2030	AM	2,400	0.711	10.92	15.6	58.2	180.1
		IP	764	0.196	3.3	15.5	56.1	61.9
		PM	2,098	0.591	9.18	15.4	57.2	110.3
	Option 2036	AM	2,573	0.765	11.9	15.6	58.6	193.3
		IP	819	0.210	3.54	15.5	56.2	66.4
		PM	2,248	0.635	9.87	15.4	57.4	118.4
	Option 2042	AM	2,745	0.818	12.88	15.6	59.1	206.8
		IP	874	0.224	3.78	15.5	56.2	70.8
		PM	2,400	0.679	10.58	15.4	57.6	126.5

INTERSECTION SUMMARY

Site: 2015 AM

SH58 - Moonshine Road Intersection
2009 surveys adjusted to 2015 AM peak
Giveway / Yield (Two-Way)

Intersection Performance - Hourly Values		
Performance Measure	**Vehicles**	**Persons**
Demand Flows (Total)	1970 veh/h	2955 pers/h
Percent Heavy Vehicles (Demand)	2.2 %	
Degree of Saturation	0.568	
Practical Spare Capacity	40.9 %	
Effective Intersection Capacity	3470 veh/h	
Control Delay (Total)	2.08 veh-h/h	3.13 pers-h/h
Control Delay (Average)	3.8 sec	3.8 sec
Control Delay (Worst Lane)	195.1 sec	
Control Delay (Worst Movement)	195.1 sec	195.1 sec
Geometric Delay (Average)	1.2 sec	
Stop-Line Delay (Average)	2.6 sec	
Idling Time (Average)	2.2 sec	
Intersection Level of Service (LOS)	NA	
95% Back of Queue - Vehicles (Worst Lane)	1.5 veh	
95% Back of Queue - Distance (Worst Lane)	10.7 m	
Queue Storage Ratio (Worst Lane)	0.01	
Total Effective Stops	116 veh/h	174 pers/h
Effective Stop Rate	0.06 per veh	0.06 per pers
Proportion Queued	0.05	0.05
Performance Index	28.2	28.2
Travel Distance (Total)	2413.3 veh-km/h	3619.9 pers-km/h
Travel Distance (Average)	1225 m	1225 m
Travel Time (Total)	26.2 veh-h/h	39.3 pers-h/h
Travel Time (Average)	47.9 sec	47.9 sec
Travel Speed	92.1 km/h	92.1 km/h
Cost (Total)	880.18 $/h	880.18 $/h
Fuel Consumption (Total)	138.3 L/h	
Carbon Dioxide (Total)	326.1 kg/h	
Hydrocarbons (Total)	0.072 kg/h	
Carbon Monoxide (Total)	0.855 kg/h	
NOx (Total)	1.033 kg/h	

Level of Service (LOS) Method: Delay (HCM 2000).
NA: Intersection LOS for Vehicles is Not Applicable for two-way sign control since the average intersection delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.

Intersection Performance - Annual Values		
Performance Measure	**Vehicles**	**Persons**
Demand Flows (Total)	945,758 veh/y	1,418,637 pers/y
Delay	1,000 veh-h/y	1,500 pers-h/y
Effective Stops	55,533 veh/y	83,300 pers/y
Travel Distance	1,158,372 veh-km/y	1,737,558 pers-km/y
Travel Time	12,584 veh-h/y	18,876 pers-h/y
Cost	422,486 $/y	422,486 $/y
Fuel Consumption	66,377 L/y	
Carbon Dioxide	156,508 kg/y	
Hydrocarbons	35 kg/y	
Carbon Monoxide	411 kg/y	
NOx	496 kg/y	

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SIDRA INTERSECTION 6.0.12.4072

Project: \\NZCHC2S01\Projects_2012 Onwards\NZ Transport Agency\80501811 NZTA Haywards Substation SAR \Reporting\Economics\SIDRA update\SH58 Moonshine Road Intersection_SAR_DKW_DR.sip6
8000949, MWH, NETWORK / Enterprise

SIDRA INTERSECTION 6

INTERSECTION SUMMARY

Site: Option 3 2015 AM

SH58 - Moonshine Road Intersection
Option 3 2015 AM peak
Roundabout

Intersection Performance - Hourly Values		
Performance Measure	**Vehicles**	**Persons**
Demand Flows (Total)	1970 veh/h	2955 pers/h
Percent Heavy Vehicles (Demand)	2.2 %	
Degree of Saturation	0.579	
Practical Spare Capacity	46.7 %	
Effective Intersection Capacity	3401 veh/h	
Control Delay (Total)	8.77 veh-h/h	13.15 pers-h/h
Control Delay (Average)	16.0 sec	16.0 sec
Control Delay (Worst Lane)	32.3 sec	
Control Delay (Worst Movement)	32.3 sec	32.3 sec
Geometric Delay (Average)	15.6 sec	
Stop-Line Delay (Average)	0.4 sec	
Idling Time (Average)	0.1 sec	
Intersection Level of Service (LOS)	LOS B	
95% Back of Queue - Vehicles (Worst Lane)	5.7 veh	
95% Back of Queue - Distance (Worst Lane)	40.1 m	
Queue Storage Ratio (Worst Lane)	0.03	
Total Effective Stops	1106 veh/h	1658 pers/h
Effective Stop Rate	0.56 per veh	0.56 per pers
Proportion Queued	0.22	0.22
Performance Index	45.3	45.3
Travel Distance (Total)	2205.1 veh-km/h	3307.6 pers-km/h
Travel Distance (Average)	1119 m	1119 m
Travel Time (Total)	31.5 veh-h/h	47.2 pers-h/h
Travel Time (Average)	57.5 sec	57.5 sec
Travel Speed	70.1 km/h	70.1 km/h
Cost (Total)	1024.26 $/h	1024.26 $/h
Fuel Consumption (Total)	147.2 L/h	
Carbon Dioxide (Total)	347.1 kg/h	
Hydrocarbons (Total)	0.088 kg/h	
Carbon Monoxide (Total)	0.909 kg/h	
NOx (Total)	1.136 kg/h	

Level of Service (LOS) Method: Delay (HCM 2000).
Roundabout LOS Method: Same as Signalised Intersections.
Intersection LOS value for Vehicles is based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.

Intersection Performance - Annual Values		
Performance Measure	**Vehicles**	**Persons**
Demand Flows (Total)	945,758 veh/y	1,418,637 pers/y
Delay	4,208 veh-h/y	6,312 pers-h/y
Effective Stops	530,690 veh/y	796,035 pers/y
Travel Distance	1,058,444 veh-km/y	1,587,666 pers-km/y
Travel Time	15,100 veh-h/y	22,650 pers-h/y
Cost	491,644 $/y	491,644 $/y
Fuel Consumption	70,665 L/y	
Carbon Dioxide	166,609 kg/y	
Hydrocarbons	42 kg/y	
Carbon Monoxide	437 kg/y	
NOx	545 kg/y	

INTERSECTION SUMMARY

Site: 2042 AM

SH58 - Moonshine Road Intersection
2009 surveys adjusted to 2042 AM peak
Giveway / Yield (Two-Way)

Intersection Performance - Hourly Values

Performance Measure	Vehicles		Persons	
Demand Flows (Total)	2745	veh/h	4118	pers/h
Percent Heavy Vehicles (Demand)	2.2	%		
Degree of Saturation	1.007			
Practical Spare Capacity	-20.6	%		
Effective Intersection Capacity	2725	veh/h		
Control Delay (Total)	7.63	veh-h/h	11.44	pers-h/h
Control Delay (Average)	10.0	sec	10.0	sec
Control Delay (Worst Lane)	281.4	sec		
Control Delay (Worst Movement)	281.4	sec	281.4	sec
Geometric Delay (Average)	1.2	sec		
Stop-Line Delay (Average)	8.8	sec		
Idling Time (Average)	7.8	sec		
Intersection Level of Service (LOS)	NA			
95% Back of Queue - Vehicles (Worst Lane)	4.2	veh		
95% Back of Queue - Distance (Worst Lane)	31.5	m		
Queue Storage Ratio (Worst Lane)	0.02			
Total Effective Stops	179	veh/h	268	pers/h
Effective Stop Rate	0.07	per veh	0.07	per pers
Proportion Queued	0.05		0.05	
Performance Index	46.3		46.3	
Travel Distance (Total)	3320.7	veh-km/h	4981.1	pers-km/h
Travel Distance (Average)	1210	m	1210	m
Travel Time (Total)	40.8	veh-h/h	61.3	pers-h/h
Travel Time (Average)	53.6	sec	53.6	sec
Travel Speed	81.3	km/h	81.3	km/h
Cost (Total)	1314.45	$/h	1314.45	$/h
Fuel Consumption (Total)	195.8	L/h		
Carbon Dioxide (Total)	461.6	kg/h		
Hydrocarbons (Total)	0.111	kg/h		
Carbon Monoxide (Total)	1.227	kg/h		
NOx (Total)	1.425	kg/h		

Level of Service (LOS) Method: Delay (HCM 2000).
NA: Intersection LOS for Vehicles is Not Applicable for two-way sign control since the average intersection delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.

Intersection Performance - Annual Values

Performance Measure	Vehicles		Persons	
Demand Flows (Total)	1,317,626	veh/y	1,976,439	pers/y
Delay	3,661	veh-h/y	5,491	pers-h/y
Effective Stops	85,878	veh/y	128,817	pers/y
Travel Distance	1,593,944	veh-km/y	2,390,915	pers-km/y
Travel Time	19,600	veh-h/y	29,400	pers-h/y
Cost	630,936	$/y	630,936	$/y
Fuel Consumption	93,975	L/y		
Carbon Dioxide	221,589	kg/y		
Hydrocarbons	53	kg/y		
Carbon Monoxide	589	kg/y		
NOx	684	kg/y		

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SIDRA INTERSECTION 6

INTERSECTION SUMMARY

Site: Option 3 2042 AM

SH58 - Moonshine Road Intersection
Option 3 2013 AM peak
Roundabout

Intersection Performance - Hourly Values				
Performance Measure	**Vehicles**		**Persons**	
Demand Flows (Total)	2745	veh/h	4118	pers/h
Percent Heavy Vehicles (Demand)	2.2	%		
Degree of Saturation	0.818			
Practical Spare Capacity	3.9	%		
Effective Intersection Capacity	3357	veh/h		
Control Delay (Total)	12.88	veh-h/h	19.32	pers-h/h
Control Delay (Average)	16.9	sec	16.9	sec
Control Delay (Worst Lane)	54.0	sec		
Control Delay (Worst Movement)	54.0	sec	54.0	sec
Geometric Delay (Average)	15.6	sec		
Stop-Line Delay (Average)	1.3	sec		
Idling Time (Average)	0.7	sec		
Intersection Level of Service (LOS)	LOS B			
95% Back of Queue - Vehicles (Worst Lane)	16.0	veh		
95% Back of Queue - Distance (Worst Lane)	113.2	m		
Queue Storage Ratio (Worst Lane)	0.09			
Total Effective Stops	1494	veh/h	2241	pers/h
Effective Stop Rate	0.54	per veh	0.54	per pers
Proportion Queued	0.36		0.36	
Performance Index	72.3		72.3	
Travel Distance (Total)	3072.1	veh-km/h	4608.1	pers-km/h
Travel Distance (Average)	1119	m	1119	m
Travel Time (Total)	45.0	veh-h/h	67.5	pers-h/h
Travel Time (Average)	59.1	sec	59.1	sec
Travel Speed	68.2	km/h	68.2	km/h
Cost (Total)	1454.69	$/h	1454.69	$/h
Fuel Consumption (Total)	206.8	L/h		
Carbon Dioxide (Total)	487.5	kg/h		
Hydrocarbons (Total)	0.126	kg/h		
Carbon Monoxide (Total)	1.281	kg/h		
NOx (Total)	1.588	kg/h		

Level of Service (LOS) Method: Delay (HCM 2000).
Roundabout LOS Method: Same as Signalised Intersections.
Intersection LOS value for Vehicles is based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.

Intersection Performance - Annual Values				
Performance Measure	**Vehicles**		**Persons**	
Demand Flows (Total)	1,317,626	veh/y	1,976,439	pers/y
Delay	6,182	veh-h/y	9,273	pers-h/y
Effective Stops	717,237	veh/y	1,075,855	pers/y
Travel Distance	1,474,595	veh-km/y	2,211,891	pers-km/y
Travel Time	21,613	veh-h/y	32,420	pers-h/y
Cost	698,252	$/y	698,252	$/y
Fuel Consumption	99,250	L/y		
Carbon Dioxide	234,008	kg/y		
Hydrocarbons	61	kg/y		
Carbon Monoxide	615	kg/y		
NOx	762	kg/y		

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SIDRA6 Results Option 4 update following the Road Safety Audit recommendations (FEB 2014)

With P2G constructed

3	Option RBT Scenario 3 with P2G	Time Period	Demand Flows (veh/h)	Deg. Of Sat	Total control delay veh-h/h)	Average Geometric delay (veh sec)	Total Fuel Consumption (l/h)
80	2013	AM	2019	0.353	4.75	8.2	62.3
80	2013	IP	781	0.119	1.79	8.2	24.7
80	2013	PM	1829	0.299	4.24	8.1	49.4
80	2021	AM	1791	0.331	4.27	8.2	55.5
80	2021	IP	864	0.136	1.99	8.2	27.3
80	2021	PM	2001	0.331	4.67	8.1	54.1
80	2031	AM	1980	0.386	4.76	8.2	61.3
80	2031	IP	1011	0.16	2.33	8.2	32
80	2031	PM	2308	0.396	5.42	8.1	62.4
80	2041	AM	2333	0.437	5.65	8.2	72.5
80	2041	IP	1126	0.178	2.6	8.2	35.6
80	2041	PM	2604	0.436	6.15	8.1	70.8

Existing T intersection (Do-Minimum)

3	Do Min (T junction) Scenario 3 with P2G	Time Period	SIDRA Demand Flows (veh/h)	Deg. Of Sat	Total control delay veh-h/h)	Geometric delay (sec/veh)	Total Fuel Consumption (l/h)
80	2013	AM	1992	0.524	0.94	0.7	56.3
80	2013	IP	768	0.191	0.16	0.6	22.2
80	2013	PM	1802	0.483	0.49	0.5	43.8
80	2021	AM	1769	0.487	0.91	0.9	50.2
80	2021	IP	851	0.222	0.18	0.6	24.6
80	2021	PM	1971	0.532	0.65	0.5	48
80	2031	AM	1956	0.565	1.44	0.9	55.8
80	2031	IP	995	0.261	0.22	0.6	28.7
80	2031	PM	2275	0.634	1.2	0.5	55.7
80	2041	AM	2303	0.655	2.72	0.9	67.1
80	2041	IP	1108	0.289	0.25	0.6	32
80	2041	PM	2567	1	3.13	0.5	65.1

No P2G constructed

4	Option RBT Scenario 4 without P2G 2 exit lanes WBD	Time Period	Demand Flows (veh/h)	Deg. Of Sat	Total control delay veh-h/h)	Average Geometric delay (veh sec)	Total Fuel Consumption (l/h)
80	2013	AM	2019	0.353	4.75	8.2	62.3
80	2013	IP	781	0.119	1.79	8.2	24.7
80	2013	PM	1829	0.299	4.24	8.1	49.4
80	2021	AM	2582	0.482	6.24	8.2	80.2
80	2021	IP	1081	0.17	2.5	8.2	34.2
80	2021	PM	2736	0.484	6.47	8.1	74.1
80	2031	AM	2707	0.514	6.64	8.2	84.4
80	2031	IP	1279	0.2	2.96	8.2	40.6
80	2031	PM	3132	0.576	7.49	8.1	85
80	2041	AM	3256	0.619	8.16	8.2	101.9
80	2041	IP	1364	0.216	3.17	8.2	43.2
80	2041	PM	3448	0.618	8.33	8.1	94.1

Existing T intersection (Do-Minimum)

4	Do Min (T junction) Scenario 4 without P2G	Time Period	Demand Flows (veh/h)	Deg. Of Sat	Total control delay veh-h/h)	Average Geometric delay (veh sec)	Total Fuel Consumption (l/h)
80	2013	AM	1992	0.524	0.94	0.7	56.3
80	2013	IP	768	0.191	0.16	0.6	22.2
80	2013	PM	1802	0.483	0.49	0.5	43.8
80	2021	AM	2549	1	5.9	0.8	77.6
80	2021	IP	1063	0.276	0.25	0.6	30.7
80	2021	PM	2696	1	3.04	0.5	67.7
80	2031	AM	2674	1	9.22	0.9	85.3
80	2031	IP	1258	0.325	0.31	0.6	36.4
80	2031	PM	3086	1	3.41	0.5	76.6
80	2041	AM	3216	1	10	0.8	100.5
80	2041	IP	1341	0.348	0.36	0.6	38.8
80	2041	PM	3398	1	4.95	0.5	84.7

INTERSECTION SUMMARY

Site: 2041 PM

SH58 - Moonshine Road Intersection
2009 surveys and Saturn modelling results adjusted to 2041 PM peak
Giveway / Yield (Two-Way)

With P2G

Intersection Performance - Hourly Values

Performance Measure	Vehicles	Persons
Demand Flows (Total)	2567 veh/h	3851 pers/h
Percent Heavy Vehicles (Demand)	0.9 %	
Degree of Saturation	1.000	
Practical Spare Capacity	-20.0 %	
Effective Intersection Capacity	2567 veh/h	
Control Delay (Total)	3.13 veh-h/h	4.70 pers-h/h
Control Delay (Average)	4.4 sec	4.4 sec
Control Delay (Worst Lane)	215.4 sec	
Control Delay (Worst Movement)	215.4 sec	215.4 sec
Geometric Delay (Average)	0.5 sec	
Stop-Line Delay (Average)	3.9 sec	
Idling Time (Average)	3.5 sec	
Intersection Level of Service (LOS)	NA	
95% Back of Queue - Vehicles (Worst Lane)	3.8 veh	
95% Back of Queue - Distance (Worst Lane)	26.8 m	
Queue Storage Ratio (Worst Lane)	0.02	
Total Effective Stops	116 veh/h	173 pers/h
Effective Stop Rate	0.05 per veh	0.05 per pers
Proportion Queued	0.03	0.03
Performance Index	27.6	27.6
Travel Distance (Total)	1770.3 veh-km/h	2655.4 pers-km/h
Travel Distance (Average)	690 m	690 m
Travel Time (Total)	25.3 veh-h/h	37.9 pers-h/h
Travel Time (Average)	35.4 sec	35.4 sec
Travel Speed	70.1 km/h	70.1 km/h
Cost (Total)	637.11 $/h	637.11 $/h
Fuel Consumption (Total)	65.1 L/h	
Carbon Dioxide (Total)	153.2 kg/h	
Hydrocarbons (Total)	0.061 kg/h	
Carbon Monoxide (Total)	0.579 kg/h	
NOx (Total)	0.113 kg/h	

Level of Service (LOS) Method: Delay (HCM 2000).
NA: Intersection LOS for Vehicles is Not Applicable for two-way sign control since the average intersection delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.

