Contract No. TNZ 2/03-011/501

Hillcrest & Morrinsville Road Intersection Improvements

Scheme Assessment Report

Prepared for:

TRANSIT NEW ZEALAND
ARARAU AOTEAROA

Prepared by:

Resolve
GROUP

Every attempt has been made to ensure that the information in this document is correct at the time of publication. Any errors should be reported as soon as possible so that corrections can be issued. Comments and suggestions for future editions are welcomed.

Quality Assurance

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Reviewed by			
Approved by	Martin Leak		

Revision History

Revision	Date	Prepared By	Authorised By	Description
R1	08/2004	Dominic Giroux	Martin Leak	Final for peer review
R2	07/2005	Dominic Giroux	Martin Leak	Revised after peer review
R	11/2007	Penny Wang Tony Fong Hanford Cheung	Martin Leak	Draft revised to include re-assessment of Signalisation option as requested by the Client

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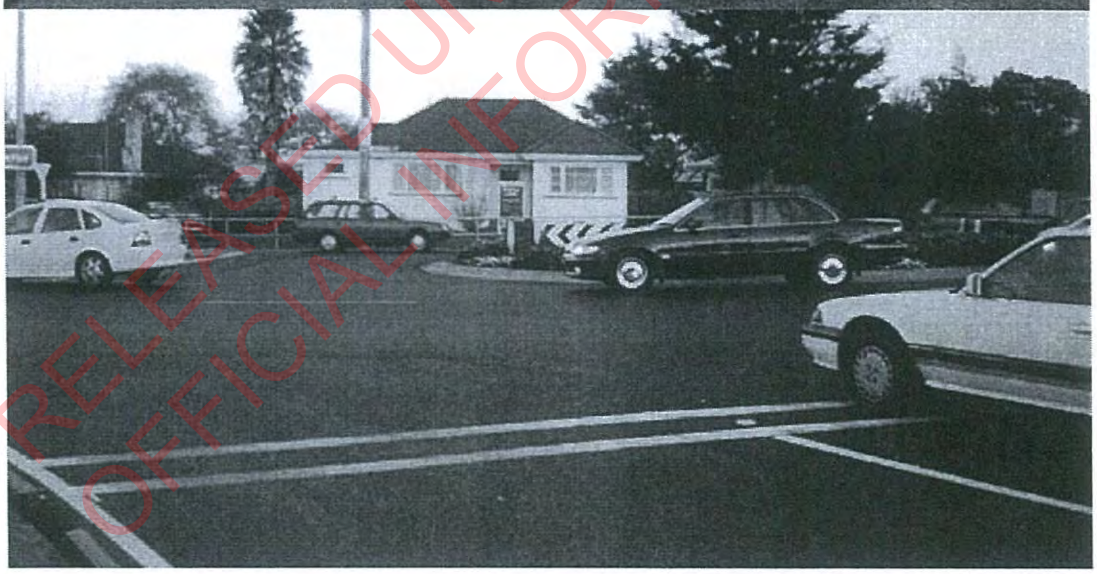

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R4	02/2008	Penny Tony Fong Hanford Cheung	Martin Leak	Final Draft for Client review

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EXECUTIVE SUMMARY

Resolve Group was commissioned by Transit New Zealand to produce a Scheme Assessment Report, the definitive document in the Investigation & Reporting Phase for the upgrade of two intersections of State Highway 1 (SH1) within Hamilton City Council's urban area. The two intersections concerned are generally referred to as the Hillcrest and Morrinsville intersections. The purpose of this report is to precisely define the problems and recommend a preferred solution that meets current Client policy, standards and guidelines to maximise the safe and efficient operation of the highway.

The recommendations contained in the SAR are consistent with Transit's Mission, "To plan, develop and maintain the State Highway system in a way that contributes to an integrated, safe, responsive and sustainable land transport system for New Zealand."

Problems associated with the Hillcrest intersection include:

- Turning movement accidents, particularly with vehicles travelling south on Cambridge Road.
- High queuing delays to southbound traffic flows on SH1, specifically during afternoon peak periods.
- High queuing delays to Cambridge Road traffic flows turning left onto SH1, especially during morning peak periods.

Problems associated with the Morrinsville intersection include:

- Crossing and turning crashes, particularly with vehicles travelling north on Cambridge Road.
- Conflicting turning movements, associated with the 4th leg layout and U-turners from the south.
- A high queuing delay to both northbound and southbound traffic flows on Cambridge Road, especially during peak periods.

The modelling shows that strong traffic growth will occur over the next seventeen years. There is an increase in projected traffic of about 10% at the Hillcrest intersection, and about 15% at the Morrinsville intersection from 2001 to 2011, and from 2012 to 2021 in the case that the Hamilton bypass is not built. The latter increase does not occur if there is a bypass – the predicted traffic volumes being similar to those in 2011 for both intersections.

The 2 ½ Lane Roundabout and Signalisation options were investigated and reported on. This study include peak hour traffic surveys, SIDRA analysis of the existing environment, TRACKS modelling of flows on the roading network, traffic microsimulations using Paramics, an initial assessment of environmental effects, geotechnical constraints, and an economic assessment in accordance with the latest Economic Evaluation Manual.

Previously Assessed Options

Previous studies raised a number of potential treatment options which were assessed against their performance with respect to the project objectives. Grade-separated options were deemed unsuitable due to substandard alignments that would require substantial land purchases, high construction costs and incompatibility with adjacent at-grade intersections. Two-lane roundabouts were considered inappropriate due to the limited capacity improvement over the existing situation. Three-lane roundabouts were considered inappropriate due to the increased opportunity for vehicle conflict between lanes, incompatibility with cyclists, and greater land purchase requirements.

Options Development

The options are influenced by the need for capacity improvement and accident reduction, the consideration of the needs of all road users, maintaining a balance between through traffic and local traffic needs, constructability of the layout and minimisation of traffic disruption, the retention of the good safety and operational feature of a continuous physical median connecting the two roundabouts, and the minimisation of property acquisitions.

Option 1 – 2 ½ lane roundabouts

The proposed 2½ lane roundabouts operate within the existing road alignment and require minimal land acquisition to achieve significant gains in safety and capacity benefits.

In general, the features of the proposed design include additional approach lanes at all but one major approach, modifications to approach geometry including traffic islands, central rotary islands and medians, altered crossing positions to allow for pedestrians to cross between stopped traffic, and the addition of cycle lanes and dual-use footpaths in several locations. Stairwell access to the south side of Morrinsville underpass is also included.

At Hillcrest intersection, specific features of the roundabout include the provision of underground ducting to allow for future installation of roundabout signal metering. This will provide the means to improve capacity and operation in the future as traffic volumes increase. At Morrinsville intersection, the lay-by parking area to the northwest of the intersection is changed to angle parking. There will also be small changes to the existing road designation to accommodate the additional slip lanes and the larger overall footprint of the intersection layout.

The option to close the shopping complex leg was discarded due to the fact that it was not considered necessary and was confirmed through traffic modelling exercises.

Option 2 - Signalisation

The proposed signalised intersections operate more or less within the existing road alignment and require slightly more land acquisition to achieve gains in safety and capacity benefits.

In general, the signalisation option involves the introduction of new right turn lanes and left turn slip lanes from SH1. The right turn lanes and queue stacking lengths are required to maintain satisfactory operations of the upstream intersections.

At Hillcrest intersection, specific features of the intersection include the provision of two right turn lanes with approximately 100 metres of stacking length each. At Morrinsville intersection, specific features of the intersection include the provision of a right turn lane into the shopping complex, and two right turn lanes with approximately 40 metres of stacking length each. Alterations to the kerb lines and islands are proposed for both intersections.

Signalisation Sub-Option

A signalisation sub-option was investigated, the sub-option is based on Option 2, with Morrinsville intersection's shopping complex leg closed, converting the intersection to a 3-leg signalised intersection. The sub-option performs slightly better than the main signalisation option, however it also reduced performance of one of the major movements.

Geotechnical Investigation
Geotechnical investigations revealed that the pavements in the area consist of a sand 'subbase' with some gravels, topped by a heavily cement stablised basecourse which varies in thickness, and overlain by asphaltic concrete (AC). Subgrade strengths were found to be low.

The existing pavement will be overlaid with a 75mm thick AC running surface, tapering and cut into existing AC pavement as necessary to match the existing drainage.

AC asphalt overlay was selected for the pavement design due to its speed of application and ability to be trafficked soon after placement. One of the advantages of such treatment is its minimal effect on local traffic. It is thought that new pavement in areas of widening will be rigid design to broadly match the expected deflection characteristics of the overlaid existing pavement above. Use of geotextile is proposed to mitigate the effects of slab cracking. Where appropriate, it may be possible to build up the new concrete/AC pavement on the old stabilised basecourse layer without the need for excavation.

Economics Evaluation
Roundabouts
The economics evaluation demonstrated that significant travel time savings and vehicle operating costs savings can be attained through implementation of the 2½ lane roundabout improvements at both the Hillcrest and Morrinsville intersections, thus improving the overall efficiency & trip reliability in the area. This is consistent with the project objectives as per the RFT. In addition, the capital cost is significant lower than for signalisation. Furthermore, the option of adding signal metering in the future presents an opportunity to add capacity to deal with traffic growth in the longer term.

The 2½ lane roundabout improvement option is likely to reduce the number of crashes at both intersections and produce accident cost savings.

Provisions for cyclists and pedestrians have been made for this option. The costs of the facilities have been included in the economic analysis, but the assessed benefits are not included in the economic analysis due to the difficulties in accurately assessing the level of walking and cycling demand. A slightly higher BCR can be obtained if these benefits are included in the economic analysis.

The assessed BCR is 3.9 and the FYRR is 15%.

Traffic Signals
The traffic modelling results of the signalisation options demonstrated that the options do not produce any travel time, vehicle operating and accident cost savings. The model indicated that signalisation will increase travel time and delay at the intersections compared with the existing situation, particularly during the interpeak period. The negative costs savings resulted in negative BCR's for these options.

The assessed BCR is -6.3 for the signalisation option, and -4.6 for the modified signalisation option.

Despite the negative BCR's, the signalisation options enable Transit to actively management traffic at the intersections. This strategic benefit needs to be taken into account for determining the preferred option.

Favoured Option
Although the signalisation options enable Transit to fulfil Land Transport Management Act's requirements of ensuring the sustainability of the State Highway, the additional delay imposed on the travelling public is considered to high.

Therefore, it is recommended Transit proceed with the detailed design of the roundabout option.

Options Summary

	Options		
	2 ½ Lane Roundabout	**Signalisation**	**Signalisation (Modified Sub-option with closure of shopping complex leg of Morrinsville Intersection**
Description	Upgrade existing roundabouts at Hillcrest and Morrinsville intersections to 2 ½ Lane Roundabouts with reconfigured approaches and larger centre islands	Change the current roundabout controlled intersections to signalised intersections, which involves the widening of the approaches to provide additional queue stacking lengths.	Change the current roundabout controlled intersections to signalised intersections, which involves the widening of the approaches to provide additional queue stacking lengths
Assessed Benefits in accordance with Economics Evaluation Manual	13,875,000	-26,897,000	-19,727,000
Physical Works Cost Expected Estimate	3,678,113	4,718,985	4,718,985
Benefit Cost Ratio	3.9	- 6.3	- 4.6
Advantages	• improves capacity and operation of the existing roundabouts • minimal maintenance cost increase compared with the existing roundabouts • design form is consistent with the existing roundabouts • less environmental impact than other improvement options, i.e. • when compared with traffic signals, a roundabout produces less light pollution, requires less energy to run • when compared with grade separation, a roundabout does not involve the construction of major structures and hence requires less resources to construct • lower initial capital cost, lower ongoing operating and maintenance costs than other forms of intersection improvement, e.g. grade separation, traffic signals • the 2 ½ lane roundabouts option enables safe u-turn movements to be made for locals wishing to access the school on the southern side of the State Highway between the two intersections • the option requires less queue stacking lengths than signalisation	• improves capacity and operation of the existing roundabouts • traffic signals enable the active management of travel demands and priority can be given to through movement on State Highway 1 • signals allow better provisions for cyclists and pedestrians than at roundabouts; signals are generally safer for cyclists and pedestrians than roundabouts	• All benefits of the main signalisation option plus slightly better performance
Disadvantages	• Provision for cyclists and pedestrians is not as straight forward as making such provision at a signalised intersection • Without roundabout metering, roundabout does not allow prioritisation of the through traffic on State Highway 1, i.e. active management of travel demand, the priority is shared with traffic from local roads and State Highway 26 • The traffic growth at the project site is relatively high, which means the safety benefits obtained may diminish during times of high traffic flows	• signalisation option has higher capital and maintenance costs than roundabouts option • the signalisation option does not safely allow u-turns to be made at the two intersections, traffic wishing to access the school on the southern side of the State Highway will be required to perform U-turn elsewhere on the network. • the stakeholders were not previously consulted on the signalisation option, therefore the consultation process will need to be recommenced and the change in project direction will need to be conveyed to the public • the signalisation options will increase the average delay during off-peak and interpeak, therefore increasing the vehicle operation and travel time costs of the travelling public • traffic signal is not the most common form of intersection control in the project area, therefore it is likely that the delays imposed on the travelling public will cause public criticism • the signalisation of McCracken Avenue is considered necessary to enable successful implementation of the signalisation option overall • The signalisation options imposes similar amount of delay onto motorists, with the three-leg sub-option imposes slightly less delay during	

Options Summary			
	Options		
	2 ½ Lane Roundabout	Signalisation	Signalisation (Modified Sub-option with closure of shopping complex leg of Morrinsville Intersection
		pm-peak and inter-peak than the four-leg option. On the other hand, the three-leg sub-option imposes more delay during am-peak than the four-leg option. • The signalisation options impose very significant delay compared with the roundabout option. Based on the SIDRA outputs, the signalisation options are likely to impose delay three times that of the roundabout option in most situations. • Even though highly co-ordinated traffic signals may be more efficient than roundabouts along a heavily trafficked corridor with minor crossing traffic, the traffic profile at the two intersections investigate favours roundabout, in terms of both delay and degree of saturation.	
Preferred Option	Although the signalisation options enable Transit to fulfil Land Transport Management Act's requirements of ensuring the sustainability of the State Highway, the additional delay imposed on the travelling public is considered to high. Therefore, it is recommended Transit proceed with the detailed design of the roundabout option.		

1. INTRODUCTION

1.1 Background

The subject of this project is two adjacent intersections together with approximately 310 metres of State Highway 1 in eastern urban Hamilton:

- SH1 Cobham Drive and Cambridge Road Roundabout, hereafter referred to as the Hillcrest intersection.

- SH1/SH26 Morrinsville Road Roundabout, hereafter referred to as the Morrinsville intersection.

Figure 1 Aerial Plan of the Study Area

The term *study area* has been used throughout this document to generally describe the area defined by these two intersections and the connecting section of SH1. At Hillcrest intersection, the study area also extends back on Cobham Drive and Cambridge Road about 30 metres and likewise for Morrinsville Road/SH26 at Morrinsville intersection. Furthermore, on the SH1 leg of Morrinsville Intersection the area extends to SH1/ McCracken Road intersection. The study area takes into account all properties with frontage on, as well as those which gain direct access via these sections of roads. It is worth noting that traffic studies and public consultation exercises were not necessarily constrained to this immediate area, and took into account relevant information on a network-wide basis as required.

Resolve Group was commissioned by Transit New Zealand (Transit) to produce a Scoping Report, identifying all potential options for the upgrade of the two intersections. The purpose of that report was to identify and examine all the potential options which would meet the objectives of the project.

The outcome of the scoping phase was the recommendation of an innovative option based on two 2½ lane roundabouts for progression to the Scheme Assessment Report (SAR) stage. Hence, the 'favoured options' discussed herein include 2½ Lane roundabouts at both Hillcrest & Morrinsville intersections. The rehabilitation of the associated pavement along SH1 between the 2 intersections has now been included in the improvements project.

This document is the Scheme Assessment Report which is the definitive step in the Investigation & Reporting (I&R) phase of Transit's Contract No. 2/03-011/501.

The concept of a 2½ lane roundabout is new to New Zealand. The benefits of using 2½ lane roundabouts are discussed in this report.

A supporting Assessment of Environmental Effects document was also produced in July 2004.

Environment Waikato has prepared a Regional Land Transport Strategy (RLTS) which recommended to Transit that the Hillcrest & Morrinsville project be given the second highest priority in the Regional Block Plan category in the 2004/05 Land Transport Programme for State Highways in the Waikato Region. This, in turn was evaluated against the objectives of the New Zealand Transport Strategy. The project is also consistent with other regional and national transport objectives including the Waikato Regional Land Transport Strategy 2002-2012 and the Hamilton Integrated Transport Strategy (HITS).

The improvements proposed herein are considered necessary to provide sound solutions to pre-existing congestion and safety problems on a major route in an urban (and highly visible environment) road network, and to do this in a way which provides for all road users including cyclists and pedestrians.

The original Scheme Assessment was updated in July 2005 as a result of the Economics Peer Review and some additional consultation.

1.2 The Brief

The Scheme Assessment Report (SAR) for the above Transit contract is to satisfy the following sets of requirements:

- Precisely define the problems and recommend a solution that meets current Client policy, standards and guidelines to maximise the safe and efficient operation of the highway.
- Include an economic assessment, which compares the benefits accruing to road users and the wider community from constructing a project at the project cost, as documented in Land Transport New Zealand's Economic Evaluation Manual.

The recommendations contained herein are consistent with Transit's Mission "To plan, develop and maintain the State Highway system in a way that contributes to an integrated, safe, responsive and sustainable land transport system for New Zealand."

2. BACKGROUND AND GENERAL DETAILS

2.1 Site Description

Both intersections are located on State Highway One (Cambridge Road), approximately 310 metres apart, in the suburb of Hamilton East. Cambridge Road is a major arterial route carrying greater than 36,500 vpd and has a speed restriction of 60 km/h.

Several site visits were carried out; the site photos are included in Appendix A.

2.1.1 Hillcrest Intersection

The intersection is located at the intersection SH1 Cobham Drive and Cambridge Road Roundabout. The intersection comprise of a three-leg roundabout. Cambridge Road serves as access to the Hamilton East suburb, to Waikato University, and to the north via Peachgrove Road.

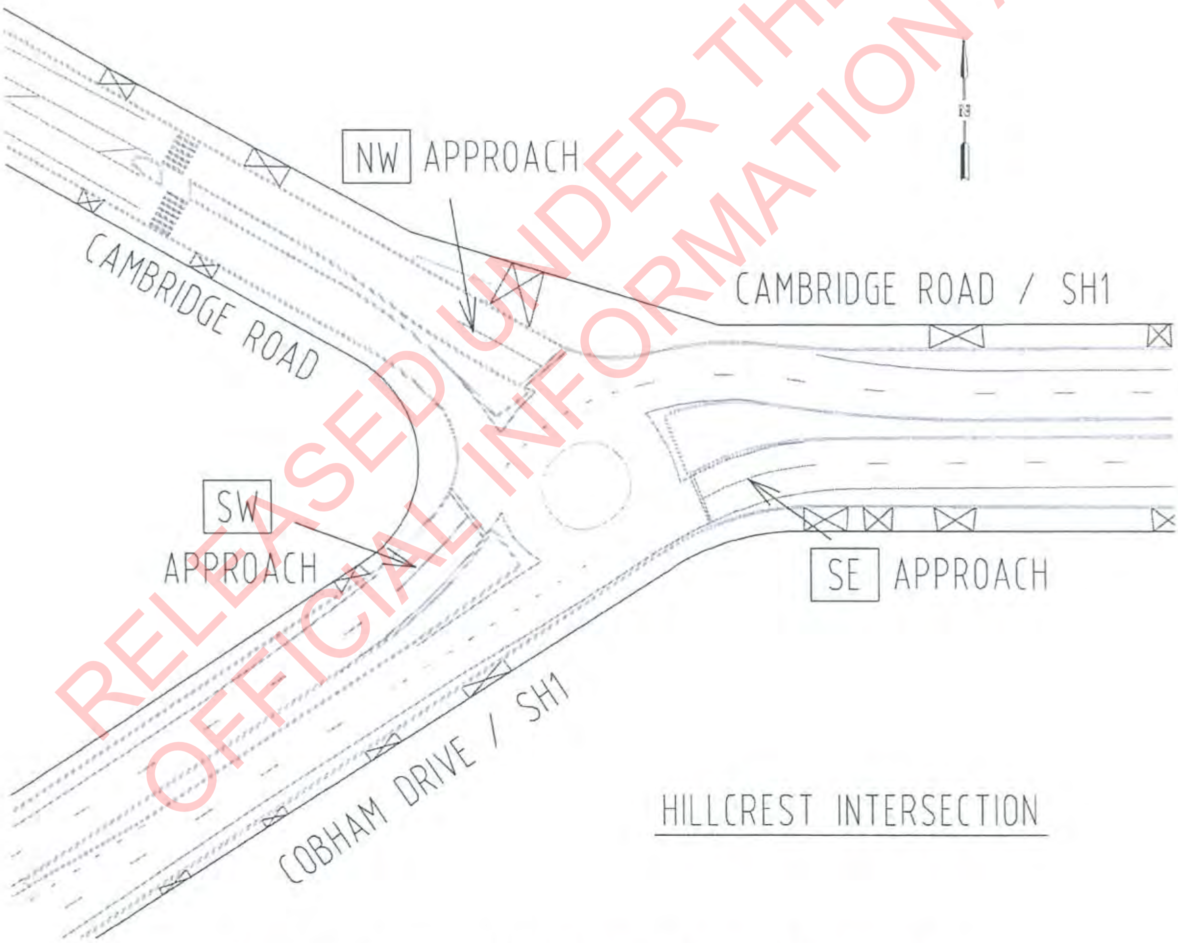

Figure 2 Labelling Convention – Hillcrest Intersection

2.1.2 Morrinsville Intersection

The four-leg roundabout is located at the intersection of SH1 and SH26 and commonly called the Morrinsville Road Roundabout. The 4th leg was added in 1997 to provide access into a fast food restaurant and shopping complex.

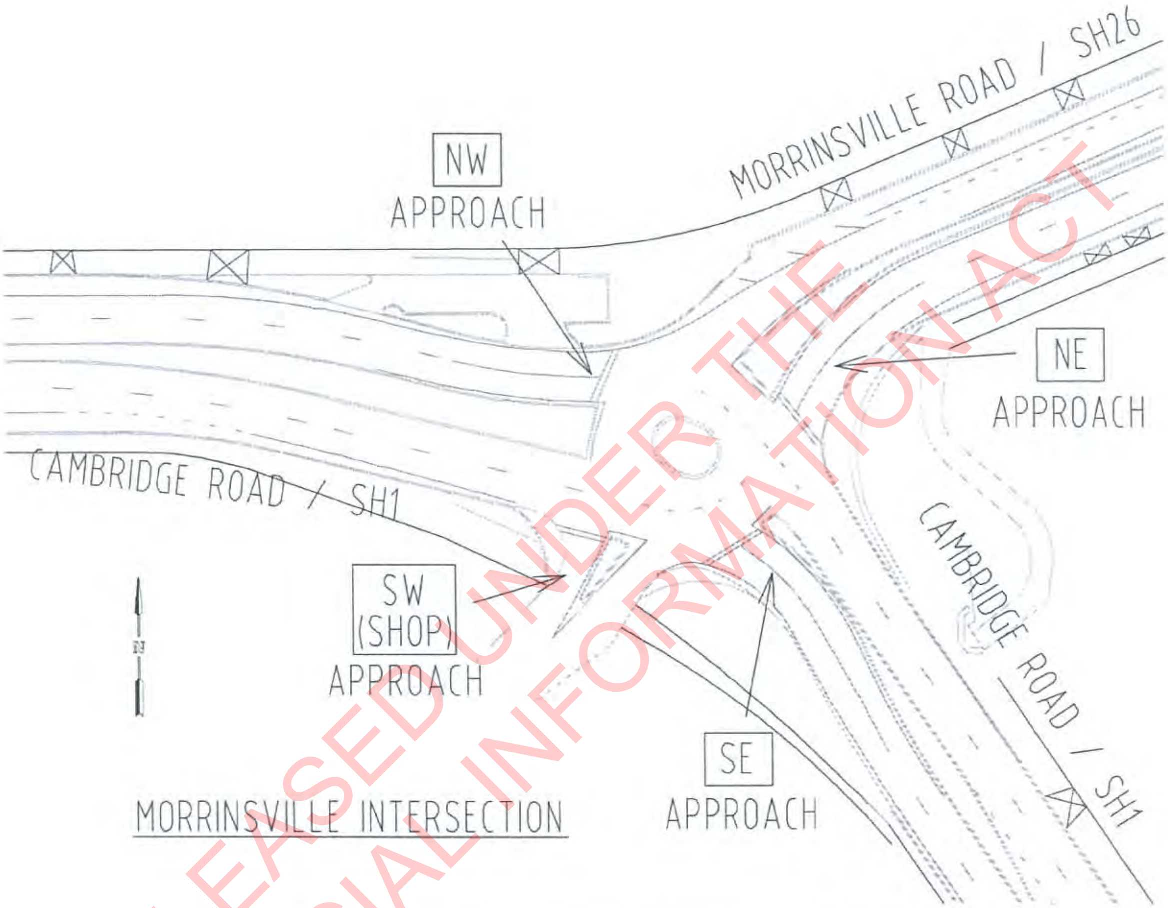

Figure 3 Labelling Convention – Morrinsville Intersection

2.2 Background to Problems

2.2.1 Hillcrest Intersection

Problems associated with the Hillcrest intersection include:

- Turning movement accidents, particularly with vehicles travelling south on Cambridge Road.
- High queuing delays to southbound traffic flows on SH1, specifically during afternoon peak periods.
- High queuing delays to Cambridge Road traffic flows turning left onto SH1, especially during morning peak periods.

2.2.2 Morrinsville Intersection

Problems associated with the Morrinsville intersection include:

- Crossing and turning crashes, particularly with vehicles travelling north on Cambridge Road.
- Conflicting turning movements, associated with the 4th leg layout and U-turners from the south.
- A high queuing delay to both northbound and southbound traffic flows on Cambridge Road, especially during peak periods.

The Morrinsville intersection was investigated in a Crash Reduction Study – Region 3 & 4 CRS 2002: Package Draft Report (Opus International Consultants). It was recommended that further options to reconfigure the roundabout be evaluated (including the access points to the shopping complex). It was reported that the geometry of the roundabout was considered substandard. Specifically, the small diameter of the roundabout and unsatisfactory sight triangles at the approaches, compounded by the growing traffic, all contribute to a less than desirable layout. A roll over accident involving a logging truck at this intersection demonstrated this inadequate geometry.

The grade-separated options indicated in earlier reports were considered unworkable in terms of their through roadway alignments, the remaining intersections, and need for access restoration.

3. TRAFFIC CONDITIONS ASSESSMENT

3.1 Assessment Methodology

The methodology adopted for the traffic analysis investigation is as follows:

- Collection of traffic data including volumes and turning movements counts;
- Preparation of functional layout designs for each option;
- Carrying out a SIDRA analysis for each option;
- Undertaking a Paramics analysis for each option;
- Preparing cost estimates for each option based on these layouts.

