NZ TRANSPORT AGENCY
WAKA KOTAHI

Roads of national significance

Ara Tūhono – Pūhoi to Wellsford

FURTHER NORTH

Pūhoi to Warkworth

Construction Traffic Assessment Report

August 2013

Pūhoi to Warkworth

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Glossary of abbreviations

Abbreviation	Definition
AADT	Average Annual Daily Traffic
AEE	Assessment of Environmental Effects
COPTTM	Manual for Traffic Control Devices – Section 8: Code of Practice for Temporary Traffic Management (New Zealand Transport Agency)
CTMP	Construction Traffic Management Plan
ha	Hectares
HCV	Heavy Commercial Vehicles
km	Kilometre
kph	Kilometres per hour
m	Metre
m^3	Cubic metres
MfTCD	Manual for Traffic Control Devices
MOTSAM	Manual of Traffic Signs and Markings
MSE	Mechanically stabilised earth
NGTR	Northern Gateway Toll Road
NZTA	New Zealand Transport Agency
OPW	Outline Plan of Works
RCA	Road Controlling Authority
RoNS	Road of National Significance
SATURN	Simulation and Assignment of Traffic to Urban Road Networks
SH1	State Highway One
SIDRA	Signalised and Un-signalised Intersection Design and Research Aid
SISD	Safe Intersection Sight Distance
SSTMP	Site Specific Traffic Management Plan
TTM	Temporary Traffic Management
vpd	Vehicles per day

Abbreviation	Definition
vph	Vehicles per hour

Glossary of defined terms

Term	Definition
Alignment	The route or position of an alignment of an existing or proposed motorway or state highway.
Auckland Council	The unitary authority that replaced eight councils in the Auckland Region as of 1 November 2010.
Contra-Flow	The controlled channelling of traffic flows, usually onto temporary alignments, to maintain a traffic flow in both directions. Delineation devices or physical barrier systems are normally used to separate the traffic flows.
Grade separated interchange	The layout of roads, where one road crosses over/under the other at a different height.
Indicative Alignment	A route and designation footprint selected after short-list and long-list development to enable consultation with the community. This development involved specialist work assessing environmental, social and engineering inputs.
Level of service	The Highway Capacity Manual (2010) defines level of service as a quantitative stratification of a performance measure or measures that represent quality of service, measured on an A-F scale, with level of service A representing the best operating conditions from a traveller's perspective and level of service F the worst. Within a traffic stream, it describes operational conditions generally in terms of speed and travel time, freedom to manoeuvre, traffic interruptions, and comfort and convenience.
Motorway	Motorway means a motorway declared as such by the Governor-General in Council under section 138 of the PWA or under section 71 of the Government Roading Powers Act 1989.
Portal	The entrance way to a tunnel starting where the road is completely uncovered to where it is completely covered.
Project Area	From the Johnstone's Hill tunnel portals in the south to Kaipara Flats Road in the north.
Requiring Authority	Defined in section 166 of the RMA as a Minister of the Crown, a local authority or a network utility operator approved as a requiring authority under section 167 of the RMA.
SATURN Traffic Model	SATURN is a suite of flexible network analysis programmes developed at the Institute for Transport Studies, University of Leeds in the United Kingdom.

Contents

1. Introduction

This Report forms part of a suite of technical reports prepared for the New Zealand Transport Agency's (NZTA's) Ara Tūhono Pūhoi to Wellsford Road of National Significance (RoNS) Pūhoi to Warkworth Section (the Project). Its purpose is to inform the Assessment of Environmental Effects (AEE) and to support the resource consent applications and Notices of Requirement for the Project.

The Project realigns the existing State Highway One (SH1) between the Northern Gateway Toll Road (NGTR) at the Johnstone's Hill tunnels and just north of Warkworth. The alignment will bypass Warkworth on the western side and tie into the existing SH1 north of Warkworth. It will be a total of 18.5km in length. The upgrade will be a new four-lane dual carriageway road, designed and constructed to motorway standards and the NZTA RoNS standards.

A preliminary construction programme / methodology has been developed for the Project that identifies a construction duration of approximately five years.

The existing transport environment is described in detail in Section 3 of the Transportation and Traffic Assessment Report.

1.1 Purpose of report

This report forms part of a suite of technical reports prepared for the New Zealand Transport Agency's (NZTA's) Ara Tūhono Pūhoi to Wellsford Road of National Significance (RoNS) Pūhoi to Warkworth Section (the Project). Its purpose is to inform the AEE and to support the resource consent applications and Notices of Requirement for the Project. This report has been written by Andrew Bell with the valuable assistance of Tim Brown and Bruce Conaghan.

The indicative alignment shown on the Project drawings has been developed through a series of multi-disciplinary specialist studies and refinement. A NZTA scheme assessment phase was completed in 2011, and further design changes have been adopted throughout the AEE assessment process for the Project in response to a range of construction and environmental considerations.

It is anticipated that the final alignment for the Project will be refined and confirmed at the detailed design stage through conditions and outline plan of works (OPW). This assessment has addressed the actual and potential effects arising from the indicative alignment, however, we consider that our assessment is representative of construction of any similar project within the designation boundary. We consider our assessment to be representative because the scale of the construction traffic movements will be similar, irrespective of the final design and methodology. In addition, SH1 provides the only real access for construction traffic for the majority of the alignment. Even if access points were in different places on SH1, the issues that would need to be addressed would be similar. Similarly, access at the north would likely be required via Woodcocks Road in a similar way to that assessed in this Report.

It is anticipated that the final alignment will be refined and confirmed at the detailed design stage through conditions and OPW. For that reason, this assessment has addressed the actual and potential effects arising from the indicative alignment, and covers the proposed designation boundary area.

1.2 Project description

This Project description provides the context for this assessment. Sections 5 and 6 of the Assessment of Environment Effects (Volume 2) further describe the construction and operational aspects of the Project and should be relied upon as a full description of the Project.

The Project realigns the existing SH1 between the Northern Gateway Toll Road (NGTR) at the Johnstone's Hill tunnels and just north of Warkworth. The alignment will bypass Warkworth on the western side and tie into the existing SH1 north of Warkworth. It will be a total of 18.5 km in length. The upgrade will be a new four-lane dual carriageway road, designed and constructed to motorway standards and the NZTA RoNS standards.

1.3 Project features

Subject to further refinements at the detailed design stage, key features of the Project are:

- A four lane dual carriageway (two lanes in each direction with a median and barrier dividing oncoming lanes);
- A connection with the existing NGTR at the Project's southern extent;
- A half diamond interchange providing a northbound off-ramp at Pūhoi Road and a southbound on-ramp from existing SH1 just south of Pūhoi;
- A western bypass of Warkworth;
- A roundabout at the Project's northern extent, just south of Kaipara Flats Road to tie-in to the existing SH1 north of Warkworth and provide connections north to Wellsford and Whangarei;
- Construction of seven large viaducts, five bridges (largely underpasses or overpasses and one flood bridge), and 40 culverts in two drainage catchments: the Pūhoi River catchment and the Mahurangi River catchment;
- A predicted volume of earthworks being approximately 8M m^3 cut and 6.2M m^3 fill within a proposed designation area of approximately 189 ha earthworks.

The existing single northbound lane from Waiwera Viaduct and through the tunnel at Johnstone's Hill will be remarked to be two lanes. This design fully realises the design potential of the Johnstone's Hill tunnels.

The current southbound tie in from the existing SH1 to the Hibiscus Coast Highway will be remarked to provide two way traffic (northbound and southbound), maintaining an alternative route to the NGTR. The existing northbound tie in will be closed to public traffic as it will no longer be necessary.

1.4 Interchanges and tie-in points

The Project includes one main interchange and two tie-in points to the existing SH1, namely:

- The Pūhoi Interchange;
- Southern tie-in where the alignment will connect with the existing NGTR; and
- Northern tie-in where the alignment will terminate at a roundabout providing a connection with the existing SH1, just south of Kaipara Flats Road north of Warkworth.

1.5 Route description by Sector

For assessment and communication purposes, the Project has been split into six sectors, as shown in Section 5.3 of the AEE.

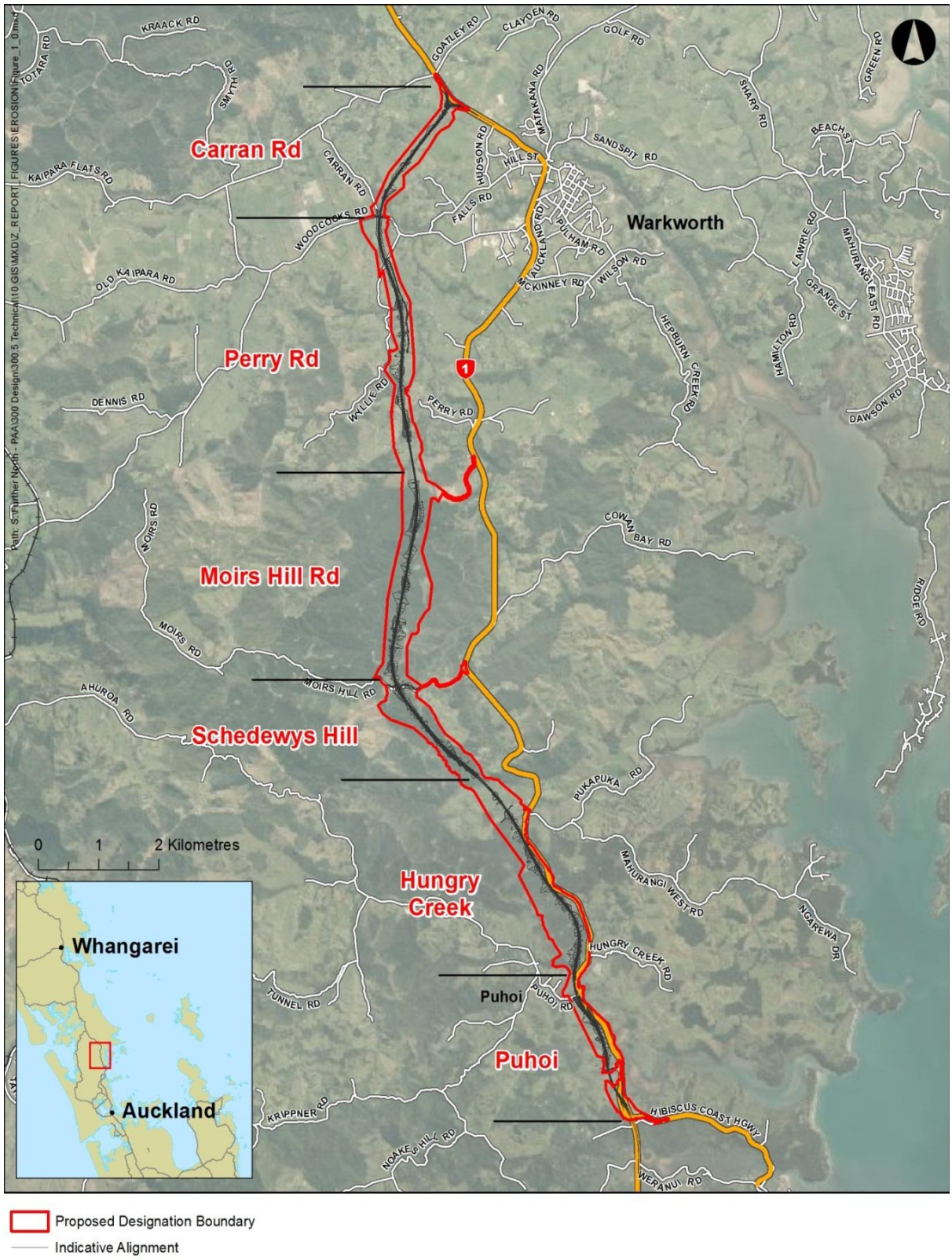


Figure 1: Project sectors

1.6 Preliminary construction methodology / programme

A preliminary construction programme / methodology has been developed for the Project that identifies a construction duration of approximately five years. Details of the preliminary construction methodology and programme are described in the AEE: Section 6. It is anticipated that the earthworks will be constructed during the normal earthworks season (October – May) for the five year programme. The construction of the structures is expected to take between three and four years per structure. It is expected that during the earthworks season, all of the sites may be operating concurrently.

1.7 Existing Transport Environment

The existing transport environment is described in detail in the Transportation and Traffic Assessment Report: Section 3 and summarised below.

The SH1 corridor from Pūhoi to Warkworth is primarily characterised by rolling or steep terrain with some particularly low speed horizontal curves and steep grades. The route is primarily a single carriageway with some passing lanes. The majority of the route has a posted speed limit of 100 kph. Warkworth experiences significant congestion during holiday periods and also during weekday evening commuter peak and on weekends.

The 2012 Average Annual Daily Traffic (AADT) volume is approximately 17,400 vehicles per day (vpd) for the Pūhoi to Warkworth section of SH1. SH1 carries high volumes of freight traffic, with up to seven per cent1 of traffic being HCVs along the route between Pūhoi and Warkworth.

The section of SH1 between Warkworth and the NGTR has a poor crash history. There is an average of 13 injury crashes per year on SH1 between Pūhoi and the proposed northern connection with the Project.

Inter-city bus services and tourist shuttles currently provide the only public transport services within the corridor. Some bus services are planned to run between Warkworth and Silverdale in the near future.

Given the large distances between centres, there is limited opportunity for walking or commuter cycling between centres. Recreational cyclists do however use the existing SH1. Walking and cycling takes place within Warkworth itself. Whilst the SH1 corridor has seen some improvements in pedestrian and cycle facilities in recent years, these road users can feel intimidated by the high volumes of SH1 traffic, which affects the perceived safety and enjoyment of travel by these modes of transport.

[1] Based on The NZTA's TMS counts measured at the count sites at Pohuehue Viaduct and North of Hungry Creek Road.

2. General principles for temporary traffic management

The primary standard that will be adhered to in planning, coordinating and implementing Temporary Traffic Management (TTM) for this Project is the Code of Practice for Temporary Traffic Management (COPTTM) (including the local road supplement and Road Controlling Authority (RCA)-specific procedures).

The NZTA has a long history of delivering large scale roading projects whilst minimising the impacts to the travelling public. In the Auckland Region, recent examples include the Victoria Park Tunnel, Newmarket Viaduct Replacement and the Northern Gateway Toll Road.