Intersection Performance - Annual Values

Performance Measure	Vehicles	Persons
Demand Flows (Total)	1,232,176 veh/y	1,848,264 pers/y
Delay	1,503 veh-h/y	2,255 pers-h/y
Effective Stops	55,463 veh/y	83,195 pers/y
Travel Distance	849,727 veh-km/y	1,274,591 pers-km/y
Travel Time	12,125 veh-h/y	18,187 pers-h/y
Cost	305,814 $/y	305,814 $/y
Fuel Consumption	31,265 L/y	
Carbon Dioxide	73,554 kg/y	
Hydrocarbons	29 kg/y	
Carbon Monoxide	278 kg/y	
NOx	54 kg/y	

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SIDRA INTERSECTION 6

INTERSECTION SUMMARY

Site: Option 4 2041 PM normal wb_RSA Update

SH58 - Moonshine Road Intersection
Option 4 2041 PM peak
Roundabout

With P2G

Intersection Performance - Hourly Values

Performance Measure	Vehicles		Persons	
Demand Flows (Total)	2604	veh/h	3906	pers/h
Percent Heavy Vehicles (Demand)	0.9	%		
Degree of Saturation	0.436			
Practical Spare Capacity	94.8	%		
Effective Intersection Capacity	5968	veh/h		
Control Delay (Total)	6.15	veh-h/h	9.23	pers-h/h
Control Delay (Average)	8.5	sec	8.5	sec
Control Delay (Worst Lane)	18.2	sec		
Control Delay (Worst Movement)	20.4	sec	20.4	sec
Geometric Delay (Average)	8.1	sec		
Stop-Line Delay (Average)	0.4	sec		
Idling Time (Average)	0.1	sec		
Intersection Level of Service (LOS)	LOS A			
95% Back of Queue - Vehicles (Worst Lane)	3.7	veh		
95% Back of Queue - Distance (Worst Lane)	25.8	m		
Queue Storage Ratio (Worst Lane)	0.02			
Total Effective Stops	1337	veh/h	2006	pers/h
Effective Stop Rate	0.51	per veh	0.51	per pers
Proportion Queued	0.24		0.24	
Performance Index	45.7		45.7	
Travel Distance (Total)	1788.9	veh-km/h	2683.3	pers-km/h
Travel Distance (Average)	687	m	687	m
Travel Time (Total)	29.4	veh-h/h	44.1	pers-h/h
Travel Time (Average)	40.7	sec	40.7	sec
Travel Speed	60.8	km/h	60.8	km/h
Cost (Total)	730.59	$/h	730.59	$/h
Fuel Consumption (Total)	70.8	L/h		
Carbon Dioxide (Total)	166.5	kg/h		
Hydrocarbons (Total)	0.072	kg/h		
Carbon Monoxide (Total)	0.627	kg/h		
NOx (Total)	0.123	kg/h		

Level of Service (LOS) Method: Delay (HCM 2000).
Roundabout LOS Method: Same as Signalised Intersections.
Intersection LOS value for Vehicles is based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.

Intersection Performance - Annual Values

Performance Measure	Vehicles		Persons	
Demand Flows (Total)	1,249,860	veh/y	1,874,790	pers/y
Delay	2,953	veh-h/y	4,430	pers-h/y
Effective Stops	641,850	veh/y	962,774	pers/y
Travel Distance	858,651	veh-km/y	1,287,976	pers-km/y
Travel Time	14,113	veh-h/y	21,170	pers-h/y
Cost	350,682	$/y	350,682	$/y
Fuel Consumption	33,970	L/y		
Carbon Dioxide	79,921	kg/y		
Hydrocarbons	34	kg/y		
Carbon Monoxide	301	kg/y		
NOx	59	kg/y		

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SIDRA INTERSECTION 6

INTERSECTION SUMMARY

Site: 2041 PM

SH58 - Moonshine Road Intersection
2009 surveys adjusted to 2041 PM peak
Giveway / Yield (Two-Way)

Without P2G

Intersection Performance - Hourly Values		
Performance Measure	**Vehicles**	**Persons**
Demand Flows (Total)	3398 veh/h	5097 pers/h
Percent Heavy Vehicles (Demand)	0.9 %	
Degree of Saturation	1.000	
Practical Spare Capacity	-20.0 %	
Effective Intersection Capacity	3398 veh/h	
Control Delay (Total)	4.95 veh-h/h	7.42 pers-h/h
Control Delay (Average)	5.2 sec	5.2 sec
Control Delay (Worst Lane)	143.4 sec	
Control Delay (Worst Movement)	143.4 sec	143.4 sec
Geometric Delay (Average)	0.5 sec	
Stop-Line Delay (Average)	4.8 sec	
Idling Time (Average)	2.9 sec	
Intersection Level of Service (LOS)	NA	
95% Back of Queue - Vehicles (Worst Lane)	3.1 veh	
95% Back of Queue - Distance (Worst Lane)	21.9 m	
Queue Storage Ratio (Worst Lane)	0.02	
Total Effective Stops	150 veh/h	225 pers/h
Effective Stop Rate	0.04 per veh	0.04 per pers
Proportion Queued	0.03	0.03
Performance Index	36.1	36.1
Travel Distance (Total)	2287.1 veh-km/h	3430.6 pers-km/h
Travel Distance (Average)	673 m	673 m
Travel Time (Total)	33.5 veh-h/h	50.3 pers-h/h
Travel Time (Average)	35.5 sec	35.5 sec
Travel Speed	68.2 km/h	68.2 km/h
Cost (Total)	841.30 $/h	841.30 $/h
Fuel Consumption (Total)	84.7 L/h	
Carbon Dioxide (Total)	199.4 kg/h	
Hydrocarbons (Total)	0.081 kg/h	
Carbon Monoxide (Total)	0.756 kg/h	
NOx (Total)	0.139 kg/h	

Level of Service (LOS) Method: Delay (HCM 2000).
NA: Intersection LOS for Vehicles is Not Applicable for two-way sign control since the average intersection delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.

Intersection Performance - Annual Values		
Performance Measure	**Vehicles**	**Persons**
Demand Flows (Total)	1,630,945 veh/y	2,446,417 pers/y
Delay	2,376 veh-h/y	3,564 pers-h/y
Effective Stops	72,152 veh/y	108,229 pers/y
Travel Distance	1,097,804 veh-km/y	1,646,706 pers-km/y
Travel Time	16,098 veh-h/y	24,147 pers-h/y
Cost	403,822 $/y	403,822 $/y
Fuel Consumption	40,678 L/y	
Carbon Dioxide	95,697 kg/y	
Hydrocarbons	39 kg/y	
Carbon Monoxide	363 kg/y	
NOx	67 kg/y	

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SIDRA INTERSECTION 6

INTERSECTION SUMMARY

Site: Option 4 2041 PM normal wb - RSA Update

SH58 - Moonshine Road Intersection
Option 3 2041 PM peak
Roundabout

Without P2G

Intersection Performance - Hourly Values		
Performance Measure	**Vehicles**	**Persons**
Demand Flows (Total)	3448 veh/h	5172 pers/h
Percent Heavy Vehicles (Demand)	0.9 %	
Degree of Saturation	0.618	
Practical Spare Capacity	37.5 %	
Effective Intersection Capacity	5580 veh/h	
Control Delay (Total)	8.33 veh-h/h	12.50 pers-h/h
Control Delay (Average)	8.7 sec	8.7 sec
Control Delay (Worst Lane)	19.9 sec	
Control Delay (Worst Movement)	22.1 sec	22.1 sec
Geometric Delay (Average)	8.1 sec	
Stop-Line Delay (Average)	0.6 sec	
Idling Time (Average)	0.1 sec	
Intersection Level of Service (LOS)	LOS A	
95% Back of Queue - Vehicles (Worst Lane)	6.8 veh	
95% Back of Queue - Distance (Worst Lane)	47.9 m	
Queue Storage Ratio (Worst Lane)	0.04	
Total Effective Stops	1771 veh/h	2657 pers/h
Effective Stop Rate	0.51 per veh	0.51 per pers
Proportion Queued	0.34	0.34
Performance Index	64.2	64.2
Travel Distance (Total)	2368.9 veh-km/h	3553.4 pers-km/h
Travel Distance (Average)	687 m	687 m
Travel Time (Total)	39.6 veh-h/h	59.4 pers-h/h
Travel Time (Average)	41.3 sec	41.3 sec
Travel Speed	59.8 km/h	59.8 km/h
Cost (Total)	980.58 $/h	980.58 $/h
Fuel Consumption (Total)	94.1 L/h	
Carbon Dioxide (Total)	221.5 kg/h	
Hydrocarbons (Total)	0.096 kg/h	
Carbon Monoxide (Total)	0.835 kg/h	
NOx (Total)	0.157 kg/h	

Level of Service (LOS) Method: Delay (HCM 2000).
Roundabout LOS Method: Same as Signalised Intersections.
Intersection LOS value for Vehicles is based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.

Intersection Performance - Annual Values		
Performance Measure	**Vehicles**	**Persons**
Demand Flows (Total)	1,655,198 veh/y	2,482,797 pers/y
Delay	4,000 veh-h/y	6,000 pers-h/y
Effective Stops	850,148 veh/y	1,275,222 pers/y
Travel Distance	1,137,096 veh-km/y	1,705,643 pers-km/y
Travel Time	19,001 veh-h/y	28,502 pers-h/y
Cost	470,679 $/y	470,679 $/y
Fuel Consumption	45,191 L/y	
Carbon Dioxide	106,316 kg/y	
Hydrocarbons	46 kg/y	
Carbon Monoxide	401 kg/y	
NOx	76 kg/y	

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SIDRA INTERSECTION 6

Appendix L Economic Evaluation

Traffic Growth Assumptions for original options 1-3, prior to updated modelling results

Traffic Growth Appendix L

Note: the TG base case assumes Petone to Grenada is constructed, hence the traffic growth between time zero and 2026 has been determined based on the TG predicted 2026 base case of 12,500 vpd (without project) and 14,700 with TG. This has been calculated as -0.7%.

Other Major Local Routes

Road	Section	Weekday Traffic Volume, 2026		Change, 2026	
		Basecase (without Project)	With Project	Absolute	%
State Highway 58	East of Paremata	16,800	12,600	-4,200	-25%
	West of Project	12,500	8,700	-3,800	-30%
	East of Project	12,500	14,700	+2,200	+18%

Source http://www.nzta.govt.nz/projects/transmission-gully-application/docs/evidence-tim-kelly.pdf.

	Future Scenarios include:	2043
1	0.5% arithmetic growth (AG) rate from time zero onward (modelled in economics)	15,755
2	1.5% growth rate from time zero onward (modelled in economics)	19,865
3	-0.7% growth rate from time zero to 2026 (to reflect TG 2026 Base of 12,500), where TG introduces a step change increasing daily traffic by 18% (to 14,700), following this the traffic growth returns to the base of 0.5%	15,950
4	-0.7% growth rate from time zero to 2026 (to reflect TG 2026 Base of 12,500), where TG introduces a step change increasing daily traffic by 18% (to 14,700), following this the traffic growth increases to 1.0%	17,199

The results show that by the 2043, the predicted AADT for the two modelled periods provide both a low end and high end estimate of future traffic growth.

The time frames and assumptions relating to SH2/SH58 grade separation and Petone to Grenada have changed since the model was developed. It is noted that a review of the modelling and underlying assumptions of the TG model is being revisited as part of Petone to Grenada.

Until this update occurs the future traffic growth is uncertain, therefore we have adopted growth rates of 0.5% and 1.5% to cover likely scenarios, which can be updated once information becomes available.

		Growth R	0.50%	1.5%	-0.7%	-0.7%				
			Scenario 1	Scenario 2	Scenario 3	Scenario 4				
Year	Year (Time Zero)	Year	Traffic Volume	Traffic Volume	Traffic Volume	Traffic Volume				
0	0	2013	13,700	13,700	13,700	13,700				
1	1	2014	13,769	13,906	13,608	13,608				
2	2	2015	13,837	14,111	13,515	13,515				
3	3	2016	13,906	14,317	13,423	13,423				
4	4	2017	13,974	14,522	13,331	13,331				
5	5	2018	14,043	14,728	13,238	13,238				
6	6	2019	14,111	14,933	13,146	13,146				
7	7	2020	14,180	15,139	13,054	13,054				
8	8	2021	14,248	15,344	12,962	12,962				
9	9	2022	14,317	15,550	12,869	12,869		-0.7%		0.5%
10	10	2023	14,385	15,755	12,777	12,777		-92	73.5	
11	11	2024	14,454	15,961	12,685	12,685				1.0%
12	12	2025	14,522	16,166	12,592	12,592	TG year	model year	147	
13	13	2026	14,591	16,372	14,700	14,700	0	12500	TG: Base 12,500 vpd (base with P2G), 14,700 vpd (with	
14	14	2027	14,659	16,577	14,774	14,847	1			
15	15	2028	14,728	16,783	14,847	14,994	2			
16	16	2029	14,796	16,988	14,921	15,141	3			
17	17	2030	14,865	17,194	14,994	15,288	4			
18	18	2031	14,933	17,399	15,068	15,435	5			
19	19	2032	15,002	17,605	15,141	15,582	6			
20	20	2033	15,070	17,810	15,215	15,729	7			
21	21	2034	15,139	18,016	15,288	15,876	8			
22	22	2035	15,207	18,221	15,362	16,023	9			
23	23	2036	15,276	18,427	15,435	16,170	10			
24	24	2037	15,344	18,632	15,509	16,317	11			
25	25	2038	15,413	18,838	15,582	16,464	12			
26	26	2039	15,481	19,043	15,656	16,611	13			
27	27	2040	15,550	19,249	15,729	16,758	14			
28	28	2041	15,618	19,454	15,803	16,905	15			
29	29	2042	15,687	19,660	15,876	17,052	16			
30	**30**	**2043**	**15,755**	**19,865**	**15,950**	**17,199**	**17**			
31	31	2044	15,824	20,071	16,023	17,346	18			
32	32	2045	15,892	20,276	16,097	17,493	19			

MWH

SH58 - Haywards to Pauatahanui Roundabout Improvements Economic Evaluation

EVALUATION SUMMARY — WORKSHEET 1

1 Evaluator(s) Dhimantha Ranatunga
Reviewer(s) Phil Peet, David Wanty

2 Project / Package Details

Approved Organisation Name	NZTA
Project / Package Name	SH58 Haywards Substation Curves
Your Reference	80501811
Project Description	Safety Improvements
Describe the problem to be addressed	Reduce crashes

3 Location

Brief description of location: State Highway 58, from Haywards Hill to the Pauatahanui Roundabout RP0/0.1 to RP0/9.8

4 Alternatives and Options

Describe the Do Minimum: Continued Maintenance

Summarise the options assessed: Option 1: Curve realignment of 4 sites, 1.5 full extent shoulder widening, edge guardrail and ATP

5 Timing

Time Zero	1 July 2013
Expected duration of construction (years)	1.00
End construction	1 July 2015

6 Economic Efficiency

Date economic evaluation completed (mm/yyyy)	Aug-13
Base date for costs	1 July 2013
AADT at Time Zero	13,700
Traffic Growth Rate at Time Zero (%)	1.5%

Existing Roughness	3.10	IRI or NAASRA	Existing Traffic Speed	80-95	km/hr (surv/est)
Predicted Roughness	2.50	IRI or NAASRA	Predicted Traffic Speed	85-95	km/hr
Length of curves Before Improvements	1.98	km	Posted Speed Limit	100	km/hr
Length of curves After Improvements	1.94	km	Road Type	Rural Strategic	
			Gradient Before Improvements	7%	
			Gradient After Improvements	7%	

7 PV Cost of Do Minimum — **Cost $** $1,169,478 **A**

8 PV Cost of the Option — **Cost $** $27,535,453 **B**

9 Benefit values from Worksheet 4, 5 or 6

PV Travel Time Cost savings:	$ $3,507,655	**C**	x Update Factor^{TT}	1.37	= $ $4,805,488	**W**
PV VOC & CO2 savings:	$ $649,635	**D**	x Update Factor^{VOC}	1.06	= $ $688,613	**Y**
PV Accident Cost savings:	$ $24,315,246	**E**	x Update Factor^{AC}	1.20	= $ $29,178,296	**Z**

10 B/C Ratio = $\frac{W + Y + Z}{B - A} = \frac{\text{BENEFITS}}{\text{COSTS}} = \frac{4805488 + 688613 + 29178296}{27535453 - 1169478} =$ **1.3**

11 FYRR = $\frac{1^{st}\text{ Year BENEFITS}}{\text{COSTS}} = \frac{\$2,035,693}{\$26,365,975} =$ **8%**

File SAR Economics Summary_Sept_update, Worksheet WS 1_opt1

MWH.