Paramics is a microsimulation program that enables qualitative and quantitative analyses of traffic operations to be undertaken for a road network. It fills a niche role - between macro/meso models (TRIPS, EMME/2) and analytical models (at intersection level) such as SIDRA. The outputs from Paramics are both visual (discrete vehicles can be seen moving around a road network) and numerical. Traffic detectors can be placed at specific locations to retrieve information of lane flow density, traffic flow rate and instantaneous traffic speed. Useful outputs such as route travel times and relative delays between one network scenario and the next can be obtained. Unlike analytical models, Paramics cannot conveniently output intersection "degree of saturation" (DoS[1]) and "delay" values. DoS can be indirectly derived from the modelled flow and movement capacity. Movement delay along a route or across an intersection can be derived by subtracting the free-flow travel time from the modelled travel time.

In Paramics, the movement of individual vehicles is governed by three interacting models representing vehicle following, gap acceptance and lane changing. Vehicle dynamics are relatively simple, combining a mixture of driver behaviour and some limitations based on vehicles' physical type (car, bus, tram, truck) and kinematics (eg. size (mass, length, width) & acceleration/deceleration). These models are applied simultaneously at the level of individual vehicles which aggregate to display the characteristic features of congested traffic flow which are otherwise difficult to model deterministically.

There are no theoretical limits to the type of applications and complexity of networks that can be coded within Paramics. However, the task of achieving reasonable validation of traffic operations increases exponentially with size – hence there are practical limits within practical budgets. The following is a sample of projects on which Paramics has been used by the modeller:

- Detailed Town Centre Modelling – Ringwood CBD, Melbourne western CBD. With the Melbourne CBD project, detailed traffic signal characteristics (including hook-turns, signal coordination), tram operations and impacts of pedestrian delays were modelled.
- Interaction of controls along a route (Intersection Signals, Pedestrian Signals, Roundabout, Stop/Give-Way Controls, Signal Coordination). The impact of queues "blocking back" from a congested intersection can be assessed.
- Loop activated controls – railway level crossing, pedestrian crossing, T-junction approaches.

[1] Degree of Saturation, or DoS is a numerical output of traffic microsimulations. By definition it is the ratio of flow to capacity. In practice it is the primary measure of how congested an intersection is. Its value is between 0.0 (free flow, uncongested) to 1.0 (at capacity.) Intersections with high DoS values are generally described as being 'saturated'. Values greater then 1.0 are generally described as being 'oversaturated'.

- Lane restrictions for different vehicle classes, e.g. HOV, bus, tram, trucks.
- Roundabout designs ranging from "standard" to ones where one or more of the movements are signalised.
- Freeway Management Studies – stand-alone roundabout metering, RTA-NSW SCATS-algorithm activated roundabout metering, and analyses of weaving and merges. With the SCATS metering model, we are able to control the ramp-meter trigger criteria.

3.2 Turning Movement Count Data

In 2004/05, Resolve Group undertook manual counts of turning movements and manual classification counts for the two intersections. The AM peak counts were undertaken on Friday 30 January 2004 between 7:30am – 9:00am, and the PM peak counts were undertaken on Thursday 29 January 2004 between 3:30pm – 6:00pm. Interpeak counts were undertaken on Tuesday 12 April 2005 between 11:30am to 2:00pm.

In order to understand the trend of traffic movements over the last three years, the turning movement surveys were carried out on Wednesday, 19 September 2007 for AM peak, Interpeak and PM peak period. The methodology and the duration of three time periods are the same as those in 2004/05.

2007 survey results confirmed that:

- Traffic growth rate from 2004 to 2007 is not significantly different from the modelling forecast, which is documented in Section 3.3.
- There were no unanticipated significant changes at any leg of the intersections

The results of the 2004/05 and the 2007 survey are both included in Appendix B.

3.3 Traffic Projection

The traffic projection model for Hamilton City has been built using TRACKS, which has been in existence since the late 1970's with regular updates. There are three time period models, and a 24 hour model, with all the intersections explicitly modelled during the assignment. Forecast years are 2006, 2011, 2016, 2021, 2031, and 2046. For this project, we have obtained modelled data for 2001, 2011, and 2021(with and without the Hamilton eastern bypass). Detailed count data sheets are provided in Appendix C.

An examination of Figures 4 to 7 that follow shows that:

- There is an increase in projected traffic of about 10% at the Hillcrest intersection, and about 15% at the Morrinsville intersection from 2001 to 2011;
- There is a similar increase in projected traffic of about 10% at the Hillcrest intersection, and about 15% at the Morrinsville intersection from 2011 to 2021 – if there is no bypass;
- This latter increase does not occur if there is a bypass – the predicted traffic volumes being similar to those in 2011.

These relationships have been used in forward-projecting the likely operation of the alternative treatments for each site – each has been increased over the 2007 data by 10% for 2017, and 20% for 2027 (except that the bypass option can use the 2017 predicted traffic.) These future projections are used to check the adequacy of the capacity of the design options, and to test the economics of these options.

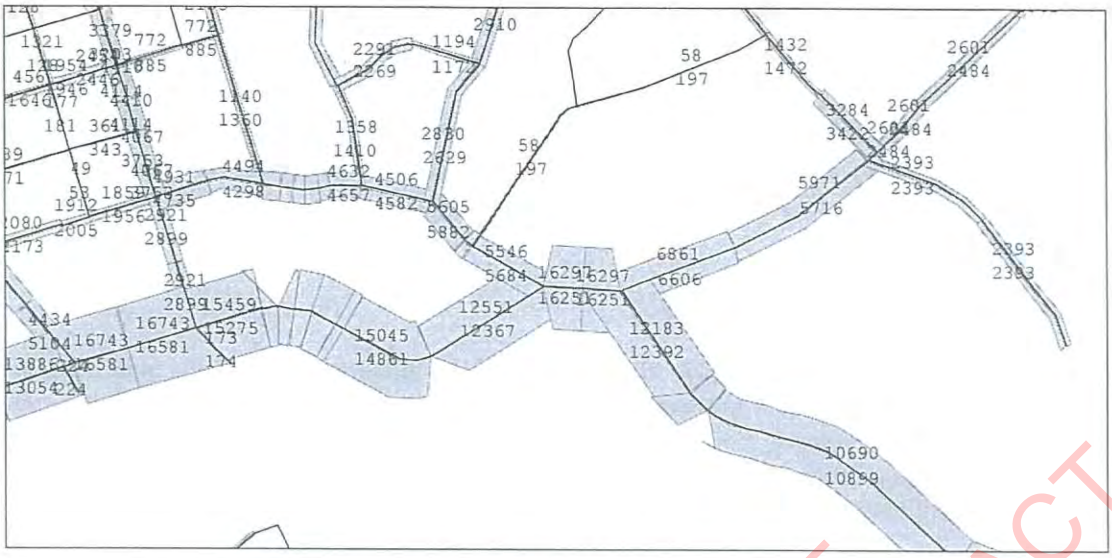

Figure 4 Daily Traffic Volumes - 2001

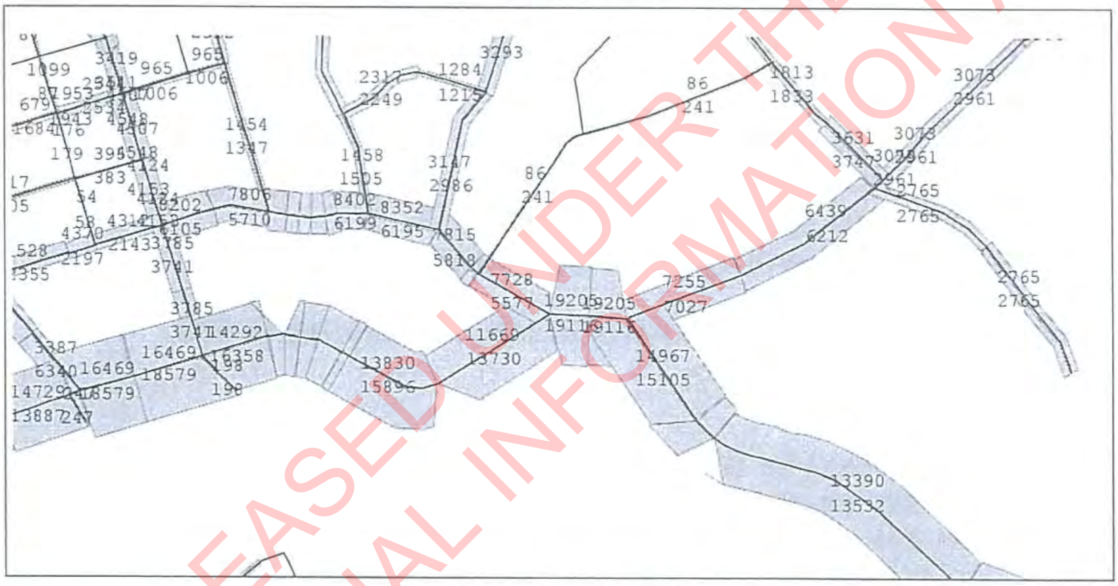

Figure 5 Daily Traffic Volumes - 2011

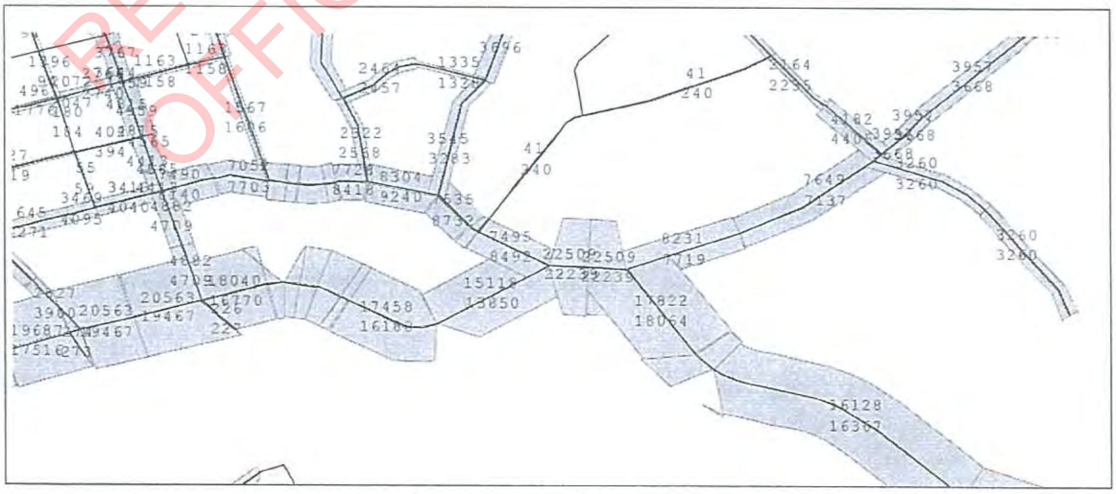

Figure 6 Daily Traffic Volumes - 2021 (no Bypass)

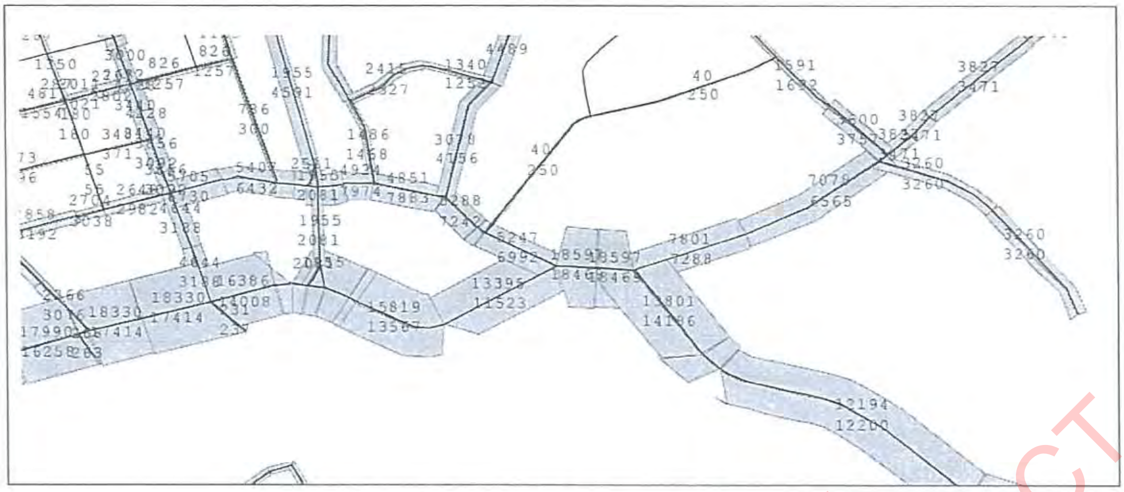

Figure 7 Daily Traffic Volumes - 2021 (with Bypass)

3.4 Comparison of Traffic Flow between Modelled and Observed

The TRACKS model also produces turning movement counts estimated for each of the intersections. The data provided (detailed in Appendix C) is for a 2-hour period. For the assessments in this comparison, the peak hour is assumed to be 60% of the 2-hour period (noting that an assumption for Auckland is 55%) The modelled data for 2001, 2011, and 2021(with and without the eastern bypass of Hamilton) are shown together with the 2002, 2004 and 2007 turning movement counts data for a visual comparison in Table 1~~Table 1~~ below.

The modelled peak period volumes at the two intersections for 2001 can be used as a reasonable comparison with recent (2002, 2004) and current (2007) traffic flows.

Note that approach labels were presented in Figures 2 and 3 in Section 2.

Table 1 Comparison of TRACKS model & Observed Traffic Flow

Table 1-1 Comparison of TRACKS Model & Observed Traffic Flow – Hillcrest Intersection

Approach	Peak Period	2001 (Model)	2004 (Counts)	2007 (Counts)	2011 (Model)	2021 Model (No bypass)	2021 Model (With bypass)
SE	AM	1736	1789	1314	2058		1960
	PM	1604	1466	1457	1480	2260	1800
NW	AM	360	692	654	630		430
	PM	570	773	780	450	790	445
SW	AM	1045	867	994	855		986
	PM	1590	1486	1349	1860	2020	1770

1258am 1786pm
1027 652PM
1571 am 1358 pm

Table 1-2 Comparison of TRACKS Model & Observed Traffic Flow – Morrinsville Intersection

Approach	Peak Period	2001 (Model)	2004 (Counts)	2007 (Counts)	2011 (Model)	2021 Model (No bypass)	2021 Model (With bypass)
SE	AM	1291	1481	1571	1590		1400
	PM	1241	1337	1358	1498	1814	1440
NE	AM	672	861	1027	733		810
	PM	701	657	652	680	837	708
NW	AM	1234	1136	1258	1476		1408
	PM	2001	1872	1786	2288	2804	2209
SW (Shopping)	AM		54	62			
	PM		99	95			

There appears to be some shifts in the travel demand in the 2007 counts. It is considered that the sample size was too small to identify any real change. There are some minor shifts noticed in the 2004 and 2007 data in relation to the seasonal factor. The Transit counts from 2004 to 2007 showed that there are significant seasonal impacts on the traffic on SH1 and SH26 in the vicinity of the study area. The recorded average daily traffic in January is 6% higher than that in September. Our analyses have taken these into account and this ensured accurate traffic and economic models are produced.

3.5 SIDRA Analyses of Existing Conditions

A SIDRA analysis of the intersections was conducted to determine estimates of capacity and performance statistics such as delay, queue lengths and degrees of saturation.

The SIDRA results on the existing conditions are presented in Table 2~~Table 2~~ for the Hillcrest & Morrinsville intersections.

Table 2 Existing Performance of Intersections

Table 2-1 Existing Performance of Intersections – Hillcrest Intersection

Option	Peak Period		Performance (DoS and 95 Percentile Queue Length in Metres)						
			DoS				Queue 95% back (m)		
			SE	NW	SW	Overall	SE	NW	SW
Existing Roundabout	AM	Left	0.788	0.667	0.639	0.79	100	46	64
		Right	0.789	0.381	0.639		100	18	64
	IP	Left	0.439	0.427	0.423	0.44	32	22	28
		Right	0.439	0.131	0.423		31	9	27
	PM	Left	0.591	0.931	0.720	0.93	51	102	82
		Right	0.591	0.490	0.719		50	23	78

Table 2-2 Existing Performance of Intersections – Morrinsville Intersection

Option	Peak Period		Performance (DoS and 95 Percentile Queue Length in Metres)								
			DoS					Queue 95% back (m)			
			SE	NE	NW	SW shop	Overall	SE	NE	NW	SW shop
Existing Roundabout	AM	Left	1.000	0.742	0.597	0.336	1.0	252	58	45	16
		Through	1.021	0.750	0.597	0.339		252	58	45	16
		Right	1.021	0.742	0.600	0.339		234	58	45	16
	IP	Left	0.513	0.264	0.456	0.201	0.51	31	11	32	8
		Through	0.513	0.264	0.456	0.200		31	11	32	8
		Right	0.513	0.338	0.456	0.200		31	16	31	8
	PM	Left	0.842	0.624	0.841	0.396	0.84	104	35	131	20
		Through	0.842	0.625	0.842	0.395		104	35	131	20
		Right	0.842	0.842	0.844	0.395		101	70	127	20

Note: Red colour shows the VC ratio exceeds 0.7, i.e. congestion begins.

The above tables confirm the congestion problems discussed earlier in Section 3.3.

The model for the existing Morrinsville intersection required some adjustment using a "10% extra bunching" factor on the all approaches except the shopping centre access in the AM period as the DoS exceeded 1.0 in the initial analysis.

As SIDRA can give quite variable results when analysing roundabouts, and great care has been taken when testing for future conditions to ensure robust results are obtained. The SIDRA outputs are included in Appendix D.

4. CRASH ANALYSIS

4.1 Crash Statistics

Land Transport New Zealand's Crash Analysis System (CAS) was used to obtain the crash history. Detailed crash data was retrieved from CAS for the period between 1 January 2002 and 31 December 2006 for Hillcrest, Morrisville and SH1/ McCracken Avenue intersections. A summary of crash numbers and crash severity is provided Table 3~~Table 3~~.

Table 3 Summary of LTNZ CAS Crash Data

Table 3-1 LTNZ CAS Crash Data – Hillcrest Intersection

Year	*Injury Severity*				Total
	Fatal	**Serious**	**Minor**	**Non-Injury**	
2002	0	0	3	4	7
2003	0	0	2	3	5
2004	0	0	0	4	4
2005	0	0	2	4	6
2006	0	0	1	6	7
TOTAL	**0**	**0**	**8**	**21**	**29**

Table 3-2 LTNZ CAS Crash Data – Morrinsville Intersection

Year	*Injury Severity*				Total
	Fatal	**Serious**	**Minor**	**Non-Injury**	
2002	0	0	0	3	3
2003	0	0	3	4	7
2004	0	0	1	6	7
2005	0	0	1	1	2
2006	0	0	0	3	3
TOTAL	**0**	**0**	**5**	**17**	**22**

Table 3-3 LTNZ CAS Crash Data – McCracken Avenue Intersection

Year	*Injury Severity*				Total
	Fatal	**Serious**	**Minor**	**Non-Injury**	
2002	0	0	1	0	1
2003	0	0	0	5	5
2004	0	0	0	1	1
2005	0	0	0	1	1
2006	0	0	1	1	2
TOTAL	**0**	**0**	**2**	**8**	**10**

Crash data sheets and diagrams have been prepared for the three intersections and are provided in Appendix E.

4.2 Accident Trends

4.2.1 Hillcrest Intersection

The crash history of Hillcrest intersection has the following characteristics:

- there were no "Fatal" or "Serious Injury" crashes reported
- the majority (52%) of crashes are crossing/ turning type – this is typical for a roundabout operating close to or at its capacity

- rear end/ obstruction type crashes are also relatively common at 24% of all crashes – this is typical for a roundabout operating close to or at its capacity and where there are geometric deficiencies
- the most common driver/ vehicle factor contributing to injury crashes was failure to give way or stop – this is typical for a roundabout operating close to or at its capacity, where driver frustration causes risk taking and unsafe manoeuvres
- the proportion of wet crashes appears to be no worse than a typical roundabout – this is anticipated as Transit operates a robust pavement management system
- the proportion of dark crashes appears to be no worse than a typical roundabout
- it appears that there is a concentration of crashes on the circulating lanes between Cambridge Road and Cobham Drive (SH1) and the left turn from Cambridge Road (SH1) into Cobham Drive (SH1) – the geometric deficiency of the existing roundabout is likely to be a contributor to these crashes

4.2.2 Morrinsville Intersection

The crash history of Morrinsville intersection has the following characteristics:

- there were no "Fatal" or "Serious Injury" crashes reported
- the vast majority (75%) of the crashes are crossing/ turning type – this is typical for a roundabout operating close to or at its capacity
- the most common driver/ vehicle factors contributing to injury crashes were failure to give way or stop and poor observation – this is typical for a roundabout operating close to or at its capacity, where driver frustration causes risk taking and unsafe manoeuvres, geometric deficiency of the existing roundabout is also likely to be a contributor to poor observation by drivers
- the proportion of wet crashes appears to be no worse than a typical roundabout – this is anticipated as Transit operates a robust pavement management system
- the proportion of dark crashes appears to be no worse than a typical roundabout
- it appears that the crashes are concentrated on the circulating lanes of the roundabout – this is typical for a roundabout operating close to or at its capacity where drivers frustration causes risk taking and unsafe manoeuvres, the geometric deficiency of the existing roundabout is likely to be a contributor to these crashes
- the shopping centre leg (southwestern approach) of the intersection does not appear to have any significant safety impact on the operation of the intersection

4.2.3 SH1/ McCracken Avenue Intersection

The crash history of McCracken Avenue intersection has the following characteristics:

- there were no "Fatal" or "Serious Injury" crashes reported
- the majority (50%) of the crashes are crossing/ turning type
- the most common driver/ vehicle factors contributing to injury crashes were failure to give way or stop and poor observation
- the proportion of wet crashes appears to be no worse than a typical priority controlled intersection
- the proportion of dark crashes appears to be no worse than a typical priority controlled intersection

5. GEOTECHNICAL ASSESSMENT

5.1 Field Testpits

On June 29 and 30 2004, a total of eight testpits (TPs) was excavated down to subgrade level, logged and samples taken for laboratory testing. Four of them were on sealed pavement. Of these, three were on live traffic lanes (TPs 2, 6 and 7) and one was located in the lay-by parking area (TP 4). The other four were on non-sealed locations. From the base of the testpits, an auger was used to investigate materials at greater depth along with shear vanes tests at intervals and a Scala Penetrometer to gauge subgrade material strength.

Full testpit logs and associated shear vane/Scala results are contained along with the geotechnical factual report in Appendix F. The following figure summarises the testpit logs for those testpits where old pavement was found (all except for TP3 and TP5).

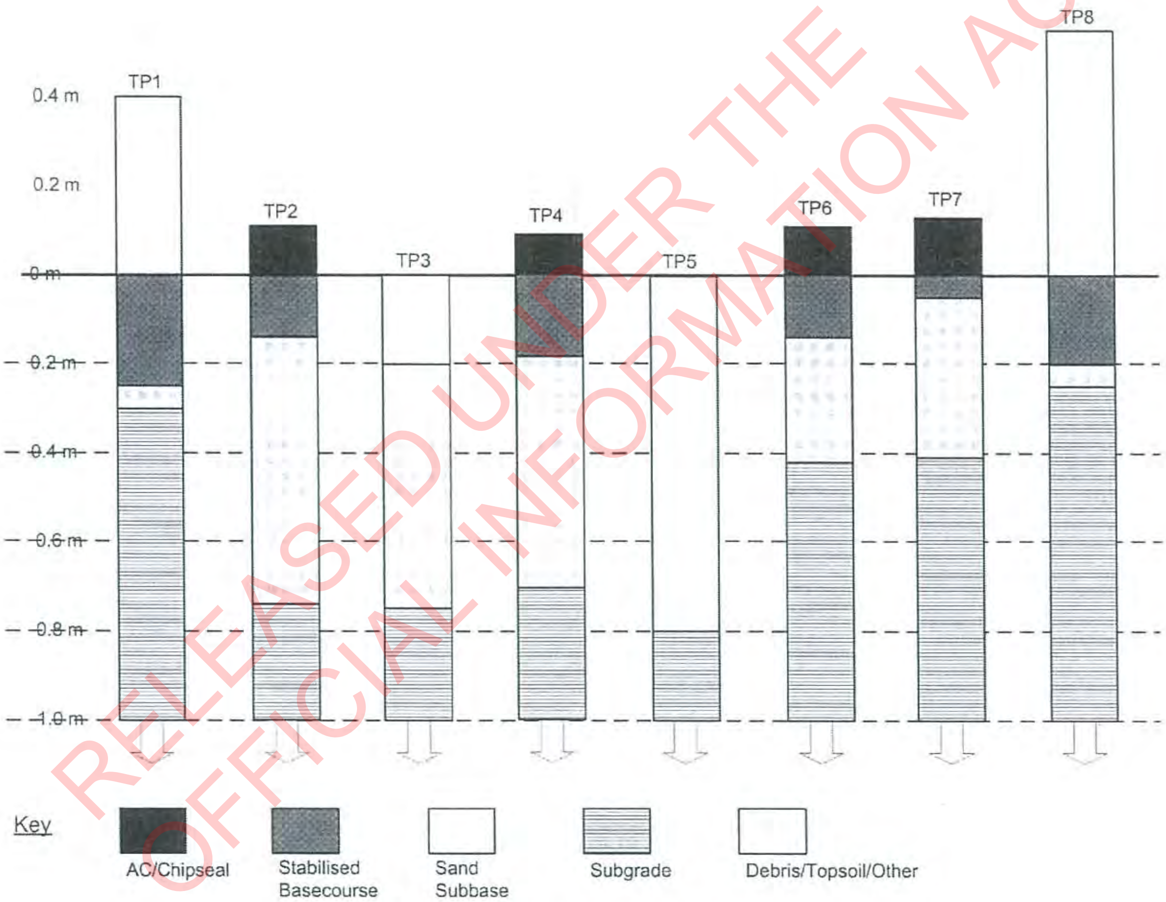

Figure 8 Testpit Log Summary

The logs are reasonably consistent in terms of subgrade material and the overlying pavement. The subgrade in all testpits is an orange brown silty clay or clayey silt, very moist to moist and soft to firm depending on water content.

The pavement consists of a yellowish brown sand 'subbase' with some gravels topped by a heavily cement stablised basecourse and asphaltic concrete (AC). The sand subbase varies in thickness between 300mm and 500mm thick where it underlies the existing trafficked pavement. The thickness of the stabilised basecourse varies significantly across the site from as little as 50mm (TP7) to a typical 180-200mm. The stabilised basecourse is in turn overlain by an AC layer of between 90mm and 130 mm thick (generally in good condition, some new). The basecourse and overlying AC is reportedly showing clear signs of slab cracking.

Of some note is the discovery of the old sand/stabilised basecourse pavement at depth in testpits outside the limits of the current trafficked carriageway (TP1 and TP8). In both these testpits, the sand layer is quite thin (~50mm) but with a significant depth of stablised basecourse (up to 250mm) overlying it. This old pavement is now covered by some 400-500mm of silts/gravel/sand and topsoil (TP8 only). A similar profile is observed in TP3 but without the stabilised basecourse which is inferred to have been removed at some time for median planting[2].