For other projects, the NZTA has developed Construction Traffic Management Plan (CTMP) as part of the outline plan of works process for the Project. Site Specific Traffic Management Plans (SSTMP) have been produced for each activity in accordance with COPTTM to demonstrate that the effects of the construction activity on the transport network will comply with designation conditions, and will minimise disruption.

2.1 Framework for temporary traffic management

The requirements for TTM are regulated through the Land Transport Act 1998 and the Land Transport Rules made pursuant to that Act. The rules that relate to TTM, include:

- Land Transport (Road User) Rule 2004;
- Land Transport Rule: Traffic Control Devices 2004; and
- Land Transport Rule: Setting of Speed Limits 2003.

The NZTA Manual for Traffic Control Devices (MfTCD) provides guidance on industry good practice, including, where necessary, practice mandated by law in relation to the use of traffic control devices. The primary standard (which forms part of the MfTCD) that will be adhered to in planning, coordinating and implementing TTM for this Project is the Code of Practice for Temporary Traffic Management (COPTTM) (including the local road supplement and Road Controlling Authority (RCA)-specific procedures).

2.2 The NZTA's traffic management processes

Having been involved in a number of large NZTA projects, we understand NZTA's standard processes in relation to planning and implementation of traffic management for large projects. In the Auckland Region, recent examples of large scale projects include the Victoria Park Tunnel, Newmarket Viaduct Replacement and the Northern Gateway Toll Road. In our experience, the NZTA has delivered these roading projects whilst minimising the impacts to the travelling public during the construction phase.

For these other projects, the NZTA developed a Construction Traffic Management Plan (CTMP). Site Specific Traffic Management Plans (SSTMP) have been produced for each activity in accordance with the COPTTM to demonstrate that the effects of the construction activity on the

transport network will comply with designation conditions, and will minimise disruption wherever practicable.

A CTMP typically incorporates the following objectives for the delivery of TTM during the construction of a project:

- Provide TTM complying fully with the COPTTM wherever practicable. Non-compliance should be addressed through Engineering Exception Decisions[2] signed off by the NZTA's implementation team delivering the Project and the relevant RCAs;
- Focus on current best industry standards with regard to TTM and safety;
- Minimise disruption on the State Highways and local roads wherever practicable;
- Maintain existing flows and travel times on State Highways and local roads adjacent to the work site where practicable;
- Minimise the impact of works on pedestrians and cyclists wherever practicable;
- Minimise the effects of construction traffic on local roads used for access wherever practicable;
- Minimise the impact of construction parking wherever practicable;
- Develop SSTMPs having consideration for key stakeholders (mainly local residents and Auckland Transport, but also the wider travelling public);
- Identify all issues and have a planned SSTMP approved at least five days before implementation is required in consultation with the applicable RCA and the NZTA's network management consultant;
- Provide effective communication to affected parties and the travelling public; and
- Implement TTM that provides stakeholders with functionality and clarity of direction of travel through roadwork sites.

Typically, these objectives can be achieved through the implementation of the CTMP and associated SSTMPs to ensure the overall effects of construction are minor. Given their success in other projects, as discussed in more detail later, we recommend that these objectives be applied when developing a CTMP for the Project.

The Newmarket Viaduct Replacement project is a recent example of how NZTA manage construction traffic effects of large scale infrastructure projects. SH1 (which carries more than 150,000 vehicles a day) was closed for many hours at a time during the course of the project. The management of these closures was the subject of considerable focus of the project team and the mitigation measures undertaken (for example, the timing of closures and engagement with affected users) resulted in positive feedback from the public and were considered a success by those involved.

In comparison the construction traffic effects of the Project are less complicated and of a smaller scale, providing confidence that the traffic management approach that the NZTA undertake will appropriately manage any effects.

[2] A written decision made following consideration of all factors, including the safety of all concerned, to vary a code of practice(s), standard(s) and/or guideline(s), to suit a particular situation. The decision must be included with the traffic management plan (TMP)

3. Methodology for assessing Project construction traffic effects

We have assessed the nature and scale of effects that the construction of the Project will have on the transport network. We undertook our assessment of the construction traffic effects by identifying where construction activities (physical works and construction related vehicle movements) would potentially impact on the transport network based on the preliminary construction methodology set out in section 6 of the AEE.

The approach we used was to identify:

- Locations where construction operations would directly affect the existing roading network ie where TTM measures would need to be put in place;
- Construction access points required for staff, equipment and material; and
- The number of vehicle movements associated with construction of the Project, their origins and destinations.

Based on our experience of the way that the NZTA typically manages the construction effects of projects, and assuming that appropriate typical mitigation measures were put in place, we then assessed:

- The effects of TTM measures; and
- The effect of construction traffic moving through the transport network for a typical construction day.

3.1 Assessment methodology

We have assessed the preliminary construction methodology for the Project in two parts:

- The effects of temporary traffic management measures and mitigation; and
- The effect of construction traffic moving through the transport network.

3.1.1 Temporary traffic management effects and mitigation

We assessed the effect of general traffic management activities by considering the likely construction activities and associated TTM activities on the existing network. We undertook a qualitative assessment to determine the likely level of impact from the activities based on our experience and understanding of capacity reductions and delays caused by traffic management activities.

We also assessed the potential for alternative routes to be used as detour routes if roads were to be closed for a given time. As part of developing the CTMP and associated SSTMPs for the Project, we recommend that the NZTA also consider the suitability of detour routes where short-term road closures are considered necessary to facilitate construction works (as is usual NZTA practice).

Our TTM effects and mitigation assessment is presented in Section 4 of this Report.

3.1.2 Effects of construction traffic movements and mitigation

To assess the effects of additional construction traffic movements on the network, we identified likely and reasonable access points to the worksites required for staff, equipment and material. We then used construction traffic volume assessments informed by the preliminary construction methodology in the AEE (chapter 6) to identify the number of construction vehicles that would use the site accesses to access the public road network.

Using this information, we assessed the effects of construction traffic movements on construction site access intersections in terms of:

- The safety of the indicative construction access locations and available sight distances. These factors were was assessed through our site observations and by reviewing crash histories for each location;
- The efficiency of the intersection between the construction access and the adjacent road, including an assessment of an appropriate intersection treatment to minimise delay. Where appropriate delay was assessed using SIDRA[3]; and

We then assessed the cumulative effects of the additional traffic generated by construction activities on local roads and SH1.

The effects of construction traffic movements are assessed in Section 5 of this Report.

[3] SIDRA (Signalised and Un-signalised Intersection Design and Research Aid) INTERSECTION is an advanced micro-analytical traffic evaluation tool that simulates traffic conditions at intersections.

4. Temporary traffic management effects and mitigation

We assessed the effect of construction activities by considering the location and scale of construction activities and associated TTM measures on the existing network. We undertook a qualitative assessment to determine the likely level of impact from the activities based on our experience and understanding of capacity reductions and delays caused by traffic management activities.

The key locations where TTM measures are likely to be required with the potential to affect operating conditions on the existing road network are identified below:

- SH1 – Southern tie-in;
- Pūhoi Road and its intersection with SH1;
- SH1 – Hungry Creek;
- Moirs Hill Road;
- Wyllie Road;
- Woodcocks Road/Wyllie Road; and
- SH1 – Northern tie-in.

We consider that the effects of the temporary traffic management activities can be effectively managed to minimise disruption through the implementation of CTMPs and SSTMP's.

The key locations where TTM measures are likely to be required for the Project, and which have the potential to affect operating conditions on the existing road network, are shown in Figure 2:

- SH1 – Southern tie-in;
- Pūhoi Road and its intersection with SH1;
- SH1 – Hungry Creek (two sites);
- Moirs Hill Road;
- Wyllie Road;
- Woodcocks Road/Wyllie Road; and
- SH1 – Northern tie-in.

The following sections describe the works in the vicinity of the existing roads and identify the types of potential mitigation measures that will be used to ensure that the effects of the Project construction activities on traffic are no more than minor.

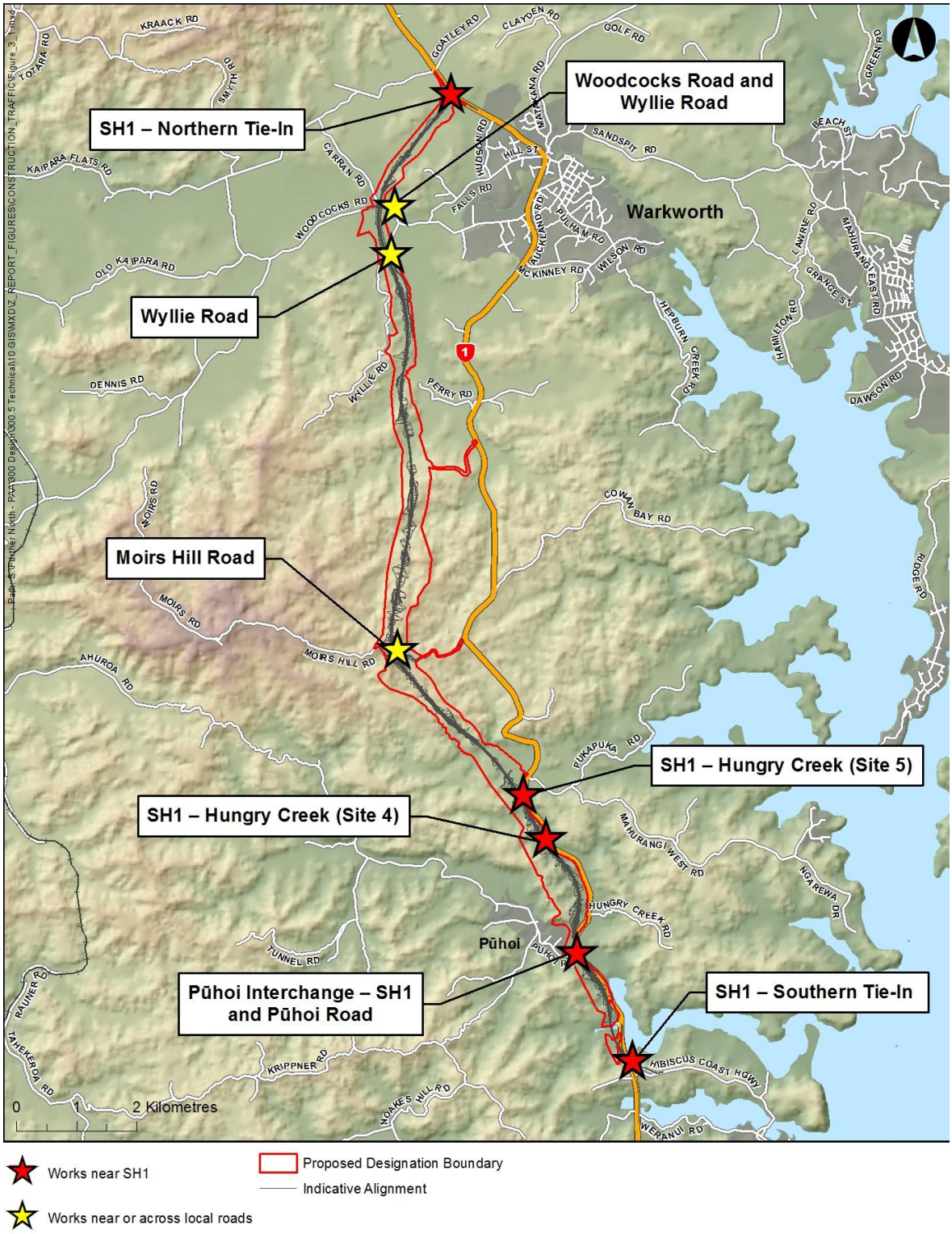


Figure 2 Construction in the vicinity of existing road network

4.1 SH1 - Southern tie-in

The construction activity in this area consists of integrating the existing Hibiscus Coast Highway and SH1 alignments with the new four-lane carriageway. The current proposal is to retain the existing northbound on-ramp from Hibiscus Coast Highway as an emergency access once the works are completed and provide a two-lane, two-way road connecting the existing SH1 with Hibiscus Coast Highway.

The majority of the construction will be undertaken off-line; however the final integration with the existing alignment through the Johnstone's Hill tunnels will need to be carefully managed through the use of temporary road construction and contra-flow measures over an 18 month period. This traffic management will minimise delays to road users and ensure that the current number of lanes available from the Johnstone's Hill tunnels and Hibiscus Coast Highway is maintained at all times. We have determined this traffic management to be feasible by using the new alignment to facilitate the staged integration with the existing alignment.

The works are likely to require speed and lane width restrictions, and potentially the use of the opposing carriageway near to the tunnel portal. There may be some minor temporary loss of road capacity over the duration of TTM operations but the current number of lanes will be maintained in each direction with the main impact being a reduction in speed limit, which may cause delays.

In developing the SSTMP for this section of the Project we recommend that the NZTA programme works that significantly reduce capacity outside of peak holiday periods and develop a communication campaign in advance of significant components of work to advise the public of road layout changes and so that motorists can make informed decisions about the timing of their travel while the work is being undertaken.

We consider that the construction activities in this area can be undertaken and managed so that the traffic effects on SH1 and the Hibiscus Coast Highway are minor.

4.2 Pūhoi Interchange – SH1 and Pūhoi Road

Significant TTM activities will be required to facilitate construction of the Pūhoi Interchange and Pūhoi Viaduct. The construction of the south-facing ramps will mainly be undertaken off-line. Shoulder closures over an 18 month period covering two construction seasons will be required to facilitate the tie-in of the ramps to the existing SH1 alignment and Pūhoi Road.

Some works will require operations in or over existing traffic lanes, such as the installation of bridge beams. To facilitate this, closures of Pūhoi Road may be required for short durations. These closures will generally be scheduled to occur at night or during other periods of low demand, with cessation of works if delays are excessive, queues extend to SH1 or emergency access is required.

We undertook traffic counts of the AM and PM peak periods on Tuesday 21 May 2013. These counts indicate that even during peak periods, the maximum hourly two-way volume on Pūhoi Road is approximately 170vph. This volume is less than three vehicles per minute on average. Due to low volumes of traffic on Pūhoi Road, construction works and associated TTM are unlikely to greatly affect travel.

We consider that the construction activities can be undertaken and managed so that the traffic effects on SH1 and Pūhoi Road in this area are minor.