SH58 - Haywards to Pauatahanui Roundabout Improvements Economic Evaluation

EVALUATION SUMMARY — WORKSHEET 1

1 Evaluator(s) Dhimantha Ranatunga
Reviewer(s) Phil Peet, David Wanty

2 Project / Package Details

Approved Organisation Name	NZTA
Project / Package Name	SH58 Haywards Substation Curves
Your Reference	80501811
Project Description	Safety Improvements
Describe the problem to be addressed	Reduce crashes

3 Location

Brief description of location: State Highway 58, from Haywards Hill to the Pauatahanui Roundabout RP0/0.1 to RP0/9.8

4 Alternatives and Options

Describe the Do Minimum: Continued Maintenance

Summarise the options assessed: Option 2: Curve realignment of 4 sites, 1.5 full extent shoulder widening, 2.0 flush median, edge guardrail and ATP

5 Timing

Time Zero	1 July 2013
Expected duration of construction (years)	1.00
End construction	1 July 2015

6 Economic Efficiency

Date economic evaluation completed (mm/yyyy)	Aug-13
Base date for costs	1 July 2013
AADT at Time Zero	13,700
Traffic Growth Rate at Time Zero (%)	1.5%

Existing Roughness	3.10	IRI or NAASRA	Existing Traffic Speed	80-95	km/hr (surv/est)
Predicted Roughness	2.50	IRI or NAASRA	Predicted Traffic Speed	85-95	km/hr
Length of curves Before Improvements	1.98	km	Posted Speed Limit	100	km/hr
Length of curves After Improvements	1.94	km	Road Type	Rural Strategic	
			Gradient Before Improvements	7%	
			Gradient After Improvements	7%	

7 PV Cost of Do Minimum — **Cost $** $1,169,478 **A**

8 PV Cost of the Option — **Cost $** $30,280,433 **B**

9 Benefit values from Worksheet 4, 5 or 6

PV Travel Time Cost savings: **$**	$3,507,655	**C**	x Update Factor^{TT}	1.37	= **$**	$4,805,488 **W**
PV VOC & CO2 savings: **$**	$649,635	**D**	x Update Factor^{VOC}	1.06	= **$**	$688,613 **Y**
PV Accident Cost savings: **$**	$30,160,407	**E**	x Update Factor^{AC}	1.20	= **$**	$36,192,488 **Z**

10 B/C Ratio = $\frac{W + Y + Z}{B - A} = \frac{\text{BENEFITS}}{\text{COSTS}} = \frac{4805488 + 688613 + 36192488}{30280433 - 1169478} =$ **1.4**

11 FYRR = $\frac{1^{st}\text{ Year BENEFITS}}{\text{COSTS}} = \frac{\$2,463,482}{\$29,110,956} =$ **8%**

MWH.

SH58 - Haywards to Pauatahanui Roundabout Improvements Economic Evaluation

EVALUATION SUMMARY — WORKSHEET 1

1 Evaluator(s) Dhimantha Ranatunga
Reviewer(s) Phil Peet, David Wanty

2 Project / Package Details

Approved Organisation Name	NZTA
Project / Package Name	SH58 Haywards Substation Curves
Your Reference	80501811
Project Description	Safety Improvements
Describe the problem to be addressed	Reduce crashes

3 Location

Brief description of location: State Highway 58, from Haywards Hill to the Pauatahanui Roundabout RP0/0.1 to RP0/9.8

4 Alternatives and Options

Describe the Do Minimum: Continued Maintenance

Summarise the options assessed: Option 3: Curve realignment of 4 sites, 1.5 full extent shoulder widening, central 2.0m median WRB , edge guardrail and ATP (including a roundabout at Moonshine Road intersection)

5 Timing

Time Zero	1 July 2013
Expected duration of construction (years)	1.00
End construction	1 July 2015

6 Economic Efficiency

Date economic evaluation completed (mm/yyyy)	Aug-13
Base date for costs	1 July 2013
AADT at Time Zero	13,700
Traffic Growth Rate at Time Zero (%)	1.5%

Existing Roughness	3.10	IRI or NAASRA	Existing Traffic Speed	80-95	km/hr (surv/est)
Predicted Roughness	2.50	IRI or NAASRA	Predicted Traffic Speed	85-95	km/hr
Length of curves Before Improvements	1.98	km	Posted Speed Limit	100	km/hr
Length of curves After Improvements	1.94	km	Road Type	Rural Strategic	
			Gradient Before Improvements	7%	
			Gradient After Improvements	7%	

7 PV Cost of Do Minimum — **Cost $** $1,169,478 **A**

8 PV Cost of the Option — **Cost $** $33,247,234 **B**

9 Benefit values from Worksheet 4, 5 or 6

PV Travel Time Cost savings: **$**	-$706,974	**C**	x Update Factor^{TT}	1.37	= $	-$968,554 **W**
PV VOC & CO2 savings: **$**	-$1,402,625	**D**	x Update Factor^{VOC}	1.06	= $	-$1,486,783 **Y**
PV Accident Cost savings: **$**	$36,382,291	**E**	x Update Factor^{AC}	1.20	= $	$43,658,749 **Z**

10 B/C Ratio = $\frac{W + Y + Z}{B - A} = \frac{\text{BENEFITS}}{\text{COSTS}} = \frac{-968554 + -1486783 + 43658749}{33247234 - 1169478} =$ **1.3**

11 FYRR = $\frac{1^{st}\text{ Year BENEFITS}}{\text{COSTS}} = \frac{\$2,631,134}{\$32,077,757} =$ **8%**

SH58 - Haywards to Pauatahanui Roundabout Improvements Economic Evaluation
Sensitivity Analysis **Worksheet 6**

1.32

Option 1	BCR	1.3						
Variable	Basic Assumption		Lower Bound			Upper Bound		
	Value	Assumptions	Value	Assumptions	BCR	Value	Assumptions	BCR
Construction Costs	$29,077,662	Scheme Expected Estimate	$25,013,922	Base Estimate	1.5	$35,860,862	95th percentile estimate	1.1
Traffic Growth	1.5%	Adopted traffic growth from count data 1992-2012 (1.7% actual)	0.5%	Calculated traffic growth from count data recent 10 year period (0.6% actual)	1.1			
Analysis period and Discount Rate	30 years, 8%	EEM Evaluation	40 years,6% (0.5% growth)	Upcoming EEM update	1.5	40 years,6% (1.5% growth)	Upcoming EEM update	1.8
Traffic Composition	Rural Strategic	100km/h State Highway	Urban Arterial	Due to the traffic composition data showing urban trends (low % HV and high commuter peaks)	1.3			
NPV Crash Benefits	$29,178,296	Existing Crashes 08-12 (2F, 13S)				$33,298,069	1 additional serious LoS and fatal Head on (midblock)	1.5

1.43

Option 2	BCR	1.4						
Variable	Basic Assumption		Lower Bound			Upper Bound		
	Value	Assumptions	Value	Assumptions	BCR	Value	Assumptions	BCR
Construction Costs	$31,998,584	Scheme Expected Estimate	$27,278,034	Base Estimate	1.7	$39,866,084	95th percentile estimate	1.1
Traffic Growth	1.5%	Adopted traffic growth from count data 1992-2012 (1.7% actual)	0.5%	Calculated traffic growth from count data recent 10 year period (0.6% actual)	1.2			
Analysis period and Discount Rate	30 years, 8%	EEM Evaluation	40 years,6% (0.5% growth)	Upcoming EEM update	1.6	40 years,6%	Upcoming EEM update	2.0
Traffic Composition	Rural Strategic	100km/h State Highway	Urban Arterial	Due to the traffic composition data showing urban trends (low % HV and high commuter peaks)	1.4			
NPV Crash Benefits	$36,192,488	Additional serious LoS and serious Head on (midblock)				$41,424,552	1 additional serious LoS and fatal Head on (midblock)	1.6

1.28

Option 3	BCR	1.3						
Variable	Basic Assumption		Lower Bound			Upper Bound		
	Value	Assumptions	Value	Assumptions	BCR	Value	Assumptions	BCR
Construction Costs	$33,873,089	Scheme Expected Estimate	$28,853,049	Base Estimate	1.5	$42,239,589	95th percentile estimate	1.0
Traffic Growth	1.5%	Adopted traffic growth from count data 1992-2012 (1.7% actual)	0.5%	Calculated traffic growth from count data recent 10 year period (0.6% actual)	1.1			
Analysis period and Discount Rate	30 years, 8%	EEM Evaluation	40 years,6% (0.5% growth)	Upcoming EEM update	1.5	40 years,6%	Upcoming EEM update	1.8
Traffic Composition	Rural Strategic	100km/h State Highway	Urban Arterial	Due to the traffic composition data showing urban trends (low % HV and high commuter peaks)	1.3			
NPV Crash Benefits	$43,658,749	Additional serious LoS and serious Head on (midblock)				$51,094,266	1 additional serious LoS and fatal Head on (midblock)	1.5

SH58 - Haywards to Pauatahanui Roundabout Improvements Economic Evaluation
First Year Rate of Return **Worksheet 5**

Option:	Option 1	Option 2	Option 3
Present Value of Net Costs:	26,365,975	29,110,956	32,077,757
Mid Point of First Year of Benefits (Relative to Time Zero):	2.50	2.50	2.50
SPPWF for First Year of Benefits (Table A1.2):	0.8250	0.8250	0.8250

Benefit	*Annual Do Minimum Benefit*	*Annual Option 1 Benefit*	*Annual Net Benefit (Option 1) (at year 2.0)*	*Annual Option 2 Benefit*	*Annual Net Benefit (Option 2) (at year 2.0)*	*Annual Option 3 Benefit*	*Annual Net Benefit (Option 3) (at year 2.0)*	*Growth Rate (as a decimal)*	*PV of Benefits Option 1*	*PV of Benefits Option2*	*PV of Benefits Option 3*
Travel Time Costs	2,936,710	2,665,966	270,744	2,665,966	270,744	2,770,889	165,822	0.015	231,733	231,733	141,929
Vehicle Operating Costs	4,978,827	4,955,258	23,569	4,955,258	23,569	5,084,608	(105,781)	0.015	20,173	20,173	(90,539)
Crash Costs	5,380,430	3,295,200	2,085,230	2,793,930	2,586,500	2,246,852	3,133,578	0.015	1,784,772	2,213,814	2,682,065
Carbon Dioxide	199,153	198,210	943	198,210	943	203,384	(4,231)	0.015	807	807	(3,622)
Maintenance	13,608	15,701	(2,093)	17,166	(3,558)	128,922	(115,314)	0.015	(1,791)	(3,045)	(98,699)
								Present Value of Benefits in First Year	2,035,693	2,463,482	2,631,134
								First Year Rate of Return	**8%**	**8%**	**8%**

SH58 - Haywards to Pauatahanui Roundabout Improvements Economic Evaluation

BCR AND INCREMENTAL ANALYSIS

WORKSHEET 4

Time Zero 01-07-13 Base Date 01-07-13

BCR_N	Do Minimum	Option 1	Option 2	Option 3	Option 1	Option 2	Option 3
	PV of Costs as Calculated				PV of Net Benefits		
Travel Time Cost Savings	$60,559,996	$55,754,508	$55,754,508	$61,528,550	$4,805,488	$4,805,488	-$968,554
VOC & CO2 Savings	$89,084,205	$88,395,591	$88,395,591	$90,570,987	$688,613	$688,613	-$1,486,783
Accident Cost Savings	$87,430,750	$58,252,455	$51,238,262	$43,772,001	$29,178,296	$36,192,488	$43,658,749
PV Total Net Benefits					**$34,672,397**	**$41,686,589**	**$41,203,412**
		PV of Costs as Calculated			PV of Net Costs		
Capital Costs	$0	$26,561,210	$29,232,102	$30,942,902	$26,561,210	$29,232,102	$30,942,902
Maintenance Costs	$1,169,478	$974,243	$1,048,331	$2,304,333	-$195,235	-$121,147	$1,134,855
PV Total Net Costs					**$26,365,975**	**$29,110,956**	**$32,077,757**
				BCR_N	**1.3**	**1.4**	**1.3**

BASE OPTION FOR COMPARISON			NEXT HIGHER COST OPTION			INCREMENTAL ANALYSIS		
Option	Total Costs	Total Benefits	Option	Total Costs	Total Benefits	Incremental Costs	Incremental Benefits	Incremental BCR_N
	(1)	(2)		(3)	(4)	(5) = (3) - (1)	(6) = (4) - (2)	(7) = (6) / (5)
1	$26,365,975	$34,672,397	2	$29,110,956	$41,686,589	$2,744,980	$7,014,192	**2.6**
2	$29,110,956	$41,686,589	3	$32,077,757	$41,203,412	$2,966,801	-$483,177	-0.2

Preferred Option BCR	Then Incremental BCR
B/C <= 2	1.0
2 < B/C < 4	2.0
B/C >= 4	4.0

Preferred Option = **Option 2**

0.67	Factor applied to combinations of three or more crash reduction factors (Turner, B. “Estimating the Safety Benefits when Using Multiple Road Engineering Treatments,” Road Safety Risk Reporter, 11, June 2011) http://www.arrb.com.au/admin/file/content13/c6/RiskReporterIssue11.pdf			
			Crash 2008 -2012	
ALL VEHICLES	Movement category		F+S,M,N	F+S,M,N
Transfer % reductions into Safety Ben Master			Curves	Midblock
ws6-ALLmvt	all movements			
	crash reduction			
ws6-Headon	Head on	AB, B	1S, 1M, 4N	2S, 2M, 1N
ws6-Hitobj	Hit object	E	1N	1N
ws6-LCoff	Lost control off road	AD,CB,CC,CO,D	2S, 10M, 19N	1F,5S, 10M, 36N
ws6-Lcon	Lost control on road	CA	1N	1S, 1M
ws6-Misc	Miscellaneous	Q	0	4N
ws6-Over	Overtaking	AA,AC,AE-AO,GE	1S	2M, 4N
ws6-Ped	Pedestrian	N,P	0	0
ws6-RExing	Rear end - crossing	FB,FC,GD	0	2M, 4N
ws6-REque	Rear end - queuing	FD,FE,FF,FO	2N	1M, 4N
ws6-REslow	Rear end - slow veh	FA,GA,GB,GC,GO	1S, 1M	1S, 3N
ws6-XgDir	Crossing - direct	H	0	0
ws6-XgDir	Crossing - turning	J,K,L,M	1N	1F, 3M, 4N

	Treatment: Curve Realignment + consistent superelevation				Treatment: 1.5m shoulder widening (curves)				Treatment: 1.5m shoulder widening (Midblock)				Treatment: Centreline ATP			
	Option included?	1	2	3	Option included?	1	2	3	Option included?	1	2	3	Option included?	1	2	3
		1	1	1		1	1	1		1	1	1		1	1	0
	Curves R	consistent super and design sp		C	1.5m shoulder widening Curves (0.6m weighted avg exis			C	1.5m shoulder widening Midblock (1.0m existing)			M	Curves and Midblock Note: exclude H/O crashes		C/L AT	B
ws6-ALLmvt	ALL	F+S	M	N	ALL	F+S	M	N	ALL	F+S	M	N	ALL	F+S	M	N
crash reduction	15				35				22				33.0612245			
ws6-Headon	15	15	15	15	35				22				33	36	36	
ws6-Hitobj	15				35				22				0			
ws6-LCoff	15				35				22				24			
ws6-Lcon	15				35				22				0			
ws6-Misc	0				35				22				0			
ws6-Over	15				35				22				0	36	36	
ws6-Ped	0				35				22				0			
ws6-RExing	0				35				22				0			
ws6-REque	15				35				22				0			
ws6-REslow	15				35				22				0			
ws6-XgDir (Crossing - direct)	0				35				22				0			
ws6-XgDir (Crossing - turning)	0				35				22				0			

	Treatment: Edgeline ATP				Treatment: Guardrail roadside protection				Treatment: Rural flush median				Treatment: Wire rope barrier			
	Option included?	1	2	3	Option included?	1	2	3	Option included?	1	2	3	Option included?	1	2	3
		1	1	1		1	1	1		0	1	0		0	0	1
	Curves and Midblock			B	Curves and Midblock			B	Curves and Midblock			B	Curves and Midblock			B
ws6-ALLmvt	ALL	F+S	M	N	ALL	F+S	M	N	ALL	F+S	M	N	ALL	F+S	M	N
crash reduction	27				40				40				75			
ws6-Headon	0				0				47	71	52		80	90	0	-20
ws6-Hitobj	0				0				0				0			
ws6-LCoff	32	42	32	32	18	16	10	-10	0	20			0	75		
ws6-Lcon	0				0				40				75	75		
ws6-Misc	0				0				0				0			
ws6-Over	0				0				40				25	25	25	25
ws6-Ped	0				0				0				0			
ws6-RExing	0				0				40				0			
ws6-REque	0				0				40				0			
ws6-REslow	0				0				40				0			
ws6-XgDir (Crossing - direct)	0				0				40				75			
ws6-XgDir (Crossing - turning)	0				0				40				75			

A reliable and specific crash severity reduction for a movement type were used in prefernce for the multiplicative approach, if a crash reduction for a severity was not avavlible, then the crash reduction for the movement was used. If the treatment option did not provide a movement injury crash rate, then the severity reduction for the treatment, or ultimately the general crash reduction for the treatment was used.