5.2 Laboratory Testing

Laboratory testing consisted of determining water content and CBR values of the excavated subgrade material.

CBR tests from subgrade samples from TP2, TP4 and TP6 returned natural CBR values of 2.5%, 3.5% and 2.5% respectively. These results were consistent with the worst case inferred CBR values as determined by in-situ Scala tests.

A CBR on a lime stabilised sample of subgrade for TP4 was also undertaken. The addition of 3% lime resulted in a CBR of 40%.

Water content of the subgrade was highly variable across the site and within individual testpits/augers. For example, TP3 water content increased from 45% (moist) to 84% (wet) with increasing depth. This increase in water content correlated with a reduction in CBR (inferred from Scala) from >10% to 2% over the same depth range.

5.3 Conclusions

5.3.1 Subgrade Condition

The clay/silt subgrade is typically weak with a design CBR of 3%, although this could be improved if the subgrade was kept dry with additional drainage. The material responds well to lime stabilisation with a substantial increase in strength and a CBR of 40%.

5.3.2 Pavement Condition

The existing trafficked pavement typically consists of 100mm of asphaltic concrete over a 200mm thick heavily stabilised basecourse over a 400mm sand subbase. The stabilised basecourse is very hard and is essentially acting as a semi-rigid pavement. It is thin in places and appears to be slab cracking along with the overlying AC. The scale and full extent of this failure type is not well understood.

5.3.3 Pavement Design

a) Existing Pavement

The existing pavement will be overlaid with a 75mm thick AC running surface, tapering and cut into existing AC pavement as necessary to match the existing drainage.

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[2] See Geotechnical Report titled "SH1, Hillcrest, Hamilton: Intersection Improvements, Opus International Consultants, July 2004, Appended to this SAR (Appendix F)

Prior to the overlay, it is proposed to treat the existing pavement with a heavy geotextile fabric as a means of mitigating the risk from further slab cracking.

b) *New Pavement*

New pavement in areas of widening will be 'rigid' to broadly match the expected deflection characteristics of the existing pavement overlaid above. Any existing pavement/subgrade material will be excavated to a depth of 600mm below finished level and built back up with 325mm of sand, 200mm of concrete and 75mm of AC running course (Option A). Where appropriate, it may be possible to build up the new concrete/AC pavement on the old stabilised basecourse layer without the need for excavation (Option B).

All joints between new and existing pavement will be treated with geotextile (overlapping at least one metre across each pavement).

The pavement design proposed in the geotechnical factual report (Opus, July 2004) was not reflected in this pavement design on the basis that the overlay method proposed can be constructed as effectively, more quickly and with a minimal effect on traffic.

The overall pavement design is shown below in Figure 9 (new pavement in green.)

Figure 9 Pavement Design

6. OPTIONS CONSIDERED

6.1 Objectives

The specific objectives of this project are to:

- Improve the safety and efficiency of both SH1/Morrinsville and SH1/Cambridge Road Intersections
- Improve the trip reliability by minimising traffic disruptions and managing traffic demand, and in particular congestion in peak periods
- Protect the long-term function of the State Highways
- Consider and provide for the needs of cyclists and pedestrians
- Deliver the project in the most cost-effective and efficient manner

These objectives guided the development of options from the start of the I&R phase of the project.

6.2 Background

The generic advantages and disadvantages of different forms of intersection control were considered during the development of options. These options included:

- Traffic signals
- 2½ Roundabout
- Grade separation

6.2.1 Traffic Signals

Signalisation of the Hillcrest and Morrinsville Intersections is considered to be a viable improvement option, as the traffic demand volumes at the intersections meet the warrant stated in Austroads Part 7 Traffic Signals.

One key advantage of traffic signals is the ability of traffic signals to actively assign priorities, enabling the road controlling authority to manage travel demand on strategic routes.

Non-Site Specific Advantages	Non-Site Specific Disadvantages
Traffic Signals enable the active management of traffic demand at intersections, allowing more flexible management of the major road flow, including but not limited to increasing the capacity of critical approaches through additional green time. Furthermore, making provisions for pedestrians at a signalised intersection is simpler than other options for control.	Signalisation of Intersection is generally costlier than other forms of intersection improvement in the long run, as signals consume electricity and require periodic servicing (e.g. lantern, detector, controller). Furthermore, when more complex signal phasing causes longer waiting times at intersections, both drivers and pedestrians tend to become impatient and may violate red lights or drivers are tempted to short cut through neighbourhood streets. This subjects local residents to a greater risk of collisions, worse congestion and more air and noise pollution. Therefore, for the signal option to be

Non-Site Specific Advantages	Non-Site Specific Disadvantages
	successfully implemented, delays imposed onto traffic coming from the local road cannot increase compared with the status quo. In urban fringe areas, particularly during off-peak hours, the delays imposed on the travelling public are likely to cause public criticism.

6.2.2 Roundabout

Roundabout is the existing form of control at Hillcrest & Morrinsville Intersections. Since the existing roundabout does not provide sufficient capacity during peak hours, improvements made to the roundabout could increase the capacity of the roundabout in both cases.

Non-Site Specific Advantages	Non-Site Specific Disadvantages
Roundabouts tend to be a safer form of intersection control compared with priority controlled and signalised intersection. This is because roundabouts have less conflict points than signalised or priority controlled intersections. Furthermore, Roundabouts generally require less storage length for queues and hence would minimise land take. Roundabout also enables u-turn movements to be made safely. One other significant advantage of roundabout is that it imposes minimal delay during off-peak.	Roundabout does not allow active management of travel demand (unless metered by traffic signals). The operation of a roundabout involves sharing of priority based on vehicle movement rather than assignment of priority. Therefore, roundabout may not be the most efficient form of intersection control when there are significant imbalances among flow demands. Furthermore, the relative safety advantages of roundabout intersection diminish at high traffic flows, particularly with regard to pedestrians and cyclists safety. Making provisions for pedestrians and cyclists is inherently difficult at roundabouts.

Roundabout Metering

Roundabout approach(es) can be metered to increase movement(s) capacity where required/ desired for traffic management purposes. It is considered that the metering of roundabout is a positive form of travel demand management. It enables roundabout controlled intersections to have the ability to assign priority to the major road flow, similar to a signalised intersection.

6.2.3 Grade Separation

Grade separation in the context of this project is the process of aligning an intersection of two roads at different grades (height) so that they will not disrupt flow on other roads when they cross each other.

Non-Site Specific Advantages	Non-Site Specific Disadvantages
Grade separated intersections tend to be the safest form of intersection control compared with other forms of intersection. This is because the amount of conflict points has significantly reduced.	Grade separation is generally the costliest solution amongst intersection improvement options. The quantum of civil works required for grade separation is substantial and may not be

Non-Site Specific Advantages	Non-Site Specific Disadvantages
The capacity of the intersecting roads would no longer be limited by the form of intersection control, therefore the capacity and throughputs of the routes would increase significantly.	feasible if the intersection is located in a built-up area. The social and environmental impacts of grade separating existing intersections generally cannot be easily justified, unless the intersection suffers from very severe congestion and the period of congestion is significant.

6.3 Options Assessed in Previous Reports

The following table summarises the options investigated in previous reports.

Report & Time	Intersection	Option Number and Description
Project Feasibility Report, (DWK, 2003)	Hillcrest	Option A – Signalised Right Turns
		Option B – Upgrade Status Quo to 2 Lane Roundabout
		Option C – Grade Separation
		Option D – 3-Lane Roundabout
	Morrinsville	Option E – Signals (for all movements)
		Option F – Upgrade to 2 Lane Roundabout
		Option G – Grade Separation
		Option H – Close Shopping Complex leg (Burger King Entrance)
Scoping Report (Resolve Group, March 2004)	Hillcrest	1N – Signalisation –of all movements
		2N – 2 ½ - Lane Roundabout (with and without metering)
	Morrinsville	1S – Signalisation (of all movements)
		2S – 2 ½ Lane Roundabout (with and without metering)
		3S – Signalisation of Morrinsville and McCracken Avenue
		4S – 2 ½ Lane Roundabout metered
SAR (Resolve Group, August 2004)	Hillcrest	Favoured Option – 2 ½ Lane Roundabout (with metering provisions)
	Morrinsville	Favoured Option – 2 ½ Lane Roundabout

6.4 Options not further Evaluated in this Report

6.4.1 Grade Separation

Grade Separation was investigated earlier in the I&R phase; this option was not further evaluated in this report for the following reasons:

- grade separation will involve construction of bridges or underpasses, these structures do not fit in well with the existing roading and urban environment, the social and environmental impacts of this option were considered unacceptable

- grade separation will involve substantial property acquisitions and the impacts are considered unacceptable to the surrounding community for the limited amount of benefits gained over other options
- the construction cost of grade separation is very high and the current travel demand does not warrant grade separation
- the benefits attainable from grade separation are limited at both the Hillcrest and Morrinsville intersections

6.4.2 2 or 3 Lane Roundabouts

2 or 3 Lane roundabouts were investigated earlier in the I&R phase; these options were not further investigated in this report for the following reasons:

- Installation of 2 lane roundabouts at both Hillcrest and Morrinsville intersections do not provide sufficient capacity during AM and PM peaks
- 3 lane roundabouts require large areas to operate effectively, and hence will involve substantial property acquisition at both intersections
- 3 lane roundabouts are likely to have more conflict and may increase crash rates at both intersections; picking gaps across 3 circulating lanes is not an easy task for most drivers
- it is very difficult to make provisions for pedestrians and cyclists at 3 lane roundabouts
- the operational capacity of a 3 lane roundabout is not significantly more than a 2 ½ lane roundabout

6.5 Do-Minimum Option

The proposed options were compared to a 'do minimum' option of maintaining the current layout at both intersections, and carrying out a scheduled network maintenance regime. This was done for the purposes of the economic assessment.

The purpose of considering a number of alternatives is to identify a treatment option which meets the project objectives at least cost with maximum benefits.

The Fourth Schedule of the Resource Management Act (1991) requires that:
'Where it is likely that an activity will result in any significant adverse effect on the environment, a description of any possible alternative locations or methods for undertaking the activity… is required as part of an assessment of environmental effects.'

In addition, section 168 (3) (c) of the RMA states that any notice of requirement shall include: 'The effects that the public work or project or work will have on the environment, and the ways in which any adverse effects may be mitigated, and the extent to which alternative sites, routes and methods have been considered.'

6.6 Options Assessed in this Scheme Assessment Report

There are two forms of intersection control considered in this revised Scheme Assessment Report, i.e. Traffic Signals and Roundabouts. It is considered that the Hillcrest (SH1 Cobham Drive/ Cambridge Road) and Morrinsville (SH1 Cambridge Road/ SH26 Morrinsville Road) intersections should have the same form of intersection control due to their close proximity to each other.

Having a mixture of traffic signal and roundabout is not considered to be a viable option as traffic signals do not work well with uncoordinated intersection(s) from a network operations perspective.

The two options assessed in this revised Scheme Assessment Report:

- 2 ½ Lane Roundabouts at both Hillcrest and Morrinsville Intersections with provisions made for metering in the future
- Signalisation of both Hillcrest and Morrinsville Intersections and the signalisation of McCracken Avenue/ Cambridge Road (SH1) intersection is also proposed as part of this option to enable satisfactory operation of the signals at Hillcrest and Morrinsville

6.7 Option 1 – 2 ½ Lane Roundabout

A **2½ lane roundabout** treatment is proposed at both intersections. This type of roundabout may be described as one which has 3 entering lanes, but no more than 2 exit lanes. Such a design requires allocation of approach lanes into the intersection – e.g. the right lane being right turn movements only.

6.7.1 Hillcrest Intersection – Proposed Layout

At Hillcrest intersection, the proposed layout includes the following features:

- three entry lanes on the south-eastern approach, and south-western approaches, and two entry lanes on the north-western approach;
- an additional exit lane has been provided at the NW (Cambridge Rd) exit, allowing two exit lanes at all three exits;
- the position of the roundabout centre island has been shifted to the north-west. The tree on the roundabout has been removed to enhance visibility at the intersection;
- modifications to medians and traffic islands to accommodate altered geometric layout;
- provisions for the installation of entrance metering in the future (underground ducting).

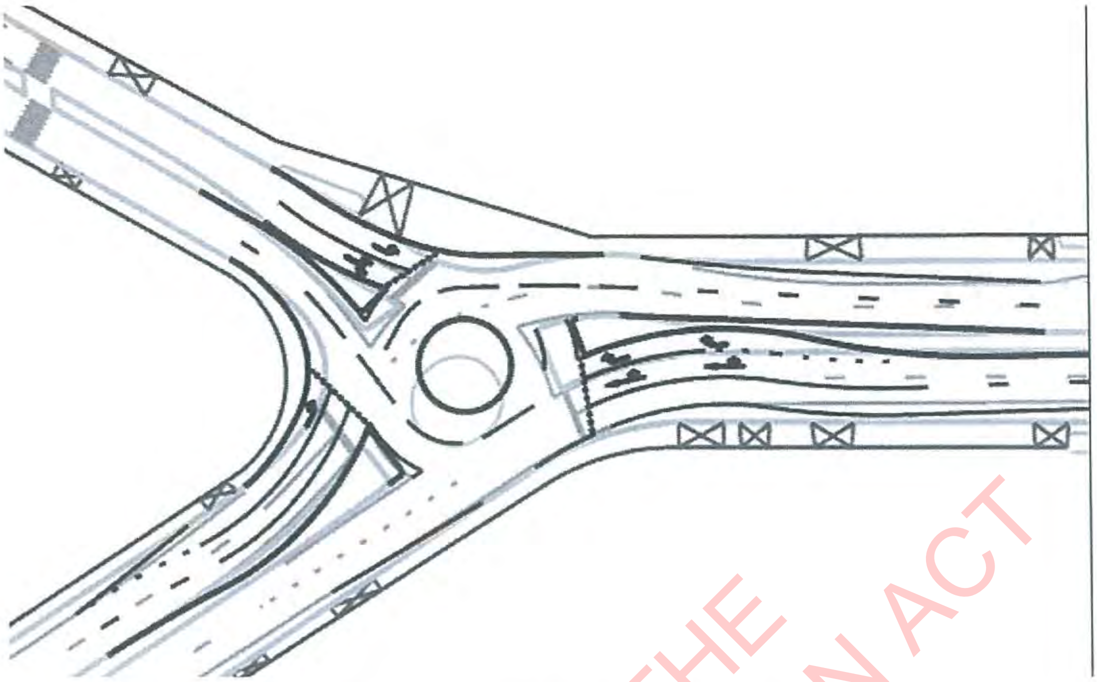

Figure 10 2 ½ Lane Roundabout Option for Hillcrest Intersection

6.7.2 Morrinsville Intersection – Proposed Layout

At Morrinsville intersection, the proposed layout includes the following features:

- a dedicated right turn lane is proposed at the southeast approach. A left turn slip lane has been proposed at the northwest and northeast approaches. The number of approach lanes (1) remains unchanged at the shopping complex leg;
- the central roundabout island is enlarged to improve motorists' ability to select gaps in the circulating flow, thus improving the overall operation of the roundabout;
- the number of exit lanes remains unchanged (two at all major exits), however their positions have been altered slightly.
- angle parking has been proposed at the lay-by parking area to the northwest of the intersection. The number of spaces has changed from 8 to 5. The existing egress from the lay-by area is unsafe and its closure has been recommended by the Police;
- appropriate signage and road markings are proposed to formally signify that the intersection includes 4 approaches;
- modifications to medians and traffic islands to accommodate altered geometric layout.

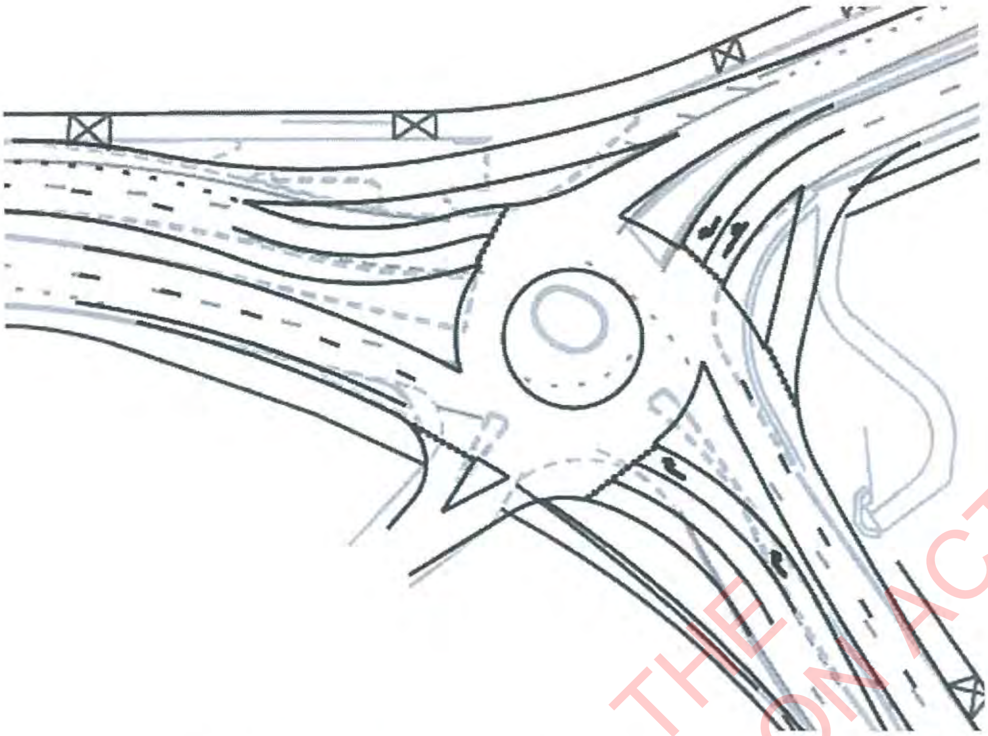

Figure 11 2 ½ Lane Roundabout Option for Morrinsville Intersection

6.7.3 Provisions for Roundabout Metering

Roundabout metering will provide the ability to improve operation in the future by making use of spare capacity in one or more legs and assigning it to one that is congested. The metering of the roundabouts enables the provision of benefits of traffic signals with reduced initial capital costs, deferring the operational costs of traffic signals and reduces the whole of life cost of the intersection improvement.

The exact timing of the need for metering remains to be determined, however it is thought that it will become desirable approaching year 2021 at Hillcrest Intersection.

The metering of the SH26 leg (Northeastern approach) of the Morrinsville intersection will significantly increase the capacity of the roundabout by allowing more vehicles to enter the roundabout from the critical SH1 leg (Southeastern approach). Such metering arrangement at the Morrinsville intersection will enable the roundabout option to function well for the 20% growth scenario.

6.7.4 Capacity Improvement

A SIDRA analysis was conducted to evaluate the 2 ½ lane roundabout to determine estimates of capacity and performance statistics such as delay, queue lengths, degree of saturation. A Paramics micro-simulation model was developed to model the flow, movement capacity and travel time. The Paramics results are also used as a "sanity" check for the SIDRA outputs.

Table 4~~Table 4~~, Table 5~~Table 5~~ and Table 6~~Table 6~~ provide the intersection performance outputs from SIDRA for 2007 existing flow, a 10% and 20% increase in traffic respectively, and are used to estimate conditions in 2017 and 2027 traffic volumes (no bypass) respectively. They show that there would be plenty of spare capacity in both peaks, except for the south-eastern leg in AM period in the 20% increase flow scenario.

Table 4 Intersection Performance for 2007 Existing Flow – Roundabout Option

Table 4-1 Roundabout Performance for Existing Flow (2007) – Hillcrest Intersection

Option	Peak Period		Performance (DoS and 95 Percentile Queue Length in Metres)						
			DoS				Queue 95% back (m)		
			SE	NW	SW	Overall	SE	NW	SW
2 ½ lane Roundabout	AM	Left	0.489	0.467	0.241	0.49	39	25	13
		Right	0.472	0.468	0.420		35	24	28
	IP	Left	0.270	0.296	0.166	0.30	17	13	7
		Right	0.270	0.296	0.301		16	12	15
	PM	Left	0.361	0.606	0.158	0.61	26	37	7
		Right	0.361	0.606	0.525		26	35	33

Table 4-2 Roundabout Performance for Existing Flow (2007) – Morrinsville Intersection

Option	Peak Period		Performance (DoS and 95 Percentile Queue Length in Metres)								
			DoS					Queue 95% back (m)			
			SE	NE	NW	SW shop	Overall	SE	NE	NW	SW shop
2 ½ lane Roundabout	AM	Left	0.700	0.276	0.253	0.311		54	12		14
		Through	0.699	0.558	0.399	0.313	0.7	54	33	27	14
		Right	0.349	0.564	0.400	0.313		16	33	26	14
	IP	Left	0.342	0.304	0.180	0.168		17	13		6
		Through	0.342	0.111	0.329	0.168	0.34	17	4	20	6
		Right	0.342	0.111	0.329	0.169		6	4	19	6
	PM	Left	0.500	0.300	0.222	0.265		30	15		11
		Through	0.504	0.324	0.635	0.264	0.64	30	16	58	11
		Right	0.334	0.323	0.634	0.266		16	16	57	11

Table 5 Intersection Performance for 10% Flow Increase – Roundabout Option

Table 5-1 Roundabout Performance for 10% Flow Increase (2017, approx=2021 with Bypass) - Hillcrest Intersection

Option	Peak Period		Performance (DoS and 95 Percentile Queue Length in Metres)						
			DoS				Queue 95% back (m)		
			SE	NW	SW	Overall	SE	NW	SW
2 ½ lane Roundabout	AM	Left	0.549	0.561	0.285	0.56	46	34	16
		Right	0.531	0.561	0.496		42	32	38
	IP	Left	0.301	0.342	0.187	0.34	20	15	8
		Right	0.301	0.342	0.340		19	15	18
	PM	Left	0.405	0.745	0.177	0.75	30	53	8
		Right	0.405	0.746	0.598		30	49	44

Table 5-2 Roundabout Performance for 10% Flow Increase (2017, approx=2021 with Bypass) - Morrinsville Intersection

Option	Peak Period		Performance (DoS and 95 Percentile Queue Length in Metres)								
			DoS					Queue 95% back (m			
			SE	NE	NW	SW shop	Overall	SE	NE	NW	SW shop
2 ½ lane Roundabout	AM	Left	0.821	0.323	0.278	0.441	0.83	80	15		22
		Through	0.826	0.667	0.452	0.442		80	44	32	22
		Right	0.410	0.669	0.454	0.442		20	44	30	22
	IP	Left	0.417	0.183	0.199	0.214	0.42	22	8		8
		Through	0.419	0.224	0.369	0.213		22	9	23	8
		Right	0.195	0.225	0.369	0.214		8	9	23	8
	PM	Left	0.581	0.382	0.244	0.335	0.73	39	20		15
		Through	0.572	0.418	0.724	0.337		39	22	81	15
		Right	0.381	0.419	0.725	0.333		19	22	79	15

Note: Red colour shows the VC ratio exceeds 0.7, i.e. congestion begins.

Table 6 Intersection Performance for 20% Flow Increase – Roundabout Option

Table 6-1 Roundabout Performance for 20% Flow Increase (2027, no Bypass) - Hillcrest Intersection

Option	Peak Period		Performance (DoS and 95 Percentile Queue Length in Metres)						
			DoS				Queue 95% back (m)		
			SE	NW	SW	Overall	SE	NW	SW
2 ½ lane Roundabout	AM	Left	0.611	0.673	0.337	0.67	55	46	20
		Right	0.594	0.674	0.589		50	43	54
	IP	Left	0.332	0.394	0.210	0.39	22	19	9
		Right	0.332	0.393	0.381		22	18	21
	PM	Left	0.451	0.922	0.201	0.92	36	98	9
		Right	0.451	0.923	0.679		36	88	58

Table 6-2 Roundabout Performance for 20% Flow Increase (2027, no Bypass) - Morrinsville Intersection

Option	Peak Period		Performance (DoS and 95 Percentile Queue Length in Metres)								
			DoS					Queue 95% back (m)			
			SE	NE	NW	SW shop	Overall	SE	NE	NW	SW shop
2 ½ lane Roundabout	AM	Left	0.962	0.377	0.303	0.678		179	18		40
		Through	0.976	0.784	0.508	0.676	**0.98**	179	62	37	40
		Right	0.483	0.792	0.509	0.676		26	62	36	40
	IP	Left	0.469	0.209	0.216	0.255		26	9		10
		Through	0.469	0.262	0.411	0.254	**0.47**	26	11	27	10
		Right	0.219	0.262	0.411	0.254		9	11	26	10
	PM	Left	0.655	0.493	0.267	0.422		50	29		20
		Through	0.645	0.560	0.820	0.422	**0.82**	50	32	118	20
		Right	0.429	0.557	0.818	0.426		22	32	114	20

Note: Red colour shows the VC ratio exceeds 0.7, i.e. congestion begins.

6.7.5 Discussions

Stakeholder consultation was undertaken for the implementation of this option. The 2 ½ lane roundabouts option proposed has the following advantages:

- improves capacity and operation of the existing roundabouts
- minimal maintenance cost increase compared with the existing roundabouts
- design form is consistent with the existing roundabouts
- less environmental impact than other improvement options, i.e.
  - when compared with traffic signals, a roundabout produces less light pollution, requires less energy to run
  - when compared with grade separation, a roundabout does not involve the construction of major structures and hence requires less resources to construct
- lower initial capital cost, lower ongoing operating and maintenance costs than other forms of intersection improvement, e.g. grade separation, traffic signals
- the 2 ½ lane roundabouts option enables safe u-turn movements to be made for locals wishing to access the school on the southern side of the State Highway between the two intersections
- the option requires less queue stacking lengths than signalisation

On the contrary, the roundabouts option proposed has the following disadvantages:

- Provision for cyclists and pedestrians is not as straight forward as making such provision at a signalised intersection
- Without roundabout metering, roundabout does not allow prioritisation of the through traffic on SH1, i.e. active management of travel demand, the priority is shared with traffic from local roads and SH26
- The traffic growth at the project site is relatively high, which means the safety benefits obtained may diminish during times of high traffic flows

6.8 Option 2 – Signalised Intersections

Signalisation is proposed at both intersections. For this option to operate satisfactorily, the intersection of McCracken Avenue and Cambridge Road (SH1) also needs to be signalised as part of this option to enable satisfactory operation of the intersections in the study area. The implementation of this option will require the consultation process to be restarted from the very beginning, as the stakeholders had not previously been consulted about this option.