4.3 SH1 – Hungry Creek

The indicative alignment passes close to the existing SH1 alignment at two locations between Pūhoi Road and Schedewys Hill. Construction works in this area will include earthworks, retaining wall construction and construction of an underpass for Watson's Road. These works are likely to require shoulder closures, temporary speed restrictions and potentially the closure of the southbound overtaking lane to facilitate site access (refer to Appendix B) over a 30 month period covering three construction seasons. The closure of the passing lane is unlikely to have a significant impact on either the capacity or the operating conditions along the existing SH1 given that the dual carriageway motorway commences approximately 2km south of this location. We consider that the construction activities can be undertaken and managed so that the effects on SH1 are minor.

4.4 Moirs Hill Road

Moirs Hill Road is narrow and winding, with the section immediately adjacent to SH1 too narrow to allow for one vehicle to pass another. The initial section adjacent to SH1 is topographically challenging as the land drops steeply away from the road on the northern side, and abuts a steep embankment on the southern side. The proposed designation boundary has been designed to allow for reconstruction of Moirs Hill Road from SH1 to the indicative alignment to allow two truck and trailer units to be able to pass should this be determined as necessary as part of the detailed construction methodology. This reconstruction is expected to be carried out over a period of six months during one construction season. These works would likely require alternating flow under stop/go or portable traffic signal control.

Closer to the indicative alignment, Moirs Hill Road is to be widened and realigned to facilitate construction access and enable the construction of the Moirs Hill underpass. The construction of the realignment of Moirs Hill Road will occur off-line. Where it connects to the existing Moirs Hill Road alignment, works are likely to require alternating flow under stop/go or portable traffic signal control.

We undertook surveys of Moirs Hill Road in the AM and PM peaks on Tuesday 21 May 2013. The maximum number of vehicles using Moirs Hill Road (two-way) over any one hour (8:00am to 9:00am) was 27 vehicles with no observed trucks and two bus movements.

Given the existing traffic volumes on Moirs Hill Road are very low, we consider that the Project construction activities can be undertaken and managed to have only minor traffic effects in this area. The widening of Moirs Hill Road will have positive benefits for users of the road in the long term.

4.5 Wyllie Road

The indicative alignment extends northward, adjacent to the western extent of the Perry Road community, and continues to the west of Genesis Aquaculture before passing over Wyllie Road and

further north to the Carran Road/Woodcocks Road intersection. Wyllie Road is an unsealed local road serving several residential properties and is estimated to carry 100-125 vpd.

The construction activities that impact on Wyllie Road will facilitate the construction of the bridge embankments and bridge structure crossing Wyllie Road, and the widening of Wyllie Road under the indicative bridge to allow for two-way operation and pedestrian access.

We anticipate that shoulder closures and alternating flow under stop/go control would be needed over 12 months covering one construction season. Access should be maintained at all times throughout the construction of the Project as there are no feasible alternative routes available.

Some works will require operations in or over existing traffic lanes, such as the installation of bridge beams. To facilitate these works, closures of Wyllie Road may be required for short durations. These closures should generally be scheduled to occur at night or during other periods of low demand, with cessation of works if delays are excessive, or emergency access is required.

Due to the very low traffic volumes on Wyllie Road, the construction activities can be undertaken and managed so that traffic effects are minor in this area.

4.6 Woodcocks Road / Carran Road

The indicative alignment crosses Woodcocks Road near Carran Road. As part of the Project works, Woodcocks Road is to be realigned to provide better sight distance and the intersection with Carran Road is to be reconstructed. This construction would be undertaken on-line and require shoulder closures and alternating flow stop/go operation as required over six months covering one construction period.

A stop/go operation was observed by Tim Brown and Andrew Bell on Woodcocks Road near this location as part of a road reconstruction project on 14 May 2013. These operations were managed so that delays were acceptable.

As part of the CTMP, NZTA should co-ordinate the staging of these activites with construction traffic movements into and out of indicative construction sites 11, 12, 13 and 15 (refer Figure 3 for the locations of these sites) to ensure they can be managed appropriately.

Both Woodcocks Road and Carran Road are signed as access routes to SH16 for use when SH1 is either closed or congested during holiday periods. The SSTMP for this section should specifically include plans to accommodate these situations.

Indicative construction activities in this area relate to the construction of the bridge embankments and bridge structure crossing Woodcocks Road, and to widen it under the indicative bridge to allow for two-way operation, pedestrian access and greater forward sight distance past the indicative bridge embankments. This construction would largely occur off-line.

Some works will require operations in or over existing traffic lanes, such as the installation of bridge beams. To facilitate these works, closures of Woodcocks Road may be required for short durations. These closures should generally be scheduled to occur at night or during other periods of low demand, with cessation of works if delays are excessive, or emergency access is required.

With the availability of Carran Road as a possible detour route, the NZTA may have some flexibility in managing the works in this area so as to accelerate launching of the viaduct sections.

Given the AADT on this section of Woodcocks Road is in the order of 2,500 vpd and the fact that Carran Road is available as a detour route, we consider that the Project construction activities can be undertaken with traffic effects that are minor in this area.

4.7 SH1 – Northern tie-in

The Project alignment will connect with SH1 north of Warkworth township just south of the intersection of SH1 and Kaipara Flats Road. The majority of the construction of this tie-in will occur off-line. However, the tie-in between the Project and the existing SH1 will require temporary road construction and contra-flow measures to minimise delays to road users over 18 months covering one construction season. We anticipate that the northbound passing lane would be closed to facilitate site access as described in Section 5.1, and would also be closed to facilitate the tie-in to the new alignment for six months.

Two-way operation will be maintained during the construction period with lane and shoulder narrowing as necessary. Speed restrictions should be put in place to allow for the narrower lanes and may lead to some minor reduction in capacity and minor increase in delay. We recommend the SSTMPs for this section of the Project be developed to minimise impacts and mitigate the effects of the TTM.

We consider that the construction activities can be undertaken and managed so that the traffic effects on SH1 are minor in this area.

4.8 Summary

Table 1: summarises the potential temporary traffic management activities and mitigation measures that could be used to ensure that the effects of the Project operations on traffic are no more than minor.

Table 1: Summary of construction traffic management activities on affected roads

Site	RCA	Duration (approx.)	Construction activities	Construction traffic management activity	Frequency (approx.)	Impact	Potential mitigation (in addition to standard requirements in COPTTM)
SH1 – Southern Tie-In	NZTA	4.5 years	Integration of new alignment with existing alignment	Shoulder closures Temporary diversions/ contraflow	Ongoing As required to facilitate staging	Minor increase in travel time due to speed restrictions	Use screens where possible Develop communications strategy to inform motorists of significant changes to road layouts Avoid peak traffic flow periods
SH1 – Pūhoi Road	NZTA	4.5 years	Construction of new on-ramp/site access Construction of Project site office access north of Pūhoi River	Shoulder closures Temporary diversions / Contraflow	Ongoing As required to facilitate staging	Minor increase in travel time due to speed restrictions	Use screens where possible Clear signage. Priority for SH1 to be maintained Minimise works in high volume periods where possible. Provide turning bay Avoid peak traffic flow periods
SH1 – Hungry Creek (Site 4)		4.5 years	Construction of earthworks and retaining wall Construction of site access	Shoulder closures Site access construction	Ongoing Project initiation	Minor increase in travel time due to speed restrictions Capacity reduction as a result of construction traffic	Avoid peak traffic flow periods
SH1 – Hungry Creek (Site 5)	NZTA	4.5 years	Construction of earthworks retaining wall and underpass for Watson Road Construction of site access	Shoulder closures	Ongoing	Minor increase in travel time due to speed restrictions and modification to passing lane	Use screens where possible Avoid peak traffic flow periods

Site	RCA	Duration (approx.)	Construction activities	Construction traffic management activity	Frequency (approx.)	Impact	Potential mitigation (in addition to standard requirements in COPTTM)
SH1 – South of Perry Road	NZTA	< 1 year	Construction of site access	Shoulder closures	Project initiation	Minor increase in travel time due to speed restrictions	Use screens where possible Avoid peak traffic flow periods
SH1 – Northern Tie-In	NZTA	3 years	Construction of approaches to new roundabout Construction of site access	Shoulder closures Temporary diversions / Contraflow	Ongoing As required to facilitate staging	Minor increase in travel time due to speed restrictions	Develop communications strategy to inform motorists of significant changes to road layouts Avoid peak traffic flow periods
Pūhoi Road	Auckland Transport	3 years	Construction of new bridge, embankments and northbound off-ramp	Shoulder closures Alternating flow Short Term closure	Ongoing Infrequent Infrequent, night only, short duration	Minor increase in travel time due to speed restrictions Capacity reduction leading to delays Delays during short-term closures – no satisfactory alternative routes available	Use screens where possible Active monitoring to ensure delays are not excessive and queues do not spill over to SH1 Emergency access needs to be provided
Moirs Hill Road	Auckland Transport	4.5 years	Construction of Moirs Hill Road underpass, alignment (earthworks), and realignment/widening of Moirs Hill Road	Alternating flow	Alternating flow at project initiation to facilitate widening at the start of Moirs Hill Road prior to heavy construction activities on Project alignment	Capacity reduction leading to delays	Advertise works to affected parties Active monitoring to ensure delays are not excessive and queues do not spill over to SH1 Emergency access needs to be provided

Site	RCA	Duration (approx.)	Construction activities	Construction traffic management activity	Frequency (approx.)	Impact	Potential mitigation (in addition to standard requirements in COPTTM)
Wyllie Road	Auckland Transport	3 years	Construction of embankments and bridge over Wyllie Road Site access construction	Shoulder closures Alternating flow Short term closure	Ongoing As required to facilitate construction Infrequent, short duration	Minor increase in travel time due to speed restrictions and contraflow operation on low volume road Delays through loss of capacity under alternating flow, and short-term closures. No satisfactory alternative routes available	Advertise closures to affected residents
Woodcocks Road	Auckland Transport	4.5 years	Construction of embankments and bridge over Wyllie Road Site access construction	Shoulder closures Alternating flow Short term closure Site access construction	Ongoing Infrequent Infrequent, short duration Project initiation	Minor increase in travel time due to speed restrictions Capacity reduction leading to delays Delays through short-term closure or resulting from using alternative route (Carran/Kaipara Flats Road)	Advertise closures and contra-flow to affected residents

5. Effects of construction traffic movements and mitigation

Our approach to assessing effects of construction traffic movements and necessary mitigation was to identify the proposed construction access locations and construction traffic volumes that would be likely to use them. This was done based on the preliminary construction methodology and an assessment of traffic volumes developed by an experienced construction engineer. The volumes developed are considered to be conservative and very much an upper range of volumes that would eventuate in reality.

We then assessed the effects of construction traffic on performance of the access intersections with public roads. We also assessed the effects of cumulative traffic volumes on the road network.

We identified potential effects on Moirs Hill Road and the proposed designation boundary has been extended to allow reconstruction from SH1 to the indicative alignment to allow two truck and trailer units to be able to pass. In terms of the effects on Woodcocks Road, it would be desirable for the NZTA to schedule works so that heavy vehicle movements do not use Woodcocks Road during the start and end of the school day when large numbers of students are expected to crossing Woodcocks Road. Our assessment indicates that with these measures in place, the effect of construction traffic on the existing network is expected to be minor.

Our assessment identified that access intersections with SH1 south of Warkworth will require right and left turning bays and acceleration lanes to keep delays to turning traffic at a manageable level. In addition, the provision of site access along the corridor is likely to result in the closure of the northbound passing lane north of Warkworth and the southbound passing lane north of Pūhoi. Our assessment indicates that with these measures in place, the effect of construction traffic on the existing network is expected to be minor.

Our assessment confirms that there is available spare capacity on SH1 and local roads to accommodate additional construction traffic. The exceptions are the peak periods of Friday afternoon (northbound), Saturday morning (northbound) and Sunday afternoon (southbound).

The NZTA will need to confirm the details of site accesses and management of construction traffic when the construction programme and methodology is developed in detail. As part of the CTMP, the NZTA will need to monitor delays on SH1 and at specific access locations throughout construction to ensure that delays to the travelling public are kept at acceptable levels. The NZTA will need to consider restricting construction vehicle movements on SH1 at peak times on Friday afternoon (northbound), Saturday morning (northbound) and Sunday afternoon (southbound).

Overall, our assessment indicates that with these measures in place, the effect of construction traffic on the existing network is expected to be minor.

5.1 Construction access locations and construction traffic volumes

Indicative staging areas (for the construction of the major viaducts) and indicative construction yards (for earthworks), along with indicative locations for the Project office and a precast yard have been identified as part of the preliminary construction methodology presented in Section 6 of the AEE. The indicative areas/sites are shown on Figure 3 along with how each of the sites connects to the road network. These areas/sites are also shown in more detail in Drawings C-101 to C-117.

The preliminary construction methodology is based on all of the traffic movements associated with earthworks being contained within the proposed designation. We have been advised by the Project team construction engineer that there would be no vehicle movements associated with hauling surplus material off-site along SH1 or the existing local roads.

As part of this preliminary construction methodology, the Project team construction engineer estimated traffic volumes travelling to and from each construction site to off-site locations for the purposes of assessing the effects of construction traffic on the existing road network. These estimated volumes were developed by an experienced construction engineer based on the number of staff required at each site and the volume of construction equipment and materials likely to be required to construct the Project. The estimated numbers of vehicle movements to and from each site (provided by the Project team construction engineer) are detailed in Appendix A.

Using these volumes (and an assessment of whether the origin or destination of the movements is to the north or the south of the site), we developed turning movements at the point where construction traffic accesses the public road network as shown in Drawings CT-101 and CT-102.

There will be some variation in the number of daily vehicle movements into and out of a site throughout the duration of construction. During some periods, a site access may not be in use where construction has not started (or has been completed) or where there is limited construction activity taking place. During critical periods, there may be increased activity. For example, there may be a larger number of trucks into and out of a bridge staging site as beams are being transported to site for launching or while plant is being delivered to site.

The number of vehicle movements on a "typical" day shown in Appendix A represents the number of movements that we would expect to access a site on an average day when the site is operating. The "peak" day represents the number of movements on a day when the site is in peak operation over a much shorter duration.

In this assessment, we have used the peak volumes to assess the performance of individual accesses during their peak usage. We have also used the cumulative typical traffic volumes from all sites to assess the effects of construction traffic moving through the network assuming every site is operating at the same time.