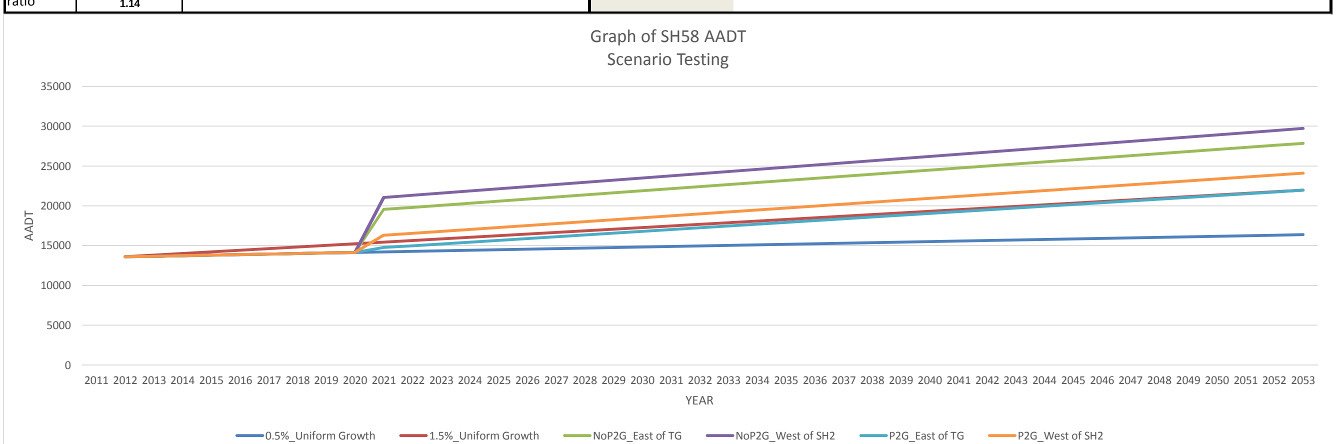
Curve Realignment	1.5m shoulder widening (curves)	1.5m shoulder widening (Midblock)	Centreline ATP	Edgeline ATP	Guardrail roadside protection	Rural flush median	Wire rope barrier
% reduction determined from HRRRG improvements to Ref.. HRRRG AMF Superelevation Graph assuming 15% as the value of 0.05 deficincy - Conservative value used due to likely crash migration due to limited curve improvements	% reduction determined from exposure based crash rate calculation (existing 0.6m vs 1.5m = 39%), 35% adopted.	% reduction determined from exposure based crash rate calculation (existing 1m vs 1.5m = 22%)	HRRRG - E2.3 [107] Sayed et al. Jan 2010 **Factored down based on existing 1.7km of C/L ATP**	HRRRG - E1.5 [41]	**Factored down based on existing guardrail** Ref.. 40% form HRRRG [17] Run-off-road from EEM Table A6.18(d), Non injury estimated to represent the increase in non-injury events	HRRRG e2.1: 52% all crashes AADT >5,000 Adopted: 40% all crashes HRRRG E2.1	HRRRG • 40–60% reduction in head-on and run-off-road crashes [3] • 100% reduction in fatal and serious crashes following installation of a 1+1 wire rope median barrier [13]Ref..

Updated Traffic Growth Rate (Option 4)

SH58 Traffic Modelling Results and Traffic Growth Rates

				2011							
	Traffic Growth	0.50%	1.5%	0.50%		Do-Minimum					
				TG, No P2G		TG, with P2G					
		0.5%_Uniform Growth	1.5%_Uniform Growth	NoP2G_East of TG	NoP2G_West of SH2	P2G_East of TG	P2G_West of SH2				
	2011								68	204	
	2012	13600	13600	13600	13600	13600	13600		0.5%	1.5%	
0	2013	13668	13804	13668	13668	13668	13668				
1	2014	13736	14008	13736	13736	13736	13736	0.5% growth rate apart from uniform options			
2	2015	13804	14212	13804	13804	13804	13804				
3	2016	13872	14416	13872	13872	13872	13872				
4	2017	13940	14620	13940	13940	13940	13940				
5	2018	14008	14824	14008	14008	14008	14008				
6	2019	14076	15028	14076	14076	14076	14076				
7	2020	14144	15232	14144	14144	14144	14144				
8	2021	14212	15436	19560	21050	14770	16300	**TG/P2G STEP CHANGE & Model growth rates (1.3%-1.5%) to end of analysis (From Opus SH58 Draft Report Issue Table 4-2 & Table 4-3: Do minimum Forecast Traffic Volumes (AADT))**			
9	2022	14280	15640	19819	21321	14995	16544				
10	2023	14348	15844	20078	21592	15220	16788				
11	2024	14416	16048	20337	21863	15445	17032				
12	2025	14484	16252	20596	22134	15670	17276				
13	2026	14552	16456	20855	22405	15895	17520				
14	2027	14620	16660	21114	22676	16120	17764				
15	2028	14688	16864	21373	22947	16345	18008				
16	2029	14756	17068	21632	23218	16570	18252				
17	2030	14824	17272	21891	23489	16795	18496				
18	2031	14892	17476	22150	23760	17020	18740		259	271	225
19	2032	14960	17680	22409	24031	17245	18984		1.32%	1.29%	1.52%
20	2033	15028	17884	22668	24302	17470	19228				
21	2034	15096	18088	22927	24573	17695	19472				
22	2035	15164	18292	23186	24844	17920	19716				
23	2036	15232	18496	23445	25115	18145	19960				
24	2037	15300	18700	23704	25386	18370	20204				
25	2038	15368	18904	23963	25657	18595	20448				
26	2039	15436	19108	24222	25928	18820	20692				
27	2040	15504	19312	24481	26199	19045	20936				
28	2041	15572	19516	24740	26470	19270	21180				
29	2042	15640	19720	24999	26741	19495	21424				
30	2043	15708	19924	25258	27012	19720	21668				
31	2044	15776	20128	25517	27283	19945	21912				
32	2045	15844	20332	25776	27554	20170	22156				
33	2046	15912	20536	26035	27825	20395	22400				
34	2047	15980	20740	26294	28096	20620	22644				
35	2048	16048	20944	26553	28367	20845	22888				
36	2049	16116	21148	26812	28638	21070	23132				
37	2050	16184	21352	27071	28909	21295	23376				
38	2051	16252	21556	27330	29180	21520	23620				
39	2052	16320	21760	27589	29451	21745	23864				
40	2053	16388	21964	27848	29722	21970	24108				
		16388	21964		28785		23039				
				1.5% Uniform	76%		95%	Therefore, the 1.5% uniform was more accurate than 0.5%, bu			
				0.5% Uniform	57%		71%	Opus used 0.5% uniform growth in the PFR			

Active Scenario	3 (Do Min)	West SH2	East TG	Average	current uniform- 1.5%		West (SH2)	East of TG	West (SH2)	East of TG
							No P2G		with P2G (assumed do min)	
	modelled years	Input values	Input values	Input values	Uniform 1.5%	Uniform 0.5%	No P2G_West (SH2)	No_P2G_East of TG	P2G_West(SH2)	P2G(East of TG)
0	2013	13668	13668	*13668*	13804	13668	13668	13668	13668	13668
2	2015	13804	13804	*13804*	14212	13804	13804	13804	13804	13804
8	2021	16300	14770	*15535*	15436	14212	21050	19560	16300	14770
18	2031	18740	17020	*17880*	17476	14892	23760	22150	18740	17020
28	2041	21180	19270	*20225*	19516	15572	26470	24740	21180	19270
38	2051	23620	21520	*22570*	21556	16252	29180	27330	23620	21520
2021/2013 ratio	1.14									



MWH.

SH58 Safety Improvements Economic Evaluation

EVALUATION SUMMARY — WORKSHEET 1

1 Evaluator(s) Dhimantha Ranatunga
Reviewer(s) Phil Peet, David Wanty

2 Project / Package Details

Approved Organisation Name	NZTA
Project / Package Name	SH58 Safety Improvements
Your Reference	80501811
Project Description	Safety Improvements
Describe the problem to be addressed	Reduce high severity crashes

3 Location

Brief description of location: State Highway 58, from Haywards Hill to Bradey Road RP0/0.1 to RP0/9.3

4 Alternatives and Options

Describe the Do Minimum: Continued Maintenance, Tranmission Gully and Petone to Grenada Constructed by 2021.

Summarise the options assessed: Option 4: Curve realignment of 3 sites, 1.5 full extent shoulder widening, central 2.0m median WRB , edge guardrail and ATP (including a roundabout at Moonshine Road intersection)

5 Timing

Time Zero	1 July 2013
Expected duration of construction (years)	1.00
End construction	1 July 2015

6 Economic Efficiency

Date economic evaluation completed (mm/yyyy)	Aug-13	updated Feb 2014 following peer review
Base date for costs	1 July 2013	
AADT at Time Zero	13,700	
Traffic Growth Rate at Time Zero (%)	0.5%-1.5%	Based on 2021/2031 Modelling outputs

Existing Roughness	3.10	IRI or NAASRA	Existing Traffic Speed	80-85	km/hr	(surv/est)
Predicted Roughness	2.50	IRI or NAASRA	Predicted Traffic Speed	85	km/hr	
Length of curves Before Improvements	1.49	km	Posted Speed Limit	80	km/hr	DM/OPTION
Length of curves After Improvements	1.46	km	Road Type	Rural Strategic		
			Gradient Before Improvements	7%		
			Gradient After Improvements	7%		

7 PV Cost of Do Minimum — **Cost $** $1,574,069 **A**

8 PV Cost of the Option — **Cost $** $32,247,532 **B**

9 Benefit values from Worksheet 4, 5 or 6

PV Travel Time Cost savings: $	-$1,064,952	C	x Update Factor^{TT}	1.40	= $ -$1,490,933	W
PV VOC & CO2 savings: $	-$1,191,772	D	x Update Factor^{VOC}	1.06	= $ -$1,263,279	Y
PV Accident Cost savings: $	$40,144,315	E	x Update Factor^{AC}	1.22	= $ $48,976,064	Z

10 B/C Ratio = $\frac{W + Y + Z}{B - A} = \frac{\text{BENEFITS}}{\text{COSTS}} = \frac{-1490933 + -1263279 + 48976064}{32247532 - 1574069} =$ **1.5**

11 FYRR = $\frac{1^{st}\text{ Year BENEFITS}}{\text{COSTS}} = \frac{\$2,369,377}{\$30,673,463} =$ **8%**

SH58 Safety Improvements Economic Evaluation

EVALUATION SUMMARY **WORKSHEET 1**

1	**Evaluator(s)**	Dhimantha Ranatunga
	Reviewer(s)	Phil Peet, David Wanty

2 Project / Package Details

Approved Organisation Name	NZTA
Project / Package Name	SH58 Safety Improvements
Your Reference	80501811
Project Description	Safety Improvements
Describe the problem to be addressed	Reduce high severity crashes

3 Location

Brief description of location: State Highway 58, from Haywards Hill to Bradey Road RP0/0.1 to RP0/9.3

4 Alternatives and Options

Describe the Do Minimum	Continued Maintenance, Tranmission Gully Constructed by 2021. P2G not constructed in 2021.
Summarise the options assessed	Option 4: Curve realignment of 3 sites, 1.5 full extent shoulder widening, central 2.0m median WRB , edge guardrail and ATP (including a roundabout at Moonshine Road intersection)

5 Timing

Time Zero	1 July 2013
Expected duration of construction (years)	1.00
End construction	1 July 2015

6 Economic Efficiency

Date economic evaluation completed (mm/yyyy)	Aug-13	updated Feb 2014 following peer review
Base date for costs	1 July 2013	
AADT at Time Zero	13,700	
Traffic Growth Rate at Time Zero (%)	0.5%-1.5%	Based on 2021/2031 Modelling outputs

Existing Roughness	3.10	IRI or NAASRA	Existing Traffic Speed	80-85	km/hr	(surv/est)
Predicted Roughness	2.50	IRI or NAASRA	Predicted Traffic Speed	85	km/hr	
Length of curves Before Improvements	1.49	km	Posted Speed Limit	80	km/hr	DM/OPTION
Length of curves After Improvements	1.46	km	Road Type	Rural Strategic		
			Gradient Before Improvements	7%		
			Gradient After Improvements	7%		

7	**PV Cost of Do Minimum**	**Cost $**	$1,562,958	**A**
8	**PV Cost of the Option**	**Cost $**	$32,201,072	**B**

9 Benefit values from Worksheet 4, 5 or 6

PV Travel Time Cost savings: $	$30,408	**C**	x Update Factor^{TT}	1.40	= $ $42,571	**W**
PV VOC & CO2 savings: $	-$1,033,849	**D**	x Update Factor^{VOC}	1.06	= $ -$1,095,880	**Y**
PV Accident Cost savings: $	$48,044,899	**E**	x Update Factor^{AC}	1.22	= $ $58,614,777	**Z**

10 B/C Ratio =

$$\frac{W + Y + Z}{B - A} = \frac{\text{BENEFITS}}{\text{COSTS}} = \frac{42571 + -1095880 + 58614777}{32201072 - 1562958} = \mathbf{1.9}$$

11 FYRR =

$$\frac{1^{st}\text{ Year BENEFITS}}{\text{COSTS}} = \frac{\$2,369,377}{\$30,638,115} = \mathbf{8\%}$$

Appendix M SH58 Strategic Study

The executive summary from the NZTA's 2009 SH58 Strategic Study is appended below.

The NZTA has developed a long-term strategic plan along State Highway 58 (SH58) over the 20-year period 2009 to 2029. This SH58 Strategic Study relates to the entire 15.1 km length of SH58, from the junction with SH2 at Manor Park in the Hutt Valley, to the junction with SH1 at Paremata. SH58 is a regional highway that joins the Hutt Valley with Porirua and the Kapiti Coast. It provides for travel between these three areas whilst also providing access to local communities such as Whitby and Pauatahanui. SH58 is also used by heavy vehicle traffic travelling between the industrial port area of Gracefield/Seaview and destinations to the west via SH1.

The current highway predominantly provides a single two-way carriageway with roundabouts and priority controlled intersections. The width of the highway is constrained in many locations due to the terrain. Traffic volumes vary from 13,800 vehicles per day (vpd) west of SH2 to 9,200 vpd east of James Cook Drive at the end of the Pauatahanui Inlet, and to 16,700 vpd east of the Paremata Roundabout. The highway is predominantly rural from SH2 to Pauatahanui, with the urban density increasing from Pauatahanui to SH1 at Paremata.

Increasing traffic volumes will place some sections of the highway under pressure within the 20-year period, depending on whether or not Transmission Gully and Grenada to Gracefield projects are completed. The current strategy assumes the Grenada to Gracefield projects are constructed within the 10 year period and Transmission Gully soon after the ten year period.

The Grenada to Gracefield projects will result in a decrease in traffic volumes on SH58, as traffic transfers to the new east-west route. However, when Transmission Gully is constructed traffic volumes on SH58 increase again, but these will only be greater than existing volumes east of the new gully route as alternative routes will be available into Porirua.

Analysis of the crash data for the 5-year period from 2004 to 2008 indicates that there are currently an average of about 16 injury crashes and 52 total crashes per year and crash costs of about $5.3 million per annum along the SH58 Corridor study length. Accordingly, there is scope for improving the safety along this highway.

Based on the background information, the capacity analysis and the crash statistics, a long-term strategic plan has been developed for SH58. This can be summarised as follows:

- *The strategy assumes the Grenada to Gracefield projects will proceed within 10 years and Transmission Gully will be complete soon after the 10 year period.*
- *Based on these assumptions, SH58 will be retained as a two-lane two-way highway with the current passing lanes.*
- *All intersections will be at-grade, with the exception of the intersections with SH2 and Transmission Gully, which will both be grade separated.*
- *The section between Manor Park and Moonshine Road will be managed as an 80 – 100km/h rural environment with a median barrier (and some provision for turning movements) considered in the long term.*
- *The section between Moonshine Road and Pauatahanui will also be managed as an 80-100km/h rural environment with minor safety upgrades in the short term. Long term, this section could become a peri-urban environment and roundabouts for safety will be considered at the Moonshine Road and Flightys Road / Murphys Road intersections in conjunction with reducing the speed limit.*
- *The section between Pauatahanui and Postgate Drive will be managed as a 70km/h peri-urban section and the section from Postgate Drive to Paremata will be managed as a 50km/h urban highway with controlled access in the short term. The long term status of SH58 from Transmission Gully to Paremata will be determined as part of the Transmission Gully project.*

- Minor safety works will continue to be undertaken to address specific crash issues that arise during the study period.