6.8.1 Hillcrest Intersection – Proposed Layout

At Hillcrest Intersection, the proposed layout includes the following features:

- a left turn slip lane is proposed at the southeast approach for left turning from Cobham Drive (SH1) into Cambridge Road
- the number of lanes on Cobham Drive remains unchanged
- two dedicated right turn lanes are proposed at the eastern approach for right turning from Cambridge Road (SH1) into Cambridge Road. The right turn lanes are approximately 100 metres long to provide for the stacking length required for right turning vehicles. These involve road widening on the southern side of Cambridge Road (SH1) to accommodate the right turn lanes
- one dedicated left turn lane from the northwest approach for left turning from Cambridge Road into Cambridge Road (SH1)
- one dedicated right turn lane from the northwest approach for right turning from Cambridge Road into Cobham Drive (SH1)
- provisions for pedestrians have been proposed at the southwest and northwest legs of the intersection
- modifications to existing and installation of new medians, kerb and traffic islands are proposed to accommodate the altered geometric layout

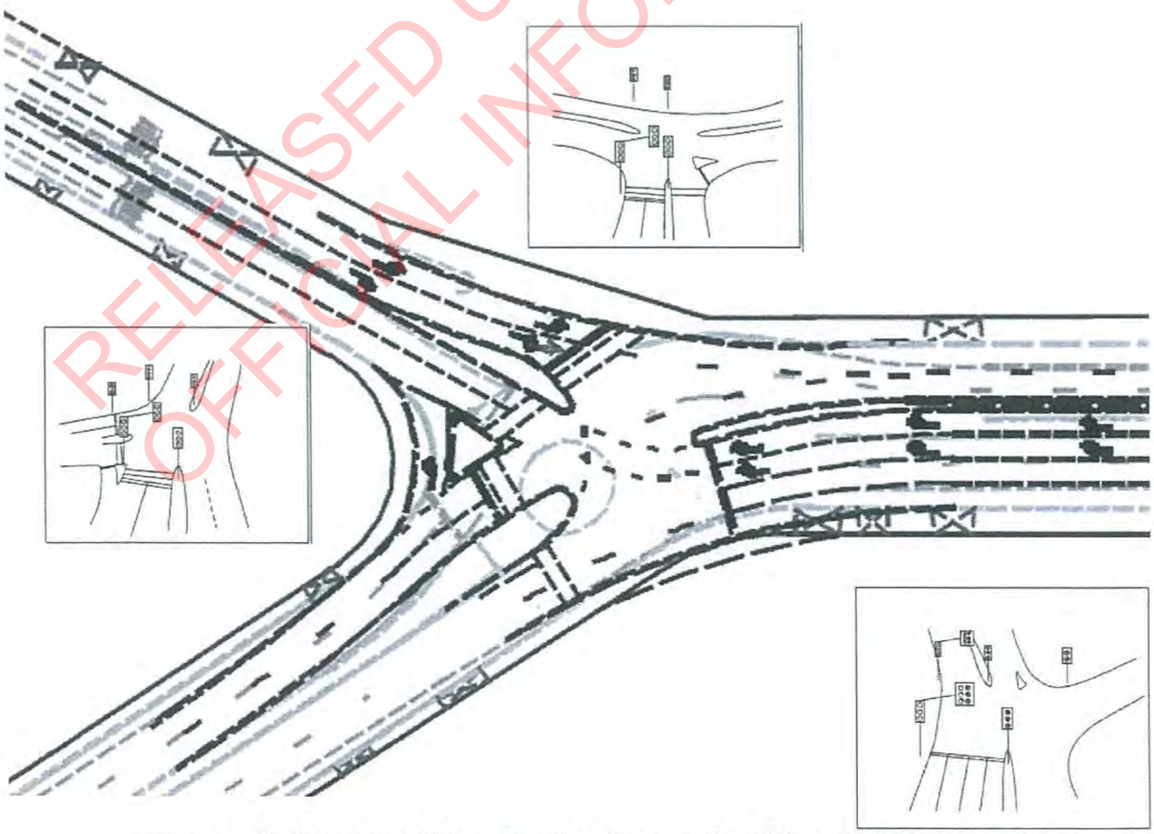

Figure 12 Proposed Signalisation Layout for Hillcrest Intersection

6.8.2 Morrinsville Intersection – Proposed Layout

At Morrinsville Intersection, the proposed layout includes the following features:

- a dedicated right turn lane is proposed at the northwest approach for right turning from Cambridge Road (SH1) into the shopping complex
- a left turn slip lane is proposed at the northwest approach for left turning from Cambridge Road (SH1) into Morrinsville Road (SH26)
- a dedicated right turn lane is proposed at the northeast approach for right turning from Morrinsville Road (SH26) into Cambridge Road (SH1). A shared right turn and through lane is proposed at the this approach for right turning from Morrinsville Road (SH26) into Cambridge Road (SH1) and through movement into the shopping complex
- a left turn slip lane is proposed at the northeast approach for left turning from Morrinsville Road (SH26) into Cambridge Road (SH1)
- provisions for pedestrian have been proposed at all four legs of the intersection
- two dedicated right turn lanes are proposed at the southeast approach for right turning from Cambridge Road (SH1) into Morrinsville Road (SH26). The right turn lanes are approximately 40 metres long to provide for the stacking length required for right turning vehicles. These involve road widening on the southern side of Cambridge Road (SH1) to accommodate the right turn lanes
- modifications to existing and installation of new medians, kerb and traffic islands are proposed to accommodate the altered geometric layout

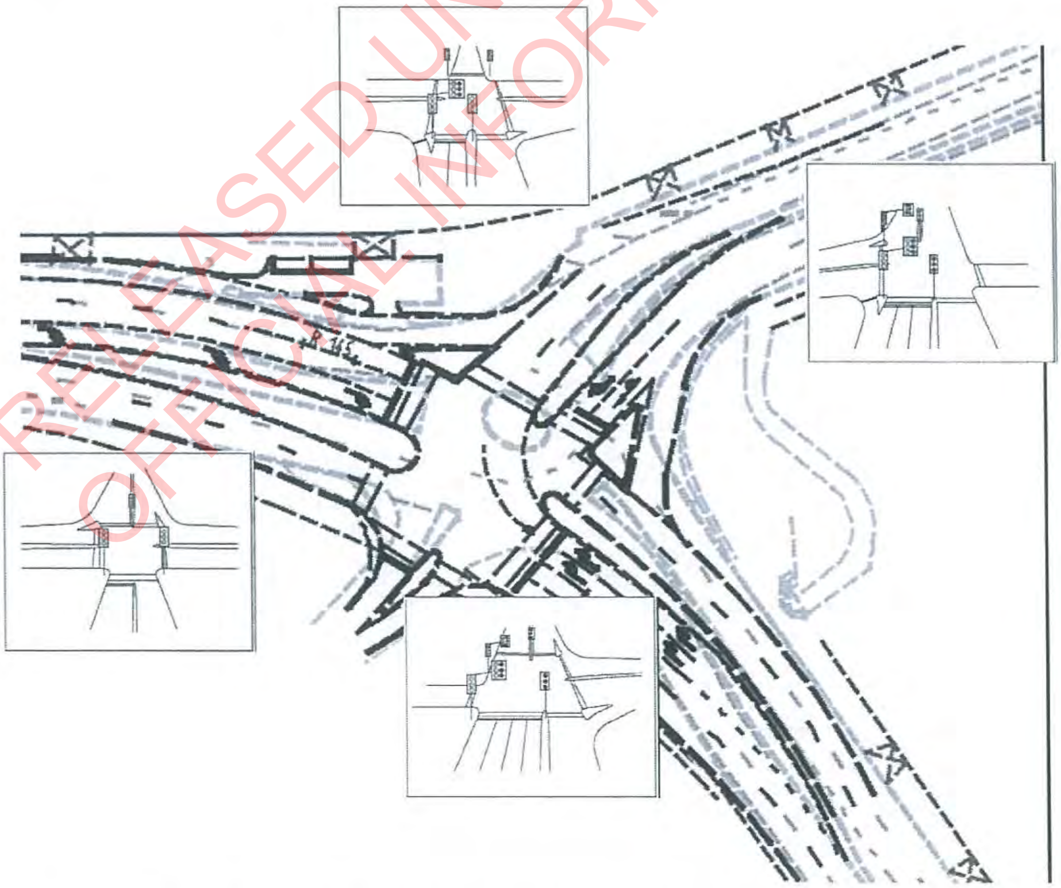

Figure 13 Proposed Signalisation Layout for Morrinsville Intersection

6.8.3 McCracken Intersection – Proposed Layout

At Cambridge Road (SH1)/ McCracken Avenue Intersection, the proposed layout includes the following features:

- a dedicated left turn lane is proposed from the southeast approach for left turning from Cambridge Road (SH1) into McCracken Avenue
- the right turn ban out of McCracken Avenue will be removed, as the right turn ban is no longer required with a signalised intersection
- one dedicated left turn and one dedicated right turn is proposed from the southwest approach for left and right turning from McCracken Avenue
- a dedicated right turn lane is proposed from the northwest approach for right turning from Cambridge Road (SH1) into McCracken Avenue
- two through lanes are proposed from the northwest approach on Cambridge Road (SH1)
- modifications to existing and installation of new medians, kerb and traffic islands are proposed to accommodate the altered geometric layout

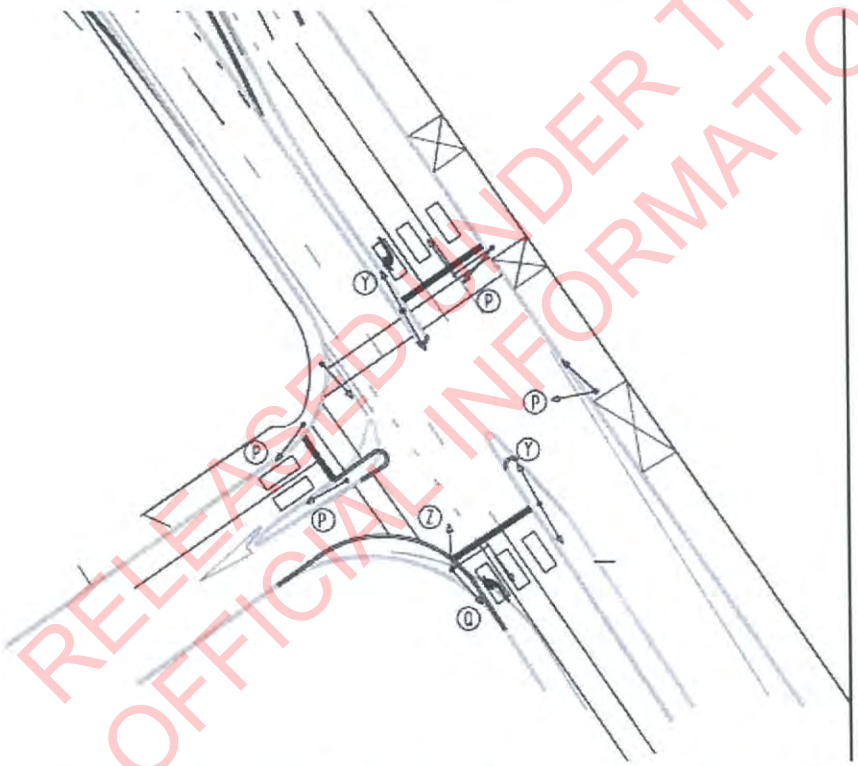

Figure 14 Proposed Signalisation Layout for McCracken Avenue Intersection

6.8.4 Capacity Improvements

A SIDRA analysis was conducted to evaluate the signalisation option, by determining estimates of capacity and performance statistics such as delay, queue lengths, degree of saturation.

Table 7~~Table 7~~, Table 8~~Table 8~~ and Table 9~~Table 9~~ provide the SIDRA outputs for 2007 existing flow, a 10% and 20% increase in traffic respectively, and are used to estimate conditions in 2017 and 2027 traffic volumes (no bypass) respectively. The signalisation option does not offer better performance than the roundabout option. The modelling results showed that the traffic signals option will generate significantly longer queues than the roundabout option.

Table 7 Intersection Performance for 2007 Existing Flow – Signalisation Option

Table 7-1 Signalisation Performance for2007 Existing Flow - Hillcrest Intersection

Option	Peak Period		Performance (DoS and 95 Percentile Queue Length in Metres)						
			DoS				Queue 95% back (m)		
			SE	NW	SW	Overall	SE	NW	SW
Signalisation	AM	Left	0.632	0.575	0.648	0.65	188	154	169
		Right	0.649	0.635	0.648		124	91	173
	IP	Left	0.351	0.484	0.501	0.50	91	120	127
		Right	0.495	0.477	0.501		85	66	134
	PM	Left	0.437	0.733	0.744	0.75	117	198	220
		Right	0.748	0.585	0.744		122	87	222

Table 7-2 Signalisation Performance for 2007 Existing Flow - Morrisville Intersection

Option	Peak Period		Performance (DoS and 95 Percentile Queue Length in Metres)								
			DoS					Queue 95% back (m)			
			SE	NE	NW	SW shop	Overall	SE	NE	NW	SW shop
Signalisation	AM	Left	0.667	0.749	0.377	0.771		198	168	25	55
		Through	0.667	0.749	0.771	0.771	0.77	198	118	178	55
		Right	0.769	0.749	0.532	0.771		68		30	55
	IP	Left	0.551	0.353	0.246	0.533		145	49	15	56
		Through	0.551	0.353	0.462	0.533	0.55	146	49	121	56
		Right	0.375	0.353	0.547	0.533		29	52	54	56
	PM	Left	0.776	0.376	0.340	0.766		215	94	26	65
		Through	0.776	0.376	0.839	0.766	0.84	215	94	254	65
		Right	0.835	0.376	0.550	0.766		76	57	67	65

Note: Red colour shows the VC ratio exceeds 0.7, i.e. congestion begins.

Table 8 Intersection Performance for 10% Flow Increase – Signalisation Option

Table 8-1 Signalisation Performance for 10% Flow Increase (2017, approx=2021 with Bypass) - Hillcrest Intersection

Option	Peak Period		Performance (DoS and 95 Percentile Queue Length in Metres)						
			DoS				Queue 95% back (m)		
			SE	NW	SW	Overall	SE	NW	SW
Signalisation	AM	Left	0.695	0.645	0.699	0.70	218	177	189
		Right	0.681	0.700	0.699		128	101	193
	IP	Left	0.386	0.544	0.543	0.54	101	135	141
		Right	0.522	0.523	0.543		87	71	148
	PM	Left	0.481	0.805	0.818	0.82	130	234	264
		Right	0.804	0.644	0.818		135	95	265

Table 8-2 1 Signalisation Performance for 10% Flow Increase (2017, approx=2021 with Bypass) - Morrinsville Intersection

Option	Peak Period		Performance (DoS and 95 Percentile Queue Length in Metres)								
			DoS					Queue 95% back (m)			
			SE	NE	NW	SW shop	)verall	SE	NE	NW	SW shop
Signalisation	AM	Left	0.721	0.824	0.429	0.843		224	191	32	61
		Through	0.721	0.824	0.872	0.843	0.90	86	191	220	61
		Right	0.897	0.824	0.605	0.843		77	129	34	61
	IP	Left	0.605	0.388	0.272	0.586		162	66	17	61
		Through	0.605	0.388	0.555	0.586	0.61	163	66	147	61
		Right	0.421	0.388	0.555	0.586		31	57	58	61
	PM	Left	0.853	0.419	0.376	0.942		265	110	29	79
		Through	0.853	0.419	0.923	0.942	0.94	265	110	336	79
		Right	0.924	0.419	0.595	0.942		80	63	72	79

Note: Red colour shows the VC ratio exceeds 0.7, i.e. congestion begins.

Table 9 Intersection Performance for 20% Flow Increase – Signalisation Option

Table 9-1 Signalisation Performance for 20% Flow Increase (2027, no Bypass) - Hillcrest Intersection

Option	Peak Period		Performance (DoS and 95 Percentile Queue Length in Metres)						
			DoS				Queue 95% back (m)		
			SE	NW	SW	Overall	SE	NW	SW
Signalisation	AM	Left	0.758	0.702	0.763	0.76	254	198	216
		Right	0.744	0.762	0.763		143	111	217
	IP	Left	0.426	0.592	0.592	0.59	113	148	159
		Right	0.592	0.541	0.592		95	76	165
	PM	Left	0.525	0.878	0.893	0.89	145	292	348
		Right	0.879	0.703	0.893		156	105	346

Table 9-2 Signalisation Performance for 20% Flow Increase (2027, no Bypass) - Morrinsville Intersection

Option	Peak Period		Performance (DoS and 95 Percentile Queue Length in Metres)								
			DoS					Queue 95% back (m)			
			SE	NE	NW	SW shop	Overall	SE	NE	NW	SW shop
Signalisation	AM	Left	0.818	0.912	0.451	0.915		276	372	32	68
		Through	0.818	0.912	0.951	0.915	1.00	276	372	282	68
		Right	1.000	0.912	0.648	0.915		85	161	37	68
	IP	Left	0.661	0.423	0.296	0.645		181	75	18	67
		Through	0.661	0.423	0.555	0.645	0.66	181	75	147	67
		Right	0.476	0.423	0.658	0.645		34	62	64	67
	PM	Left	0.935	0.496	0.398	0.918		359	122	30	82
		Through	0.935	0.496	0.985	0.918	1.00	359	122	443	82
		Right	1.000	0.496	0.637	0.918		85	74	80	82

Note: Red colour shows the VC ratio exceeds 0.7, i.e. congestion begins.

6.9 Sub-Option 2.1 Closure of Shopping Complex Entrance at Morrinsville Intersection

This sub-option is a variation of Option 2. It involves implementing the improvements proposed at Hillcrest intersection and the shopping complex entrance, i.e. south western leg of Morrinsville intersection will be closed. Access to and from the shopping complex would need to be made via McCracken Avenue.

In addition to the consultation required for the traffic signals option, this sub-option is subject to further consultation and, potentially, negotiations with the shopping complex.

6.9.1 Capacity Improvements

A SIDRA analysis was conducted to evaluate the signalisation sub-option and estimate capacity and performance statistics such as delay, queue lengths, degree of saturation.

Under existing traffic conditions (100% scenario), the performance attained by this option is essentially the same as the main signalisation option because redistribution of traffic absorbs the additional capacity released when the southwestern leg of the Morrinsville intersection is removed.

However, at 10% growth (110% scenario) and 20% (120% scenario) traffic scenarios, this sub-option provides better performance than the 4-leg signalisation option. This is because the 4-leg layout allowing movements in all directions, with imbalanced movement demands, deteriorates faster than a 3-leg layout.

This sub-option can also slightly outperform the unmetered roundabout option in the AM Peak period at 20% growth (120% scenario). Nevertheless, the addition of a meter at the SH26 Leg (northeastern approach) to the roundabout option would make the roundabout operate more effectively than this sub-option under this growth scenario because it would allow more traffic to enter the roundabout from the critical SH1 Leg (southeastern approach).

Table 10 Intersection Performance - Modified Signalisation (4th leg closed at Morrinsville Intersection)

Table 11-1 Modified Signalisation Performance for 2007 Existing Flow

Option	Peak Period		Performance (DoS and 95 Percentile Queue Length in Metres)						
			DoS				Queue 95% back (m)		
			SE	NE	NW	Overall	SE	NE	NW
Signalisation	AM	Left		0.744	0.381			185	31
		Through	0.789	0.744	0.753	0.79	234	185	178
		Right	0.733	0.744	0.234		74	186	14
	IP	Left		0.455	0.254			64	16
		Through	0.452	0.455	0.407	0.46	126	64	112
		Right	0.448	0.455	0.128		35	80	13
	PM	Left		0.636	0.343			105	30
		Through	0.511	0.636	0.789	0.79	145	105	244
		Right	0.792	0.636	0.115		86	105	7

Note: Red colour shows the VC ratio exceeds 0.7, i.e. congestion begins.

Table 11-2 Modified Signalisation Performance for 10% Flow Increase (2017, approx=2021 with Bypass)

Option	Peak Period		Performance (DoS and 95 Percentile Queue Length in Metres)						
			DoS				Queue 95% back (m)		
			SE	NE	NW	Overall	SE	NE	NW
Signalisation	AM	Left		0.819	0.425			226	38
		Through	0.868	0.819	0.808	0.87	296	226	205
		Right	0.820	0.819	0.255		83	226	15
	IP	Left		0.501	0.282			74	20
		Through	0.497	0.501	0.447	0.50	140	74	124
		Right	0.483	0.501	0.139		38	88	14
	PM	Left		0.704	0.384			120	36
		Through	0.562	0.704	0.868	0.87	165	120	313
		Right	0.870	0.704	0.126		99	120	8

Note: Red colour shows the VC ratio exceeds 0.7, i.e. congestion begins.

Table 11-3 Modified Signalisation Performance for 20% Flow Increase (2027, no Bypass)

Option	Peak Period		Performance (DoS and 95 Percentile Queue Length in Metres)						
			DoS				Queue 95% back (m)		
			SE	NE	NW	Overall	SE	NE	NW
Signalisation	AM	Left		0.895	0.467			291	44
		Through	0.947	0.895	0.904	0.95	399	291	259
		Right	0.890	0.896	0.277		95	291	16
	IP	Left		0.548	0.309			85	22
		Through	0.543	0.548	0.488	0.55	156	85	137
		Right	0.534	0.548	0.151		42	95	15
	PM	Left		0.774	0.423			137	43
		Through	0.613	0.774	0.947	0.95	186	137	428
		Right	0.954	0.774	0.137		100	137	8

Note: Red colour shows the VC ratio exceeds 0.7, i.e. congestion begins.

Table 11 Degree of Saturation comparison for Morrinsville Intersection for Major Approaches - 2007

Time & Approach / Option	AM Peak, Southeast Approach	PM peak, Northeast Approach (Left Turn)	PM peak, Northwest Approach
Keep open the shopping complex leg.	**0.769**	**0.376**	**0.839**
Close the shopping complex leg.	**0.733**	**0.636**	**0.789**

The closure of the shopping complex leg resulted in minor improvements in the degree of saturation for major approaches. It also increased the degree of saturation for some movements.

6.9.2 Discussion

The signalisation options proposed have the following advantages:

- improves capacity and operation of the existing roundabouts
- traffic signals enable the active management of travel demands and priority can be given to through movement on State Highway 1
- signals allow better provisions for cyclists and pedestrians than at roundabouts; signals are generally safer for cyclists and pedestrians than roundabouts

On the other hand, the signalisation option proposed has the following disadvantages:

- signalisation option has higher capital and maintenance costs than roundabouts option
- the signalisation option does not safely allow u-turns to be made at the two intersections, traffic wishing to access the school on the southern side of the State Highway will be required to perform U-turn elsewhere on the network.
- the stakeholders were not previously consulted on the signalisation option, therefore the consultation process will need to be recommenced and the change in project direction will need to be conveyed to the public
- the signalisation options will increase the average delay during off-peak and interpeak, therefore increasing the vehicle operation and travel time costs of the travelling public
- traffic signal is not the most common form of intersection control in the project area, therefore it is likely that the delays imposed on the travelling public will cause public criticism
- the signalisation of McCracken Avenue is considered necessary to enable successful implementation of the signalisation option overall

The sub-option of closing the shopping complex leg of Morrinsville intersection has relative performance merits compared with the signalisation option. While the closure of the shopping complex leg is beneficial to the intersection performance at higher growth scenarios, it will reroute traffic accessing the shopping complex. Therefore, there will be additional travel time and vehicle operating costs imposed on the diverted traffic.

6.10 Speed and Vehicle Delay Comparison of Various Options

Table 12~~Table 12~~ below shows the modelled speeds under 2007 existing traffic flow and 20% increase in flow for existing intersection, proposed roundabout option, proposed signalisation option and modified signalisation option, which closes the shop complex leg. This shows the roundabout option improves the average traffic speed compared to the signalisation options.

Table 12 Option Modelled Speeds Comparison

Table 13-1 Modelled Speeds Comparison for Existing Flow (km/h)

From	To	AM				IP				PM			
		Exist-ing	Round-about	Signals	Mod. Signals	Exist-ing	Round-about	Signals	Mod. Signals	Exist-ing	Round-about	Signals	Mod. Signals
1	3	54	56	52	49	55	63	51	57	45	61	48	44
1	4	54	59	43	41	58	56	40	41	52	57	42	38
2	3	50	58	50	47	57	56	50	55	48	58	50	47
2	4	52	55	51	41	56	53	41	42	48	53	43	41
4	1	33	51	34	37	60	55	36	35	52	54	34	33
4	2	38	52	51	49	61	54	48	47	56	55	45	47
3	1	44	52	31	33	51	49	34	43	37	53	29	31
3	2	49	50	45	44	57	59	42	45	45	54	46	45
Weighted Average Speed		**45**	**53**	**46**	**44**	**58**	**55**	**44**	**45**	**50**	**55**	**43**	**41**

Table 13-2 Modelled Speeds Comparison for 20% Flow Increase (km/h)

From	To	AM				IP				PM			
		Exist-ing	Round-about	Signals	Mod. Signals	Exist-ing	Round-about	Signals	Mod. Signals	Exist-ing	Round-about	Signals	Mod. Signals
1	3	52	58	41	44	54	56	47	48	44	56	39	42
1	4	57	56	33	37	64	55	39	41	43	58	35	35
2	3	48	56	44	48	59	55	48	51	19	51	45	41
2	4	48	55	38	40	58	54	40	40	21	53	43	38
4	1	20	26	31	33	52	56	35	35	23	52	22	29
4	2	22	28	41	47	58	54	48	45	28	55	34	45
3	1	30	52	22	27	47	49	30	31	28	52	25	25
3	2	35	51	32	41	55	57	45	44	29	53	45	42
Weighted Average Speed		**37**	**44**	**36**	**41**	**57**	**55**	**43**	**42**	**27**	**54**	**37**	**38**

Vehicle delay outputs from the SIDRA model were also analysed for the two main options and the signalisation sub-option, i.e.:

- 2 ½ Lane Roundabout
- Signalisation
- Signalisation sub-option (which involves closure of Morrinsville Intersection's southwestern leg)

- The signalisation options imposes similar amount of delay onto motorists, while the three-leg sub-option imposes slightly less delay during pm-peak and inter-peak than the four-leg option. On the other hand, the three-leg sub-option imposes more delay during am-peak than the four-leg option.
- The signalisation options impose very significant delays compared with the roundabout option. Based on the SIDRA outputs, the signalisation options are likely to impose delay three times that of the roundabout option in most situations.
- Even though highly co-ordinated traffic signals may be more efficient than roundabouts along a heavily trafficked corridor with minor crossing traffic, the traffic profile at the two intersections investigated favours roundabout, in terms of both delay and degree of saturation.