The final construction methodology will be determined by the contractor appointed to undertake the works. While it is likely that the construction methodology will change from that set out in the preliminary programme, we consider that our assessment of the construction traffic effects provides a conservative approach. In reality, the traffic volumes are likely to be lower than those assessed. The reasons for this are as follows:

- Peak hour traffic volumes were assumed to be ten per cent of the total assessed daily construction traffic volumes. However, shifts are likely to be 12 hours in duration. Construction traffic would be likely to be spread relatively evenly over this period. This means that volumes in the assessment are likely to be more peaked than would be observed in reality;
- Many of the light vehicle movements are likely to take place at the start and end of shifts (nominally 7am and 7pm). These will not coincide with the peak traffic volumes on the adjacent roads and would reduce the peak traffic construction volumes assessed;
- The maximum number of vehicle movements that we identified has been added cumulatively and used in our assessment. It is unlikely that the maximum of all these ranges would all occur at the same time. As a result, our approach is likely to significantly overstate the number of movements that could be expected;
- For simplicity, we have assumed that all trips are destined for a location north or south of the Project. In reality some of the movements would be from one site to another. For example, a trip taking precast bridge units from the precast yard to sites 7 or 8 would only travel from Warkworth to Moirs Hill Road rather than all the way south. This means that in reality there would be less traffic south of sites 7 and 8 than assessed; and
- The development of the CTMP for the Project will enable the NZTA and its contractors to fully programme their activities to maximise the efficiency of their operations by avoiding congested periods, and minimising the effects of their activities on the existing road network.

We do not consider parking of construction vehicles to be an issue because all parking will take place within the construction sites themselves, not on local roads or SH1.

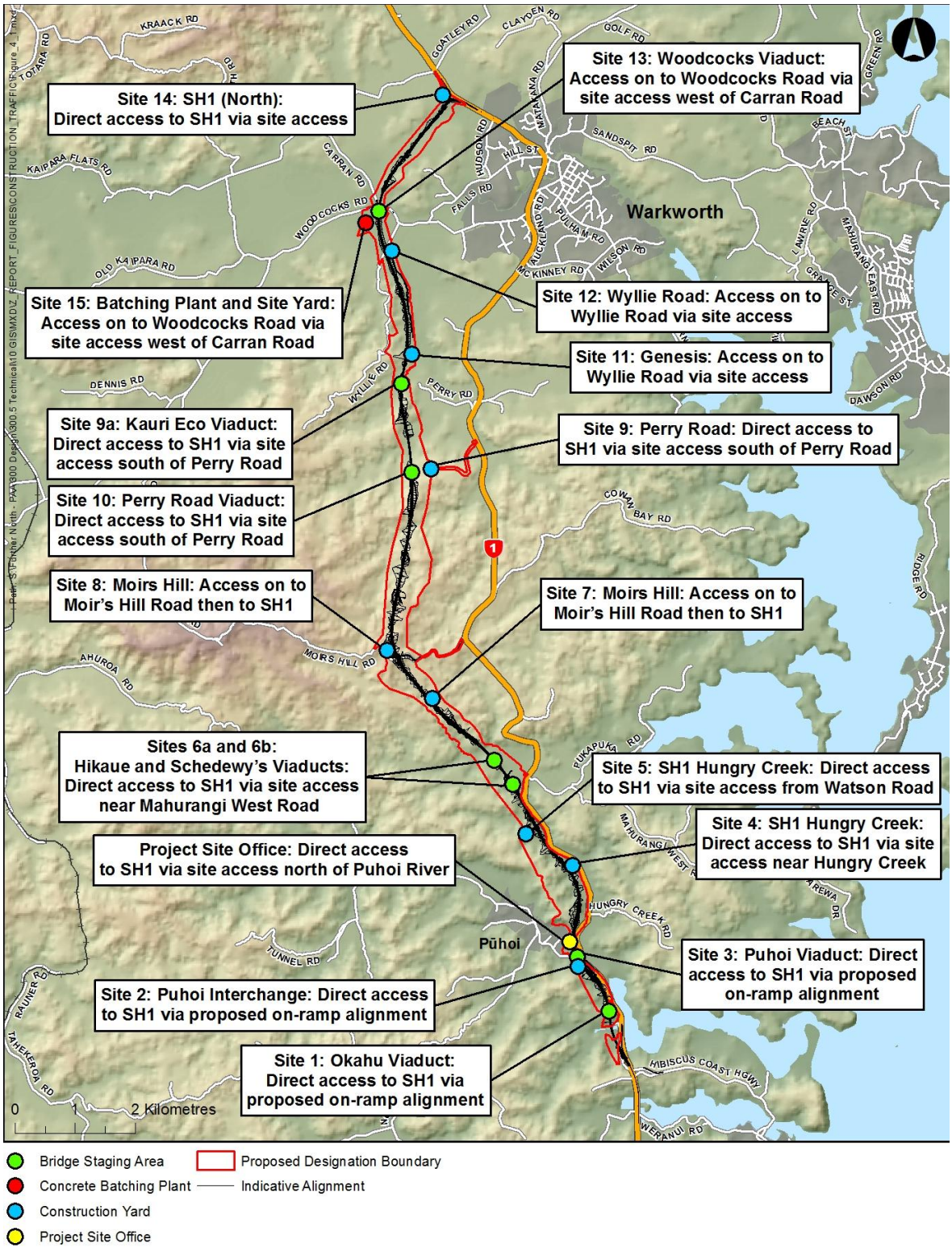


Figure 3 Construction site yards, work areas and access

5.2 Assessment of the proposed construction accesses

5.2.1 Assessment of construction accesses onto local roads

We assessed the safety of the indicative access points to the construction sites to determine whether their locations are suitable for construction traffic access onto the local road network. A summary of the access points and the assessment undertaken is provided in Appendix B.

Appendix B confirms that access from the construction sites to the local roads can be provided safely given the expected operating speeds of these roads.

We reviewed the need for additional road widening to allow turning traffic to pull clear to allow through traffic to pass at site accesses. We did this by assessing the warranted treatment outlined in the Guide to Road Design Part 4A: Unsignalised and Signalised Intersections (Austroads, 2009) (refer Appendix C). This assessment identified that for the expected traffic volumes, specific treatments are not required.

However, we consider that all access intersections would be sealed and constructed so that large HCVs could access the sites without their swept paths encroaching into opposing traffic lanes or running over verges. This may require some localised widening around accesses but we consider that this could be accommodated within the road reserve or the proposed designation.

Site 7 and Site 8 access onto Moirs Hill Road. As noted in Section 4.4, traffic volumes are very low on Moirs Hill Road so there would be more than enough capacity provided by a simple give way controlled access to ensure that there would be minimal delay to either local traffic or construction traffic.

Site 11 and Site 12 access onto Wyllie Road. Traffic volumes are very low on Wyllie Road so there would be more than enough capacity provided by a simple give way controlled access to ensure that there would be minimal delay to either local traffic or construction traffic.

Site 13 accesses onto Woodcocks Road north of Carran Road. As noted in Section 4.6, traffic volumes on Woodcocks Road are in the order of 2,500 vpd. A simple SIDRA analysis of a peak hour (assuming a peak hour factor of ten per cent of the AADT) confirmed that a give way controlled access would operate well within its capacity. Through traffic would not be delayed, and an average delay for the right turn out of the access itself of approximately 15 seconds.

Given the sight distances available at the access locations and low traffic volumes on local roads, we consider that construction vehicle movements on and off local roads at the site accesses can be managed so that there are negligible effects.

5.2.2 Assessment of construction accesses onto SH1

Appendix B confirms that accesses from the construction sites to SH1 can be provided safely given the expected operating speed of SH1 in these locations.

We reviewed the need for additional road widening to allow turning traffic to pull clear to allow through traffic to pass at site accesses. We did this by assessing the warranted treatment outlined

in the Guide to Road Design Part 4A: Unsignalised and Signalised Intersections (Austroads, 2009) (refer Appendix C). This assessment identified that for the expected volumes, all the construction work sites accesses to SH1 should be designed to provide space for left turning and right turning vehicles to pull clear of the through traffic.

We consider that to mitigate the effects of delays at the intersections of site accesses and SH1 (not controlled by traffic signals) the following treatments outlined in MOTSAM (as outlined in Appendix F) should be implemented:

- Right turn and left turn bays for traffic leaving SH1; and
- Acceleration lanes for traffic turning right on to SH1.

Our preliminary assessment indicates that there is sufficient space within the existing designation for SH1 for the construction of these treatments.

While there will be large proportion of HCVs using the site accesses, we consider that they will be able to use the accesses safety if the type of improvements detailed above are provided. The critical movement will be the right turn out onto SH1. For the majority of the sites, the HCVs will not be heavily loaded as they will have unloaded materials at the site. They will also only have to give way to northbound traffic as an acceleration lane will be provided southbound. The accesses are largely expected to operate within their capacity even during peak operations.

Assuming that the types of treatments outlined above were provided at each access intersection with SH1, we assessed the performance of site access intersections with respect to delay. We assessed the access intersections using SIDRA to determine the level of delay that traffic exiting, and the traffic turning right into the access roads, are likely to experience. The capacity assessment is shown graphically in Appendix E.

As noted above, the range of traffic volumes on SH1 in each direction during a construction working day (typically 7am – 7pm) is expected to be between 600 and 1,000 vehicles per hour. We undertook SIDRA modelling of a range of hourly volumes between 700vph and 1,100vph in each direction on SH1. This allowed the delay to traffic leaving SH1, and traffic entering SH1 to be assessed across a range of SH1 volumes that could be expected across a working day. The assessment assumes the same volume of traffic in each direction on SH1. This assumption makes the assessment conservative because typically traffic is more peaked in one direction. The level of delay for different traffic volumes on SH1 are shown by the dashed lines on the figures in Appendix E.

We developed peak hour turning movements into and out of each access assuming that 10% of the daily construction traffic movements take place in a peak hour. We considered a range of turning movements at each of the accesses. At the lower end, we assumed that the lower range of the typical day volumes eventuated. At the upper end, we assumed that the upper range of a peak day eventuated. These ranges are shown by the boxes at the bottom of the figures in Appendix E.

The results of our delay assessment are illustrated in Appendix E. The results indicate that access into and out of the sites onto SH1 are expected to operate at acceptable levels of service throughout a typical day and during peak days across a range of traffic volumes on SH1.

The intersection where we forecast the most delay is Moirs Hill Road. Moirs Hill Road is the only existing road that we analysed which has background traffic volumes. We undertook surveys of Moirs Hill Road in the AM and PM peaks on Tuesday 21 May 2013. The maximum number of vehicles using Moirs Hill Road (two-way) over any one hour was 27 vehicles. No HCVs and only one bus were observed to use the road. We have taken a very conservative approach to assessing capacity by assuming that there are 20 vph turning right out of Moirs Hill Road. We then added construction traffic on top of this volume.

As shown in Appendix E, if there is 700 vph on SH1 in each direction, average delays for right turning traffic into SH1 would remain between 20 and 30 seconds even at the upper end of the range for peak day construction traffic. If there is 1,100vph on SH1 then average delays would increase from around 40 seconds to around 60 seconds on a peak day at the upper end of the range. General traffic making these movements will also be delayed during these periods. However, the upper range of peak traffic for both Site 7 and Site 8 and these high volumes on SH1 are unlikely to coincide for long periods of time during construction.

Given the low number of general traffic movements using Moirs Hill Road, there is potential for only a minor negative effect which we consider could be managed through the CTMP.

As shown in Appendix D, traffic volumes are expected to increase above 1,100 vph in a single direction on Friday evenings, Saturday morning and Sunday afternoons, reflecting the use of SH1 for recreational traffic. We have not assessed intersection capacity during these periods. As part of the CTMP, NZTA should monitor delays at the access intersections. If significant delays are observed, NZTA should consider banning construction movements into and out of accesses during these periods to ensure that delays to general traffic (and construction traffic) are maintained at a manageable level.

We consider that any delay and safety issues for construction accesses onto SH1 can be adequately addressed when the NZTA provides further detail in the CTMP. The CTMP should address in particular the volume, distribution and timing of movements, and confirm the requirements for intersection treatments and construction vehicle management.

5.3 Construction traffic effects on the wider network

We have assessed the effects of construction traffic on the wider transport network using the cumulative typical day traffic volumes, assuming every site is operating at the same time. We consider this approach to be conservative as all sites will not be operating at the upper end of the typical day volumes at the same time. In fact it is unlikely that all sites will be operating at the same time at all. Cumulative peak day volumes have not been assessed as all sites will not be operating at their peaks at the same time.

5.3.1 Construction traffic effects on local roads

The effects of cumulative construction traffic on the majority of local roads are minor given the assessed traffic volumes. However, we have conducted a detailed assessment for Moirs Hill Road and Woodcocks Road/Wyllie Road where the construction volumes are likely to be highest.

Moirs Hill Road

As noted in Section 4.4, the existing traffic volumes on Moirs Hill Road are relatively low with the highest observed peak hour two-way traffic volumes in the order of 30 vph.

Moirs Hill Road has been identified as a critical access route for construction activities between the Schedewy's Viaduct and Perry Road bridges. The forecast construction traffic volumes range from 200 vpd (low range for a typical day) to 840 vpd (high range for peak a peak day). These volumes are relatively low, representing less than 1.5 additional light or heavy vehicle movements per minute on average, even during a peak construction day. However, as Moirs Hill Road is lightly trafficked at present, the relative increase would be noticeable.

Moirs Hill Road is narrow and winding, with the section immediately adjacent to SH1 too narrow to allow for one vehicle to pass another. The initial section adjacent to SH1 is topographically challenging as the land drops steeply away from the road on the northern side, and abuts a steep embankment on the southern side.

To mitigate the effects of the construction traffic, the proposed designation boundary has been extended to allow for reconstruction of Moirs Hill Road from SH1 to the indicative alignment to allow two truck-and-trailer units to be able to pass. This will mean that Moirs Hill Road will be relatively unaffected by additional construction traffic from a capacity perspective. This reconstruction is expected to be carried out over a period of six months during one construction season.

With these improvements in place prior to heavy construction activities, we consider the effect of the construction traffic in relation to the operation of Moirs Hill Road to be minor.

Woodcocks Road and Wyllie Road

Woodcocks Road extends west from SH1 near Mahurangi College and passes through an urban area. Beyond the Warkworth urban area (approximately Manson Heights west), Woodcocks Road becomes a rural two lane two-way road. There is a single one lane bridge (with no reported weight restrictions) on this section of Woodcocks Road.

As noted in Section 4.6, the AADT on this section of Woodcocks Road is in the order of 2,500 vpd.

Wyllie Road is a narrow unsealed rural road, which intersects Woodcocks Road south of the indicative alignment. While traffic volumes for Wylie Road in the vicinity of the site access are not available, we estimated it to carry 100-125 vpd.