Appendix N Pauatahanui Judgeford Structure Plan

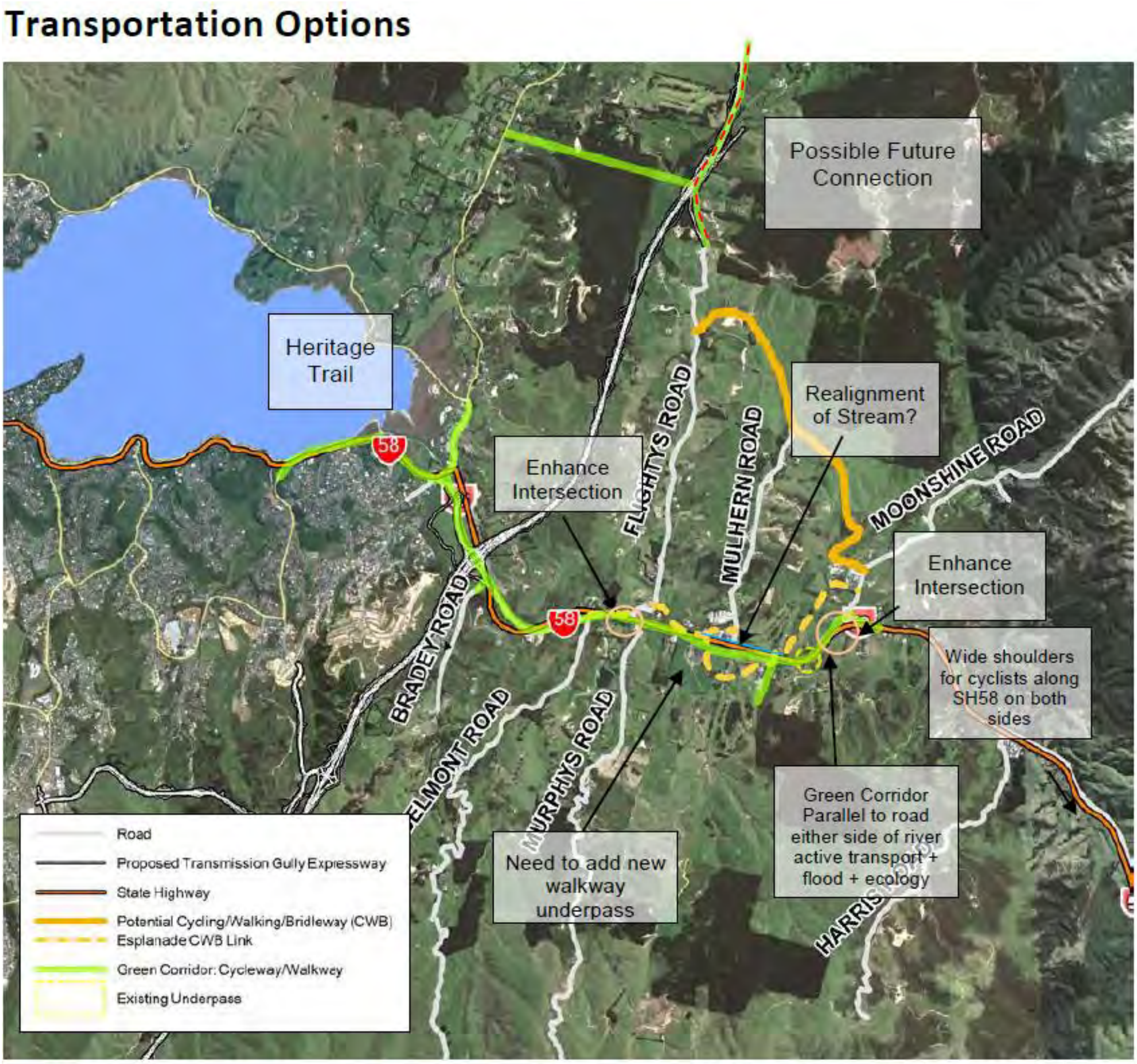


Figure 13-18: Transportation Option (Source: Appendix D, Pauatahanui Judgeford Structure Plan Technical Report -2012)

Appendix O Road Safety Audit

SH58 Safety Improvements

Opus International Consultants

Concept Stage

Safety Audit Report

Date: 18 December 2013

Table of Contents

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 Guidelines - Interim release May 2013"* the audit report should be submitted to the client who will instruct the designer to respond. The designer should consider the report and comment to the client on each of any concerns identified, including their cost implications where appropriate, and make a recommendation to either accept or reject the audit report recommendation.

For each audit team recommendation that is accepted, the client 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 Guidelines - Interim release May 2013"*, by:

- Mark Edwards, Lead Auditor, Opus International Consultants
- Adam Nicholls, Auditor, Opus International Consultants
- Ken Holst, Auditor, New Zealand Transport Agency
- Katie Levin, Observer, Opus International Consultants

The Safety Audit Team (SAT) met at the Opus office in Wellington to review the drawings and discuss the background of the project on 3 December 2013. The client, Wen Wang of the Transport Agency confirmed the scope of the audit and the designer's representative, Jamie Povall of MWH, briefed the safety audit team on the project. Designer Barbara Browne of MWH also attended the briefing meeting. A site inspection was subsequently undertaken on the same date from approximately 10:00AM to 2:00PM.

An exit meeting was held on 4 December 2013 to identify some of the main observations made during the site visit. Those included in the exit meeting were:

- Barbara Browne, MWH
- Mark Edwards, Opus
- Katie Levin, Opus
- Adam Nicholls, Opus
- Jamie Povall, MWH
- William Wallace, Opus (responsible for economic Peer Review)
- Wen Wang, the Transport Agency

1.3. Report Format

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

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

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

The frequency and severity ratings are used together to develop a combined qualitative risk ranking for each safety issue using the Concern Assessment Rating Matrix in Table 1 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)	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 Rating 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.

RISK	Suggested Action
Serious	A 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 audit is a Concept Stage Safety Audit of the SH58 drawings produced by MWH on behalf of the Transport Agency.

No previous Road Safety Audits have been carried out on earlier stages of the project.

1.5. Documents Provided

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

- State Highway 58 Safety Improvements Scheme Assessment Report, MWH (November 2013)

- SH58 Haywards Curves Concept Plan – Option 4 drawings, Revision A
  - 80501811-01-004-C001
  - 80501811-01-004-C004
  - 80501811-01-004-C021
  - 80501811-01-004-C022
  - 80501811-01-004-C023
  - 80501811-01-004-C024
  - 80501811-01-004-C025
  - 80501811-01-004-C026
  - 80501811-01-004-C027
- SH58 Haywards Curves Land Requirement Plan – Option 4 drawings, Revision A
  - 80501811-01-004-C601
  - 80501811-01-004-C602
  - 80501811-01-004-C603
  - 80501811-01-004-C604
  - 80501811-01-004-C605
  - 80501811-01-004-C606
  - 80501811-01-004-C607
  - 80501811-01-004-C610

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 nor an assessment of standards with respect to engineering or planning documents.

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

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

1.7. Project Description

The scope of the project is to improve the safety of SH58 and extends from Stn. 340 in the east (north of McDougall Grove) to Stn. 9260 in the west (south of Bradey Road). The recommended option, Option 4 in the Scheme Assessment Report, includes general provision of a minimum cross section that includes 1.5m shoulders, 3.5m lanes and a 2.0m flush median with a wire rope median barrier. In addition to the changes to the cross section, the realignment of three sections of the roadway have also been recommended as well as a new roundabout at the intersection of SH58 with Moonshine Road.

2. Safety Audit Findings

2.1. General Issues

Many of the issues identified were common to all or several parts of the project area. For this reason, general issues will be discussed in this section. The issues identified may be repeated in Section 2.2 where the specific locations of note will be discussed.

2.1.1. Speed Limit and Design Speed **Serious**

The speed limit on SH58 is currently 100km/hr and the SAT has been instructed to consider this to be the posted speed for the project. The plans provided indicate that all but one of the curves have a design speed of 90km/hr or less, with one curve having a design speed of 102km/hr. The lowest design speed is 74km/hr and the most common is 87km/hr. There is concern that despite the safety improvements and realignment of some of the out of context curves, the general geometry of the road would not be able to be negotiated safely at 100km/hr. The new sections of realignment and improved cross sections may provide a sense to drivers that the geometry is improved to a standard that is consistent with the posted 100km/hr speed limit. This is of particular concern due to the higher than average number of run off road crashes.

Recommendation:

Based on the issues discussed in the remainder of this document, the site visit and the design speeds of most of the curves, the SAT would recommend a posted speed limit of 80km/hr for all or most of SH58 within the project area.

Frequency Rating: *Crashes are likely to be* **Frequent**	***Severity Rating:*** *Death or serious injury is* **Likely**
Designer Response: The scope of the design commission was to consider improvements to the cross section, with realignment at only three sites, to make the speed environment more consistent. Accordingly the client is best placed to respond to this.	
Safety Engineer: ***Agree with auditor's comments***	
Client Decision: *Agree with auditor comments. The speed within the project site shall be set at 80km/hr*	
Action Taken: ***NZTA to reduce speed limit within project site to 80km/hr permanently***	

2.1.2. U-turn Manoeuvres **Moderate**

The provision of a wire rope barrier along most of the length of SH58, and the associated restricted movements, means that more U-turns will need to be performed for people and goods to reach their desired destinations. The additional distance added to some of the private residences in particular are upwards of 2 kilometres in one direction. A total of 4.5 kilometres would be added to one journey for some residents looking to head south on SH58. The subsequent return trip would also require an additional 1.7 kilometres of travel. The additional distances (and time) may cause drivers to make unsafe manoeuvres in order to take short cuts or accept smaller gaps out of impatience and frustration. In addition, there are several businesses using large trucks on SH58, particularly at the west end of the project. The additional time and distance required to travel to a safe U-turn area (such as the Moonshine Road roundabout) may be foregone for a less safe intersection that is closer. Table 6-1 in the SAR identifies intersection access arrangements and right turn alternatives, i.e. U-turn locations. This does not list private accesses or calculate the likely additional distances travelled as part of these trips.

Emergency services also require adequate access in order to respond to calls in a timely manner. Fire trucks generally have the tools to take down the wire rope barrier quickly and often arrive on site first; however, in the event ambulances and police arrive first or fire services do not attend, they may not be as adequately equipped.

The provision of a wire rope barrier along most of the length of SH58, and the associated restricted movements, also means that accessing businesses along the route will be more challenging. This will be particularly problematic for visitors to the area. The lack of knowledge of the appropriate route to take may result in irregular driving behaviour.

Recommendation:

Consider safety of U-turn locations as well as the distance between them. Consider setting an acceptable detour distance for private accesses and aiming to provide U-turn locations within those parameters. Consult with emergency services to determine other issues they may have.

There are several businesses that would benefit from signage on how to reach their location. This is particularly important for the golf course on SH58 that will require travel to the roundabout at Moonshine Road and U-turns at Mulhern Road in order to enter/exit and may be frequented by non-locals.

Frequency Rating: *Crashes are likely to be* **Common**	***Severity Rating:*** *Death or serious injury is* **Unlikely**
Designer Response: Consultation with locals, business owners and emergency services has not been undertaken as yet so further consideration needs be given to access and u-turn facilities after consultation which can also take into account the safety audit teams concerns The design has attempted to balance access and safety in determining the concept locations for median breaks and u-turn facilities. Due to the geometry and topography of the area, u-turn facilities cannot be provided in many locations, particularly for heavy vehicles..	
Safety Engineer: ***Agree with designers response***	
Client Decision: ***Agree with most recommendations, further details to be finalised after consultation.***	
Action Taken: ***To consult with residents, businesses and emergency services in project area on suitable turn-around facilities and locations.***	

2.1.3. Drainage Paths **Significant**

Along some lengths of SH58 there are some significant grades, a generally hilly topography, large superelevations and no median drainage. It is considered that this could result in a risk of long drainage paths and/or high drainage depths. Due to the high proportion of crashes that have occurred during wet or icy conditions on SH58 (identified as 53% in the SAR provided), this aspect of the design requires sufficient consideration. The SAT did not have sufficient information to assess the paths in more detail.

Recommendation:

Ensure drainage depths and paths are appropriate. The design team commented during the exit meeting that limits on drainage lengths were considered during design. This needs to be considered in more detail now as detailed design solutions may be difficult given the nature of the route.

Frequency Rating: *Crashes are likely to be* **Common**	***Severity Rating:*** *Death or serious injury is* **Likely**
Designer Response: Our design philosophy statement noted that this is an issue due to the topography and stated that it will be considered during detailed design. The use of median drainage and porous pavement have been considered during the Scheme Design but not explicitly designed.	
Safety Engineer: ***Ensure drainage paths are considered during detailed design to address safety concerns.***	
Client Decision: ***Agree with safety engineer, ensure appropriate surfacing option is selected in addition to assist water draining process.***	
Action Taken: ***Detailed considerations to be given at detailed design for drainage paths as well as surfacing options to minimize surface water depth.***	

2.1.4. Underpasses/culverts/etc. **Minor**

Throughout the project area there are several features that pass underneath the road including the stock underpass at Stn. 3800, the pedestrian underpass to service the golf course at Stn. 6900 and several culverts as identified in Table 3.1 of the SAR. Run-off road crashes at these locations have the potential of increased severity due to these man-made features. Therefore, adequate protection needs to be provided.

Recommendation:

Ensure guardrails are provided and/or extended to adequately protect the under road features.

Frequency Rating: *Crashes are likely to be* **Occassional**	***Severity Rating:*** *Death or serious injury is* **Unlikely**
Designer Response: Agreed. This will be further considered in the next stage of design.	
Safety Engineer: ***Agree with auditor's response***	
Client Decision: ***Agree with auditor's reponse.***	
Action Taken: ***To provide guardrails in appropriate locations. To be determined during detailed design.***	

2.1.5. Protection of Street Furniture **Significant**

There are various sections of road with significant amounts of street furniture. Some examples are:

- Power poles from Stn. 4420 to Stn. 4840 (discussed in Section 2.2.16); and
- Power poles and large trees from Stn. 6960 to Stn. 7260 (discussed in Section 2.2.22).

The power poles seen during the site visit did not appear to be frangible. These items pose added risk to vehicles that exit the roadway.

Recommendation:

Removal, relocation or protection of street furniture should be considered to reduce severity of run off road collisions and deliver a safer road.

Frequency Rating: *Crashes are likely to be* **Common**	***Severity Rating:*** *Death or serious injury is* **Likely**
Designer Response: Power services are proposed for undergrounding. Further consideration of trees will be given at the detailed design phase.	
Safety Engineer:	***Agree with auditor response.***
Client Decision:	***Agree with suditor response.***
Action Taken:	***Consider most effective solution at detail design.***

2.1.6. Rationalise Guardrails **Comment**

Despite the safety of guardrail terminal ends when installed properly, these increase risk exposure to motorists compared to a guardrail itself. Therefore, short spaces between guardrails should be avoided unless necessary to provide access.

Recommendation:

Due to the increased risk exposure posed by a guardrail termination end, and the added expense, the rationalisation of the guardrails should be completed to minimise small unnecessary gaps.

2.1.7. Lighting **Moderate**

The SAT observed during the site visit that the lighting at the various intersections was inconsistent and intermittent. No lighting has been annotated on the plans provided nor does the cost estimate in the

SAR provide a line item for lighting therefore the SAT cannot assess this in detail. This is likely not within the scope at this stage of the project.

Recommendation:

Apply a consistent lighting standard over the length of the project while ensuring sufficient lighting provided at intersections. Review lighting in detail in future project phases and the associated Road Safety Audits.

Frequency Rating: *Crashes are likely to be* **Infrequent**	***Severity Rating:*** *Death or serious injury is* **Likely**
Designer Response: Lighting is out of the scope of our current commission. Client to provide comment.	
Safety Engineer:	***Consider opportunities to improve lighting during detailed design.***
Client Decision:	***Agree with safety engineer.***
Action Taken:	***To be considered during detail design.***

2.2. Issues at Specific Locations

2.2.1. Curve No. 4 (near Stn. 700) **Moderate**

This horizontal curve occurs at the beginning of the project area where the median is 1.5m. The curve radius is 180m. There is wire rope barrier (WRB) from Stn. 450 to Stn. 880 which runs through the length of the curve. The tight horizontal curve (design speed indicated is 74km/hr) and narrow median with WRB reduces sightlines and poses a risk to motorists.

Recommendation:

Provide adequate signage indicating reduced advisory speed. Provide additional median width where practicable.