Table 13 Modelled Hourly Vehicle Delay Comparison - Signalisation and Roundabout

Table 13-1 Option Hourly Vehicle Delay Comparison – AM Period

Year	Delay (Signals) (veh-hr/hr)	Delay (Roundabout) (veh-hr/hr)	Delay Comparison (Signals ÷ Roundabout)	Difference in Delay Signals and Roundabout (veh-hr/hr)	Annual Increase in Delay (veh-hr/hr)	Annual Increase in Delay (%)
2007	70.6	23.6	3.0	47.0		
2008	71.8	24.1	3.0	47.7	0.8	1.6%
2009	73.1	24.6	3.0	48.5	0.8	1.6%
2010	74.4	25.2	3.0	49.2	0.8	1.6%
2011	75.7	25.7	2.9	50.0	0.8	1.5%
2012	77.0	26.2	2.9	50.8	0.8	1.5%
2013	78.3	26.7	2.9	51.5	0.8	1.5%
2014	79.5	27.3	2.9	52.3	0.8	1.5%
2015	80.8	27.8	2.9	53.0	0.8	1.4%
2016	82.1	28.3	2.9	53.8	0.8	1.4%
2017	83.4	28.8	2.9	54.5	0.8	1.4%
2018	85.8	30.2	2.8	55.5	1.0	1.8%

Year	Delay (Signals) (veh-hr/hr)	Delay (Roundabout) (veh-hr/hr)	Delay Comparison (Signals ÷ Roundabout)	Difference in Delay Signals and Roundabout (veh-hr/hr)	Annual Increase in Delay (veh-hr/hr)	Annual Increase in Delay (%)
2019	88.2	31.7	2.8	56.5	1.0	1.8%
2020	90.6	33.1	2.7	57.6	1.0	1.8%
2021	83.4	28.8	2.9	54.5	-3.0	-5.2%
2022	85.8	30.2	2.8	55.5	1.0	1.8%
2023	88.2	31.7	2.8	56.5	1.0	1.8%
2024	90.6	33.1	2.7	57.6	1.0	1.8%
2025	93.0	34.5	2.7	58.6	1.0	1.7%
2026	95.4	35.9	2.7	59.6	1.0	1.7%
2027	97.9	37.3	2.6	60.6	1.0	1.7%
2028	100.3	38.7	2.6	61.6	1.0	1.7%
2029	102.7	40.1	2.6	62.6	1.0	1.6%
2030	105.1	41.5	2.5	63.6	1.0	1.6%
2031	107.5	42.9	2.5	64.6	1.0	1.6%
2032	110.8	45.2	2.4	65.6	1.0	1.5%
2033	114.1	47.5	2.4	66.5	1.0	1.5%

Table 13-2 Option Hourly Vehicle Delay Comparison – IP Period

Year	Delay (Signals) (veh-hr/hr)	Delay (Roundabout) (veh-hr/hr)	Delay Comparison (Signals ÷ Roundabout)	Difference in Delay Signals and Roundabout (veh-hr/hr)	Annual Increase in Delay (veh-hr/hr)	Annual Increase in Delay (%)
2007	43.6	13.6	3.2	30.1		
2008	44.2	13.7	3.2	30.5	0.4	1.2%
2009	44.8	13.9	3.2	30.8	0.4	1.2%
2010	45.3	14.1	3.2	31.2	0.4	1.2%
2011	45.9	14.3	3.2	31.6	0.4	1.2%
2012	46.4	14.5	3.2	31.9	0.4	1.2%
2013	47.0	14.7	3.2	32.3	0.4	1.1%
2014	47.6	14.9	3.2	32.6	0.4	1.1%
2015	48.1	15.1	3.2	33.0	0.4	1.1%
2016	48.7	15.3	3.2	33.4	0.4	1.1%
2017	49.2	15.5	3.2	33.7	0.4	1.1%
2018	49.7	15.7	3.2	34.1	0.3	1.0%
2019	50.2	15.9	3.2	34.4	0.3	1.0%
2020	50.8	16.0	3.2	34.7	0.3	0.9%
2021	49.2	15.5	3.2	33.7	-1.0	-2.8%
2022	49.7	15.7	3.2	34.1	0.3	1.0%
2023	50.2	15.9	3.2	34.4	0.3	1.0%
2024	50.8	16.0	3.2	34.7	0.3	0.9%
2025	51.3	16.2	3.2	35.0	0.3	0.9%
2026	51.8	16.4	3.2	35.4	0.3	0.9%
2027	52.3	16.6	3.2	35.7	0.3	0.9%
2028	52.8	16.8	3.1	36.0	0.3	0.9%
2029	53.3	17.0	3.1	36.3	0.3	0.9%
2030	53.8	17.1	3.1	36.7	0.3	0.9%
2031	54.3	17.3	3.1	37.0	0.3	0.9%
2032	54.9	17.5	3.1	37.3	0.4	1.0%
2033	55.4	17.7	3.1	37.7	0.4	1.0%

Table 13-2 Option Hourly Vehicle Delay Comparison – PM Period

Year	Delay (Signals) (veh-hr/hr)	Delay (Roundabout) (veh-hr/hr)	Delay Comparison (Signals ÷ Roundabout)	Difference in Delay Signals and Roundabout (veh-hr/hr)	Annual Increase in Delay (veh-hr/hr)	Annual Increase in Delay (%)
2007	75.1	22.3	3.4	52.8		
2008	77.2	22.8	3.4	54.4	1.6	3.0%
2009	79.2	23.3	3.4	55.9	1.6	2.9%
2010	81.3	23.8	3.4	57.5	1.6	2.8%
2011	83.4	24.3	3.4	59.1	1.6	2.7%
2012	85.4	24.8	3.4	60.6	1.6	2.7%
2013	87.5	25.3	3.5	62.2	1.6	2.6%
2014	89.6	25.8	3.5	63.8	1.6	2.5%
2015	91.6	26.3	3.5	65.3	1.6	2.5%
2016	93.7	26.8	3.5	66.9	1.6	2.4%
2017	95.8	27.3	3.5	68.5	1.6	2.3%
2018	99.3	28.3	3.5	71.0	2.6	3.7%
2019	102.8	29.3	3.5	73.6	2.6	3.6%
2020	106.4	30.2	3.5	76.1	2.6	3.5%
2021	95.8	27.3	3.5	68.5	-7.7	-10.1%
2022	99.3	28.3	3.5	71.0	2.6	3.7%
2023	102.8	29.3	3.5	73.6	2.6	3.6%
2024	106.4	30.2	3.5	76.1	2.6	3.5%
2025	109.9	31.2	3.5	78.7	2.6	3.4%
2026	113.5	32.2	3.5	81.3	2.6	3.3%
2027	117.0	33.2	3.5	83.8	2.6	3.2%
2028	120.6	34.2	3.5	86.4	2.6	3.1%
2029	124.1	35.1	3.5	89.0	2.6	3.0%
2030	127.7	36.1	3.5	91.5	2.6	2.9%
2031	131.2	37.1	3.5	94.1	2.6	2.8%
2032	136.1	38.5	3.5	97.7	3.6	3.8%
2033	141.0	39.8	3.5	101.2	3.6	3.7%

6.11 Risk Assessment

A comprehensive risk assessment was undertaken in accordance with Transit's Risk Management Process Manual AC/Man/1. The Risk Register is included in Appendix I.

The project risks with high rank are summarised in the table below:

Table 14 Highly Ranked Project Risks

Item	Risk	Likelihood / Severity	Mitigation
2	Final Project Costs: Final project costs exceed funding	Unlikely / Major	Risk management, Quality management & financial management, appropriate project budgeting, peer review of estimate.
3	Oil price fluctuation	Unlikely / Major	Increase in the price of crude oil will affect all products price, esp. bitumen and diesel. Allowance in the cost estimate.
4	Property Acquisition: Property yet to be acquired from several property owners.	Unlikely / Major	Early identification of land requirements and minimisation of land requirements in design.
6	Property economic value: Land value increases substantially	Quite Common / Major	Rationalise design to minimise land take. Purchase land required early.
7	Access Agreement with Shopping Complex: Delays are caused due to issues surrounding existing access closure clause on MoU with Shopping Complex owners	Quite Common / Major	Effective consultation; good communication with Transit's property acquisition agent. Requirements and constraints to be developed after consultation with the Shopping Complex Owners. Phasing and buildability to be investigated fully during design phase. Contractor will be required to develop a work methodology to minimise disruption.
1	Compulsory purchase required; has implications for time/cost.	Unusual / Substantial	Maintain property purchase strategy
5	Site Flexibility: Inadequate space available for service relocation	Unlikely / Major	Services to be located very accurately; refine design. Investigate other options, i.e. leave insitu and protect.

7. ECONOMIC EVALUATION

7.1 General

The options presented have been analysed in accordance with Land Transport New Zealand's (LTNZ) (previous Transfund) Economic Evaluation Manual (EEM) using a full procedure benefit/cost analysis. The options have been compared against the 'Do Minimum' option of maintaining the current intersection layout. Refer to Appendix K for the evaluation worksheets.

Benefits have been derived mainly from Travel Time Savings and Vehicle Operating Cost Savings, i.e. congestion relieve at the intersections, with a small proportion attributed to reduction in accidents and the provision of cycling facilities.

7.2 Do Minimum Option

The 'do minimum' option involves the continued maintenance of two intersections and the highway linking them. It has been assumed that maintenance costs will be similar for both the do-minimum option and the roundabout option. For the purposes of comparison, these costs would cancel each other out. For the signalisation option, an extra annual maintenance cost occurs compared with do-minimum due to the operation of signals. As such, the maintenance costs of do-minimum and roundabout have been taken as nil and the incremental maintenance costs of the signalisation option is adopted in the worksheets.

7.3 Project Cost

7.3.1 Basis of Estimate

Cost estimates were prepared in accordance with Transit New Zealand's Cost Estimation Manual (SM014), which includes an expected estimate and 95th percentile estimate. The 95th percentile estimate includes an allowance for funding risk. All worksheets of cost estimates are included in Appendix J.

Rates for the items were assessed from experience and reviewed by professionals with local knowledge. Volumes, earthworks, kerb lengths and pavement areas were extracted from the scheme drawings based on topographical survey information and are subject to revision at the detailed design stage.

Contingencies of 25% for earthworks and 15% for other works were used for the construction cost estimate in accordance with LTNZ EEM manual. Contingencies have been assessed to allow for possible cost increases and uncertainties of cost estimates in accordance with Transit's Contingency Policy Guidelines.

As per Transit's request, we have prepared cost estimates on the basis of the construction of both Hillcrest and Morrinsville Intersections and the rehabilitation of the associated connecting pavements on SH1. Thus, all these works are considered to be a single project.

The cost estimates were prepared on the basis of using an AC overlay asphalt paving method. This method is considered to be advantageous due to its speed of construction, ability to be trafficked soon after and consequential minimal effect on traffic.

In the case of the Roundabout option with metering at both Hillcrest and Morrinsville intersection, the cost of the meters themselves was not included in the estimate due to the fact that meters would not be introduced for some time (about 2021). The costs of preliminary works which would allow for future installation of roundabout metering (underground ducting, etc) have been allowed for in the cost estimate for this option.

7.3.2 Cost Summary

The cost estimate including professional fees and contingencies shows an Expected Estimate of $3,953,704 for the roundabout option and $4,531,573 for the signalisation option in year 2007. The present value of costs is the same as expected estimated as the construction period is likely to be less than 6 months.

Table 15 Undiscounted Capital Cost Summary

Table 15-1 Undiscounted Capital Cost Summary - Roundabout Option

Item	Base Estimate ($)	Expected Estimate (with Contingency) ($)	95th Percentile Estimate (with Funding risk) ($)
Project Property Cost	126,000	157,500	183,618
I & R	50,000	55,000	58,061
D & PD	85,000	93,500	98,337
MSQA	35,000	38,500	40,500
Physical Works	3,192,565	3,678,113	3,963,524
Total	3,453,565	4,022,613	4,344,041

Table15-2 Undiscounted Capital Cost Summary - Signalisation Option

Item	Base Estimate ($)	Expected Estimate (with Contingency) ($)	95th Percentile Estimate (with Funding risk) ($)
Project Property Cost	211,838	264,797	307,677
I & R	50,000	55,000	58,039
D & PD	85,000	93,500	98,395
MSQA	35,000	38,500	40,536
Physical Works	3,684,619	4,267,188	4,476,523
Total	4,066,456	4,718,985	4,981,171

Provisional construction of a stairwell for the proposed pedestrian underpass at Morrinsville intersection and land purchase costs has been included in the cost estimate for both options.

7.4 Benefits

7.4.1 Travel Time and Vehicle Operating Costs

In order to calculate the travel time costs (TTC) and vehicle operating costs (VOC) certain assumptions have been made which are considered to be reasonable. In addition, our economic assessment presented in this report is different from Project Feasibility Report. This is because some of the earlier assumptions were reviewed and revised, as better information were obtained during the investigation phase.

Shorter peak durations than those assumed in the PFR have been used. Analysis of the traffic counts and other count data indicate that in actuality, there are four distinct time periods evident from the traffic flow profile, i.e. AM, PM, interpeak and evening. The time periods are listed below:

- 1 hour AM peak period: 7:45 - 8:45
- 2 hours PM peak period: 16:45 - 18:45
- 10 hours Interpeak period: 6:45-7:45, 8:45-16:45, 18:45-19:45
- 11 hours evening period: 19:45-6:45

The peak periods are significantly shorter than those assumed in the PFR report. As such, travel time cost savings were reduced.

There are 250 weekdays and 115 weekend days annually. Each weekend day is assumed to have one interpeak period and one evening period. There are then 250 AM and PM peaks per year and 365 interpeak periods per year.

The evening period was not explicitly microsimulated. The analysis of the ratio between evening peak delay was carried out. The results of analysis show that the total vehicle delay and total cost of evening time as follows:

- Total Vehicle Delay/Total Cost in evening peak = 1% × Total Vehicle Delay/Total Cost in interpeak period
- Vehicle Delay Cost per hour was calculated as follows:

  Vehicle Delay Cost = base value of time (VOT) + congestion cost (CRV)

The composite values of travel time and congestion (as per EEM Table A4.3) are adopted.

For interpeak times, weekday and weekend values are used, i.e.:

- Vehicle delay cost for interpeak = (250 × weekday interpeak value + 115 × weekend value) ÷ 365.
- Vehicle delay cost for evening = (250 × weekday evening value + 115 × weekend value) ÷ 365.

Values for base value of time, CRV and delay cost which have been used in the assessment are as follows in

Table 16

~~Table 16~~:

Table 16 Economic Assessment Cost Values

Time Period	Base VOT ($/h)	CRV ($/h)	Delay Cost ($/h)
AM	15.13	3.88	19.01
PM	14.96	3.79	18.75
Interpeak	16.73	3.82	20.55
Evening	14.67	3.87	18.54

7.4.2 Accident Costs

The current accident costs of the Hillcrest & Morrinsville Intersections were calculated from accident data retrieved from LTNZ CAS. The accident by accident method was adopted for the do-minimum option and the accident rate method was used for the options.

The accident growth rate was assumed to be -2%, as the traffic growth rate is around 1% annually, and according to EEM Table A6.1(b), the modification allowance is -3% for areas with speed restrictions of 50 and 60 Km/h.

Accident costs for the do minimum option and proposed options are given below:

Table 17 Present Value of Accident Costs

Option	PV Accident Cost ($000)
Do Minimum	2,153,757
2½ lane Roundabout	2,055,681
Signalisation	2,537,782

7.4.3 Cycling/Walking Benefits

Growth Rate

Population Growth – Census data has shown that Hamilton is one of the fastest growing cities in New Zealand. The average annual growth rate over the last 10 years (from 1996 to 2006) is 1.9%, which is higher than the national level 1.3%. A 1.1% annual growth rate in Hamilton is projected for the period of 2006 to 2026 according to Statistics New Zealand.

Cyclist/Pedestrian Growth – The number of pedestrians and cyclists is assumed to be in direct proportion to population. It is anticipated that an increase in residential development in the vicinity of the project site and improved access and cycling/ walking facilities will result in higher walking and cycling demand.

Hamilton City has a well developed cycling network. Council supports the continuous improvement of facilities for cycling, both on and off-street, to ensure that there is a balance between cycling and other modes of transport, as set out in Hamilton's Integrated Transport Strategy. The provision of improved cycle facility in the study area will promote cycling as a safe, environmentally friendly and healthy alternative mode of transport. The walking and cycling growth rate is expected to increase with the walking and cycling improvements associated with the project. It is considered that the number of cyclists in Hamilton estimated based on national statistics would be at a reasonable level.

In addition, Hillcrest Normal School, which has 550 pupils and staff, is currently involved in School Walking Bus project. In many areas, school cycle traffic is likely to be a significant proportion of the total cycling. If not, a poor cycling environment is likely to be suppressing use.

Therefore, the population growth rate of 1.1% is adopted for walking and cycling over a 25 year evaluation period. It is expected the number of cycling/pedestrian will increase with the implementation of demand related intervention. Therefore, it is considered that a 1.1% growth rate is considered to be conservative and appropriate.

Household Travel Survey
The 2003-2006 New Zealand household travel survey (HTS) found the national average of all trips was 1.0% by cycle, 16% by walking and 54% are vehicle drivers[3]. At the absent of the site survey information, the HTS results are used for the evaluation of cycling/walking benefits.

Cycling Benefits
Currently, the cycling routes are provided along Morrinsville Road between SH1 and Silverdale Road, and Cambridge Road between Dey Street and Masters Avenue. The provision of about 3km on / off road cycle facility between two intersections will provide a network of cycle routes between Morrinsville and Hamilton to enhance cycle route connectivity and permeability in the city.

Improvement Description – There are two main types of cycling improvements proposed.

- Provision of cycle facilities under both Signalisation and Roundabout options
- Cycle intersection improvements at both intersections under Signalisation option

Benefits – There are two types of benefits relating to the cycling improvements[4]:

1. New cycle facility: a composite benefit of $0.3 per cyclist per km of new cycle facility for all cyclists.
2. Improving a site to enable safer cycling: a benefit of $0.9 for all cyclists using the facility.

These benefits are applied to workdays (250 per year).

Walking Benefits
Improvement Description – For the signalisation option, the safety of pedestrians will be improved significantly at the intersection crossings.

Benefits – The main benefits relating to walking improvements: [5]:

- Improving a site to provide for safer walking: a benefit of $0.5 for new pedestrians using the facility.

These benefits are applied to workdays (250 per year).

Summary

[3] Comparing Travel Mode, Household Travel Survey, Ministry of Transport, Jan 2008
[4] Economic Evaluation Manual, Volume 2, LTNZ, 2007
[5] Economic Evaluation Manual, Volume 2, LTNZ, 2007

The benefits gained from the provision of cycling facilities under Roundabout option would be in a order of 50k-100k, and would be much higher for the signalisation option as the great safety improvements at the crossing.

Considering the lack of reliable data, the cycling and walking benefits were not included in this BCR calculation. As the benefits are insignificant, the calculated BCR's will not be affected significantly.

7.4.4 Evaluated Benefits

The benefits were evaluated using the EEM Manual with 25 years evaluation period. The corresponding worksheets are included in Appendix K – Economic Evaluation.

The present value of each benefit for 25 years and the proportion in total are as follows:

Table 18 Net Present Value of Benefits

Benefits	Roundabout		Signalisation	Modified Signalisation
	Present Value ($000)	Proportion	Present Value ($000)	Present Value ($000)
TTC Savings	10,009	68%	-23,315	-19,050
VOC Savings	3,589	24%	-3,045	-279
Accident Cost Savings	98	1%	-384	-384
CO2 Savings	179	1%	-152	-14
Total	13,875	100%	-26,897	-19,727

7.5 Benefit/Cost Analysis

7.5.1 B/C Analysis Results

The Benefit Cost Ratio (BCR) for the roundabout option is estimated to be 3.8 and the First Year Rate of Return (FYRR) is 15%. The BCR is -6.3 for the signalisation option, and -4.6 for the modified signalisation option.

7.6 Independent Peer Review of Economic Evaluation

Transit New Zealand commissioned an independent party to carry out an Independent Peer Review of the Economic Analysis in the previous SAR (Barry Coghlan, 2004), the main purpose of which is to provide independent confirmation of the stated benefit cost ratio.

The recommendations contained therein are summarised as follows:

1. Demonstrate that the model is calibrated against existing traffic conditions.
2. Evaluate the interpeak and evening periods explicitly, rather than using factoring. Provide a flow profile to demonstrate how the annual flow breakdown was calculated.
3. Provide the full model output results.
4. Assess the likely timing of the bypass, and include this in the evaluation assumptions, along with sensitivity tests as to alternative timing.

5. Provide separate justification for the rehabilitation of the existing pavement between the intersection works.
6. Interpolate the model results for each individual year, and then discount each year to provide the total result over the 25 year analysis period.
7. Provide an incremental B/C justification for the free-left-turn on the Morrinsville Road approach.
8. Some of the above changes will increase the B/C Ratio, while others will decrease it. It is difficult to assess the net effect based on the data given, however it is considered highly unlikely that the project would not easily achieve a fundable B/C.

A meeting was held between the Peer Reviewer, the Client and the Evaluators (Resolve Group) to discuss the issues and recommendations contained in the Peer Review Report and the Evaluator's response. An Evaluators Response Report (Resolve Group, 2005) was then finalised, addressing all of the issues raised in the Peer review Report (See Appendix L). The Peer Reviewer had verbally confirmed (in 2005) that the responses were acceptable.

7.7 Summary & Discussion

Roundabout Option

The economics evaluation demonstrated that significant travel time savings and vehicle operating costs savings can be attained through implementation of the 2½ lane roundabout improvements at both the Hillcrest and Morrinsville intersections, thus improving the overall efficiency & trip reliability in the area. This is consistent with the project objectives as per the RFT. In addition, the capital cost is significant lower than for signalisation. Furthermore, the option of adding signal metering in the future presents an opportunity to add capacity to deal with traffic growth in the longer term.

The 2½ lane roundabout improvement option is likely to reduce the number of crashes at both intersections and produce accident cost savings.

Provisions for cyclists and pedestrians have been made for this option. The costs of the facilities have been included in the economic analysis, but the assessed benefits are not included in the economic analysis due to the difficulties in accurately assessing the level of walking and cycling demand. A slightly higher BCR can be obtained if these benefits are included in the economic analysis.

The assessed BCR is 3.9 and the FYRR is 15%.

Signalisation Options

The traffic modelling results of the signalisation options demonstrated that the options do not produce any travel time, vehicle operating and accident cost savings. The model indicated that signalisation will increase travel time and delay at the intersections compared with the existing situation, particularly during the interpeak period. The negative costs savings resulted in negative BCR's for these options.

The assessed BCR is -6.3 for the signalisation option, and -4.6 for the modified signalisation option.

Despite the negative BCR's, the signalisation options enable Transit to actively management traffic at the intersections. This strategic benefit needs to be taken into account for determining the preferred option.

8. CONSULTATION

8.1 Previous Consultation

This consultation summary follows on from that undertaken for the first SAR in 2004. For this second SAR, no specific consultation was required by the client. This section reviews the consultation already done, and maps out future consultation that may be required before the detailed design phase is undertaken.

During the consultation for the first SAR, stakeholders were consulted on the 2½ lane Roundabout as the preferred option. The other options had been ruled out by the earlier Scoping Report so were not consulted on.

For this second SAR, the signalised intersection option at both intersections has been more fully examined than in the previous SAR. This option has not been fully presented to stakeholders and therefore feedback has not been received on it. The consultation treatment for this option is discussed later in this section.

8.2 Purpose of the Consultation

To reiterate from the first SAR, the purpose of consultation for this project is to:

i) show respect for the needs, views and concerns of individuals, communities and stakeholders, and
ii) To improve the quality of Transit's decisions and to effectively respond to stakeholder and community needs.

8.3 Objectives of this Consultation

The specific objectives of the consultation on the Hillcrest & Morrinsville Road Intersection Improvements project were to find out what are the needs, views and concerns of the key stakeholders in terms of how they may be affected by the proposed works.

The groups and individuals were given the opportunity to voice their concerns through written face to face meetings and written correspondence where preliminary design ideas were presented in an open and transparent manner. These groups and individuals were invited to offer their feedback on the ideas presented. The comments, views and concerns received were compiled and genuinely considered, making the process of decision-making by Transit and Resolve Group more clearly defined and robust.

8.4 Key Stakeholders

Consultation with interested and affected parties for the purposes of the Resource Management Act (RMA) was focussed on the following parties:

- Physically Affected Parties (landowners whose properties are directly affected)
- Territorial Local Authorities (Hamilton City Council, Environment Waikato)
- Known Interested or Affected Parties (e.g. Cycle Action Waikato)
- Iwi Groups
- Network Utility Companies
- NZ Police

All relevant utility operators were contacted in February 2004, advising them about the project and to determine whether or not they had services which may be affected by the works. Replies were received from Telecom, NGC, Telstra Clear, WEL Power and Hamilton City Council (HCC). Based on the information received, it not considered that any substantial service relocations will be required as a result of the proposed works. Appropriate liaison will be maintained with those utility operators who are likely to be affected during the design phase, if any.

8.5 Summary of Consultation Issues

Consultation has been carried out to identify issues concerning landowners and other parties who may be affected by any road intersection works.

At present, there appears to be a limited number of landowners who would be affected by the proposed options in this report. Most significantly:

- Hamilton City Council (affected land is on the eastern side of the Morrinsville intersection and contains a footpath down to the underpass entrance);
- Shop owners to the north of the Morrinsville intersection (affected land is a lay-by parking area which caters to the shops);
- Owners of the Hillcrest Shopping Centre property;
- Narrow segments of privately owned land on the western and southern boundaries of the Hillcrest intersection may be required for the signalised option.

A summary of Iwi consultation is presented in Section 8.7.

Table 19~~Table 19~~ below identifies the key stakeholders consulted during the first SAR's Investigation & Reporting Phase of the Hillcrest & Morrinsville Road Intersection Improvements Project. No subsequent consultation has been carried out for this second SAR. The table includes the issues raised and how they were subsequently dealt with. Copies of correspondence received from affected parties and stakeholders have been included in Appendix M of this report.

Table 19 Summary of Consultation Issues

Party Consulted	Issue Raised	How Issue has Been Dealt With
Environment Waikato Bill McMaster, (Senior Planner Land Transport), Madeleine Alderton	Concern over whether project would be Compatible with EW's Cycling & Walking Strategy.	Provision of cycle lanes where none existed before. Improved pedestrian crossing facilities at roundabout entrances and exits. Means overall improvements for cyclists and pedestrians.
A letter was sent by Transit to Environment Waikato at the first SAR stage confirming the changes made to the proposal as a result of comments received. The following summarises the outcomes of the resulting discussions. No immediate reply was received. A phone call was placed by Resolve Group to Bill McMaster. Bill indicated that he had no further concerns regarding the revised proposal. It was understood that EW would provide written comment if any further issues had arisen. None were received.		