The construction activities at indicative sites 11, 12, 13 and 15 will generate traffic that will all use the Woodcocks Road south of the Carran Road intersection. We expect these sites to generate between 200 vpd (low range for a typical day) and 1,240 vpd (high range for peak a peak day). These vpd numbers equate to peak hour, two-way traffic volumes between 20 vph and 124vph each way. The upper end of this range would only occur if all of the sites were operating at the upper end of their peak day ranges concurrently which we consider unlikely.

Even at the upper end of the range, these volumes are equivalent to approximately one vehicle per minute in each direction. These volumes are not expected to have a significant effect on the operation of Woodcocks Road. However, there would be an increase in potential conflicts between pedestrians and traffic near the school, increasing pedestrian safety risk.

We undertook site observations on Woodcocks Road at Mahurangi College during the morning and school peaks. These observations indicated a significant level of congestion related to school traffic and pedestrian movements for short durations (15 – 30 minutes). There are a number of school bus movements during this time reflecting the geographic area served by the school. There were a large number of school students who walked to school from the residential areas to the north, and to the east of the school.

There is a zebra crossing on Woodcocks Road outside Mahurangi College located only a short distance from a sharp bend. Sight distance to this crossing for westbound vehicles is restricted by parked vehicles. During the site observations, a large number of HCV movements were observed on Woodcocks Road. On several occasions, we observed HCVs braking late on the approach to the crossing and crossing the limit line before stopping and this has the potential to be an issue irrespective of the construction activities to the west.

It would be desirable for the NZTA to schedule works (through the CTMP/SSTMP) so that heavy vehicle movements do not use Woodcocks Road during the start and end of the school day when large numbers of students are expected to be crossing Woodcocks Road. The use of the alternative route via Carran Road and Kaipara Flats Road may be an alternative during these periods.

We recommend that the NZTA provide detailed safety briefings for all truck drivers during Project inductions and as part of regular "Tool Kit" sessions to highlight the potential hazards through this area. We also recommend that as part of the CTMP, the NZTA consider requiring construction-related vehicles to reduce their speeds to 30-40kph on the approach to the school. Such a reduction would have little impact on delays to construction traffic but would help reduce any safety risk.

Additional construction traffic would use the Woodcocks Road / Wyllie Road intersection. The intersection is give way controlled with Woodcocks Road having priority. Given the low background traffic volumes on both these roads, we expect this intersection to work within its capacity, even with the additional construction traffic. Through traffic on Woodcocks Road would not be affected. A simple SIDRA analysis of this intersection confirms that the worst performing movement at the intersection would be the right turn out of Wyllie Road into Woodcocks Road, which is forecast to operate with average delays in the order of 15 – 19 seconds; even with peak day construction traffic volumes. We consider there to be a minor effect on this intersection due to the low volumes of traffic using Wyllie Road.

Volumes across the one-way bridge on Woodcocks Road will also increase as a result of additional construction traffic. A simple SIDRA analysis of this bridge in a peak hour with peak day construction traffic included indicates that it will continue to operate well within its capacity. We forecast average delays of less than 15 seconds even with the additional construction traffic included. Given the relatively low volumes of general traffic on Woodcocks Road, we consider that construction traffic will have a minor impact on the performance of the one-way bridge.

At the SH1 / Woodcocks Road intersection, we expect the maximum increase in vehicle movements associated with construction traffic to be in the order of two additional vehicle movements to and from Woodcocks Road per traffic signal cycle (based on a 120 second traffic signal cycle). We consider that this level of additional traffic can be accommodated by the traffic signals with only minor effects on delays to other vehicles. We expect the operation to operate at the same level of service as present with around 25 seconds of average delay.

The construction traffic effects are manageable on Woodcocks Road and Wyllie Road with careful planning to mitigate the potential for safety-related concerns associated with the peak pedestrian activity in the vicinity of the school. With appropriate safety measures provided for in the CTMP, we consider that the effects of construction traffic in this area can be managed so that they are minor.

5.3.2 Construction traffic effects on SH1

We assessed the effect of Project construction traffic on the performance of the existing SH1 by determining the spare capacity on SH1 to accommodate the expected construction traffic volumes.

We obtained existing traffic flow profiles from the NZTA's permanent traffic count site south of McKinney's Road. Four per cent per annum traffic growth (consistent with that observed over the last 5 years) was added to these profiles to develop a baseline 2016 profile.

Our forecast number of construction vehicle movements on a typical day along SH1 is shown in Appendix F. This typical day scenario is based on the assumption that all construction sites are operating, and would all produce the upper range of typical day traffic volumes. Assuming that these movements are spread across the day with ten per cent occurring in the peak hour, we added the additional construction traffic to the existing traffic profiles to develop a combined forecast traffic profile as shown in Appendix D.

These profiles, demonstrate that with these forecast construction traffic volumes, the peak traffic volume per direction on a typical day during construction is likely to be in the order of 1,000 vehicles per hour per direction.

SH1 has a nominal capacity of 1,300 vehicles per hour per direction. Because capacity is substantially higher than the forecast demand, this analysis indicates that even with the additional construction traffic, SH1 will operate within its capacity with minimal impact on delays. Even if a worst case assumption was used where all the sites were operating concurrently at their peak traffic volumes, there would still be additional capacity available on SH1.

There will be a large number of additional heavy vehicle movements on SH1 as a result of the additional construction traffic. For example the number of construction related HCVs forecast to be on SH1 south of Puhoi Road is approximately 420 vpd. If this number of additional HCVs were included onto SH1 at the moment, this would have the effect of increasing the HCV proportion from approximately seven per cent to nine per cent. We do not consider that this level of additional HCVs would have a significant effect on the operation of SH1. Having said that, there would be some larger or oversized loads as part of the construction traffic. These loads would need to be scheduled to avoid peak traffic periods and managed as oversized loads are normally managed on the road network.

The exceptions to there being available spare capacity on SH1 are the peak periods of Friday afternoon (northbound), Saturday morning (northbound) and Sunday afternoon (southbound). During these periods, traffic volumes on SH1 would reach or exceed the nominal capacity of SH1. As the volumes approach capacity of SH1, congestion will increase and travel times will also increase.

As part of the CTMP, NZTA should monitor delays on SH1. If significant delays are observed we recommend that the NZTA consider banning construction movements during these peak periods to ensure that delays to general traffic (and construction traffic) are maintained at a manageable level.

NZTA has a good track record of managing delays to road users on projects like the NGTR, Central Motorway Junction, Newmarket Viaduct and Victoria Park Tunnel. NZTA typically includes requirements in its construction contracts to ensure delays are monitored and do not exceed fixed limits. An example of this is the "Minimum Requirements" of the SH16 Causeway project which require the NZTA Alliance to limit delays on a number of key travel time routes. These requirements were not required by the designation conditions, but were put in place by the NZTA as delays to the travelling public are one of the NZTA's key performance measures.

We also recommend that the NZTA restrict construction vehicle movements on SH1 during peak periods so its construction vehicles are not held up in congested conditions, as this would reduce the efficiency of the construction.

Through the Warkworth township north of Woodcocks Road (including the signalised intersections), we expect the increase in vehicle movements associated with construction traffic to range from 10 – 55vph on a typical day. To put this in context, this extra traffic would equal a maximum of two vehicles per traffic signal cycle in each direction (based on a 120 second traffic signal cycle). The NZTA should consider scheduling (through the CTMP), Project construction vehicle movements to avoid the peak periods if delays are observed to increase to unmanageable levels.

Overall, we consider that the effects of the traffic generated by Project construction activities are likely to be minor based on the capacity of SH1 to accommodate additional traffic for most of the week during the earthworks season. The CTMP will allow the NZTA to manage the construction traffic movements to minimise the impact on the travelling public and maximise the efficiency of the construction operations.

6. Potential effects on pedestrians and cyclists

While there is limited data available in relation to walking and cycling in the area, it is necessary to ensure that they are catered for in areas where they can be expected.

The approach we used to assess the construction traffic effects was to identify those sites where there could be increased conflicts between pedestrians and cyclists and construction activity. Provided that the CTMP and SSTMP's adequately address truck movements at the start and end of the school day in the vicinity of Mahurangi College, the effects of the construction activities on pedestrians and cyclists are expected to be minor.

As noted in Section 3.8 of the Transportation and Traffic Assessment Report, there is a limited amount of data available in relation to walking and cycling in the Project area. Given the large distances between centres (ie Pūhoi and Warkworth), there is limited opportunity for walking or commuter cycling between centres. There is the potential for a small number of pedestrian movements along Pūhoi Road to SH1 to access the Intercity Bus Services.

There are no roads that form part of the Auckland Regional Cycle Network that are within the vicinity of the construction works. However, recreational cyclists do use the existing SH1, and there are existing on-road facilities on SH1. The works associated with the indicative alignment also include sufficient width for local roads crossed by the indicative alignment to provide for pedestrians.

There will be some additional traffic on SH1 which could increase the exposure of pedestrians and cyclists to additional conflicts. However, given the relatively low proportion of construction traffic to general traffic, we do not consider potential conflicts to be an issue.

As reported in Section 5.3.1 there is a zebra crossing on Woodcocks Road outside Mahurangi College located only a short distance from a sharp bend. Existing sight distance to this crossing for westbound traffic is restricted by parked vehicles. During our site observations, a large number of truck movements were observed and on several occasions we observed heavy vehicle movements braking late on the approach to the crossing and crossing the limit line before stopping. With the complex traffic movements (including pedestrians) near the school, the pedestrians' safety risk may increase with the increased traffic volumes.

It would be desirable for the NZTA to schedule works (through the CTMP/SSTMP) so that heavy vehicle movements do not use Woodcocks Road during the start and end of the school day when large numbers of students are expected to be crossing Woodcocks Road. The use of the alternative route via Carran Road and Kaipara Flats Road for construction traffic may be an alternative during these periods.

The NZTA should provide detailed safety briefings for all truck drivers during Project inductions and as part of regular "Tool Kit" sessions to highlight the potential hazards through this area. We also recommend that as part of the CTMP, consideration be given to requiring construction related vehicles to reduce their speeds to 30-40kph on the approach to the school. Such a reduction would have little impact on delays to construction traffic but would help reduce any safety risk.

The NZTA, in developing the Project CTMP and SSTMPs, will need to give due consideration to the safe passage of pedestrians and cyclists through the areas controlled by TTM and routes used by construction traffic. We consider that the effects of the construction activities on pedestrians and cyclists can be managed so that they are no more than minor.

We consider it is necessary to ensure that passenger transport is taken into consideration and potential effects properly managed.

The approach we used to assess the construction traffic effects on passenger transport was to identify those sites where there could be increased conflicts between passenger transport activity and construction activity.

We recommend that the NZTA consider providing a suitable location as a set-down area for buses to allow for passengers to board and alight and access Pūhoi.

Provided that access is maintained for scheduled and school bus routes the effects of construction are expected to be minor.

7. Potential effects on passenger transport

As outlined in Section 3.9 of the Transportation and Traffic Assessment Report, only a small number of regular passenger transport services and some tourist shuttle services use the existing SH1 in the Project area. A number of school bus services also use the local road network. These services would be subject to the same road performance conditions as general traffic as described previously in our Report. The Kowhai Connection is a bus service between Warkworth and Matakana via Snells Beach that runs a limited daily service and provides a number of options for boarding and alighting.

The regular passenger transport services (Intercity Bus services) allow pre-booked passengers to board and alight on SH1 at the Pūhoi intersection. To facilitate this boarding and alighting, we recommend that the NZTA consider providing a suitable location as a set-down area. This set-down area will need to be detailed in the CTMP and SSTMPs.

The schools in Warkworth are well served by school buses using Woodcocks Road and Hill Street. Bus boarding and alighting takes place on Mahurangi College grounds and not on Woodcocks Road so we do not consider construction traffic would impact on this boarding/alighting. Moirs Hill Road is also a school bus route. Provided that access is maintained for these routes and suitable set-down areas are maintained, we expect the effects on passenger transport during construction to be minor.

8. Conclusion/Recommendations

This assessment has provided an appraisal of the traffic impacts that are anticipated to arise from the construction of the Project. The traffic management methodology has been developed and impacts identified on the basis of an indicative, but a feasible construction methodology. We have used a conservative approach in the assessment by using the upper end of the likely ranges of construction traffic and adding these cumulatively where construction traffic from multiple sites comes together.

We identified a number of potential impacts on SH1 and the local road network as a result of Project construction traffic that will require detailed mitigation strategies at the construction planning stage. The effects and mitigation strategies identified in this assessment can be used to inform the traffic management methodologies employed for facilitating the successful construction of the Project.

As such, it is anticipated that the traffic management methodology and understanding of the associated impacts will undergo further refinement through the detailed design, outline plan of works process and upon involvement of the contractor. To this end, this assessment is largely qualitative and provides an appraisal upon which preliminary mitigation measures have been developed.

In general our view is that the effects outlined in this assessment are able to be mitigated acceptably provided a CTMP is developed and implemented in line with normal NZTA practices. The effects are not anticipated to be significantly greater or unusual compared with other major road construction projects completed in the Auckland region in the last five to ten years. As such, the NZTA has considerable experience and a strong track record of successfully managing the traffic effects of construction that would be carried through to this Project.

This assessment has provided an appraisal of the traffic impacts that are anticipated to arise from the construction of the Project. We have developed the traffic management methodology and identified the impacts on the basis of an indicative, but feasible construction methodology.

We identified a number of potential impacts to SH1 and the local road network as a result of Project construction traffic that will require detailed mitigation strategies at the construction planning stage. The effects and mitigation strategies identified in this assessment can be used to inform the traffic management methodologies employed for facilitating the successful construction of the Project.

The traffic management methodology and understanding of the associated impacts will need to be refined through the detailed design, OPW process and upon involvement of the contractor. To this end, this assessment is largely qualitative and provides an appraisal upon which preliminary mitigation measures have been developed.

We recommend that NZTA should complete a CTMP. The CTMP would typically include the following objectives:

- Provide TTM complying fully with the COPTTM wherever practicable. Non-compliance should be addressed through engineering exception decisions signed off by the NZTA's implementation team delivering the Project and the relevant RCAs;
- Focus on current best industry standards with regard to TTM and safety;
- Minimise disruption on the State Highways and local roads wherever practicable;
- Maintain existing flows and travel times on State Highways and local roads adjacent to the work site where practicable;
- Minimise the impact of works on pedestrians and cyclists wherever practicable;
- Minimise the effects of construction traffic on local roads used for access wherever practicable;
- Minimise the impact of construction parking wherever practicable;
- Develop SSTMPs having consideration for key stakeholders (mainly local residents and Auckland Transport, but also the wider travelling public);
- Identify all issues and have a planned SSTMP approved at least five days before implementation is required, in consultation with the applicable RCA and the NZTA's network management consultant;
- Provide effective communication to affected parties and the travelling public; and
- Implement TTM that provides stakeholders with functionality and clarity of direction of travel through roadwork sites.