Frequency Rating: *Crashes are likely to be* **Occassional**	***Severity Rating:*** *Death or serious injury is* **Likely**
Designer Response: Agreed that additional signage should be considered. Actual median width through this section was reduced form 2.0m to 1.5m in revised project scope to reduce significant earthwork volumes. For eastbound traffic, it is noted that additional effective median width is provided through this section as a result of the widening for the development of the right turn bay to Hugh Duncan Street. For westbound traffic there is limited SSD at present due to the road curvature and whilst it is possible the wire rope barrier could obstruct forward visibility additional shoulder width will be provided. Providing additional median width is likely to prove prohibitive due to cost but can be reassessed at detailed design stage.	
Safety Engineer:	***Agree with designer response.***
Client Decision:	***Agree with designer response.***
Action Taken:	***To investigate options at detail design stage to reduce limited SSD***

risk.

2.2.2. Hugh Duncan Street Intersection **Serious**

The intersection with SH58 and Hugh Duncan Street is located on a grade that limits sight distance to the north for both right turns in and right turns out. The sight distance appeared to be less than 100m to the crest of the hill when looking right from the stop line at Hugh Duncan Street (Austroads specifies the Safe Intersection Sight Distance (SISD) for 100km/hr is approximately 250m). The addition of the WRB may reduce the sightlines for traffic turning right into Hugh Duncan Street from SH58. While the current traffic volumes are low on Hugh Duncan Street, the limited right turn options due to the WRB will likely increase use of this intersection for U-turns. Transpower currently operates their gates as left in / left out, and drivers are directed to turn around using the McDougall Grove area. However, other traffic and non-Transpower employees may use Hugh Duncan Street instead of driving the additional distance to McDougall Grove.

Recommendation:

Reconsider U-turn locations and restricted accesses in the subsequent design stages of the project.

Frequency Rating: *Crashes are likely to be* **Common**	***Severity Rating:*** *Death or serious injury is* **Very likely**
Designer Response: It is accepted that the existing situation of limited SISD at Hugh Duncan Street / SH58 is below the desirable Austroads standards. However it is also noted that there have been zero intersection related crashes at this location during the 5 year assessment period. The provision of wire rope barrier of SH58 north of the Hugh Duncan intersection will however be reduced by 60m to ensure no obstruction of visibility can eventuate for right turning traffic into Hugh Duncan Street. Right turns out from Hugh Duncan Street will be improved with the proposed length reduction of the existing eastbound passing lane on SH58 at this point which removes the need for vehicles to turn out of Hugh Duncan into a passing lane. A new merge area will also be provided (as per MOTSAM requirements) for the right turn out of Hugh Duncan (with lane line continuation). Additionally, as per 2.1.2, further consideration of access and u-turns needs to be carried out after consultation.	
Safety Engineer: ***Consider left in left out at consultation stage.***	
Client Decision: ***Agree with safety engineer***	
Action Taken: ***To consider the most appropriate safety design at detail design stage, post initial consultation.***	

2.2.3. Access Road Entrance (Stn. 1230) **Minor**

The angle of the access road to the water tower on the west side of SH58 is highly in favour of traffic turning left into the access. However, vehicles exiting the access road are facing oncoming traffic when travelling down to the road entrance.

Recommendation:

Square the entrance to the highway to reduce possibility of entering into wrong way traffic and providing better sightlines for exiting vehicles.

Frequency Rating: *Crashes are likely to be* **Infrequent**	***Severity Rating:*** *Death or serious injury is* **Unlikely**
Designer Response: Agreed. This will be considered in the next phase of design.	
Safety Engineer: ***Agree with designer***	
Client Decision: ***Agree with designer***	
Action Taken: ***To be considered at detail design.***	

2.2.4. Kaitawa Street / Transpower Accesses (Gates A, B and C) / Old Haywards Road **Significant**

Kaitawa Street has good sight distances however it is restricted to a left in / left out access. Some vehicles will use Hugh Duncan Street to perform U-turns. Transpower currently has three accesses to SH58 within approximately 300m of one another. Gate C is located at Kaitawa Street, Gate A is adjacent to Old Haywards Road and Gate B is between the two. Transpower is currently undergoing investigations into the access arrangement at this location.

The plans indicate that the new intersection at Old Haywards Road and SH58 will connect the current Old Haywards Road to SH58 with a more square intersection and the Transpower access will be located within the intersection. This provides a large paved area that has little control and could be used for U-turn movements. There is also a large level difference between SH58 and Old Haywards Road currently. Good sightlines are observed at this location however the proposed intersection layout restricts prevent right turns out from Old Haywards Road to SH58. There is currently a passing lane on SH58 at this location which supports the movement restriction.

Recommendation:

This new project may provide an opportunity to restructure the accesses to reduce conflict points on the highway. It is recommended that the U-turn locations and restricted accesses in the design be reviewed with the safety implications in mind. There may be an opportunity to consult with Transpower on this issue.

At the Old Haywards Road intersection, reduce the amount of pavement that could be used by U-turn vehicles unsafely to only what is required. Provide defined traffic control for Transpower access to the intersection. Consider U-turn locations and restricted accesses in design of this intersection. Sightlines at the intersection seem to be better than other locations for right turns out. However, this would require altering the design of the passing lane and ensuring that the vegetation on the east side of SH58 was cut back appropriately to maintain sight distances.

Frequency Rating: *Crashes are likely to be* **Common**	***Severity Rating:*** *Death or serious injury is* **Likely**
Designer Response: As per 2.1.2, further consideration of access and u-turns needs to be	

carried out after consultation. It is also noted that Hugh Duncan Street is a cul-de-sac with a reasonable daily traffic flow and therefore providing for direct access is considered important to negate unnecessary U-turns (and associated conflict) on the network. Breaking the wire rope barrier at Kaitawa Street would necessitate a further reduction of the existing passing lane length prior to the significant uphill gradient for eastbound vehciles which is not considered feasible. The final detail of the pavement provision / road markings of Old Haywards Road can be further refined at detailed design stage.
Safety Engineer: ***Consider access point safety in more detail after feedback at initial consultation.***
Client Decision: ***Agree with safety engineer.***
Action Taken: ***Consider further during/ after consultation and implement the most appropriate solution at detail design.***

2.2.5. Old Haywards Road **Moderate**

There are raised services present on the west side of SH58 across from the proposed Old Haywards Road intersection. This location is on the outside of a horizontal curve but there is no proposed barrier protection.

Recommendation:

Relocate or protect services using appropriate barrier system.

Frequency Rating: *Crashes are likely to be* **Infrequent**	***Severity Rating:*** *Death or serious injury is* **Likely**
Designer Response: Agreed. This will be considered in the next phase of design.	
Safety Engineer: ***Agree with auditor.***	
Client Decision: ***Agree with auditor.***	
Action Taken: ***To be considered at detail design.***	

2.2.6. Curve No. 10 (near Stn. 1940) **Moderate**

It is noted on Drawing No. C022 that Curve No. 10 has a tight horizontal radius (185m) and design speed of 78km/hr, a superelevation of 7% and is on a steep grade (~8%). Generally curves with one limiting factor are deemed acceptable; however, this curve has three limiting factors which is considered an issue, especially as a combination of these limiting factors would all potentially contribute to loss of control and run off road crashes, which are over represented on this route.

Recommendation:

Redesign curve or provide advisory speed signs with reduced speed.

Frequency Rating: *Crashes are likely to be* **Occassional**	***Severity Rating:*** *Death or serious injury is* **Likely**
Designer Response: This is outside the scope of our current commission but we agree that this curve should be considered for realignment.	
Safety Engineer: ***Provide advisory signs as a minimum.***	
Client Decision: ***Agree with safety engineer.***	
Action Taken: ***To install advisory signs as a minimum during construction.***	

2.2.7. End of Passing Lane (Stn. 2280) **Comment**

Where the northbound passing lane ends near Stn. 2280, shoulder markings have not been indicated on the plans.

Recommendation:

Ensure provision of appropriate pavement markings to signify the end of the passing lane at this location.

2.2.8. Private Access (2 Mount Cecil Road) **Comment**

The plans show that an access to SH58 south of Mount Cecil Road has been closed and guardrail placed at this location. The property has an additional access via Mount Cecil Road and thus the SAT supports the access closure. However, the guardrail seems to extend further than necessary on the inside of the curve.

Recommendation:

Consider reducing the length of the guardrail to no longer than where it sufficiently blocks the access.

2.2.9. Mount Cecil Road **Comment**

The intersection with Mount Cecil Road and SH58 occurs at the end of realignment section 3 and thus current sightlines from the intersection may not represent those that will occur once the project is complete. However, while on site it was observed that the vegetation on the east side of SH58, particularly to the north of the intersection, could be impeding sightlines at the intersection. The SAT had concerns regarding the termination of the WRB at Stn. 2850; however, during the site visit it was seen that the WRB was terminated at this point to provide adequate sight distance and thus the SAT supports this design. The give way line at the intersection is not square and if implemented as drawn would reduce sightlines to the north.

Recommendation:

Ensure adequate sightlines at intersection. Cut back vegetation if necessary. Square give way line at intersection.

2.2.10. Curve No. 14 (near Stn. 2960) **Comment**

There is guardrail suggested on the outside of Curve No. 14 from Stn. 2830 to Stn. 2990, approximately, with a 20 metre gap where a current cut bank exists.

Recommendation:

It may be appropriate to provide the additional length of guardrail instead of having four terminating points over this short span of guardrail. The additional guardrail is considered safer than the additional end points as well.

2.2.11. Proposed Winstones Cleanfill Access **Comment**

The arrangement proposed at the Winstones Cleanfill Access is for empty trucks exiting the site to the south, i.e. turning right out of the site, to cross over the active traffic lane and accelerate up the hill using a wide shoulder. This shoulder extends past Mount Cecil Road providing additional space should the trucks be unable to merge back into the traffic lane in the allotted distance. The SAT supports this design with the caveat that care be taken to ensure the acceleration lane not be misjudged as a passing lane and that sufficient space be obtained to provide the lane as designed as the design exceeds the current designation.

Recommendation:

The current plans show triangle of paint, presumably to show drivers where to go but prevent mainstream traffic from using the lane. It is recommended that instead of as shown on plans, a wide edgeline of 200mm be used to prevent traffic from using the lane as a passing lane. Truck drivers will be able to be briefed on the appropriate procedures when leaving the site. Also, ensure the designation is achieved to provide the width of the shoulder lane as drawn.

2.2.12. Curve No. 18 (near Stn. 4280) **Significant**

There is currently no guardrail proposed on the outside of Curve No. 18 (east side of SH58) despite the hazards present (several non-frangible power poles and a drop-off). There is currently guardrail proposed on the inside of Curve No. 18 (west side of SH58) from Stn. 4040 to Stn. 4170. The SAT observed several hazards on this side of the road during the site visit including a drop-off and some large trees close to the road beyond the protection of the guardrail.

Recommendation:

Extend the guardrail from Curve No. 17 (Stn. 4040) through Curve No, 18 to Stn. 4380 on the east side of SH58. Extend the guardrail from Stn. 4170 through Curve No, 18 to Stn. 4220 on the west side of SH58.

Frequency Rating: *Crashes are likely to be* **Occassional**	***Severity Rating:*** *Death or serious injury is* **Very likely**
Designer Response: Agreed. This will be considered in the next phase of design.	
Safety Engineer: ***Agree with designer.***	
Client Decision: ***Agree with designer.***	
Action Taken: ***To be considered during detailed design.***	

2.2.13. Stn. 4420 to Stn. 4840 **Moderate**

There is currently no guardrail proposed on the east side of SH58 for this stretch of road (between the existing accesses that are to be retained) despite the power poles present and this being the end of a passing lane.

Recommendation:

Provide guardrail from Stn. 4540 to Stn. 4700 on the east side of SH58. There are a number of power poles outside this length from Stn. 4220 through to Stn. 4850 that should be removed or protected.

Frequency Rating: *Crashes are likely to be* **Occassional**	***Severity Rating:*** *Death or serious injury is* **Likely**
Designer Response: Agreed. This will be considered in the next phase of design in conjunction with the undergrounding of the power services.	
Safety Engineer: ***Agree with auditor.***	
Client Decision: ***Agree with auditor.***	
Action Taken: ***To be considered during detailed design.***	

2.2.14. Harris Road **Comment**

The intersection with Harris Road has been suggested as the access point for the business located at the southwest corner of the intersection. This business appears to be a house moving company which requires a larger access point. The current Harris Road is significantly higher in elevation than the businesses premises, thus making the use of this access impractical.

Recommendation:

Ensure adequate provision is made for the business access noting in particular the need to transport large loads. This location may be considered as a full movement intersection due to the good sight lines from Harris Road, however, it is noted this would be in conflict with the end of the passing lane.

2.2.15. Stn. 4750 to Stn. 4960 **Comment**

There is currently guardrail proposed on the west side of SH58 for this stretch of road (between Harris Road and an existing private access that is to be retained) despite this being a straight stretch of road adjacent to a cut slope.

Recommendation:

Consider removing guardrail if unnecessary.

2.2.16. Private Access (Stn. 6210) **Comment**

The roundabout proposed at Moonshine Road has proposed concrete medians at each leg. These medians restrict access to a private residence at Stn. 6210 (400A). Turning "right out" of the residence will be minimally impacted as the roundabout can be used to complete this movement easily in the new layout. However, turning "right-in" will require a significant detour to Harris Road, adding an additional distance of approximately 3 kilometres (total) to the trip. The SAT was concerned that instead of making this detour, unsafe manoeuvres may be attempted by drivers wishing to access the property, such as, driving the wrong way up the east approach leg, particularly during off peak periods.

Recommendation:

Consider shortening median or providing a route across the median to allow right turns into property.

2.2.17. Moonshine Road Roundabout **Serious**

Several issues and considerations were identified at the new roundabout at Moonshine Road. Those are:

- The roundabout appears to be off balance and the SAT question the need for the dedicated left lane into Moonshine Rd. This may be confused as an additional through lane as is provided on the other SH58 leg;
- Larger traffic volumes will be using the roundabout than are currently as this will become a facility for U-turns. This needs to be accommodated for in the circulatory width of the carriageway;
- No provision can be seen on the plans to accommodate the existing bus stop at this location, nor for pedestrian access or egress to the bus stop. This a significant concern, especially if the bus stop was rearranged to locations on both sides of SH58;
- The right lane turn only marking on the right lane of the east approach may be ignored by oncoming traffic as there are two exit lanes provided. This could create conflicts due to the expectations of other drivers using the roundabout;
- Several accesses occur within the current area that would occupy the roundabout; and
- Several services are located within the current area that would occupy the roundabout.

Recommendation:

The recommendations to consider in further design of the roundabout and for the current conceptual design are as follows:

- Remove the left turn lane on the west approach if unnecessary or provide two lanes through and to the east exit of the roundabout to ensure consistency;
- Ensure the roundabout is adequately designed for U-turns, particularly for large vehicles. Consideration may also be given to providing a two-lane roundabout with the hatching where two lanes are not required (i.e. at the head of the medians) to ensure adequate space;
- Provided facilities for pedestrians and buses. The design team commented during the exit meeting that provision of a bus stop was being considered on Moonshine Road;
- Allow right and through movement from the right lane of the east approach;
- Ensure adequate provision of access for properties within the existing intersection;
- Ensure services adequately protected and maintenance access provided; and
- Ensure adequate deflection to reduce speed of through movement from east to west.

Frequency Rating: *Crashes are likely to be* **Frequent**	***Severity Rating:*** *Death or serious injury is* **Likely**

Designer Response: Accepted - two through lanes will be provided on the west approach and the easternern exit. Hatching will be provided at the head of the medians. The design and size of roundabout has been tracked to ensure adequacy for u turning for large vehicles and deflection.

The eastern approach will be amended to provide for through movements and right turns from the right lane.

Access provision for properties within the intersection will be provided for, following public consultation. Similarly, a bus stop facility on Moonshine Road is being considered to replace the current location on SH58 – this would negate the need for a bus stop either side of SH58 (as well as removing associated pedestrian crossing demand).

Safety Engineer: ***Check that the roundabout operates efficiently and safely. Ie. Sidra model with the increase in u-turn traffic movement.***

Agree with other safety audit team comments.

Client Decision: Agree with SAT. Access to the roundabout should be for SH traffic only and private accesses should be diverted to moonshine road.

Relocation of bus stop to moonshine road is a good idea, to be considered further.

Agree with other Designer & auditor comments.

Action Taken: Bus stop relocation to be reviewed and taking into account vehicle and pedestrian safety as well as turn around facility for bus if required.

Detail design shall reflect on agreed designer, safety engineer and SAT comments.

2.2.18. Access to Golf Course (Stn. 6950) **Significant**

The Judgeford Golf Course, unlike a private access, is a destination that will receive many trips per day. A significant portion of those trips will need to make U-turns on their way to or leaving the destination. This puts additional pressure on the closest intersections in either direction, Moonshine Road and Mulhern Road, and thus additional risk.

Recommendation:

While the roundabout at Moonshine Road should be able to handle these additional trips, the small intersection at Mulhern Road is less equipped. Consideration may be given to providing turn around bays at Mulhern Road.

Frequency Rating: *Crashes are likely to be* **Common**	***Severity Rating:*** *Death or serious injury is* **Likely**
Designer Response: Agreed. Further consideration of access and u-turn facilities will be undertaken after consultation.	
Safety Engineer: ***Agree with auditor.***	
Client Decision: ***Agree with auditor.***	
Action Taken: ***Further consideration for turn-around facility to be made post consultation.***	

2.2.19. Stn. 6960 to Stn. 7260 **Minor**

This stretch of road is has trees and power poles on both sides adjacent to the road. Plans have not indicated whether these trees will be removed thus they pose a hazard to vehicles.