Party Consulted	Issue Raised	How Issue has Been Dealt With
Hamilton City Council Cliff Boyt (then Roads & Traffic Manager)	Expressed interest in the effects of education-related traffic, and that it should be noted that the area is a large catchment for schools.	Improved pedestrian facilities, as well as cycle lanes have been introduced, improving the safety for students using them. Improved capacity during peak flows would tend to have a positive effect on traffic coming to/from the schools in the area.
Nick Evetts (Network Development Manager)	Expressed concern that it would be good to undertake the works under this contract along with plans to underground overhead power reticulation in the area.	It has been established that the contract area does not have any remaining overhead powerlines.
	Hamilton City Development Manual should be used when considering local standards for roadside amenities i.e. catchpits, footpaths, drainage, etc. Transit roads in Hamilton are seen as being part of the HCC network.	Resolve Group has employed standards as per this manual.
Andrew McKillop (Traffic Manager)	Expressed concern on issue of safety of the lay-by parking area for shops at Morrinsville intersection: visibility is poor when exiting parking area. Getting in and out of the area is not ideal. Would like to see things change in this respect.	Lay-by parking arrangement has been significantly altered: includes angle parking, elimination of right turn movement from parking area. Left turn movement now facilitated by separated slip lane.
Helen Bailey (Landscape Architect, HCC)	That new planting scheme should be done in accordance with HCC Planting Guidelines for City Street Beautification.	Consideration has been made on this matter. Planted species will be in accordance with this document, and will be chosen to minimise visibility obstructions at the intersections.
A letter was sent at the first SAR stage to Hamilton City Council (from Transit) confirming the changes made to the proposal as a result of comments received. The following summarises the outcomes of the resulting discussions:		
Hamilton City Council continued. Meeting was held 17 August at Hamilton City offices with Transit, Andrew O'Brien (Traffic Designer for Resolve Group). Roger Ward (current Roads & Traffic Manager), Nick Evetts, Andrew McKillop	New concerns regarding the following: 1. That the limit lines for the 4th leg (Burger King) would appear to need to be set back 4 to 5 metres and that the central hub should be larger/egg shaped to constrict and provide sufficient deflection for traffic exiting from the shopping complex. 2. Some concerns with the proposed deflections for northbound traffic on Cambridge Rd/SH1 at both intersections.	The preceding issues were examined by Andrew O'Brien (AOB), who provided the following:
	3. Concern over the necessity of the slip lanes. Hamilton city wants confidence that the slip lanes are essential to the design. This is because they see them as posing	AOB: Response – The slip lanes are necessary because they will remove and reallocate some congestive traffic from the approaches where they are introduced. In addition, traffic islands

Party Consulted	Issue Raised	How Issue has Been Dealt With
	significant safety risks for pedestrians and are not yet convinced that they will contribute significantly to capacity improvements. 4. Concern over the tightness caused by the central hub, particularly its effect on the southbound manoeuvre (right turn) from Cobham Dr to Cambridge Rd.	at these locations prevent drivers from performing 'through and left' turn movements from the slip lane.
	Question: What will be the efficiency gain as a result of the proposed improvements?	AOB: Response – there is no easy answer to give; but can safely say that volumes of conflict will be reduced through introduction of slip lanes, and re-allocation of entry approaches. Noted that the functional layout was designed to operate with 20% increase in traffic volumes over current levels.
	Expressed nervousness over the northern slip lane at Morrinsville intersection. Specifically, the lack of speed reduction characteristics, and the fact that it runs across the lay-by shop frontage and parking. Proposed that some type of speed control be used in this case.	AOB: Response – cited examples of long slip lanes such as this one used in NZ and Australia. Would agree in principle that the use of some type of speed hump (sinusoidal) would be appropriate to slow drivers down. (in front of shops).
	Concern over the 'looking back' angle being too acute for drivers south bound on SH1 at Morrinsville IC to see cars coming from shopping centre entrance.	AOB: Response – Does not see this as being too acute, and does not expect this to pose problems.
	Concern over amount of deflection provided for the north-bound approach from the south at Morrinsville IC; that it may not slow drivers down enough and that drivers will simply take the 'short line', driving over painted lane lines.	AOB: Response – Believes that the level of deflection is adequate, (if drivers stay in their lanes). Could provide 'rumble strips' along lane edges, similar to what is used on the motorway, as a means to remind drivers to remain in their lanes. Traffic design manual radii were used in all instances.
	At Hillcrest intersection, the position of the roundabout makes for a tightened right turn (or 'through') movement, at a place where it was already reasonably tight to begin with. Also, this means that south bound traffic must now pick a gap from 2 right turning lanes instead of 1. Trees – Wanted to know if keeping trees on roundabouts is feasible.	AOB: Response – Has considered this, and does not think that the turn will be too tight. Also mentioned that the proposed layout shown was designed to accommodate +20% traffic volumes over current ones. If Hamilton City is not comfortable using the layout shown right away, current traffic volumes will probably

Party Consulted	Issue Raised	How Issue has Been Dealt With
	Other landscaping issues – Hamilton City has certain standards, and find that certain plant species are well-suited for use on traffic islands and roundabout hubs. Issue of cycle lanes, especially at 'pinch points' – Resolve Group proposed to use a smooth rollover type kerb at these locations. AOB would prefer to use this type of kerb in all locations due to their user-friendliness to cyclists and forgiving nature to cars which ride up on them. Believes they are good for everybody.	allow a 2-lane approach south bound at Hillcrest IC. When traffic volumes increase, the double right turn would need to be implemented AOB: Response – Feels that keeping trees on roundabout hubs would be good, and should be done if possible. But not if they obstruct visibility. RG – Noted that large tree at Morrinsville IC will be lost, but others behind it will remain RG to note at design stage and liaise with HCC on this issue. Hamilton City is opposed to using rollover type kerbs because they have caused problems in the past in other parts of the city and they are more conspicuous. May be willing to use this type of kerb at pinch points due to the positive effect for cyclists.
NZ Police Sgt. Warren Shaw (Traffic Services Section)	Similar concern over visibility at lay-by parking area. Egress movement is awkward, and visibility is poor. Oncoming traffic travelling at high speed.	See above.
	Comment: Would support any design scheme which would lower traffic speeds, and the subsequent positive effect on accidents.	
A letter was sent at the first SAR stage to Sgt. Shaw confirming the changes made to the proposal as a result of comments received. No further comments were received.		
Road Transport Association Bill McLeod, (Chairman, Board Member)	Issue: concern of performance of new layout with respect to long vehicles (B-trains) and potential encroachment onto adjacent lanes.	All movements have been checked for the ability of long vehicles to turn, however in some cases the movement may not be done entirely in one lane.
	Concern over the sensitivity of trucks to the degree of camber (super-elevation) on intersections.	Again, this issue will be addressed at the detailed design stage.
	Stated that in general, the RTA would be very supportive of the proposed improvement works and that the extra lanes would significantly improve capacity.	Noted as positive effect.
	Bill completed and returned an Affected Persons Consent Form.	It is noted that the RTA do not object to the proposal sighted.
A letter was sent at the first SAR stage to RTA confirming the changes made to the proposal as a result of comments received. No further issues have been raised by the Road Transport Association.		
Affected Shop Owners (North of Morrinsville Intersection)		

Party Consulted	Issue Raised	How Issue has Been Dealt With
[redacted]	Consultation meeting with owners of 3 shops raised the issue of how the proposed works would eliminate several of the car parks on the lay-by area serving their shops. A net loss of 4-5 spaces was shown. Secondly, the effect of the slip lane on the right turn movement out of the parking area was shown as being eliminated. Resolve Group was to review the technical need for the proposed slip lane position. It was also noted during the meeting that : a) A safety problem was recognised by the shop owners with making the right turn movement back into town from the car parks. b) An angle parking scheme would be supported by the shop owners. c) Acknowledgement that some of the spaces would have to be sacrificed for the improvements.	Upon consideration of the concern over the lay-by parking, an angle parking scheme was introduced. The effect was to preserve 5 of the 8 car parks. The right turn out from the parking area remains restricted for safety reasons.
A letter was sent at the first SAR stage to the Shop Owners confirming the changes made to the proposal as a result of comments received. The outcomes of this is presented below:		
[redacted]	Expressed concern that the revised proposal still resulted in a loss of some car parks. Not concerned over loss of property. Would like to have seen more land taken in exchange for more car parks. Expects effects to be felt during Christmas shopping season.	More car parks can not be provided in the area without further land purchase.
[redacted]	Similar concern to [redacted] would prefer more car parks if it meant more land taken.	
[redacted]	Was not comfortable with his English to express his concerns, but felt the other adjacent tenants' concerns once read to him applied to him as well. Also said he was trying to sell his business.	
Cycle Action Waikato [redacted]	Issue: should be aware that the area of concern is a large school catchment, including Berkeley Intermediate School. This is a reasonably large generator of young cyclists and secondary pedestrian traffic.	Improved pedestrian facilities, as well as cycle lanes have been introduced, improving the safety for students using them. Improved capacity during peak flows would tend to have a positive effect on traffic coming to/from the schools in the area.
	Issue: Underpass near Hillcrest intersection is not conspicuous.	Consideration will be given to improving/increasing signage alerting road users to the presence of this older of the two pedestrian underpasses.

Party Consulted	Issue Raised	How Issue has Been Dealt With
	Issue: To providing extra width around the new slip lanes at both intersections to accommodate the cyclists.	Consideration was given to providing cycle lanes to a maximum possible width.
	Providing bi-directional cycle lanes.	These items have been noted, and will be revisited during the detailed design stage if it is found that the provisions made already are insufficient/ inappropriate.
	Possibility of employing dual-use footpaths i.e. pedestrians and cyclists sharing the footpath over selected sections.	
	Issue with proposed proximity of pedestrian crossing at Hillcrest Intersection.	The positions of the pedestrian crossings were carefully considered by our traffic designer with safety in mind.
	Issue: advised that it is Hamilton City Council's policy to incorporate cycle improvements when undertaking capital projects.	As above, pedestrian and cyclists facilities added where there were none before.
	Cyclist barriers, bollards at underpass should be more visible.	This issue can be easily dealt with at the detail design stage, and has been noted.
	It would be good to provide a single direction ramp at Hillcrest underpass instead of 2 shorter ones in 2 directions.	This issue has been raised and it does not appear that Transit will be able to make an allowance for major underpass improvements at this time.
	Issue: At Morrinsville underpass, the provision of further ramp access from southeastern side (south-bound) of Cambridge Rd down to underpass.	Additional ramp access down to the underpass has been incorporated into the scheme design.
A letter was sent at the first SAR stage to CAW confirming the changes made to the proposal as a result of comments received. CAW requested a further meeting with Transit. This meeting was held 13 August 2004, and raised the following issues:		
Cycle Action Waikato (CAW) [redacted] Meeting held 13 August 2004. CAW raised many valid points regarding the proposal and had many suggestions to improve the design for cyclists.	1. Appreciated additional ramp access down to Morrinsville underpass, and proposed increased visibility of bollards and cyclist barriers.	Noted.
	2. Noted that parents dropping kids off contributes to congestion problem – anything which would allow parents to let their kids cycle to school (i.e. a safe ride) would help the situation.	Noted.
	3. Requested smooth kerb cut downs at key locations, especially to cater for cyclists (but would benefit other as well.)	This can be accommodated at the detailed design stage.
	4. Requested that bi-directional (dual-use) footpath options be adopted at i) on the north side of Cambridge Rd from Cambridge Rd pedestrian crossing to underpass, and ii) on south side	This feature will be looked at more closely. The minimum width required for shared use footpaths is 2.5 m. Resolve Group traffic designer sees no reason why this option should not be used.

Party Consulted	Issue Raised	How Issue has Been Dealt With
	of SH1/Cambridge Rd from eastern underpass to the shopping centre. This is preferred over cycle lanes at these locations as cyclists are kept out of vehicular traffic. The locations of the requested bi-directional footpaths were given in detail.	
	5. If bi-directional (dual-use) footpaths cannot be accommodated, CAW requests that continuous cycle lanes be used on both sides of SH1 and that 'No parking' restrictions be applied as well.	
	6. Concern that the cycle lanes proposed leading into Morrinsville roundabout will encourage school age children to cycle through this busy multilane roundabout. Note that studies show that cycle lanes around the periphery of a RAB are dangerous, as the cyclist is positioned in the peripheral vision of motorists.	Resolve Group note that it may be better to have no cycle lanes at all within the roundabout, due to the message it may send to younger cyclists.
	7. Issue of cycle lanes along slip lanes: especially left from Morrinsville Rd to Cambridge Rd. This would provide better continuity for cyclists and along with pram crossings, would link to the underpass for cyclists. Cars also tend to 'hug' the kerb when travelling through a slip lane.	Cycle lanes are not generally used inside slip lanes due to the fact that it is already a lowered speed environment with plenty of room for both cars & cyclists. However in this case, the fact that the cycle lane in this area also serves as a link to the underpass may warrant using a formal cycle lane.
	8. Requested that cycle lane be shown across the Hillcrest Shopping Centre Entrance.	Painting a cycle lane across the exit from a roundabout can be confusing to a motorist making an exit movement. The cycle lane could possibly be shown across the entrance lane and along the median island.
	9. Requested that a cycle lane be shown for left turn northbound on SH1 at Hillcrest intersection. Acknowledges fact that this is a cyclist 'pinch point', but that the cycle lane would help alleviate this danger. Noted that Hamilton City practice is to 'green-in' cycle lanes at pinch points.	A cycle lane could be provided here (1.5 m). In addition, a smooth rollover type kerb should also be provided here to allow a cyclist easy escape onto the footpath if needed.
Hamilton Regional Fire Service Martin Barryman, Chief Fire Service Hamilton – No issues raised		
St. John's Ambulance – Wendy Hamilton, Area Manager		

Party Consulted	Issue Raised	How Issue has Been Dealt With
– No issues raised		
Hamilton City Buses – Bruce Bates, General Manager – No issues raised		
Affected Landowners – Letters sent 1 July 2004.		
Hamilton City Council	No issues raised by HCC regarding land owned by HCC that is required for the proposed works.	Land purchase will proceed as per standard procedure involving the Property Group Ltd., HCC and Transit.
Hillcrest Shopping Centre Owners 13August 2004, met on site with [redacted]	Issue: [redacted] (Body Corporate Manager) not present.	[redacted] was contacted by telephone during the meeting and made aware of the meeting. Agreed to meet with Transit in person at a later date.
Note that not all owners were represented at this meeting.	Issue: compensation for land required at shopping centre entrance.	Compensation would include sharing in the safety and congestion benefits to be realised as a result of the construction. Transit explained that in light of previous agreements (regarding the potential to close the entrance down if accidents increased after 4^{th} leg was opened), the proposed approach included TNZ meeting the costs associated with making the safety improvements required to bring the entrance up to standard. This would be done if the owners agreed to supply the necessary land.
	Issue: Effects of the land take include the loss of a car park and the shopping centre sign is in the way.	The car park could be relocated, resulting in a null loss of car parks. Transit is prepared to meet the costs of relocating the shopping centre sign to an agreed-to location.
	[redacted] noted that he thought the proposal would be good for the owners because it will benefit the customers who use the complex.	
	No objections to the project were voiced during the meeting.	
Subsequent meetings between [redacted] and Transit indicated that there would be no objection to the proposal whereby the Hillcrest Shopping Complex owners would supply the land necessary to undertake the proposed improvement works.		
Affected Property Owners		
[redacted] ([redacted] Cambridge Rd); [redacted] ([redacted] Cambridge Rd)	Letter was sent to inform and get feedback on the fact that their property will be affected by the proposed works; i.e. the shared driveway (privateway) will become left in - left out under the new layout	

Party Consulted	Issue Raised	How Issue has Been Dealt With
[redacted] ([redacted] Cambridge Rd)	due to the elimination of the lay-by parking arrangement and installation of a free left turn slip lane. In the case of the [redacted] they were also informed of the fact that a mature tree in front of their property would be lost under the works due to the construction of the slip lane.	
St. Francis Cooperative Parish (249 Cambridge Rd)	[redacted] of St. Francis Cooperative Parish responded to the letter, noting that they did not have any problem with the proposal but asked that the following points be considered: 1. That the driveway serving 249 Cambridge rd be clearly marked so that it does not become obstructed by parking cars. 2. That consideration is given to narrowing the island between the slip lane and SH1 to provide more parking for the shops in the lay-by. 3. That consideration is given to providing barriers to protect pedestrians approaching the underpass.	This issue can be accommodated at the detailed design stage. This slip lane has been narrowed and more parking has been provided since initial consultation meetings with the lay-by shop owners. Further narrowing of the median would undermine the deflection characteristics and pedestrian refuge characteristics of the slip lane. The use of pedestrian barriers is not thought to be necessary in this case.
Parties affected by removal of painted public car parks on SH1 between 212 to 216 Cambridge Rd.		
Hamilton City Council Roger Ward Nick Evetts Andrew McKillop	Parking issues were discussed during the meeting held with HCC on 17 August 2004. This was seen as a relatively minor issue for Council in the light of other safety and geometry-related design issues.	The current layout has been retained, including the removal of these 6 painted car parks.

8.6 Future Consultation

Due to the passage of time since the consultation carried out for the first SAR, and a subsequent requirement to investigate the signalised option more closely, it is recommended that further consultation be undertaken. This would take place before the detailed design phase.

The consultation objectives and process would be similar to the first round. The key stakeholders noted above will be consulted again regarding the 2½ Roundabout and signalised intersection options, including the provision of off-road combined cycle and pedestrian pathways, and on-road cycle lanes. Again the groups and individuals will be given the opportunity to voice their concerns through face to face meetings and written correspondence, where preliminary design ideas will be presented in an open and transparent manner. These groups and individuals will again be invited to offer their feedback on the ideas presented.

The comments, views and concerns received will be compiled and genuinely considered during the detailed design phase decision-making process by Transit and their design consultant. This will ensure the final design is more clearly defined and robust.

8.7 Statement of Identified Maori Interest

The following is a table summarising the consultation carried out during the first SAR with the region's two dominant iwi groups, Waikato Rapatu Lands Trust Ltd and Nga Mana Toopu O Kirikiriroa (NaMTOK). No further consultation with iwi groups has been undertaken.

Table 20 Summary of Iwi Consultation

	Description of Consultation and Issues Raised	Outcome
NaMTOK [redacted] and An initial meeting was held with the above on 28 April 2004. The outcome of this meeting was that NaMTOK were to deliver a brief report on any issues or findings with respect to cultural significance in the study area.	A report was prepared by the group which outlined the cultural significance of this project to Maori. The report found no immediate issues/concerns with the proposed developments due to the fact that the area has been modified extensively through successive road improvements. However, it stipulated that Hapu protocol should be followed in the event that any objects associated with ancient Maori habitation are found or should a death occur on site during the works. In addition it was proposed that an interpretive panel be installed on site to record the significance of the historic events which transpired at this location in1881; and that the site is populated with native plant species as mitigation.	The findings of the report are noted. The installation of an interpretive panel would appear to be achievable and will be considered and further discussed with NaMTOK as to the details surrounding the incident in 1881. *NaMTOK Protocols for Undertaking Earthworks* have been received and noted. The contract documents will contain appropriate provisions so that the successful contractor will be required to follow them. Native plant species form part of the Hamilton City Council Planting Guidelines, the standard which will be followed for the landscaping for this project.
Waikato Rapatu Lands Trust Ltd. [redacted]	An initial consultation letter was sent to [redacted] inviting feedback on the proposal.	Reply received, and stated that group has no issues to raise.

Based on this initial consultation and the response of the identified iwi groups, it is not considered necessary to produce a Statement of Identified Maori Interest. It is noted that the NaMTOK Protocols for Undertaking Earthworks apply to this project. A copy of these protocols is appended to this report (Appendix N.)

Notwithstanding the above, regular contact with the two organisations above will be maintained throughout the project. This is consistent with Part II matters of the Resource Management Act 1991 and the Transit SIMI worksheet.

9. ASSESSMENT OF ENVIRONMENTAL EFFECTS

This detailed Assessment of Environmental Effects (AEE) is included in Appendix O. The Environmental effects are summarised in the table below.

Table 21 Summary of Environmental Effects

Table 21-1 Summary of Environmental Effects - Roundabout Option

Item	Nature of Effect(s)	Effect Level
Social Effects – General	Improvements in traffic flows, delay reductions.	Positive effect.
	Better accessibility for cyclists and pedestrians.	Positive effect for these road users, and for the local student population.
	Informal crossing of SH1 at unsafe locations will be discouraged through erection of barriers on the central median.	Positive safety effect.
	Restricted or limited access for many properties fronting on SH1 during construction.	Minor short term effect.
	Loss of five public parking spaces on SH1 northbound carriageway.	Minor effect. Hamilton City does not oppose this.
Social – Effects on Commercial and Suburban Centres (Shopping Complex and lay-by shops)	Access/egress to shopping complex to be kept open; no movements to be restricted.	Positive effect. Users of this entrance will share in safety and capacity improvements generated by overall proposed improvements.
	Additional stair access proposed at Morrinsville underpass.	Positive effect for pedestrians in terms of convenience by creating more inviting underpass.
	Land requirement – loss of land resulting in loss of car park, traffic moving closer to shops and customers.	Slight negative effect on shops to be mitigated by car park relocation, Transit to meet costs of safety improvements. Additional guard railing proposed in front of restaurant.
	Angle parking proposed will result in loss of some car parking.	Minor effect. Angle parking has been designed to allow a vehicle to reverse without entering traffic lane.
	Right turn movement from lay-by parking has been restricted.	Minor effect. Proposed design eliminates layout deemed unsafe by NZ Police and Hamilton City Council.
Traffic Effects	Increased efficiency and trip reliability.	Positive effect.
	Increased safety (predicted reduced accident benefits.)	Positive effect.
	Ability to improve in the future (roundabout signal metering).	Positive effect.

Item	Nature of Effect(s)	Effect Level
	Interruption to some property access during construction.	Minor effect. Effect will be temporary.
	Highway traffic may experience disruptions to traffic flow as a result of the reconstruction of the Hillcrest and Morrinsville intersections.	Minor effect. Disruption will be minimised through the preparation of Traffic Management Plans and the staging of construction activities.
Economic Effects	Substantial travel time and vehicle operating cost savings, as well as savings in accident and CO_2 costs.	Positive effect.
Erosion and Sediment Yield	Potential for sedimentation during construction period.	Low risk area – minor effect. All activities are permitted. Effect will be temporary.
Effects on Trees and Vegetation	Loss of three trees due to seal widening.	Minor visual effect. All trees are on State Highway designation.
	Loss of vegetation on traffic islands and roundabouts.	Minor effect; vegetation will be reinstated. Effect will be temporary.
Geotechnical Environment Effects	No effects on environment.	
Long Term Drainage Effects	Decrease in stormwater quality due to the works will be minor.	Minor effect to be mitigated through use of diversion channels or bunds and other control measures. Effect will be temporary.
Traffic Noise	Increase in noise levels by just over 1 dB 10 years after construction. The max increase is 2 dB.	Moderate effect that can be mitigated by constructing low-noise road surface, e.g. OGPA can reduce traffic noise generation by 3 dB.
Construction Noise	L_{max} of 90 dBA within 50m of construction activity.	Minor temporary effect. Develop a "Construction Noise Management Plan" (CNMP) to mitigate.

Table 21-2 Summary of Environmental Effects – Signalised Option

Item	Nature of Effect(s)	Effect Level
Social Effects – General	Improvements in traffic flows, but increase in delays interpeak.	Minor effect as capacity and improved operation balanced against delays.
	Better accessibility for cyclists and pedestrians.	Positive effect for these road users, and for the local student population.
	Informal crossing of SH1 at unsafe locations will be discouraged through erection of barriers on the central median.	Positive safety effect.
	Restricted or limited access for many properties fronting on SH1 during construction.	Minor short term effect.

Item	Nature of Effect(s)	Effect Level
	Loss of seven public parking spaces on SH1 northbound carriageway.	Minor effect. Hamilton City does not oppose this.
Social – Effects on Commercial and Suburban Centres (Shopping Complex and lay-by shops)	Access/egress to shopping complex to be kept open; no movements to be restricted.	Positive effect. Users of this entrance will share in safety and capacity improvements generated by overall proposed improvements.
	Additional stair access proposed at Morrinsville underpass.	Positive effect for pedestrians in terms of convenience by creating more inviting underpass.
	Land requirement – loss of land resulting in loss of car park, traffic moving closer to shops and customers.	Slight negative effect on shops to be mitigated by car park relocation, Transit to meet costs of safety improvements. Additional guard railing proposed in front of restaurant.
	Angle parking proposed will result in loss of some car parking.	Minor effect. Angle parking has been designed to allow a vehicle to reverse without entering traffic lane.
	Right turn movement from lay-by parking has been restricted.	Minor effect. Proposed design eliminates layout deemed unsafe by NZ Police and Hamilton City Council.
Traffic Effects	Increased efficiency and trip reliability.	Positive effect.
	Increased safety (predicted reduced accident benefits.)	Positive effect.
	Ability to actively manage traffic demand, especially on SH1.	Positive effect.
	Interruption to some property access during construction.	Minor effect. Effect will be temporary.
	Highway traffic may experience disruptions to traffic flow as a result of the reconstruction of the Hillcrest and Morrinsville intersections.	Minor effect. Disruption will be minimised through the preparation of Traffic Management Plans and the staging of construction activities.
Economic Effects	Negative benefits. There will be increased travel time and vehicle operating costs, as well as additional accident and CO_2 costs.	Negative effect.
Erosion and Sediment Yield	Potential for sedimentation during construction period.	Low risk area – minor effect. All activities are permitted. Effect will be temporary.
Effects on Trees and Vegetation	Loss of three trees due to seal widening.	Minor visual effect. All trees are on State Highway designation.
	Loss of vegetation on traffic islands and roundabouts.	Minor effect; vegetation will be reinstated. Effect will be temporary.
Geotechnical Environment Effects	No effects on environment.	

Item	Nature of Effect(s)	Effect Level
Long Term Drainage Effects	Decrease in stormwater quality due to the works will be minor.	Minor effect to be mitigated through use of diversion channels or bunds and other control measures. Effect will be temporary.
Traffic Noise	Increase in noise levels by just over 1 dB 10 years after construction. The max increase is 2 dB.	Moderate effect that can be mitigated by constructing low-noise road surface, e.g. OGPA can reduce traffic noise generation by 3 dB.
Construction Noise	L_{max} of 90 dBA within 50m of construction activity.	Minor temporary effect. Develop a "Construction Noise Management Plan" (CNMP) to mitigate.

PSF/13 – Social and Environmental Screen is included in Appendix P

10. PREFERRED OPTION

10.1 Form of intersection control

In determining the preferred option, a number of factors need to be considered in addition to the modelling. These are discussed below.

The key advantage of traffic signals to a road controlling authority is the ability to actively manage the amount of traffic being allowed to access a particular facility, i.e. SH1 in the study area, by means of priority assignment.

Traffic signals may be more efficient than roundabouts, where they are highly co-ordinated along a heavily trafficked corridor with minor crossing traffic. However, the intersections in the study area do not fall into this category.

The existing roundabouts do not have sufficient capacity during peak periods, deficient and sub-standard geometrically. Increasing the capacity of the roundabout represents a logical step to improve performance of the intersections during peak hours, while maintaining the operational merits of the roundabout at other times.

However, upgrading the roundabouts, unless metered, will not enable active management of travel demand.

10.2 Effectiveness of Solutions

The modelling results showed that the traffic signals options increase the overall delay at the intersections significantly, while the roundabout option reduces the overall delay at the intersections. The travel time penalty of the traffic signals options is therefore giving those options negative benefit-costs ratios when evaluated in accordance with the Economic Evaluation Manual. From a value for money perspective, it is difficult to justify the signalisation options.

10.3 Public Acceptability

It is considered that there are significant travel time penalty for signalising the intersections, even though the installation of traffic signals would enable active management of travel demand.

While the active management of traffic may benefit the network as a whole, the authors' experience with introducing traffic signals in urban fringe areas shows that the local community is likely to react negatively to the additional delay imposed onto them, especially during Interpeak period.

10.4 Transit's Strategic Goals

Under the Land Transport Management Act, Transit is required to manage travel demand actively to ensure the sustainability of its network. It is considered that the implementation of the traffic signals would enable this requirement to be fulfilled. Traffic signals require ongoing monitoring and management to ensure the strategic goals are fulfilled.