When developing the CTMP and SSTMPs we recommend that NZTA specifically address the following:

- Suitability of detour routes where short-term road closures are considered necessary to facilitate construction works;
- Programming of works that significantly reduce capacity on SH1 outside of peak holiday periods;
- Development of communication campaigns in advance of significant components of work, to advise the public of road layout changes and allow motorists to make informed decisions about the timing of their travel;
- Co-ordination of the staging of physical works on Woodcocks Road so that these activities do not conflict with large volumes of construction traffic movements into and out of indicative construction sites 11, 12, 13 and 15;
- Plans to accommodate traffic on both Woodcocks Road and Carran Road when SH1 is either closed or congested during holiday periods;
- Programing of construction activities to avoid large numbers of construction movements taking place during congested periods;
- Monitoring of delays at the key access intersections and on SH1 on Friday evenings, Saturday mornings and Sunday afternoons to ensure that delays to general traffic (and construction traffic) are maintained at a manageable levels;
- Reconstruction of Moirs Hill Road from SH1 to the indicative alignment to allow two truck-and-trailer units to be able to pass;
- Scheduling of heavy vehicle movements so that they do not use Woodcocks Road during the start and end of the school day when large numbers of students are expected to be crossing Woodcocks Road;

- Provide detailed safety briefings for all truck drivers during Project inductions and as part of regular "Tool Kit" sessions to highlight the potential pedestrian hazards around Mahurangi College;
- Consideration of reducing construction-related vehicle speeds to 30-40kph on the approaches to Mahurangi College; and
- Provision of suitable set-down areas for bus services to facilitate boarding and alighting.

In general, we consider the traffic effects outlined in this assessment are able to be mitigated acceptably provided a CTMP is developed and implemented in line with normal NZTA practices. We do not anticipate that the construction traffic effects of the Project will be significantly greater or unusual compared with other major road construction projects completed in the Auckland region in the last five to ten years. As such, we consider the NZTA has considerable experience and a strong track record of successfully managing construction traffic effects that will be carried through onto the Project.

9. References

Guide to Road Design: Part 4A – Unsignalised and Signalised Intersections, Austroads, 2009

Manual of Traffic Signs and Markings: Part 3, NZTA, 2011

Manual for Traffic Control Devices: Part 8 – Code of Practice for Temporary Traffic Management, NZTA, 2012

Appendix A. Assessed Construction Traffic Movements

Description	Zone	Heavy Vehicles (Day)										Light Vehicles (Day)							
		No. HCV	Total	Year	Day	Average	North	South	Peak	North	South	No. LV	Total	Average	North	South	Peak	North	South
							33%	67%		33%	67%				25%	75%		25%	75%
Bridge Staging Area-1	Okahu Viaduct	12.5	6,500	3	750	<10	<10	<10	10-30	<10	10-30	200	13,000	30-60	<10	10-30	60-100	10-30	30-60
Project Office				5		<10	<10	<10	<10	<10	<10			>100	10-30	60-100	>100	30-60	>100
Construction Yard-2	Zone-1																		
	Zone-3																		
		20	31,600	4.5	1,125	10-30	<10	10-30	60-100	10-30	30-60	80	15,800	10-30	<10	10-30	30-60	10-30	30-60
Bridge Staging Area-3	Puhoi Viaduct	10	2,900	2.5	625	<10	<10	<10	10-30	<10	<10	275	9,969	30-60	<10	10-30	30-60	10-30	30-60
Construction Yard-4	Zone-5 South	20	30,300	4.5	1,125	10-30	<10	10-30	60-100	10-30	30-60	80	15,150	10-30	<10	10-30	30-60	10-30	30-60
Construction Yard-5	Zone-5 North																		
	Zone 6B																		
		20	34,200	4.5	1,125	30-60	10-30	10-30	60-100	10-30	30-60	80	17,100	30-60	<10	10-30	30-60	10-30	30-60
Bridge Staging Area-6A	Hikauae Viaduct	10	1,800	2	500	<10	<10	<10	<10	<10	<10	275	6,188	10-30	<10	10-30	30-60	10-30	30-60
Bridge Staging Area-6B	Schedewys Viaduct	12.5	4,625	3.6	875	<10	<10	10-30	<10	<10	<10	200	9,250	10-30	<10	10-30	30-60	<10	10-30
Construction Yard-7	Zone-7A	20	21,350	4.5	1,125	10-30	<10	10-30	30-60	10-30	30-60	80	10,675	10-30	<10	10-30	30-60	<10	10-30
Construction Yard-8	Zone-7A	20	51,850	4.5	1,125	30-60	10-30	30-60	>100	30-60	60-100	80	25,925	30-60	10-30	10-30	60-100	10-30	60-100
Construction Yard-9	Zone-7B																		
	Zone-9A																		
		20	49,400	4.5	1,125	30-60	10-30	10-30	>100	30-60	60-100	80	24,700	30-60	10-30	30-60	60-100	10-30	30-60
Bridge Staging Area-10	Perry Road Viaduct	12.5	6,375	3.5	875	<10	<10	<10	10-30	<10	10-30	200	12,750	10-30	<10	10-30	30-60	10-30	30-60
Bridge Staging Area-9A	Kauri Eco-Viaduct	10	2,200	2.5	625	<10	<10	<10	<10	<10	<10	275	7,563	10-30	<10	30-60	30-60	10-30	30-60
Construction Yard-11	Zone-9C South	20	27,150	4.5	1,125	10-30	<10	10-30	60-100	10-30	30-60	80	13,575	10-30	<10	30-60	30-60	10-30	30-60
Construction Yard-12	Zone-9C North	20	27,150	4.5	1,125	10-30	<10	10-30	60-100	10-30	30-60	80	13,575	10-30	<10	30-60	30-60	10-30	30-60
Bridge Staging Area-13	Woodcocks Road Viaduct	10	2,800	3	750	<10	<10	<10	<10	<10	<10	275	9,625	10-30	<10	30-60	30-60	10-30	30-60
Precase Yard-15 (+ Batch Plant)		7.5	17,775	3.5	875	10-30	<10	10-30	30-60	10-30	10-30	100	29,625	30-60	10-30	60-100	60-100	10-30	30-60
Construction Yard-14	Zone-11	20	37,600	4.5	1,125	30-60	10-30	10-30	60-100	30-60	30-60	80	18,800	30-60	<10	30-60	30-60	10-30	30-60

Appendix B. Summary of construction access locations

Area	Frontage road	Carriageway width of frontage road	Sealed / unsealed	Alignment	Available sight distance (approx) (m)	SISD[4] operating speed (looking south or west) (km/h)	Available sight distance (approx) (m)	SISD operating speed (Looking north or east) (km/h)	Comments
Site 1: Okahu Viaduct, Site Yard 2 and Site 3: Pūhoi Viaduct	SH1 - south of Pūhoi Road	>7m	Sealed	Undulating and Curved	As Per Final Design				Site access uses the indicative on-ramp alignment. Design of access to be as per the final design.
Project Site Office	SH1 – North of Pūhoi River	5.5-7.0m	Sealed	Flat and Curved	275	>100kph	185	80-90kph	Site accesses uses space currently set aside as a layover. Posted speed is 80kph through to Pūhoi Road and sight distance is satisfactory.
Site Yard 4	SH1	>7m	Sealed	Flat and Curved	230	90-100kph	245	90-100kph	Indicative location provides maximises available sight distance in both directions
Site Yard 5	SH1 via Watson Road	>7m	Sealed	Flat and Curved	395	>100kph	195	80-90kph	**Observations:** 1. Sight distance to the north not desirable for the 100kph posted speed. 2. Right turn out of Watson Road turn into the passing lane. This is not considered safe. 3. Provision of full acceleration lane for right turns out would result in a right side merge, with insufficient distance between this merge and the end of the overtaking lane

[4] Safe Intersection Site Distance

Area	Frontage road	Carriageway width of frontage road	Sealed / unsealed	Alignment	Available sight distance (approx) (m)	SISD[4] operating speed (looking south or west) (km/h)	Available sight distance (approx) (m)	SISD operating speed (Looking north or east) (km/h)	Comments
									Preferred Option: Provide typical rural right turn treatment as prescribed in MOTSAM, utilising the current southbound passing lane as an acceleration lane
Sites 6a and 6b: Hikuae and Schedewy's Viaducts	SH1 via	>7m	Sealed	Flat and Curved	220	90-100kph	215	90-100kph	**Observations:** 1. Sight distance to the south restricted when there is southbound traffic blocking visibility. 2. Sight distance for light vehicles exiting the sight looking north is restricted by the bridge barrier. 3. Provision of a right turn bay into the site may require bridge widening **Preferred Option:** 1. Modify start of overtaking lane to a layout similar to a rural intersection treatment to allow right turns from site to enter into their own lane.
Site Yard 7	Moirs Hill Road	5.5-7.0m	Sealed	Hilly and Winding	105	60-70kph	115	60-70kph	**Observations:** 1. Access from Moirs Hill Road appears to allow for sufficient sight distance based on expected operating speeds given that it is unsealed. 2. Moirs Hill Road is used for logging. SH1 has "Trucks Turning" warning signs posted
	SH1 (Intersection with Moirs Hill Road)	>7m	Sealed	Hilly and Curved	170	70-80kph	260	>100kph	

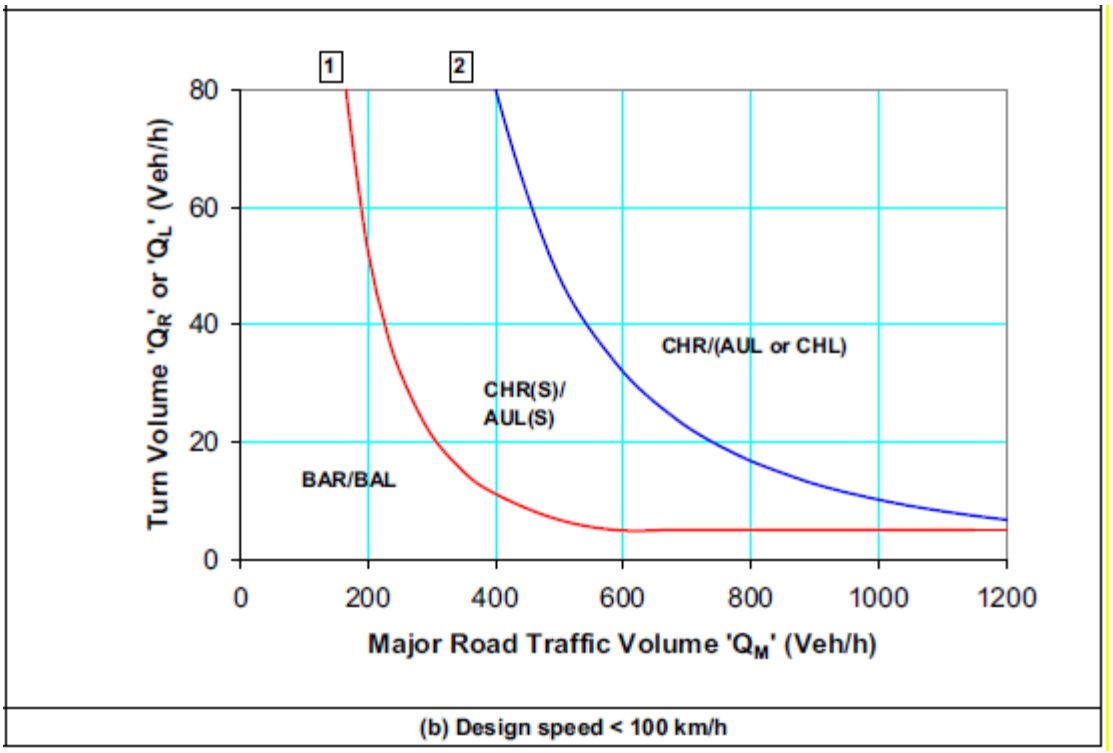
Area	Frontage road	Carriageway width of frontage road	Sealed / unsealed	Alignment	Available sight distance (approx) (m)	SISD[4] operating speed (looking south or west) (km/h)	Available sight distance (approx) (m)	SISD operating speed (Looking north or east) (km/h)	Comments
Site Yard 8	Moirs Hill Road	5.5-7.0m	Unsealed	Hilly and Winding	95	50-60kph	170	70-80kph	3. Moirs Hill Road is too narrow for vehicles to pass each other approaching SH1 4. Available sight distance from Moirs Hill Road to the south at SH1 is consistent with an operating speed rated in accordance with the curve speed advisory signs of 75km/h 5. 1 intersection related accident recorded in the last 5 years **Preferred Option:** 1. Realignment of Moirs Hill Road to allow vehicles to pass each other
	(Intersection with Moirs Hill Road)	>7m	Sealed	Hilly and Curved	170	70-80kph	260	>100kph	

Area	Frontage road	Carriageway width of frontage road	Sealed / unsealed	Alignment	Available sight distance (approx) (m)	SISD[5] (looking south or west) (m)	Available sight distance (approx) (m)	SISD (looking north or east) (m)	Comments
Site Yards 9 and 9a and Site 10: Perry Road Viaduct and Kauri Eco Viaduct	SH1 - Private driveway access	>7m	Sealed	Undulating and Curved	390	>100kph	245	90-100kph	No significant issues with this location.
Site Yard 11 and Site Yard 12	Wyllie Road (Direct access)	5.5-7.0m	Unsealed	Flat and Straight	320	>100kph	320	>100kph	No significant issues with this location.
	Woodcocks Road (intersection with Wyllie Road)	5.5-7.0m	Sealed	Flat and Curved	230	90-100kph	105	60-70kph	**Observations:** 1. No issue with sight distance and access on to Wyllie Road 2. Sight distance to the east at the intersection of Woodcocks and Wyllie Road is restricted to 100m which provides SISD for approx. 60kph. However, speed on the approach is reduced due to curve radius, and it is an existing intersection. Not considered to be a significant issue. 3. Carran Road and Kaipara Flats Road are suitable alternative routes to Woodcocks Road for construction traffic

[5] Safe Intersection Site Distance

Area	Frontage road	Carriageway width of frontage road	Sealed / unsealed	Alignment	Available sight distance (approx) (m)	SISD[5] (looking south or west) (m)	Available sight distance (approx) (m)	SISD (looking north or east) (m)	Comments
Site 13: Woodcocks Road Viaduct and Site 15: Precast Yard	Woodcocks Road	5.5-7.0m	Sealed	Flat and Curved	580	>100kph	240	90-100kph	**Observations:** 1. No issue with this location 2. Carran Road and Kaipara Flats Road are suitable alternative routes to Woodcocks Road for construction traffic
Site Yard 14	SH1	>7m	Sealed	Undulating and Curved	240	90-100kph	240	90-100kph	Observations: 1. Access location is at the end of the passing lane prior to the start of the merge. Passing lane will be closed when the new alignment ties into the existing alignment. 2. Access location is close to the apex of the curve and crest on SH1 therefore maximising sight distance in both directions. **Available Options** 1. Terminate passing lane prior to the apex of the curve until permanently closed 2. Close passing lane to allow for construction of a rural right turn treatment for the sight access.