Recommendation:

If the trees are to be removed, then only the power poles require protection. However, consideration of the bordering golf course and associated stray golf balls would then need to be taken. If the trees are to remain, then guardrail protection should be provided.

Frequency Rating: *Crashes are likely to be* **Occassional**	***Severity Rating:*** *Death or serious injury is* **Unlikely**
Designer Response: Agreed. Further consideration will be given to this in conjunction with undergrounding of the power services.	
Safety Engineer: ***Agree with auditor.***	
Client Decision: ***Agree with designer.***	
Action Taken: ***Most appropriate solution to be agreed at detail design stage.***	

2.2.20. Flightys Road and Murphys Road **Significant**

The east and west approaches to Flightys Road and Murphys Road have lengthy right turn bays with the WRB terminating well in advance of the intersection. This is inconsistent with the rest of the project design. In addition, this intersection is the closest turn around opportunity for the businesses to the west that will require areas for their trucks to make U-turns. If they don't make the turn at this intersection they have to travel an additional 4 to 5 kilometres to use the Moonshine Road roundabout as a turnaround point putting additional pressure on this intersection.

Recommendation:

Design WRB and right turn bays to be more consistent with the rest of the project. Ensure adequate space available for U-turning trucks or provide other facilities. The possibility of relocating the intersection of Flightys Road and Murphys Road further east on SH58 is a project that is being considered outside of this commission. The SAT would support that general idea as it would improve sightlines and could be designed effectively for truck movements.

Frequency Rating: *Crashes are likely to be* **Common**	***Severity Rating:*** *Death or serious injury is* **Likely**
Designer Response: In general, movement of this intersection is supported, but we have not seen the latest iteration of this proposal and it was not considered within the scope of this project.	
Safety Engineer:	***Consider at consultation stage.***
Client Decision:	***Consider appropriate turn around option after consultation.***
Action Taken:	***Consider appropriate turn around option after consultation.***

2.2.21. Accesses (Stn. 8740 and Stn. 8880) **Comment**

There are seemingly two accesses to the Rural Service Centre from SH58, one at Stn. 8740 and one at Stn. 8880. Stn. 8880 also provides access to a private residence.

Recommendation:

This new project may provide an opportunity to restructure the accesses to reduce conflict points on the highway.

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: ...Mark Edwards... Date: 18/12/2013
Mark Edwards
Lead Auditor, Opus International Consultants

Signed: .... Date: 18/12/2013
Adam Nicholls
Auditor, Opus International Consultants

Signed: .... Date: 18/12/2013
Ken Holst
Auditor, New Zealand Transport Agency

Designer:	*Name*	*Position* DESIGN TEAM LEADER.
	Signature JAMIE POWALL	*Date* 24/2/14.
Safety Engineer:	*Name*	*Position* SENIOR SAFETY ENGINEER
	Signature SC JAMES	*Date* 21/2/14
Project Manager:	*Name* Wen Wang	*Position* Project Manager
	Signature	*Date* 24/02/14
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: ......

Appendix P Economic Peer Review

Economic Evaluation Peer Review Report

SH58 Safety Improvement SAR

Prepared for the NZ Transport Agency

February 2014

Economic Evaluation Peer Review Report

SH58 Safety Improvement SAR

Prepared for the NZ Transport Agency

February 2014

Prepared By

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Approved for Release By

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Adam Nicholls

QA Status

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Status	Date	Distribution Organisations	Distribution Contact	Details
Draft 2	05/02/2014	NZTA / MWH	Wen.W / Jamie.P	1st Issue of Draft Report
Final Draft	19/02/2014	NZTA/MWH	Wen.W / Jamie.P	2nd Issue of Draft Report
Final	24/02/2014	NZTA/MWH	Wen.W / Jamie.P	Issue of Final Report

Contents

Introduction

The State Highway 58 safety improvement Scheme Assessment Report (SAR) was complete by MWH for the New Zealand Transport Agency. Opus was commissioned to carry out an economic peer review.

The following documentations were provided for the reviewer:

- SH58 Safety Improvement SAR (Nov 2013);
- PDF worksheets for discounting calculation;
- PDF worksheets for Safety benefits calculation;
- PDF worksheets for TTC&VOC benefits calculation; and
- PDF BCR summary worksheets.

The following peer review is split into 6 parts from Section A to Section F. An outline for each section is provided below.

Two email responses (dated on the 12th February and 21st February) have been provided to the reviewer post to the peer review teleconference discussion on the 5th February (see attached response email). Relevant comments have been provided and the methodology of revising the economic assessment has been proposed. The proposed methodology has reduced all the significant concerns from the reviewer. However, assessment revision has not been undertaken at the time of this final review.

1 General Information (Section A)

Application for Funding: (Organisation)	New Zealand Transport Agency
Evaluator(s): (Name and Organisation)	Dhimantha Ranatunga, MWH New Zealand Ltd. Wellington
Evaluation date:	November 2013
Reviewer: (Name and Organisation)	Hailin (Bob) Hu, Opus International Consultants Ltd. Wellington
Project Name:	Contract NZTA 481 PN SH58 Safety Improvement SAR
Problem description:	The SAR has identified that a 10 km section of SH58 between the Pauatahanui roundabout and SH2 at Haywards has experienced a high number of serious and fatal crashes in recent years. The report concludes that the high injury crash risk is mainly caused by the current poor horizontal alignment, the presence of roadside hazards and narrow cross sections. The run off road and head on crashes were identified to be the dominant crash type, which comprised 62% and 8% of the reported crashes in accordingly.
Alternatives and Options considered:	The SAR presented four options over the full length: Option 1, realignment at 4 sites and provision of 1.5m shoulders throughout; Option 2, realignment at 4 sites and provision of 1.5m shoulders throughout with flush median; and Option 3, realignment at 4 sites and provision of 1.5m shoulders throughout with wire rope barriers, and a new roundabout at Moonshine Rd. Option 4, realignment at 3 sites and provision of 1.5m shoulders throughout with wire rope barriers, and a new roundabout at Moonshine Rd. Five other alternatives were also commented on; those were reduce speed limit, reduce the standards for the route, addressing wet weather crashes only, implementing guardrail, and addressing fatal and serious injury crashes only.
Preferred Option:	Option 4 as above
Do Minimum:	As per existing with reduced posted speed limit to 80 km/hr.
Project costs: (Undiscounted construction /	The capital cost of option 4 is estimated to be $31.1M which includes property costs, design costs, construction and MSQA

implementation cost, including escalation, lease and operating costs where applicable.)	costs. The sunk cost has been excluded which aligns with the EEM requirement.
Key project attributes: (e.g. length, accident history, existing and predicted roughness, existing and predicted traffic speed etc.)	Although the SAR identified a 10 km section this has been shortened at the northern end due to the adjacent Transmission Gully project. The preferred option is, therefore, covering a 9 km section of the SH58. The proposed route will have 1.5m shoulders throughout and an additional 2.0m of seal width is provided for the provision of a wire rope median barrier. The three sites that will be realigned are: - Site2, RP58/0/1.128-1.470; - Site3, RP58/0/2.411-3.000; and - Site4, RP58/0/3.376-4.000; The current priority intersection at Moonshine Rd/SH58 is proposed to be roundabout controlled intersection with SH58 WB slip-lane. However, this does not appear in the drawings. AADT 13,600 (2012), 4% HCV, 1.5% growth rate. Peak hours are identified as 7:30-8:30, 11:15-12:15 and 4:45-5:45 for AM, Inter and PM peaks accordingly. Surveyed speed 78-86km/hr (2013). In the last five years from 2008 to 2012, there have been a total of 138 crashes including 2 fatal and 13 serious injury crashes.

2 Conclusions (Section B)

Conformity: (With the Planning, programming and funding manual and the EEM)	The economic evaluation has been undertaken using full procedures. The economic appraisal has been undertaken in accordance with the Transport Agency's Economic Evaluation Manual, where a number of crash reduction factors are adopted from the Transport Agency's High-risk rural roads guide (HRRRG). The following three benefits are captured in the economic assessment: - Travel Time (TT); - VOC and CO2; and - Accident. The general procedure is considered appropriate.
Credibility: (Problem description, results of economic evaluation, costs, key benefits, assumptions, risks)	Problem definition, identification of risks, economic analysis work sheet pdfs and associated drawing are included in the SAR supplied to the reviewer. Analysis presented in SAR included TT savings outside of the realignment sections. These TT savings will not be expected and these should be removed (see 3.4 for details). The crash reduction factor reference should be provided clearly.
Choice of do-minimum:	The assumption of 80 km/hr speed limit under the do minimum scenario and the Method A crash assessment is not considered appropriate, because all the crash history retrieved from CAS is for a 100 km/hr speed limit condition, and the change in speed limit will possibly result in fundamental change in crash behaviour. If an 80 km/hr speed limit is assumed under the do minimum, the crash assessment should be undertaken using Method B in accordance with the EEM. The options should also be assumed as 80km/hr as well, in order to compare like with like. It is understood that the realignment will not have a significant impact on design speed for the full corridor. Where the options/sensitivity tests assumed 100 km/hr speed, these should always compare to a 100 km/hr do-minimum. The SAR was comparing 100 km/hr options with 80 km/hr do-minimum, this is not considered acceptable (see 3.5 for details). In the latest email (21st Feb) MWH proposed to update the economic assessment by assuming both do-minimum and option have the same post speed limit of 80 km/hr as suggested by the reviewer.

<table>
<tr><td></td><td colspan="4">MWH also proposed to apply Method A for the crash analysis, and the crash saving resulted by the speed reduction (i.e. 100 km/hr to 80 km/hr) will be removed from the economic assessment.

The proposed methodology is considered acceptable. However, it has not been undertaken at the time of this final review.</td></tr>
<tr><td>Identification of Options:</td><td colspan="4">The options identified are considered to be logical; however the same speed limit assumed in do minimum should be carried under the options as discussed above.</td></tr>
<tr><td>Economic efficiency evaluation:

(Reviewer's analysis versus evaluator's analysis, incremental analysis – see Sections D and E)</td><td colspan="4">Refer to section D and E.</td></tr>
<tr><td>Sensitivity and risk analysis</td><td colspan="4">Sensitivity analysis has been provided for 8% discount rate and 30 year analysis period, crash reduction level and adjacent scheme (P2G) effects.

Sensitivity test on option 4 with 100 kph should be revised and compared to a do Minimum with 100 kph (see 3.5 for details).

It is also recommended that sensitivity test on a low growth rate (i.e. benefits capping to 2031) should be carried out (see 3.8 for details).

Sensitivity tests suggested by reviewer have been carried out. From these tests, the BCR is still above 1.0, meaning economic viable.</td></tr>
<tr><td rowspan="4">Assessment profile:

(Reviewer's profile versus evaluator's profile)</td><td colspan="2">Evaluator's Profile</td><td colspan="2">Reviewer's Profile</td></tr>
<tr><td>Strategic Fit:</td><td>H</td><td>Strategic Fit:</td><td>H</td></tr>
<tr><td>Effectiveness:</td><td>M</td><td>Effectiveness:</td><td>M</td></tr>
<tr><td>Economic Efficiency:</td><td>tba</td><td>Economic Efficiency:</td><td>L</td></tr>
<tr><td>Reviewer's comments:</td><td colspan="4">As discussed above, the TT dis-benefits are expected to be increased by correcting TT saving sections and applying same speed limit between both do minimum and option; the crash benefit are expected to be decreased by adopting the appropriate method. Therefore, the BCR is expected to drop below 2.0 (i.e. economic efficiency is Low).

Based on the assessment profile HML, the priority order of the project is estimated to be 5 according to the Transport Agency's Planning and Investment Knowledge Base.</td></tr>
<tr><td>Funding applicant's</td><td colspan="4"></td></tr>
</table>

response: (Answers to discrepancies, departures from procedure and reviewer's concerns)	

3 Reviewer's recommendations (Section C)

3.1	Provide explanation on why the estimated design speed at site 1 is 10 kph slower than site 2, where the surveyed data suggests vehicles are actually travelling faster at site 1? (refer SAR Table 4-4) The poor validation of travel time estimation has the potential to impact on the TT saving estimation on the realignment sites. Comments on estimated design speed are provided to the reviewer, and they are considered to be appropriate.
3.2	The validation / calibration information for the SIDRA modelling should be provided to ensure the robustness of the TT and VOC benefits/dis-benefits' prediction. SIDAR modelling information is provided to the reviewer, and they are considered to be appropriate.
3.3	The exact date of the crash data retrieved should be provided. Provided and concern addressed.
3.4	The realignment has been proposed for sites 2, 3 and 4 only (i.e. less than 2 km), however the SAR has claimed TT savings over the full route (i.e. 9 km), this is considered not appropriate. This should be revised by only including the realignment sites' TT savings (site 2, 3 and 4). MWH proposed to update the economic assessment by assuming both do-minimum and option have the same post speed of 80 km/hr. This proposed methodology is considered appropriate to address the concern. However, the proposed assessment has not been undertaken at the time of this final review.
3.5	The speed limit assumption on the do minimum is considered not appropriate, it is recommended that the following two assessments be carried out: a. Assume both do minimum and option have 100 km/hr speed limit, assess crash benefits using Method A of EEM, and revise TT, VOC benefits/dis-benefits; or b. Assume both do minimum and option have 80 km/hr speed limit, assess crash benefits using Method B of EEM, and revise TT, VOC benefits / dis-benefits. Obtain written agreement with the client on which of the above (a or b) should be the base estimate, and therefore the other one would be a sensitivity test for reporting. In the latest email (21st Feb) MWH proposed to update the economic assessment by assuming both do-minimum and option have the same post speed limit of 80 km/hr as suggested by the reviewer. MWH also proposed to apply Method A for the crash analysis, and the crash saving resulted by the speed reduction (i.e. 100 km/hr to 80 km/hr) will be removed from the economic assessment.

	The proposed methodology is considered acceptable. However, it has not been undertaken at the time of this final review.
3.6	PHFs are estimated based on 2009 traffic counts, the methodology is considered appropriate. However, due to the high growth rate assumed, providing comment or sensitivity test on the possible future peak spreading scenario will be valuable. Comments provided and concern addressed.
3.7	Provide comments on how the recent/planned works are included/excluded in the current scheme, and the impacts of it. Comments provided and concern addressed.
3.8	It is considered appropriate to assume the growth rate of 1.5% for the current site due to the potential growth associated with the adjacent projects (i.e. TG and P2G). However, it would be valuable to provide a sensitivity test on a low growth rate scenario, such as capping the benefits to 2031 level. Sensitivity test has been carried out as per reviewer's suggestion, concern addressed.

4 Evaluator's economic efficiency analysis (Section D)

Transport Economics Analysis Summary

Option 4 (80 kph, Median crash reduction, 40yr 6%, with P2G)

	Do Minimum	Option
Total PV Costs	**$1,628,437**	**$32,247,532**
Travel Time Benefits		-$7,630,337
Vehicle Operating Benefits		$895,542
Accidents		$67,037,003
Tangible Benefits		**$60,302,208**
Tangible B/C Ratio		2.0

5 Reviewer's economic efficiency analysis (Section E)

A full re-evaluation has not been undertaken.

However, as discussed above, the TT dis-benefits are expected to be increased by correcting TT saving sections and applying same speed limit between both do minimum and option; the crash benefit are expected to be decreased by adopting the appropriate method.

Therefore, the BCR is expected to drop below 2.0 (i.e. economic efficiency is Low).

6 Reviewer's comments on differences (Section F)

6.1 Benefits

6.1.1 Crash benefits

Discussion:

a. The exact date of the crash data retrieved should be provided;

b. The assumption of 80 km/hr speed limit under do minimum scenario and Method A crash assessment is not considered appropriate. Because all the crash history retrieved from CAS is for the 100 km/hr speed limit condition, the change in speed limit will possibly result in fundamental change in crash behaviour. Therefore, assuming 80 km/hr speed limit under do minimum, the crash history will not be appropriate for analysis, and the crash assessment should be undertaking using Method B in accordance with the EEM (A6.2). The alternative is to assume 100 km/hr for do minimum and apply Method A for crash assessment.

c. When using Method A, applying the combination of EEM and HRRRG crash reduction factors is considered appropriate; and

d. Please confirm if the correct accident trends adjustment factors (EEM table A6.1(a)) and traffic growth rate adjustment factors (EEM table A6.1(b)) are applied, as there is no evidence supporting these in the information provided.

Significance of issue: was Significant, reduced to Moderate (following evaluator's response below)

Evaluator response:

Comments provided, concerns relating to a, b and d above are addressed.

MWH proposed to update the economic assessment by assuming both do-minimum and option have the same post speed limit of 80 km/hr as suggested by the reviewer.

MWH also proposed to use Method A for the crash analysis, and any crash saving resulted by the speed reduction (i.e. 100 km/hr to 80 km/hr) will be removed from the economic assessment.

The proposed methodology is considered acceptable. However, it has not been undertaken at the time of this final review.

In addition, the evaluator (MWH) commented the speed reduction will reduce the fatal crashes by 22% but in doing so will still not cause a fundamental change to accident severity. Within the EEM, there is no clear instruction of how much reduction will be counted as a "fundamental change" on accident severity. In order to understand the risk, a sensitivity test assuming it will result in a "fundamental change" by applying Method B is recommended.