However, an executive decision needs to be made to determine whether it is acceptable to increase the overall travel times of the public and potentially increase CO_2 emissions in the short to medium term to enable the longer term sustainability of the State Highway.

10.5 Recommended Preferred Option

Although the signalisation options enable Transit to fulfil Land Transport Management Act's requirements of ensuring the sustainability of the State Highway, the additional delay imposed on the travelling public is considered too high.

Therefore, it is recommended Transit proceed with the detailed design of the roundabout option.

11. PRELIMINARY DESIGN PHILOSOPHY STATEMENT

11.1 Background

The intersections under investigation are located on SH1 (Cambridge Road), approximately 310 metres apart, in the suburb of Hamilton East. Cambridge Road is a major arterial designated as a state highway of national importance carrying greater than 37,000 vehicles per day and has a posted speed limit of 60 km/h.

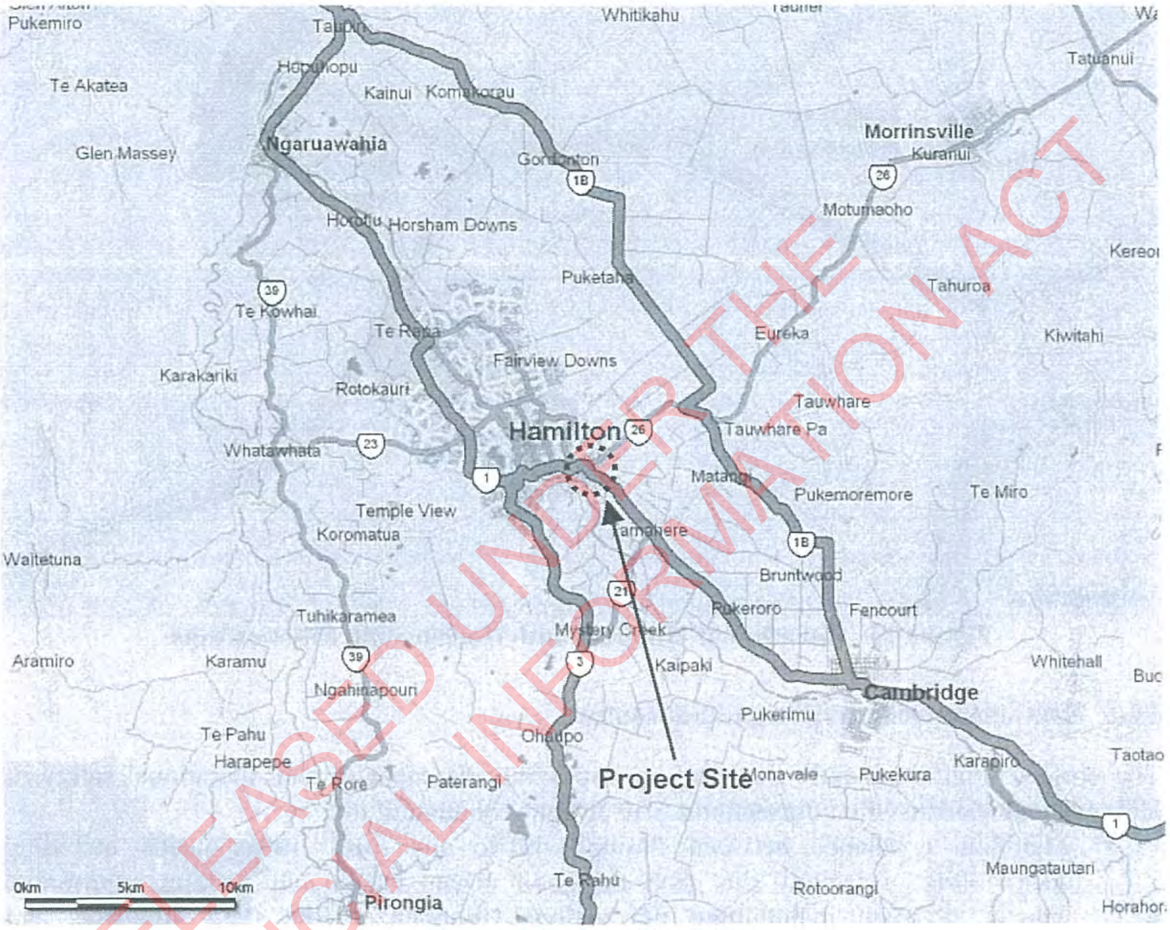

Figure 15 Locality Plan

11.1.1 Hillcrest Intersection

An existing three-leg roundabout controls this intersection. Cambridge road serves as access to the Hamilton East suburb, to the Waikato University, and to the north via Peachgrove Road. This intersection is referred to as the Hillcrest Intersection.

11.1.2 Morrinsville Intersection

An existing four-leg roundabout controls this intersection. This intersection was originally a three-leg roundabout; the fourth leg was added in 1997 to provide access into the adjoining retail complex to the south. The number of crashes at the intersection has since increased. This intersection is referred to as the Morrinsville Intersection.

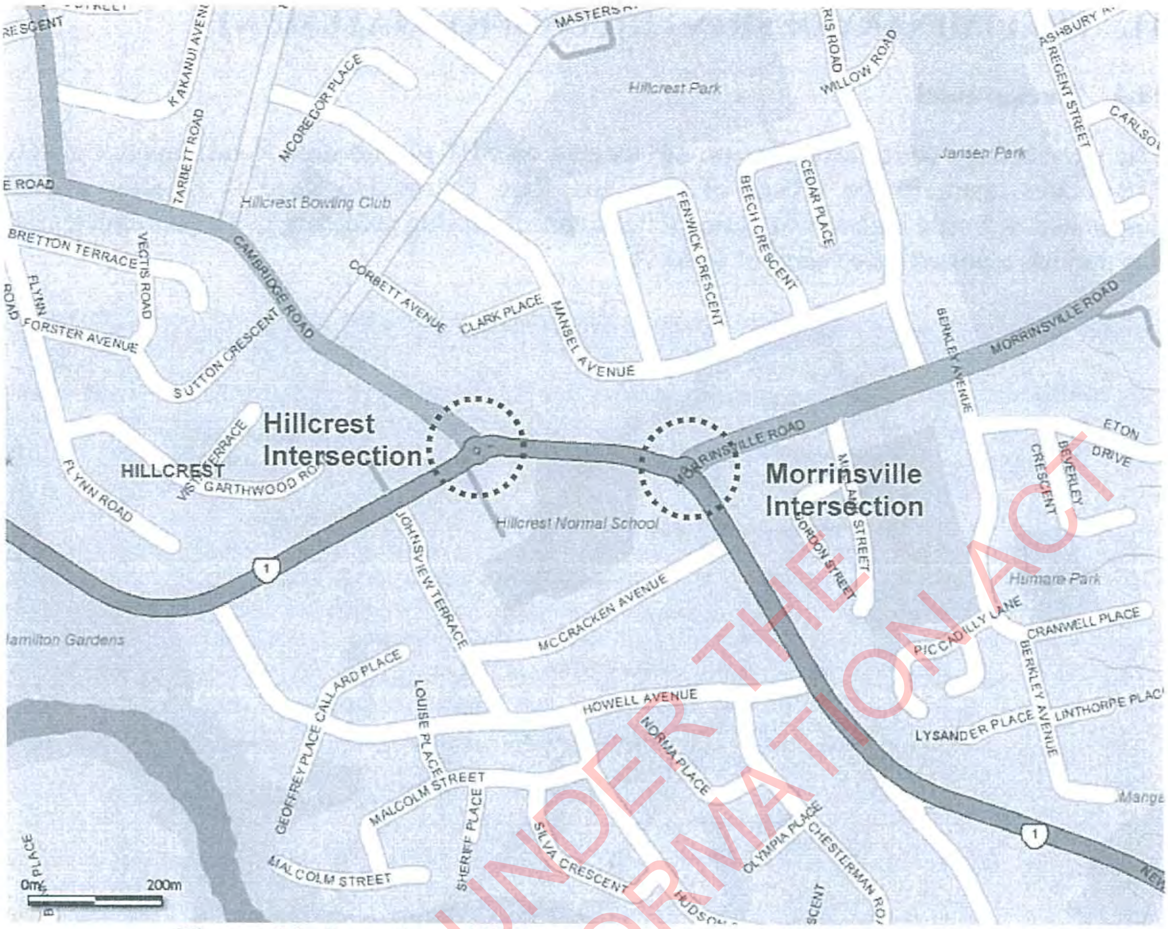

Figure 16 Location of Hillcrest and Morrinsville Intersections

11.2 Outline of General Design Philosophy

The project is predominantly focussed on improving the capacity and operational safety of Hillcrest and Morrinsville intersections. The design will attempt to:

- Maintain a balance between through traffic and local traffic needs including accessibility, especially the need for good urban design and striking appropriate balance between maintaining the national function of the state highways and accommodating local requirements.
- Protect the primary function of the state highways, as the intersections are on a section of state highway classified as National State Highway.
- Integrate the designs with the existing road environment, giving considerations to the impact of the proposed schemes
- Improve the capacity for major and minor movements at the intersections
- Increase the level of operational safety at the intersections
- Provide for the needs of all road users including vulnerable road users such as cyclists, pedestrians, young children and the disabled
- Develop a construction of the layout to enable staging of work phases and use of techniques which save time and thereby minimise disruptions to traffic. This is particularly important for ensuring the national functions of the state highways are maintained with minimal disruptions

- Retain the good safety and operational features of a continuous physical median connecting the two intersections. The effective right turn ban reduces conflict and hence the crash rate

11.3 Applicable & Referenced Policies, Strategies and Plans

As part of the Investigation and Reporting (I&R) phase, we have identified the need for this project to reflect the objectives and requirements of high level strategies, including but not limited to Transit's National State Highway Strategy and Hamilton City Council's Access Hamilton Strategy.

11.3.1 National State Highway Strategy

Transit's National State Highway Strategy (NSHS) is a guiding document which reflects Transit's obligations under New Zealand Transport Strategy (NZTS) and relevant legislation including the Land Transport Management Act (LTMA), Local Government Act and Resource Management Act.

The strategy reflects the government directive to Transit to manage carefully the capacity and levels of services on state highways in areas experiencing substantial population growth. Transit's aims in relation to safety, operations, asset management, demand management, environment and communities, integrated planning, education and continual improvement were considered as part of the assessment and development of options. The guiding principles of the NSHS will continue to be referenced and considered during the D&PD phase of the project.

11.3.2 Regional Transport Issues

The Waikato State Highway Plan & Forecast made reference to the following regional issues.

- Congestion and bottle necks: rapid population and development growth in and around Hamilton is causing congestion and increasing travel delays and transport costs for long-haul travellers, as well as a deterioration of environmental and amenity values for the communities that these long-haul routes pass through.

- Large volumes of vehicles are diverting onto unsuitable alternative routes to avoid delays, with resultant impacts on safety and economic development.

- Hamilton growth: there is significant pressure for commercial access and growth in northern and western Hamilton. This, combined with the development of the Crawford Street rail freight village, is putting significant pressure on the Hamilton Western Corridor, which also has a local road function. Transit will work closely with its transport partners to build on the *Access Hamilton* Strategy, which seeks a balance between roading, rail, passenger transport, and active modes of transport to manage demand.

- Further improvements are proposed to the Hamilton Western Corridor to complement the works already in progress. Improvements will include the identification and protection of the strategic transport corridors in south Hamilton through the planning process. Transit will also consider a number of projects on the existing routes in the meantime to relieve congestion and improve efficiency.

The above were considered during the development and assessment of options and will continue to be referenced and considered during the D&PD phase of the project.

11.3.3 City Council Strategy – Access Hamilton Strategy

The following comments are excerpted from the website of Hamilton City Council:

Hamilton is growing rapidly and there is an increasing awareness that the city's roading networks are reaching capacity at peak times. Dealing with current traffic congestion levels and planning for future growth will ensure that Hamilton has an integrated transport system that functions effectively and enables people and goods to move in and around the city freely in years to come.

As a city Hamilton is well placed at this time to consider, prepare and act upon its future transport needs, implementing changes that will help to protect the lifestyle enjoyed while avoiding the development of crippling congestion. *Access Hamilton* is about enabling good access around the city by managing traffic congestion, travel times, safety, parking and convenience, while at the same time ensuring there are good networks for all travellers whether they use cars, public transport, walk or cycle.

The *Access Hamilton* strategy addresses Hamilton's increasing traffic congestion and population growth, and aims to create a sustainable, integrated transport system for the city supporting Council's wider social, economic and environmental objectives - along with improving the quality of life of those who live and work in Hamilton, and enhancing the experience of visitors. A ten-year work programme has been developed for *Access Hamilton*, which includes financial contributions from Land Transport New Zealand and Environment Waikato to ensure a coordinated approach to Hamilton's transport system. This programme is based on Hamilton's Growth Strategy and Land Transport Management Act criteria. *Access Hamilton* includes both infrastructure improvements and incentives to encourage the use of alternative travel modes. It aims to increase public awareness of transport options and the effects of travel behaviour and travel choices. Included (inter alia) in the areas *Access Hamilton* focuses on are:

- Key roading projects that will address current traffic congestion and future city growth, including arterial intersection improvements and completion of the ring road and cross-city connector
- This includes changes and extensions to existing roads and intersections, as well as expanding the network through new initiatives like the ring road and cross-city connector. The first priority is to ensure that the existing network is working as effectively as it can and traffic is flowing freely.

The above were considered during the development and assessment of options and will continue to be referenced and considered during the D&PD phase of the project.

11.4 Specific Standards to be adopted

As detailed in this Scheme Assessment Report, two main design options were assessed:

- 2 ½ Lane Roundabouts
- Traffic Signals

11.4.1 Common Standards to be used for all options

The following standards are applicable for both roundabout and traffic signals options and will be followed during the Design and Project Documentation (D&PD) phase

Geometric Design Standards

The following geometric design standards and guides are to be followed and referenced in the D&PD phase.

- Transit New Zealand State Highway Geometric Design Manual (Draft, May 2005)
- Austroads Urban Road Design Guide (2002)

Roading Design

The following pavement design standards and guides are required to be followed and referenced in the D&PD phase.

- Austroads Pavement Design – A Guide to the Structural Design of Road Pavements (2004)
- Transit New Zealand New Zealand Supplement to Austroads Pavement Design – A Guide to the Structural Design of Road Pavements (February 2007)
- Hamilton City Council Development Manual Volume 2 Design Guide Part 3 Roading Works (August 2007)
- Hamilton City Council Development Manual Volume 3 Technical Specifications Part 3 Roading Projects (August 2007)

Stormwater Design

The following stormwater design standards and guides are required to be followed and referenced in the D&PD phase.

- Hamilton City Council Development Manual Volume 2 Design Guide Part 4 Stormwater Drainage (August 2007)
- Hamilton City Council Development Manual Volume 3 Technical Specifications Part 4 Stormwater and Wastewater networks (August 2007)

Traffic Design

The following traffic design standards and guides are to be followed and referenced in the D&PD phase.

- Transit New Zealand Manual of Traffic Signs and Markings (MOTSAM) Part 1: Traffic Signs (May 2007 Interim)
- Transit New Zealand Manual of Traffic Signs and Markings (MOTSAM) Part 2: Markings (August 2007)
- Traffic Control Devices Rule and Transit New Zealand Bylaw/ Hamilton City Council resolution requirements for the implementation of No Stopping Line.and regulatory signage
- Austroads Guide to Traffic Engineering Practice – Part 5 Intersections at Grade (2005)
- Austroads Guide to Traffic Engineering Practice – Part 8 Traffic Control Devices (2006)
- Austroads Guide to Traffic Engineering Practice – Part 9 Arterial Road Traffic Management (1988)
- Austroads Guide to Traffic Engineering Practice – Part 12 Roadway Lighting (2004)
- Austroads Guide to Traffic Engineering Practice – Part 13 Pedestrians (1995)
- Austroads Guide to Traffic Engineering Practice – Part 14 Bicycles (1999)
- Land Transport New Zealand Road and Traffic Guidelines RTS18 New Zealand on-road tracking curves for heavy motor vehicles

- New Zealand Supplement to Austroads Guide to Traffic Engineering Practice – Part 14 Bicycles (March 2005)
- Transit New Zealand Specifications and Notes
- Austroads Investigation of cyclist safety at intersections (2002)

Planning, Urban Design and Landscaping

The following planning, urban design and landscaping standards and guides are to be followed and referenced in the D&PD phase.

- Transit New Zealand Planning Policy Manual (August 2007)
- Transit New Zealand Guidelines for Highway Landscaping (December 2006)
- Transit New Zealand Urban Design Professional Services Guide (March 2007)
- Hamilton City Council Development Manual Volume 2 Design Guide Part 7 Street Landscaping (August 2007)

11.4.2 Specific Standards applicable to Traffic Signals

The following traffic signals design standards and guides are to be followed in the D&PD phase.

- Austroads Guide to Traffic Engineering Practice – Part 7 Traffic Signals (2003)
- New Zealand National Traffic Signal Specification

11.4.3 Specific Standards applicable to Roundabouts

The following roundabout design standards and guides are to be followed in the D&PD phase.

- Austroads Guide to Traffic Engineering Practice – Part 6 Roundabouts (1993)

11.5 Design Assumptions

11.5.1 Traffic Modelling and Economic Evaluation

The following assumptions were made in the development of the schemes, options selection and economic analysis.

- AM Peak starts from 7:45 to 8:45
- PM Peak starts from 16:45 to 18:45
- Interpeak periods are 6:45 – 7:45, 8:45 – 16:45, 18:45 – 19:45
- Off Peak starts from 19:45 – 6:45
- 250 weekdays, 115 weekend days per annum
- Each weekend day is assumed to have one interpeak period and one evening period
- There are 250 AM and PM peaks per year and 365 interpeak and evening periods per year
- Analysis of the ratio between evening delay and interpeak was carried out in lieu of explicit microsimulation of the evening period
- Maintenance costs will be similar for both the do-minimum option and the roundabout option.
- Accident growth rate of - 2%

The assumptions will be reviewed in the D&PD phase to ensure they remain applicable.

11.5.2 Traffic Design

Median

The raised grass median between the two intersections is to remain with some amendments to the layout, in both the roundabout and traffic signal options.

Left Turn Slip Lanes
The left turn slip lanes, where incorporated in the design, will be designed with a high entry angle, in accordance with Figure 6.18 as detailed in Austroads Guide to Engineering Practice – Part 5: Intersections at Grade, wherever practical.

Design Speed
The posted speed limit through the project area is 60 km/h. No alteration to the speed limit has been proposed in the options considered.

The roads approaching the intersections will be designed to a 60 km/h design speed standard.

11.5.3 Design Vehicle

All intersections will be designed to enable tracking for semi-trailer with four rear axles for the left and right turn movements. The design will also allow for one semi-trailer to undertake left and right turn movements with a car beside it for all double left and right turn movements.

11.5.4 Cross-sectional Standards

The typical cross section will be designed with traffic lane widths of 3.5m, entry to intersections widths of 3.0 to 3.5 m. Cycling facilities have been incorporated into the cross section, cycle paths are incorporated into the main carriageway whenever it is possible and safe. It is considered that an off-road cycleway is more appropriate for situations where multiple vehicular movements allowed at the intersection are likely to compromise the safety of cyclists. This forms the basis of the cycleway design philosophy.

11.5.5 Cycleway Design

The following assumptions were made in the development of the design of the cycleway associated with this project.

The cycleway consists of two types:
- On-road cycle path and,
- Off-road combined cycleway/pedestrian walkway.

The on-road cycleway has a design width of 1.5m which is appropriate for this speed limit. The cycleway is on-road where there is sufficient sealed shoulder width. This is generally either side of the intersections which are confined due to the increase in the number of traffic lanes. These should be designated as cycle paths and the appropriate road marking carried out.

The off-road cycleway is combined with the pedestrian walkway where it is too narrow to accommodate a cycleway on the road and at the intersections where it is considered unsafe. The nominal width is 2.5m which is within the acceptable width range for a commuter path as recommended in Austroads GTEP Part 14: Bicycles. There are short sections where the width is narrowed due to the constraint of the existing kerb line and the adjacent property boundary. To ensure a uniform 2.5m width would require additional land acquisition over and above that required for the road improvements. This would involve a combination of additional property owners and extra land from affected property owners that have already been identified. Given the short lengths involved, it is considered that these less than desirable widths are tolerable.

Cyclist-friendly drainage grates will be specified. The proposed cycle way has sufficient clearance for one cyclist, based on the design envelope in Part 14, to pass either side of the power poles. The standard cyclist envelope will be used to re-check clearance to street furniture, e.g. bus stop shelters, mail box, signs, power poles in the design phase.

11.5.6 Pavement Design

Investigatory test pits at the site have identified an extensive layer of existing cement stabilised basecourse across the site. This material provides good structure for the road at present and is essentially acting as a rigid pavement. The thickness of the layer is variable from site to site, but is typically around 180 to 200 mm.

There was no evidence of structural problems within the pavement as recorded in the test pit logs. Recent Falling Weight Deflectometer (FWD) test data supplied for the area also seems to indicate that the pavements on SH1 between the two roundabouts are in good condition. Anecdotal evidence however indicates clear signs of slab cracking of the pavement in some areas, generally on SH1 between the two intersections. However, it does not appear to include the pavements at the roundabouts.

<u>Areas of New Payment</u>
Due to the apparent variability of the cement stabilised layer, it is proposed to:

1. Strip topsoil and other fill material;
2. Excavate the existing cement stabilised basecourse layer;
3. Place fill material to grade (likely pit sand to reflect the in situ material).
4. Pour 20MPa concrete of 200mm nominal thickness. This will be used to provide a rigid pavement layer consistent with the stabilised layer. Cement concrete should also be used where levelling is required.
5. Place geotextile over areas of transition between existing seal and concrete layer, with an overlap of at least 1 m.
6. Overlay 75mm asphaltic concrete (AC) as finished pavement surface.

<u>Areas over existing pavements – AC Overlay</u>
The entire carriageway should also be overlain with AC as part of project. The overlay will be tapered and cut into the existing AC pavements as necessary. Milling of the edge area will be required for the transition.

To minimize the potential for reflective cracking, a geotextile is proposed immediately under the AC layer. The proposed concrete layers in areas with no existing cement concrete should perform in a manner consistent with the existing stabilized sections of pavement.

<u>Pavement Drainage</u>
Geotechnical investigations have indicated that the majority of the subsurface environment is well-drained. In the event that excavation exposes poorly draining sub-surface, then subsoil drains should be considered under the new kerb and channel. The provision of subsoil drains has been conservatively included in the cost estimate.

11.5.7 Constructability of the Layout

Early stages of the construction will comprise removal of the existing central islands and constructing the increased pavement width areas.

The production of appropriate traffic management plans will address traffic, cyclist and pedestrian movements through all phases of the work.

The traffic management plans will need to clearly demonstrate how the high traffic volumes of the various roading routes including SH1 and SH26 will be handled throughout the total construction period without requiring diversion of traffic away to other parts of the network.

Works at each intersection are likely to be staged to minimise disruption to traffic. This may include avoiding works during peak flow hours and undertaking works at night if possible. Traffic Management Plans (TMP) will be approved by the Engineer to the Contract prior to commencement of any works and the Network Maintenance Consultant will be notified prior to undertaking any physical activity. This will facilitate coordination with the West Waikato Traffic Management Coordinator.

Construction and works will be carried out in three main stages as follows:

Stage 1 –Hillcrest Intersection

- Relocate utility services including affected lighting along Cambridge Rd and/or Cobham Drive.
- Construct temporary stormwater drainage and treatment facilities;
- Divert traffic and/or close lanes as necessary;
- Reshape the islands on Cambridge Rd and Cobham Drive;
- Remove existing roundabout;
- Install the new roundabout/ traffic signals;
- Install ducting for future roundabout signals/ traffic signals;
- Install subsoil drainage (as required);
- Construct changes to kerb and channel;
- Construct amendments to footpath where required;
- Construct new pavement where required;
- Overlay the intersection and install new linemarking;
- Reinstate existing and install new signage;
- Reinstate guardrail;
- Install other traffic control devices;
- Install landscaping features on medians and islands (i.e. planting, sod, bark, wood chips etc.)

Stage 2 – Morrinsville Intersection

The following is a general description of how the works for improvements at Morrinsville intersection will be undertaken:

- Relocate utility services;
- Construct temporary stormwater drainage and treatment facilities;
- Carry out lane closures/traffic diversions as necessary;
- Remove large mature tree near lay-by car parking;
- Clear/grub area, remove existing facilities as needed (near lay-by parking, other green areas, obsolete kerbing and footpath)
- Construct earthworks (fill) where required and place services (if necessary);
- Install subsoil drainage (where/as required);
- Construct new kerb & channel, new traffic islands (final stormwater drainage)

- Reshape medians and traffic islands
- Construct new pavement layers where required;
- Overlay pavement and install new linemarking;
- Construct changes to footpath/cycle path to underpass;
- Reinstate safety fencing/guardrailing;
- Reinstate signage, install new signage;
- Install other traffic control devices;
- Install new landscaping features (i.e. planting, etc)

Stage 3 – Intervening Pavement Rehabilitation (SH1)

The following is a general description of how the works for the rehabilitation of the approximate 310 metres of pavement between the two intersections will be undertaken:

- Install traffic control measures
- Mill out existing pavement layer at edges and transition points
- Apply 'tack coat' and geotextile as required at joints with new pavement
- Overlay with 75mm depth of asphaltic concrete
- Reinstate road marking
- Reinstate existing and install new signage;
- Re-open to traffic

The overlay philosophy was chosen for its speed of application and ability to be trafficked soon after placement. This type of treatment will have a minimal effect on local traffic. Compared to conventional pavement construction, the process will create little dust and have fewer environmental impacts in terms of silt and sedimentation.

12. LTMA PRIORITIES AND LTNZ FUNDING

12.1 LTMA Priorities

An assessment of the project against the LTMA priorities is summarised in the table below.

Table 22~~21~~ LTMA Priorities Assessment

Table 23-1 LTMA Priorities Assessment – 2½ Lane Roundabout Option

Seriousness & Urgency	
Traffic volume	Increase in capacity to cater for increase in traffic volume
Levels of congestion	Long queues and delays on Cambridge Rd leg during peak periods will be reduced
No. fatalities	None
No. of serious injuries	None
Effectiveness – Contribution to NZTS Objectives	
Economic development	Project improves capacity of the intersection to reduce travel time and improve trip reliability
Safety & personal security	Project improves safety by reducing accidents and takes account of vulnerable users such as cyclists and pedestrians
Access & mobility	Cycle & pedestrian facility included to improve access to schools, shops and private property.
Public health	Improves public health by reducing air pollution, accidents and driver frustration. Cycleway and walkway facilities and linkages will encourage this mode.
Environmental sustainability	An Assessment of Environmental Effects (AEE) has been carried out. The environment will not be adversely affected by this option.
Efficiency	
BCR	BCR of 3.9
Confidence	
Benefits	Medium
Costs (estimate status)	Higher cost estimate
Timing (planning & property risk)	Designation, land acquisition and consents required.