Appendix C. Warrants for unsignalised intersection treatments



(b) Design speed < 100 km/h

Source: Guide to Road Design Part 4A: Design of Unsignalised and Unsignalised Intersections (Austroads, 2009)

Notes:

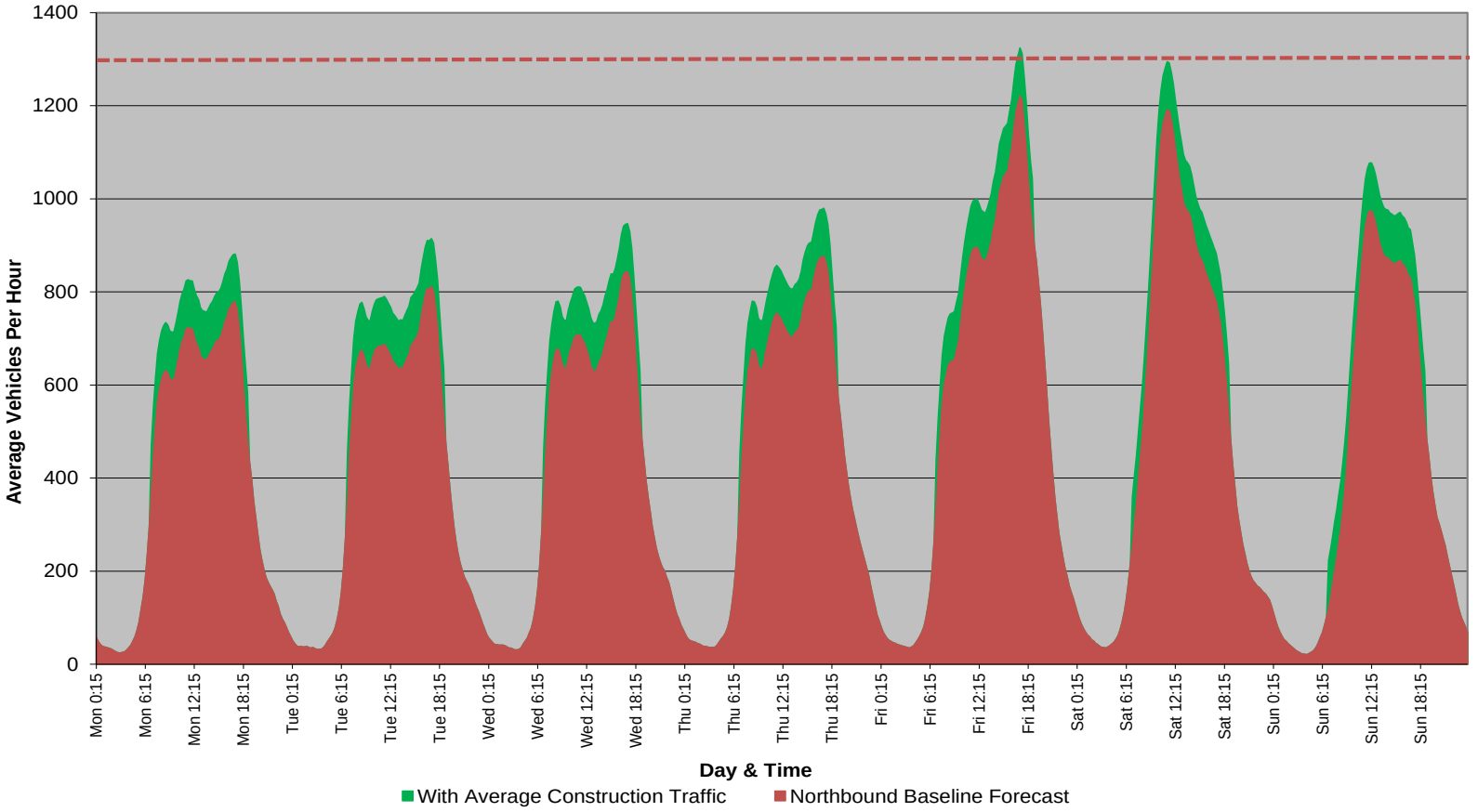
BAR/BAL – Basic Intersection Treatment with No Right Turn Bays or Left Turn Bays

AUL(S)/CHR(S) – Short Right Turn Bays and Left Turn Bays

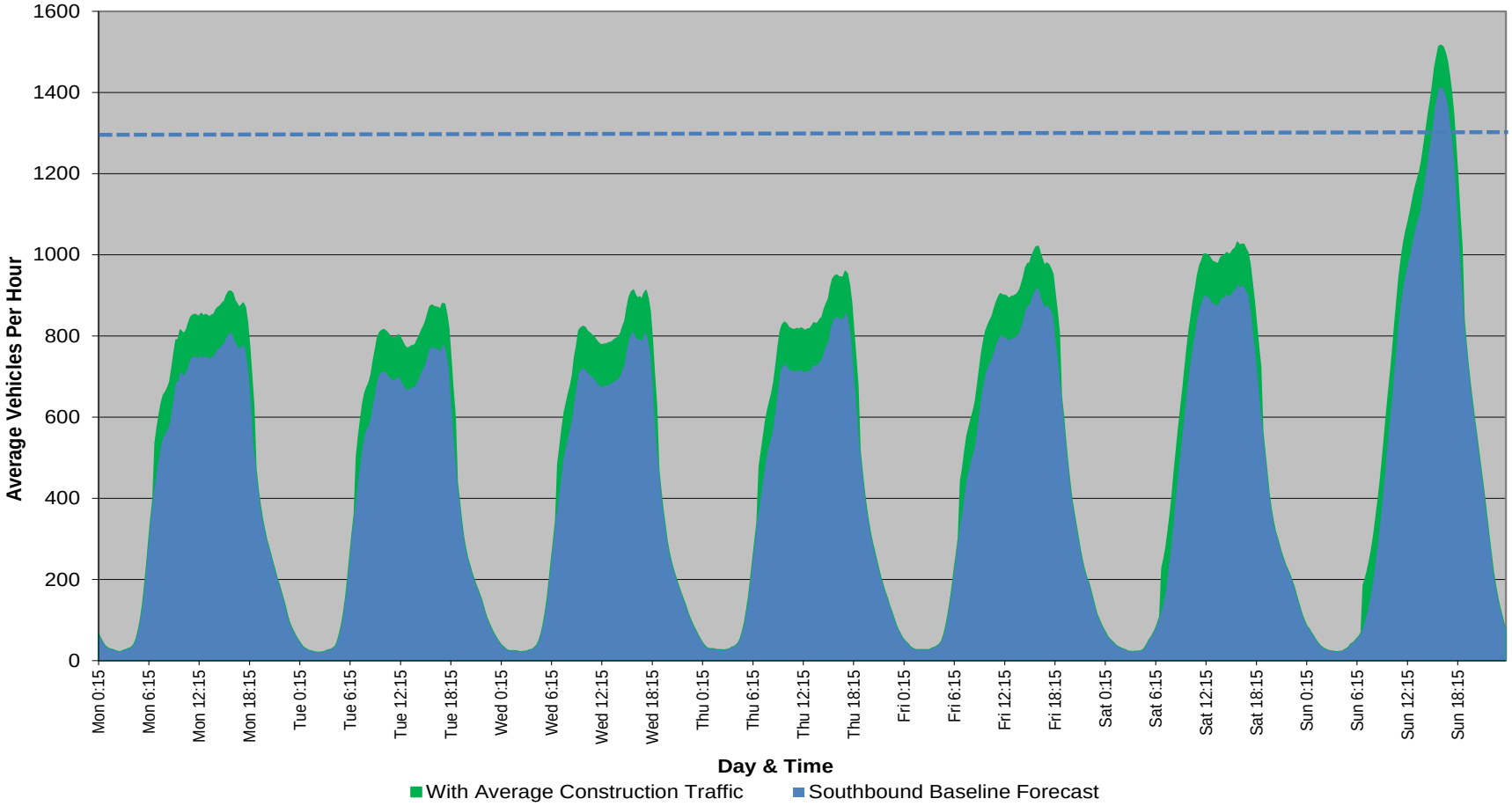
CHR/(AUL or CHR) – Intersection Treatment with Left Turn and Right Turn Bays for the full length required for deceleration.

Appendix D. Forecast traffic flow profiles on SH1 with construction traffic (upper range of typical working day)

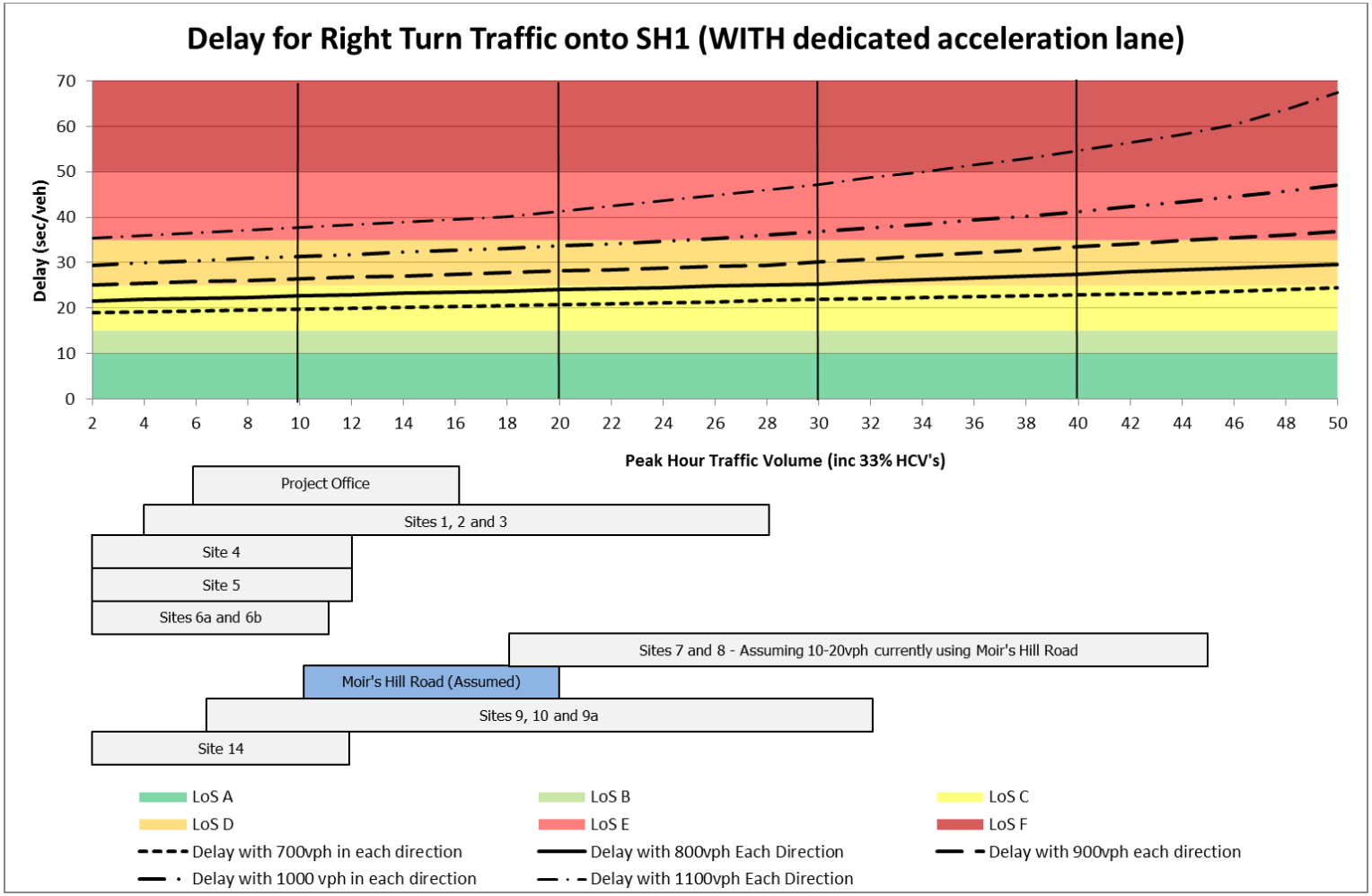
2016 Forecast Northbound Traffic Flow Profiles on SH1