6.1.2 Travel Time benefits and VOC benefits

Discussion:

Three TT benefit components have been included,

- TT dis-benefits on SH58/Moonshine Rd intersection improvement;
- TT benefits on curve realignments; and
- TT dis-benefits caused by Wire Rope Barrier.

a. Worksheets (WSA4.1) provided suggests the TT saving on curve realignments is claimed for the total route (9km with 67.2 seconds saving), which is considered inappropriate. Since the realignments are only proposed for three sites, the TT savings on the three sites (1.5km with 6.4 seconds saving) should be claimed only;

b. Travel time estimation model and SIDRA model validation / calibration results should be provided to ensure the robustness of the TT and VOC benefits / dis-benefits' prediction;

c. Same speed limit should be assumed for both do minimum and option, TT / VOC benefits resulted by speed limit increase should not be included in this project's benefits.

Significance of issue: was Significant, reduced to Moderate (following evaluator's response below)

Evaluator response:

Comment provided, and the proposed assessment methodology will address the concerns, however, it has not been undertaken at the time of this final review. So the results cannot be commented on.

6.2 Costs

6.2.1 Cost Estimates

Discussion:

A review of the capital cost estimates has not been undertaken as part of this economic peer review. The risk of cost uncertainties will lie with the Road Controlling Authority.

6.2.2 Other costs

Discussion:

The EEM requires construction effects to be included if these comprise >10% of the benefits. Please provide comment on the likely implication of construction dis-benefits.

Significance of issue: was Minor, reduced to No

Evaluator response: comments provided, concern addressed.

6.3 Assumptions and Results

6.3.1 Update factors

Discussion:

Update factors to adjust to July 2013 is appropriately adopted.

However, some of the calculation spreadsheets provided still have July 2012 update factors (i.e. Option 4_with p2g_3_58_TTC_VOC_Ben2013_SIDRAver1l_4.pdf). Please check if these are carried to the final worksheets or not.

Significance of issue: was Minor, reduced to No

Evaluator response: concern addressed

6.3.2 Value of time, VOC and CO2

Discussion:

The values applied for the economics assessment are considered appropriate.

Significance of issue: Comment only

Evaluator response: na

6.3.3 Discounting

Discussion:

Using 40 year analysis period and 6% discount rate are considered appropriate.

Significance of issue: Comment only

Evaluator response: na

6.3.4 FYRR

Discussion:

Based on the BCR of 2.0, the target FYRR will be 13%. The current 8% FYRR suggests the current year is not the optimised date to precede the project.

Significance of issue: Comment only

Evaluator response: na

6.3.5 BCR and Sensitivity test

Discussion:

The BCR should be revised base on the comments above.

Significance of issue: Significant

Evaluator response: na

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(Bob) Hailin Hu

From: Adam Nicholls
Sent: Wednesday, 12 February 2014 11:20
To: (Bob) Hailin Hu
Subject: FW: SH58 Economics Peer Review Response

Adam Nicholls | Work Group Manager - Project Delivery | Opus International Consultants Ltd
Phone +64 4 471 7059 | Mobile +64 27 266 8620 | Fax +64 4 471 1397 | Email Adam.Nicholls@opus.co.nz
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From: Jamie Povall [mailto:Jamie.J.Povall@mwhglobal.com]
Sent: Wednesday, 12 February 2014 10:44 a.m.
To: Adam Nicholls
Subject: SH58 Economics Peer Review Response

Hi Adam,

Please find our response to the Economics Peer Review Recommendations below (as agreed in our conference call):

Responses in blue to the Section C (Reviewer's Recommendations).

3.1 Provide explanation on why the estimated design speed at site 1 is 10 kph slower than site 2, where the surveyed data suggests vehicles are actually travelling faster at site 1? (refer SAR Table 4-4)
The poor validation of travel time estimation has the potential to impact on the TT saving estimation on the realignment sites.

The existing design speed estimates were based on current geometry and LIDAR (with limited ground based topographical survey) with a number of sites containing multiple curves – therefore the results are only approximate.
We would be willing to use the higher survey speed as a sensitivity however there is no need as Site 1 is no longer in the preferred option.
Of the four surveyed sites, only Site 1 had a difference between the design speed and car following survey of more than 2 km/h, therefore the validation for the Option 4 realignment sites is quite good.

3.2 The validation / calibration information for the SIDRA modelling should be provided to ensure the robustness of the TT and VOC benefits/dis-benefits' prediction.

Existing survey information from 2009 (AM, IP and PM) and 2012 (PM delay survey) was used in the development of the SIDRA models. This was supplemented by TMS data and SH58 P2G SATURN modelling results. No survey was undertaken as part of this project.

The existing T intersection was modelled and calibrated/validated based on the following:

- Aerial photography and high speed video to determine the lane geometry and turn bay lengths.

- A short 10m turn bay was modelled on the Moonshine approach to reflect actual driver behaviour, similarly a short left turn bay was modelled for Sh58 traffic turning into Moonshine Road based on aerial photography and driver behaviour.
- Vehicle movement data - negotiation radii for both the left turn out of Moonshine Road and the left turn into Moonshine Road were set as 15 m and 30 m respectively.
- SIDRA critical gaps - based on a PM peak delay survey undertaken in 2012 and adjusted to fit observed queuing on Moonshine Hill from site visits (interpeak queue <1, peak periods 95%ile queue ~1 based on delay survey) and average delay.
- AM&PM = 3.75s Rout,4.75s Lout, 5.25s right in. IP 4.25s Rout, 4.75s Lout, 5.25
- Follow up headway was assumed as 60% of the critical gap.
- The SIDRA 95% back of queue was 0.7 in the AM peak, 0.1 in the IP and 0.4 in the PM peak. This approximately matches the observed queuing of less than 1 vehicle in the IP and 1 vehicle in the peak period. Due to the low queuing on Moonshine Road it is difficult to achieve a very close validation. However, the purpose of the model was to determine the performance of the roundabout when compared to the existing, low delay, T junction.
- Exiting flow effect out of Moonshine Road = 50%/50%, with minimum departures set a 1 veh/min.

The Roundabout was modelled and calibrated based on the following:
The option modelled was a three leg, 32m central diameter roundabout; parameters including the circulating lane width (7m), entry angle, entry radii and turning radii (for the left turn into and left turn out of Moonshine Hill Road) were adjusted to reflect the option CAD model/drawings. An environment factor of 1.0 was applied to all three approaches, with a medium entry/circulating flow adjustment.

3.3 The exact date of the crash data retrieved should be provided.

27th August 2013 as shown in the coded crash listing (Appendix C). However, the 5-year crash period was taken as Jan 2008 to Dec 2012 due to the lag effects of recent crashes appearing on CAS.

In addition, following the recent October 31st 2013 fatal crash on SH58, the crash history was reviewed to gauge the effect of updating the five-year period from 2008-2012 to 2009-2013, noting that 2013 was an incomplete year. However, 2008 contained two serious crashes which would be lost at the gain of one fatal crash, with minor injury crashes and non-injury crashes remaining fairly similar. The net effect, due to the EEM's fatal/serious split was not very high, but still significant, in the range of approximately 5-10% higher annual crash cost (2009-2013). However, the NZTA has decided not to progress with this update at the time.

3.4 The realignment has been proposed for sites 2, 3 and 4 only (i.e. less than 2 km), however the SAR has claimed TT savings over the full route (i.e. 9 km), this is considered not appropriate. This should be revised by only including the realignment sites' TT savings (site 2, 3 and 4).

The original evaluation (Option 1-3) was conducted with the travel time savings based only at the realignment sites. This was based on the realignment route shortening and increased curve negotiation speed with both the Do-Minimum and option at a 100km/h posted speed limit.

As part of the work undertaken with Option 4, the client requested that the Do-Minimum be changed to 80 km/h, therefore the benefits have been claimed over the full route due to the differences in speed between the Do-Minimum and the Option. This ties into point 3.5 below over the Do-Minimum and Option speed selection.

3.5 The speed limit assumption on do minimum is considered not appropriate, it is recommended that the following two assessments should be carried out:
a. Assume both do minimum and option have 100 km/hr speed limit, assess crash benefits using Method A of EEM, and revise TT, VOC benefits/dis-benefits; and
b. Assume both do minimum and option have 80 km/hr speed limit, assess crash benefits using Method B of EEM, and revise TT, VOC benefits / dis-benefits.
Obtain written agreement with the client on which of the above (a or b) should be the base estimate, and therefore the other one would be a sensitivity test for reporting.

Agree with the comments. As noted in 3.4 above, the original economic evaluation was done for the do-minimum and option at a 100 km/h posted speed limit with Method A Crash analysis. The client then requested the do-minimum be changed to 80 km/h which required the original evaluation to be adapted as follows:

- Use of HRRRG to alter the Do-Minimum crash cost to account for the likely change with a lower speed limit (Methodology outlined in Section 11.2.4, pg 61)
- Use of 80km/h EEM crash costs for existing crashes
- Travel time savings based on the curve realignment and difference in Do-Minimum and Option speed.

3.6 PHFs are estimated based on 2009 traffic counts, the methodology is considered appropriate. However, due to the high growth rate assumed, providing comment or sensitivity test on the possible future peak spreading scenario will be valuable.

Agreed, will provide comment in the report on future peak spreading.

3.7 Provide comments on how the recent/planned works are included/excluded in the current scheme, and the impacts of it.

Recent and committed guardrail projects and existing centreline ATP present on sections of the route were accounted for as outlined below to avoid double counting of benefits.

- The crash reduction factors from guardrail (affecting loss of control crashes) was factored down based on the length of recent/committed and length of proposed guardrail.
- Similarity, the crash reduction factors from centreline ATP was factored down based on the existing 1.7km of C/L ATP and the length of proposed C/L ATP.

Other projects such as Transmission Gully and Petone to Grenada have been accounted for in the modelling and scenario testing.

3.8 It is considered appropriate to assume the growth rate of 1.5% for the current site due to the potential growth associated with the adjacent projects (i.e. TG and P2G). However, it would be valuable to provide a sensitivity test on a low growth rate scenario, such as capping the benefits to 2031 level.

A flat growth rate of 1.5% was not applied; rather two scenarios were tested. 0.5% growth from time zero to 2021 (TG completion and Petone to Grenada), where a step change in traffic would occur based on Opus P2G modelling results. The Growth rate from the supplied modelling years 2021 and 2031 (approx. 1.5%) was then carried forward for the analysis period. The second scenario assumed that only TG would be built in 2021. Impacts from a low growth scenario have been examined as part of the original evaluation (Options 1-3), which showed that the BCR of Option 3 dropped from 1.3 (1.5% growth) to 1.1 (0.5% growth).

Cheers,

Jamie

(Bob) Hailin Hu

From: Jamie Povall <Jamie.J.Povall@mwhglobal.com>
Sent: Friday, 21 February 2014 15:20
To: (Bob) Hailin Hu
Cc: Wen.Wang@nzta.govt.nz
Subject: FW: SH58 Economic Peer Review

Hi Bob / Wen, see below:

Hope this clarifies.

Thanks

Jamie

- The economic assessment will be updated assuming both Do-Minimum and Option have the same post speed of 80 km/hr, correct?; Yes
- Method A will be used for the crash analysis, and the crash saving resulted by the speed reduction (100km/hr to 80km/hr) will be removed from the economic assessment of the current project, correct?; Yes
- What is resulted BCR? And Unknown at this stage – change not yet undertaken.
- "The change in speed limit (100 km/hr to 80 km/hr) is not considered as a fundamental change, but it results in 22% reduction to fatal crashes, 16% reduction in serious crashes and 9% reduction in minor and non-injuries crashes", is this statement contradictory? No it is not contradictory. The change is speed is not considered a fundamental change to the site (ref. page 5-286 of the EEM 'fundamental change in a site'). It is considered that with a 6% drop in mean speed (~90km/h ->85 km/h) as a result of the 20km/h drop in posted speed limit, the types of crashes and the level of crash severity are not expected to change significantly.

From: Wen Wang [mailto:Wen.Wang@nzta.govt.nz]
Sent: Friday, 21 February 2014 1:33 p.m.
To: Jamie Povall
Subject: FW: SH58 Economic Peer Review

Jamie, can you please reply to Bob when you can and 'cc me in?

Thanks

Wen

From: (Bob) Hailin Hu [mailto:hailin.hu@opus.co.nz]
Sent: Friday, 21 February 2014 1:21 p.m.
To: Wen Wang
Cc: Ulvi Salayev; Caron Greenough; Steve James; Adam Nicholls
Subject: RE: SH58 Economic Peer Review

Hi Wen,

Thank you for the feedback.

Could you clarify / confirm the following points please?

- The economic assessment will be updated assuming both Do-Minimum and Option have the same post speed of 80 km/hr, correct?; Yes
- Method A will be used for the crash analysis, and the crash saving resulted by the speed reduction (100km/hr to 80km/hr) will be removed from the economic assessment of the current project, correct?; Yes
- What is resulted BCR? And Unknown at this stage – change not yet undertaken
- "The change in speed limit (100 km/hr to 80 km/hr) is not considered as a fundamental change, but it results in 22% reduction to fatal crashes, 16% reduction in serious crashes and 9% reduction in minor and non-injuries crashes", is this statement contradictory? No it is not contradictory. The change is speed is not considered a fundamental change to the site.

Depending on responses to the above questions, we can finalise the peer review.

Please feel free to contact me directly for any discussions in regarding to this.

Regards

Bob

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From: Wen Wang [mailto:Wen.Wang@nzta.govt.nz]
Sent: Friday, 21 February 2014 11:24
To: Adam Nicholls
Cc: (Bob) Hailin Hu; Ulvi Salayev; Caron Greenough; Steve James
Subject: RE: SH58 Economic Peer Review

Hello Adam,

MWH's comments are as below. I hope they are sufficient to tie up the economics review? Can we get the economics report updated and sent through by the end of today? We are getting a little tight for time on this end.

Thanks

Wen

As we have now agreed to adopt a Do-Minimum at 80km/h and the Option also at 80km/h, the travel time savings due to the speed differential between the Do-Minimum and the option is negated. Therefore Reviewer's recommendation point 3.4 regarding travel time savings outside of the realignment has been addressed.

Regarding recommendation 3.5, the peer review has agreed that the option does not result in fundamental change (see point 3.5a, with both options at 100km/h allowing use of Method A).

The issue is with the Do-Minimum at 80 km/h and the existing crash history at 100 km/h with the "change in speed limit will possibility result in a fundamental change in crash behaviour".

We agree that using the 100 km/h crash history for an 80 km/h Do-Minimum is not appropriate and propose the following (similar to what was done for the Do-Minimum at 80km/h and the Option at 100km/h):

- Apply the NZTA's High Risk Rural Guide (HRRRG) method to reduce the existing (100km/h) crash history to if it had been at 80 km/h (i.e. 100-->80km/h results in 22% reduction to fatal crashes, 16% reduction in serious crash and 9% reduction in minor and non-injuries crashes.). Refer attached spreadsheet for the methodology.
- These reductions will apply to the 5 year crash history at 100 km/h. Method A, using this modified crash history, can then be applied for the Do-Minimum and Option using an 80 km/h EEM crash cost. This is preferred to a Method B approach which will not allow use of the existing crash history.
- Due to the type of treatments proposed, namely the provision of wire rope barrier and guardrail, which reduce the severity of crashes, method A is preferred over method B.

We do not agree that the change in posted speed limit from 100 km/h to 80 km/h will result in fundamental change for the following reasons:

- The mean speed along SH58 is already below the 100 km/h posted speed limit– at approximately 90 km/h, due to the topography and highway alignment.
- As a result, reducing the posted speed limit by 20km/h will not reduce the mean speed by the same amount. According to the HRRRG Relationship between change in speed limit and change in mean speed (Figure D-1), a 20 km/h reduction in posted speed limit results in an approximately 6% reduction in mean speed (refer attached).
- As this speed change will likely only involve signage and no other improvements, it is therefore unlikely that this reduction in mean speed will cause a fundamental change in crashes along SH58.

From: Adam Nicholls [mailto:adam.nicholls@opus.co.nz]
Sent: Wednesday, 19 February 2014 3:35 p.m.
To: Wen Wang
Cc: (Bob) Hailin Hu
Subject: RE: SH58 Economic Peer Review

Wen

Please find attached a copy of the report as requested. We have kept it as a draft are there are a couple of issues that remain to be addressed by the MWH. Let us know if you want this version issued as final.

Cheers

Adam

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From: Wen Wang [mailto:Wen.Wang@nzta.govt.nz]
Sent: Wednesday, 19 February 2014 12:19 p.m.
To: Adam Nicholls
Subject: RE: SH58 Economic Peer Review

Hi Adam,

Can you confirm where we are with this item?

Thanks

Wen

From: Adam Nicholls [mailto:adam.nicholls@opus.co.nz]
Sent: Wednesday, 12 February 2014 11:47 a.m.
To: Wen Wang
Cc: (Bob) Hailin Hu
Subject: SH58 Economic Peer Review

Wen

We have just received comments back on the Economic Peer Review that we shared with mwh. We will need to revise our report accordingly and this will be done on Friday. I will try and review it over the weekend.

Cheers

Adam

OPUS

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