Table 23-2 LTMA Priorities Assessment – Signalisation Option

Seriousness & Urgency	
Traffic volume	Improves capacity but will experience longer delays.
Levels of congestion	Long queues and delays on Cambridge Rd leg during peak periods. Expect more delays during off-peak times.
No. fatalities	None
No. of serious injuries	None
Effectiveness – Contribution to NZTS Objectives	
Economic development	Project improves efficiency of the intersection by reducing uneven queuing on specific legs. But overall travel times are worse. Better trip time reliability through intersection. Access to adjacent properties improved.
Safety & personal security	Project improves safety by reducing accidents and takes account of vulnerable users such as cyclists and pedestrians
Access & mobility	Improved cycle & pedestrian facilities included to improve access to schools, shops and private property
Public health	Improves public health by reducing accidents and driver frustration. Slight deterioration in air quality because vehicles will queue longer.
Environmental sustainability	An Assessment of Environmental Effects (AEE) has been carried out. The environment will not be adversely affected by this project.
Efficiency	
BCR	Negative rating. BCR of -6.0
Confidence	
Benefits	Low, are actually negative compared to existing
Costs (estimate status)	SAR Estimates
Timing (planning & property risk)	Requires Designation, and significantly more land purchase and consents required.

12.2 LTNZ Funding Application

LTNZ funding allocation process forms is included under Appendix R.

13. CONCLUSIONS & RECOMMENDATIONS

13.1 Conclusions

The study area has congestion and safety problems. Previous reports have examined various options to treat these problems, including signalisation, roundabout improvements, grade separation and closure of the Hillcrest Shopping Centre entrance at the Morrinsville intersection.

This report focused in particular on the two options of the 2½ lane roundabout treatments and traffic signal installations at both intersections. The 2½ lane roundabout was found to be the favoured option, based on their ability to meet the project criteria better than all other treatment options.

The BCR of the favoured option is 3.9, with a first year rate of return of 15%.

13.2 Recommendations

Although the signalisation options enable Transit to fulfil Land Transport Management Act's requirements of ensuring the sustainability of the State Highway, the additional delay imposed on the travelling public is considered to high.

Therefore, it is recommended Transit proceed with the detailed design of the 2½ lane roundabout option.

Appendix Q

Stage II Safety Audit Meeting Minutes & Design Amendment Summary

Minutes of Meeting

Transit New Zealand Contract: Hillcrest & Morrinsville Road Intersection Improvements.

Date: 22 September 2004.

Venue:

Transit Hamilton office Hamilton

In attendance:

YSK Perera **(YP)**	Project Manager, Transit
Colin Brodie **(CB)**	SAT Member ,Opus
Dave Heine **(DH)**	SAT Member ,Opus
Andrew O'Brien **(AOB)**	Andrew O'Brien & Associates Pty. (Traffic Designer)
Dominic Giroux **(DG)**	Resolve Group

Not in attendance:

Bruce Robinson, SAT Member, Independent

Agenda:

Transit New Zealand engaged the nominated safety audit team to carry out the Stage 2 Safety Audit for the Hillcrest & Morrinsville Road Intersection Improvements. The operation design and principal subject of the audit was carried out by Andrew O'Brien & Associates Ltd Pty as sub consultants to Resolve Group.

The Audit was carried out in late August 2004 and the report was issued dated 15 September 2004.

Transit Project Manager initiated this meeting to gain a better understanding the issues raised in the report. Minutes of this meeting, along with the Safety Audit report will form the basis of the formal response of the Consultant to the comments and issues.

Terminology/Abbreviations

SAT	Safety Audit Team
HCC	Hamilton City Council
Hillcrest Intersection	Cobham/Cambridge intersection, or western roundabout

Morrinsville intersection	Cambridge/SH26 – Morrinsville/Shopping Centre roundabout
RG	Resolve Group
IC	Intersection

Minutes			
Date:	22 September 2004.		
Item	**Who**	**Discussion**	**Actions/Notes**
1	AOB	Was not 'surprised' by the issues raised in the report, due to fact that he had to consider these same issues during the design. Approach used going into this project was to design around the demand, with assistance from models, rather than depending entirely on their outputs.	
2	CB	Issue 2.1.1 Traffic Demand projections. – There is a public expectation for a noticeable improvement in performance. The SAT wonders whether the additional capacity realised by the proposed improvements will be immediately absorbed (and go unnoticed) due to the reduction in diverted traffic using Howell Ave, for example.	Comment in addition to what was said in report.
3	AOB	Response – The design includes a 20% capacity improvement on all legs. 'Rat running' only accommodates one or two movements. Gap acceptance at Morrinsville IC is the major restriction. Amended geometry will improve the gap acceptance. The capacity improvements should therefore make a noticeable difference to the public who make those movements, which diverters do not.	
4	CB	Wanted to ensure that TNZ is aware that the CB and DH believe that the public may not notice the safety benefit and capacity improvement.	
5	AOB	Response: can easily test the capacity comment; look at diverted traffic volumes.	Additional traffic count data for potential traffic diversion routes to be collected by Resolve from HCC and investigated by AOB.

			AOB notes crash issues; to provide comment in Client response.
6	CB	Discussion of issues at Hillcrest IC – crash patterns and visibility issues. NW Leg sight distance inadequate. Suggest that land purchase/easement agreement be considered for property on western corner at junction of Cobham & Cambridge Rd. Such a purchase would alleviate a number of visibility problems as well as widen shoulder width. SAT observations indicate that land use appears to be low – i.e. large yard with a shed and parked cars. May be an 'artificial hurdle' to TNZ.	
7	DG	Part of the problem may be that there is a high wall of vegetation with concrete base along the boundary of this property. If the landowner agreed to keep the wall low enough such that visibility was not impeded, the desired sight distance outcome could be achieved.	Resolve Group and TNZ to investigate options to improve sight distance here – speaking with HCC about acceptable fence heights.
8	AOB	Reiterated that we have designed primarily for capacity, whilst considering the real physical constraints of the site.	
9	CB	Issue 2.2.4 – Kink – does not think drivers will follow the painted line, and will instead take short path encroaching into adjacent lane.	
10	AOB	Response: Understands this view.	AOB to re-examine the layout
11	CB, DH	Minor issue – unsafe access to private property.	
12	AOB	Response: Does not see this as something that would happen often.	
13	CB	Issue 2.2.7, 2.2.8: Narrow shoulder pinch, tricky access for private driveways.	
14	AOB	Agrees.	AOB to look at reconsidering the design in this vicinity, potentially to include more of a radius for private driveways.
15	CB	Issue 2.2.9. Double right turn lanes, downstream merge. SAT indicated need to look more closely at this.	AOB to look at other ways to treat, including unmarked kea-type crossing so as to not give pedestrians sense of priority at downstream crossing.

16	CB	2.2.10 – Left turn deflection @ SE Leg.	AOB to flag this item for re-examination.
17	CB	2.2.11 – Downstream pedestrian crossing – SAT acknowledge that this may be outside scope of this project, but flag it to ensure vehicle merging situation is not worsened by the proposal.	SAT members are discussing pedestrian crossing issues with HCC.
Morrinsville IC			
18	CB	Northern slip lane. Conflict issue with pedestrians, who need to cross traffic 3 times to get across.	
19	AOB	Response: Doesn't see it this way; this was done on the basis that pedestrians prefer crossing fewer lanes (shorter exposure to traffic, fewer lanes) rather than more.	
20	CB	Sightlines 'view shaft' for the approach to the left turn lane may tend to erroneously lead SH1 southbound drivers to the incorrect position (i.e. on the left side of the island) as opposed to the right hand side of it.	
21	AOB	Believes that there is sufficient delineation and visibility, however, can look into amending the design slightly to introduce better entry deflection. Notes that the point of view may change if this 'slip lane' were considered to be a lane at a 'T' intersection, in which case the deflection would be considered to be inadequate	AOB to look at adjusting the radius for approach deflection
22	CB	Issue 2.2.3 SH1 Through speed, SE Leg deflection. SAT sees this as a major issue overall. Traffic is faster, visibility is worse in opinion of SAT.	
23	AOB	Response: Could amend the design to approach increase deflection. Another option, to be done in conjunction with the above would be to introduce exit deflection. This is done commonly in France. (i.e. hard in, hard out.) This would effectively decrease the speed of the 'through' movement.	AOB to revise design in this aspect. Note: SAT members cannot comment on this until they have seen the revised design..
24	CB	Cyclist issues: As an avid cyclist, believes diverge areas such as the one shown leading up to the northern slip lane at Morrinsville IC would lead to significant safety problems.. Asks that the slip lane be reconsidered in light of all the issues surrounding it.	
25	CB	Cannot see the benefits of marking cycle lanes through the roundabout but support the provision of a shoulder space.	

26	AOB	Response: Cyclists have requested that this not be done. AOB agreed with team; considers that delineating an area within the roundabout would be beneficial, but refrain from painting in green and cycle markings on it, so as to not give cyclists the feeling of priority.	
27	CB	Bus stop issue – could be moved in front of Caltex.	
28	AOB	Agrees.	
29	CB	Comment: Pedestrian crossing paths on northwest leg; debated the real need for facilities at this location, as most observed pedestrian traffic was crossing in front of Hillcrest Shopping Centre.	
30	CB	Summary of the major issues as seen by the SAT: 1. Capacity being soaked up immediately after improvements, TNZ and public may not notice dramatic benefits. 2. Left turn slip lane near lay-by at Morrinsville IC: number of issues as per report 3. Deflection/sight line issues associated with entrance to hillcrest Shopping centre, and the oncoming SH1 traffic from SE leg.	Resolve Group to provide response on all items raised in the safety audit report to Transit.
31	YP	Emphasised the need to ensure all issues raised in the report are addressed and resolved as soon as practicable, thanked all who were present.	

Summary of Drawing Amendments

This table is to be used in conjunction with the Designer's Response to Road Safety Audit Report.
Note on drawings provided that the lines in blue indicate amendments made following the safety audit report.

Item in Safety Audit Report	Issue	Recommendation(s)	Designer's Response & Amendment
2.2 Hillcrest Roundabout			
2.2.3 SW Leg Eastbound Approach, Left Turn Lane **Serious**	The proposed left turn lane appears to be only 2.5 m wide and is too narrow to operate safely. It also appears that the left hand shoulder is eliminated. However the lane should not be widened at the expense of the adjacent footpath, which is already quite narrow. The inclusion of the left turn lane will also pose a challenge for cyclists proceeding through the roundabout	Reconsider the need for the left turn lane on the SW leg in the light of the room available; If the left turn lane is retained, ensure that has an adequate width, including the provision of a left hand shoulder to serve as an emergency refuge for cyclists.	***Designer's Response:*** The approach needs ultimately to have some additional capacity to accommodate predicted growth. *Amendment*: There was a drafting error that showed a 2.6m lane, and this has been adjusted by slightly narrowing the adjacent lanes
2.2.4 SW Leg Eastbound Approach, Alignment **Minor**	The Scheme Plans show a kink to the right in the alignment about 25 m back from the limit line, presumably to align the approach lanes with the correct path through the roundabout. However, it is most unlikely that vehicles will follow such a tight kink and will tend to cut across it, possibly causing them to take conflicting, overlapping paths through the roundabout. The kink also reduces the central median to a very narrow width.	Amend the approach alignment on the SW leg to eliminate the proposed kink, and ensure that the approach alignment is consistent with the proposed vehicle paths through the roundabout (i.e. inside vehicle path not cut off by outside vehicle path)	***Designer's Response:*** The kink is needed to get sufficient lane width for the 3 lanes, and assists in increasing deflection. *Amendment*: The plan has been modified slightly to increase the length of the "kink" so that it will be better utilised.
2.2.8 SE Leg (SH 1), Narrow Shoulder **Significant**	The realignment of the lanes on this approach results in a very narrow shoulder pinch point that could be particularly hazardous for cyclists,	Ensure that a minimum left hand shoulder width of 1 m is maintained throughout the roundabout and its approaches.	***Designer's Response:*** This has been addressed by a minor design change.

	and possibly make it more difficult for vehicles turning into and out of driveways.	However, it should not be marked as a bicycle lane, but left unmarked to provide an optional refuge.	
2.2.9 SE Leg, Double Right Turn Lanes and Merge Arrangement **Significant**	The Scheme Plans show two right turn lanes leading into two exit lanes. The crash record shows that there are a number of rear-end and pedestrian accidents associated with the downstream pedestrian crossing on the exit leg. Care will therefore have to be taken to ensure that the merge arrangement does not exacerbate this problem by not coinciding with the crossing location	Ensure that the two exit lanes can merge safely in advance of the downstream pedestrian crossing.	***Designer's Response:*** The need for two lanes in the short term could be tested by stage-opening of the treatment using a spiked-kerb extension on the Cobham Drive entry, and no right turn arrow in the centre lane of the SH1 SE approach. In the longer term, the second stage would include using the current proposed design, the timing of this to be driven by demand. *Amendment:* The design will show a lane drop taper between the roundabout exit and the pedestrian crossing.
2.2.12 Pedestrian Refuges in the Medians **Minor**	No pedestrian refuges have been formed in the medians on either the SW or NW legs – and they should be provided on these legs. No refuges are required on the SE leg because of the proximity of the pedestrian/cycle subway	Install adequate (1.8 m long) pedestrian refuges in the medians on the NW and SW legs at suitable locations immediately upstream of the roundabout.	***Designer's Response:*** This matter was addressed in a minor redesign after the audit had been commissioned. No further action required.
2.2.13	See response report.	See response report.	See response report.

2.3 Morrinsville Roundabout			
2.3.3 SE Leg (SH 1) Northbound Approach, Through Speed **Serious**	The realignment of the approach lanes has significantly reduced the deflection for through traffic. The increased the speed of through vehicles will increase the speed differential with circulating vehicles and make them less likely to give way – particularly to those vehicles heading for the shopping centre exit. The additional entry lane may also make it more difficult for through traffic in the leftmost lane to see the gaps in traffic approaching from the left lane of the NE leg.	Provide more deflection on the approach for SH 1 through traffic in order to reduce through speeds, improve speed consistency and assist in the selection of gaps in the circulating traffic stream.	***Designer's Response:*** As would be expected from widening from 2-lanes to 3-lanes, the fastest line through the roundabout increases in radii – from about 125m to about 200m. However, the radius for a vehicle following the lane alignment is about the same – 60m. To assist vehicles to remain within a given lane on entering the roundabout, it is proposed to use a "vibraline" or similar type of line. With respect to the last point, the view line available from the southern approach holding line, there is sufficient angle between the holding line and the eastern approach to enable drivers in the left lane to see past vehicles in the adjacent lanes on the southern approach. *Amendments*: The "fastest path" issue has been addressed as follows: Removing the cycle lane and providing a separated cycle facility through the apex of the approach – reduces path from 200mR to about 175m; Tightening the entry radius from about 60m to about 40m which, coupled with the above, reduces the radius to about 150m. Note that a tighter exit alignment could be created, decreasing the negotiation speed in the correct lane, but that would increase the maximum fastest path radius slightly.
2.3.4 Shopping Centre Approach **Serious**	See report (too lengthy to include here)	See report (too lengthy to include here)	See amendments made in accordance with the above issue 2.3.3.
2.3.5 NW (SH 1 Southbound) Approach, Left Turn Slip Lane **Serious**	See report (too lengthy to include here)	See report (too lengthy to include here)	***Designer's Response:*** The positive delineation of the southbound alignment is taken mainly from the right hand lane, and facilities such as the street lighting. On the left side, the delineation provided by the bike lane treatment provides good alignment delineation. *Amendment:* The southbound through alignment has been eased slightly thus enabling improved delineation.

			See report for remainder of Sesigner's response to this issue.
2.3.6 Circulatory Roadway **Significant**		Omit the dashed lane line across the front of the SH 1 northbound (SE) entry and replace the marking with a solid lane line opposite the median islands on the SE and SW legs.	***Designer's Response& Amendment:*** There was an error with the linemarking within the roundabout that, when fixed, fully addresses this issue.
2.3.8 NE (Morrinsville Rd) Leg, Circuitous Pedestrian Crossing **Significant**	The proposed pedestrian crossing facility is indirect and involves long paths across three traffic islands. The route is not obvious for users and involves increased exposure within the carriageway. The proposed route is therefore likely to be avoided by pedestrians in favour of more direct informal routes, as occur currently. The northern end of the proposed route emerges from a group of trees that could restrict visibility to and from any pedestrians crossing the roadway from north to south. The route crosses the high-speed eastbound slip lane further adding to the safety problems of this pedestrian crossing. It is also likely that the demand for this movement is low, because the majority of pedestrians wishing to cross Morrinsville Road are likely to be travelling to or from the schools in the area and should be channelled to use the much safer mid-block	Move the pedestrian crossing on the NE leg eastward to provide a more direct crossing where the road is narrower, but keep the crossing low-key and unmarked in view of the safer alternative available further down Morrinsville Road. If the proposed crossing is retained, remove the trees at the northern end of the crossing to improve intervisibility between pedestrians and the approaching traffic.	***Designer's Response& Amendment:*** The eastbound exit from the roundabout has been slightly modified to widen the pedestrian refuge between the exit road and the slip lane. The crossing of the slip lane could only be moved to the east if more trees and shrubs are cleared. It is noted that this decision could have a further loss of visual amenity effect on adjacent residents.

	crossing further down Morrinsville Road.		
2.3.10 Combined Pedestrian/ Cycleways **Significant**	The proposed additional cycle access between the east side of the SE (SH 1) leg and the entrance to the subway should improve safety by encouraging cyclists to use the subway. A combined pedestrian/cycleway between the western end of the subway and the shopping centre entrance should also improve the safety of cyclists by encouraging them to avoid using the traffic lanes through the roundabout.	Provide a marked combined pedestrian/cycleway from the western end of the subway on the SE leg and across the shopping centre entrance.	*Designer's Response:* Agree with recommendation 27; to be added to the design.

ISSUE	APPD.	DATE	AMENDMENTS

Existing Layout
Seal Edge
Property Boundary
Footpath
Car Park
Existing Fence
Letter Box
Light Pole
Existing Tree

Resolve GROUP

TRANSIT NEW ZEALAND ARAHANUI AOTEAROA

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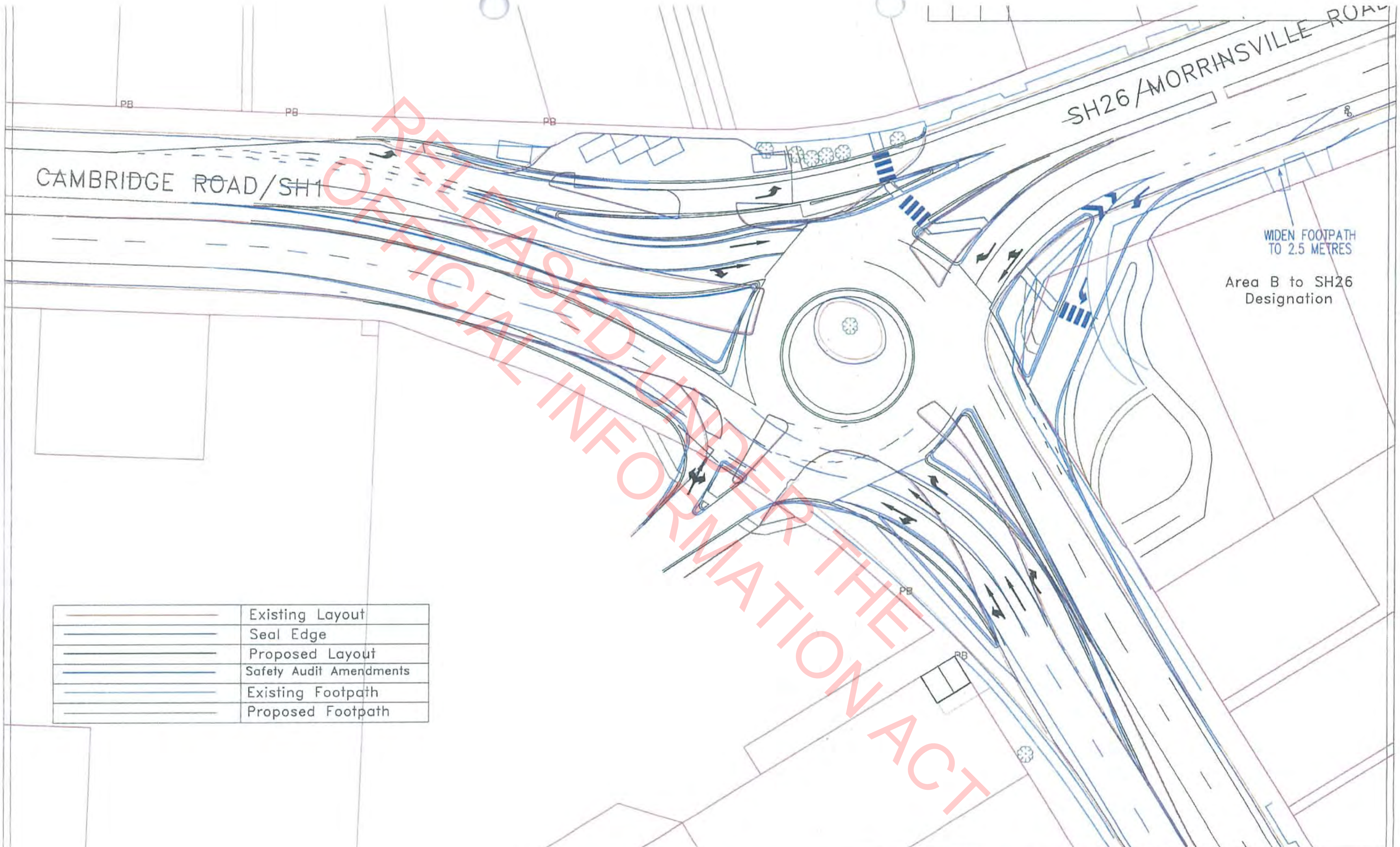
SH1, REGION 3
HILLCREST & MORRINSVILLE ROAD
INTERSECTION IMPROVEMENTS

GENERAL PLAN – PROPOSED IMPROVEMENTS

Designed: B.VANDERWERF
Engineer: A.P.O'BRIEN
Approved by: M. LEAK
Scale: 1:1200 0 25 50
Job No. J0401
Sheet No.
Drawing No.
CAD File No.
Issue A B



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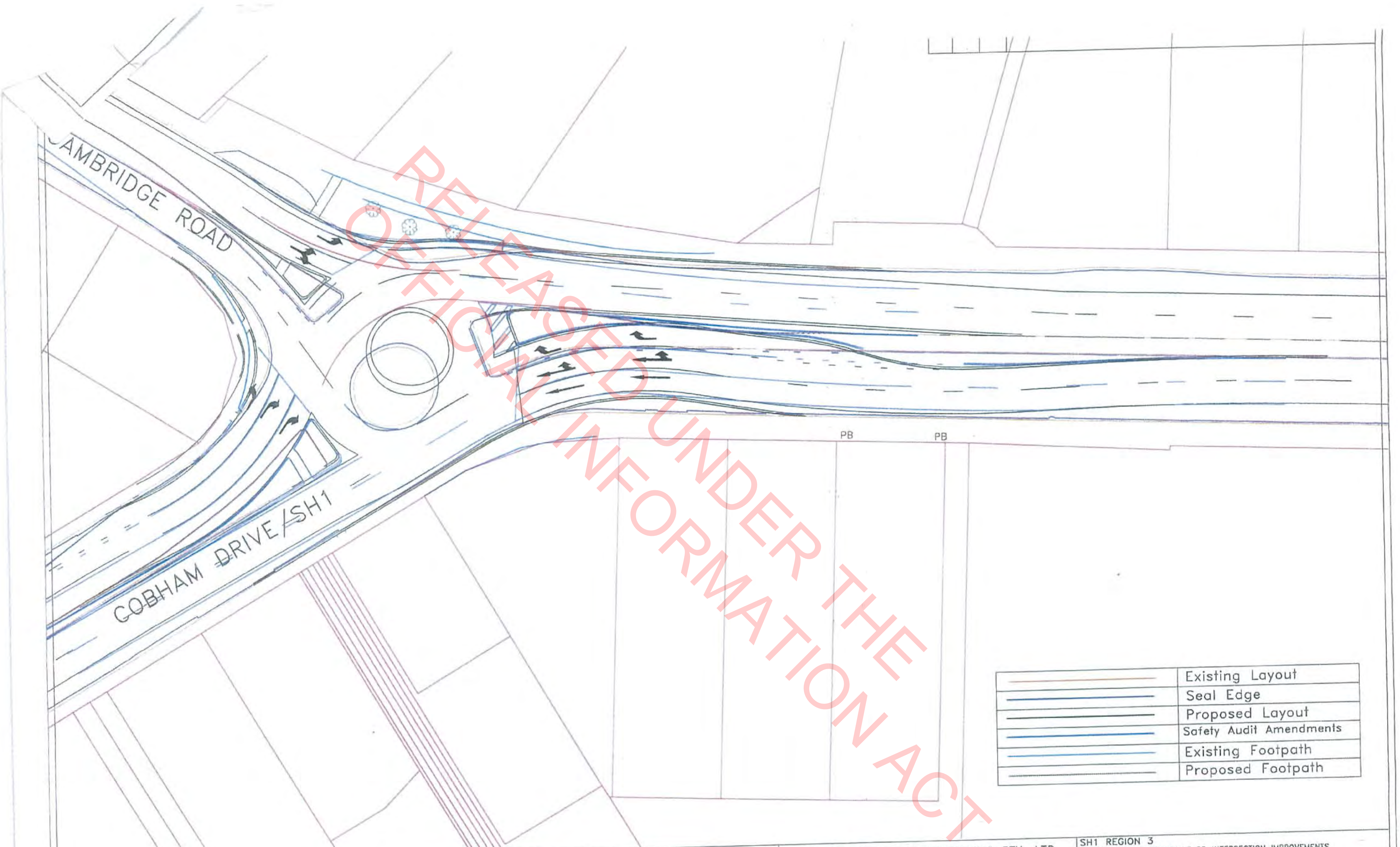
TRANSIT NEW ZEALAND

Resolve Group

SH1 REGION 3
HILLCREST & MORRINSVILLE RD INTERSECTION IMPROVEMENTS
MORRINSVILLE INTERSECTION
(CAMBRIDGE RD/SH1 & MORRINSVILLE RD/SH26)

PROPOSED IMPROVEMENTS

Designed by	Engineer	Approved by	Scale (m)	Date	Job No.	Sheet No.	Drawing No.	Issue
B.VANDERWERF	A.P.O'BRIEN	M. LEAK	1:500 (A3)	AUG 04	J0401	4 OF 8	A14	13



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SH1 REGION 3
HILLCREST & MORRINSVILLE RD INTERSECTION IMPROVEMENTS
HILLCREST INTERSECTION
(COBHAM DRIVE/SH1 & CAMBRIDGE RD)

PROPOSED IMPROVEMENTS

Designed by:	Engineer:						
B.VANDERWERF	A.P.O'BRIEN						
Approved by: M. LEAK	Scale (m) 1:500 (A3)	0 10 20	Date: AUG 04	Job No. J0401	Sheet No: 3 OF 8	Drawing No: A4	Issue: A