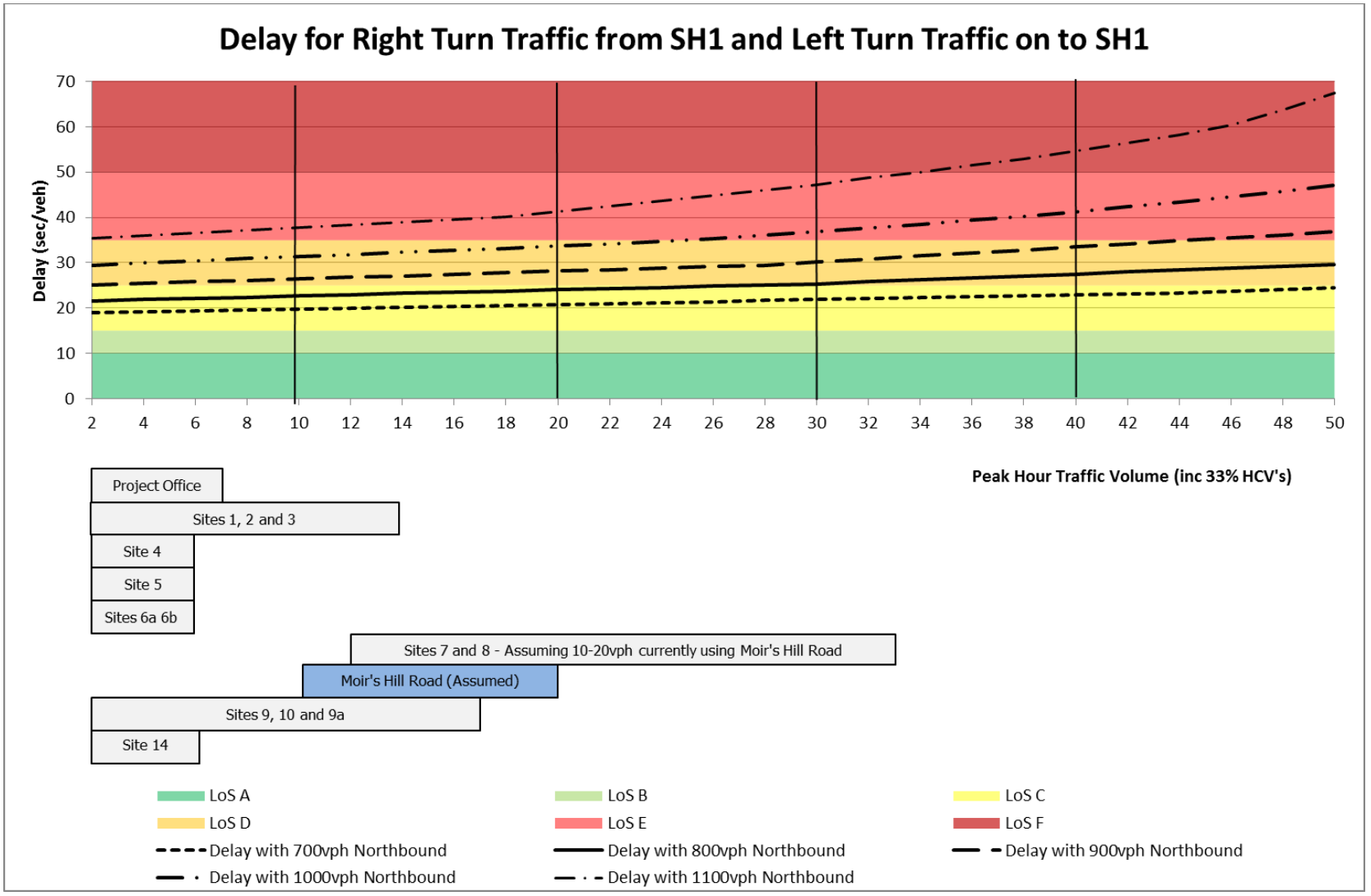


2016 Forecast Southbound Traffic Flow Profiles on SH1

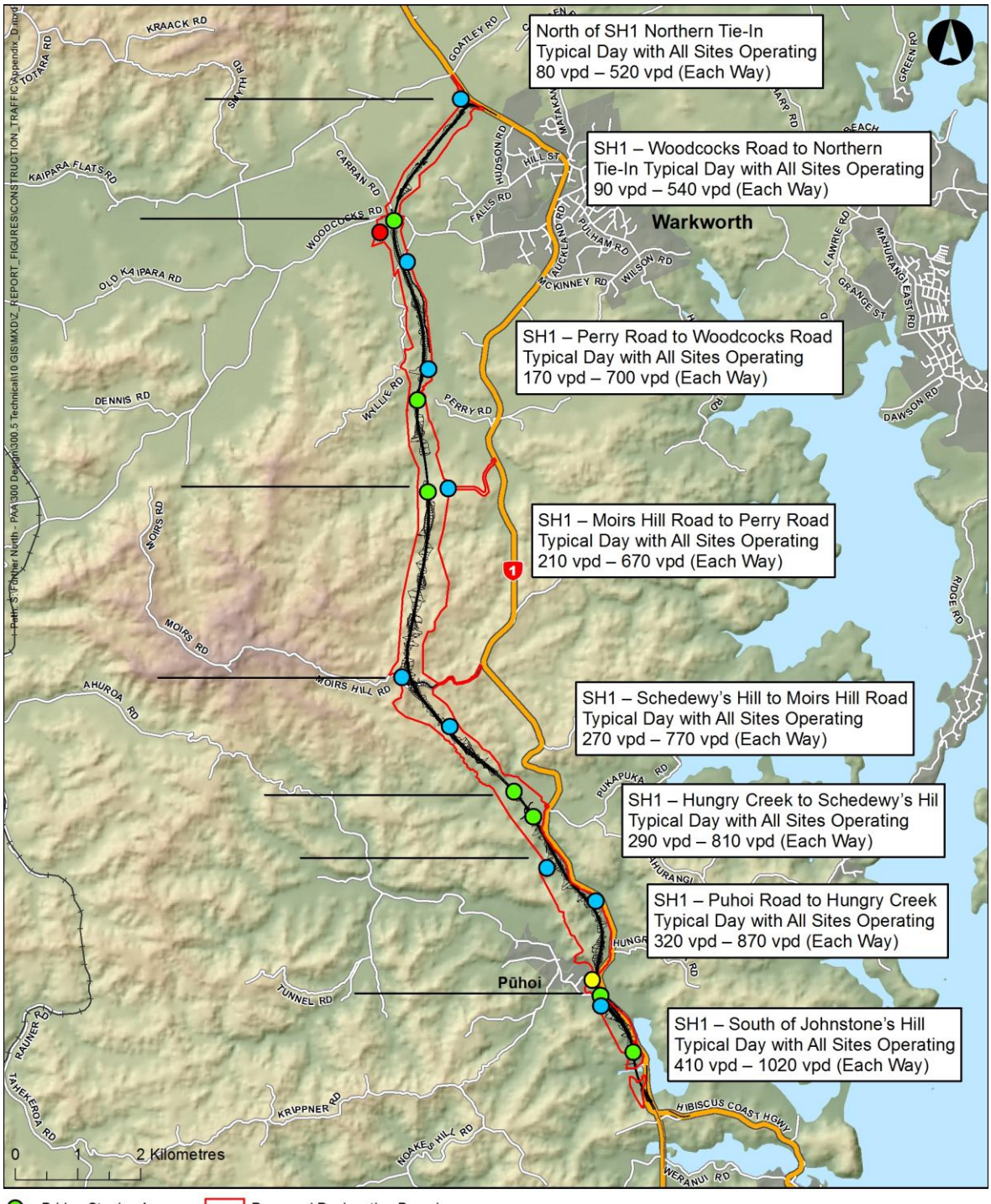


Appendix E. Assessment for intersections with SH1 (except Woodcocks Road/SH1)




Delay for Right Turn Traffic from SH1 and Left Turn Traffic on to SH1
Delay (sec/veh)
70
60
50
40
30
20
10
0
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50
Peak Hour Traffic Volume (inc 33% HCV's)
Project Office
Sites 1, 2 and 3
Site 4
Site 5
Sites 6a 6b
Sites 7 and 8 - Assuming 10-20vph currently using Moir's Hill Road
Moir's Hill Road (Assumed)
Sites 9, 10 and 9a
Site 14
LoS A
LoS B
LoS C
LoS D
LoS E
LoS F
Delay with 700vph Northbound
Delay with 800vph Northbound
Delay with 900vph Northbound
Delay with 1000vph Northbound
Delay with 1100vph Northbound

Appendix F. Cumulative traffic volume increases on SH1



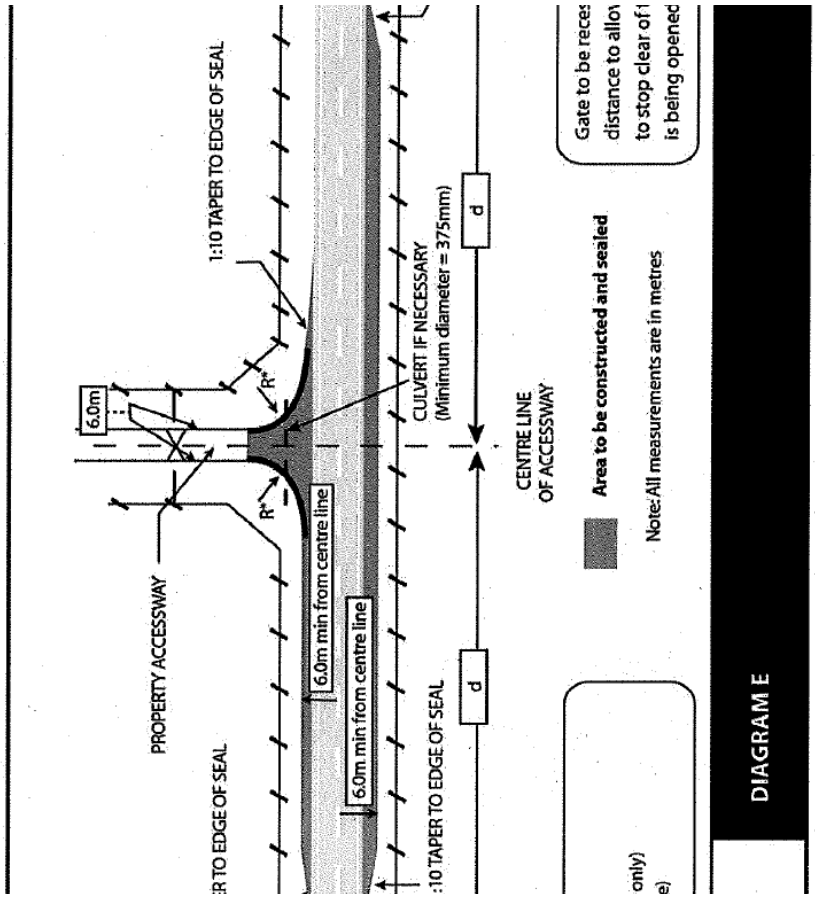
Appendix G. Typical right turn treatments

Treatment 1: Accessway treatment on to State Highway's (Source: The NZTA's Planning and Policy Manual, NZTA, 2005)

Treatment 2: Rural Right Turn Treatment (Source: MOTSAM, NZTA 2012)

Treatment 3: Rural Right Turn Treatment example of good practice (Source: MOTSAM, NZTA 2012)

Treatment 1: Accessway treatment on to State Highway's (Source: The NZTA's Planning and Policy Manual, NZTA, 2005)



Treatment 2: Rural Right Turn Treatment (Source: MOTSAM, NZTA 2011)

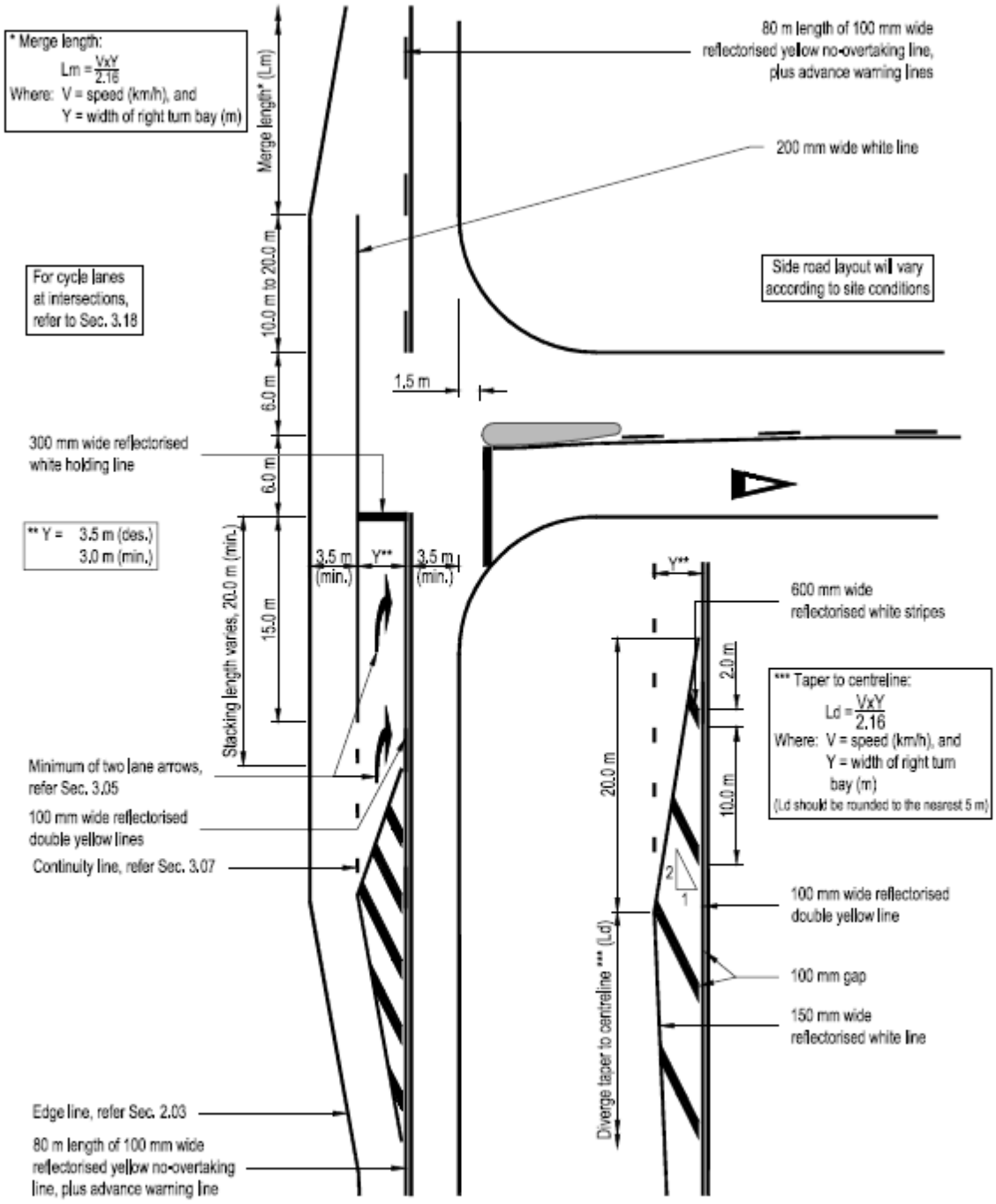


FIGURE 3.25 MARKINGS FOR RIGHT TURN BAYS IN RURAL AREAS

Treatment 3: Rural right turn treatment example of good practice (Source: MOTSAM, NZTA 2012)

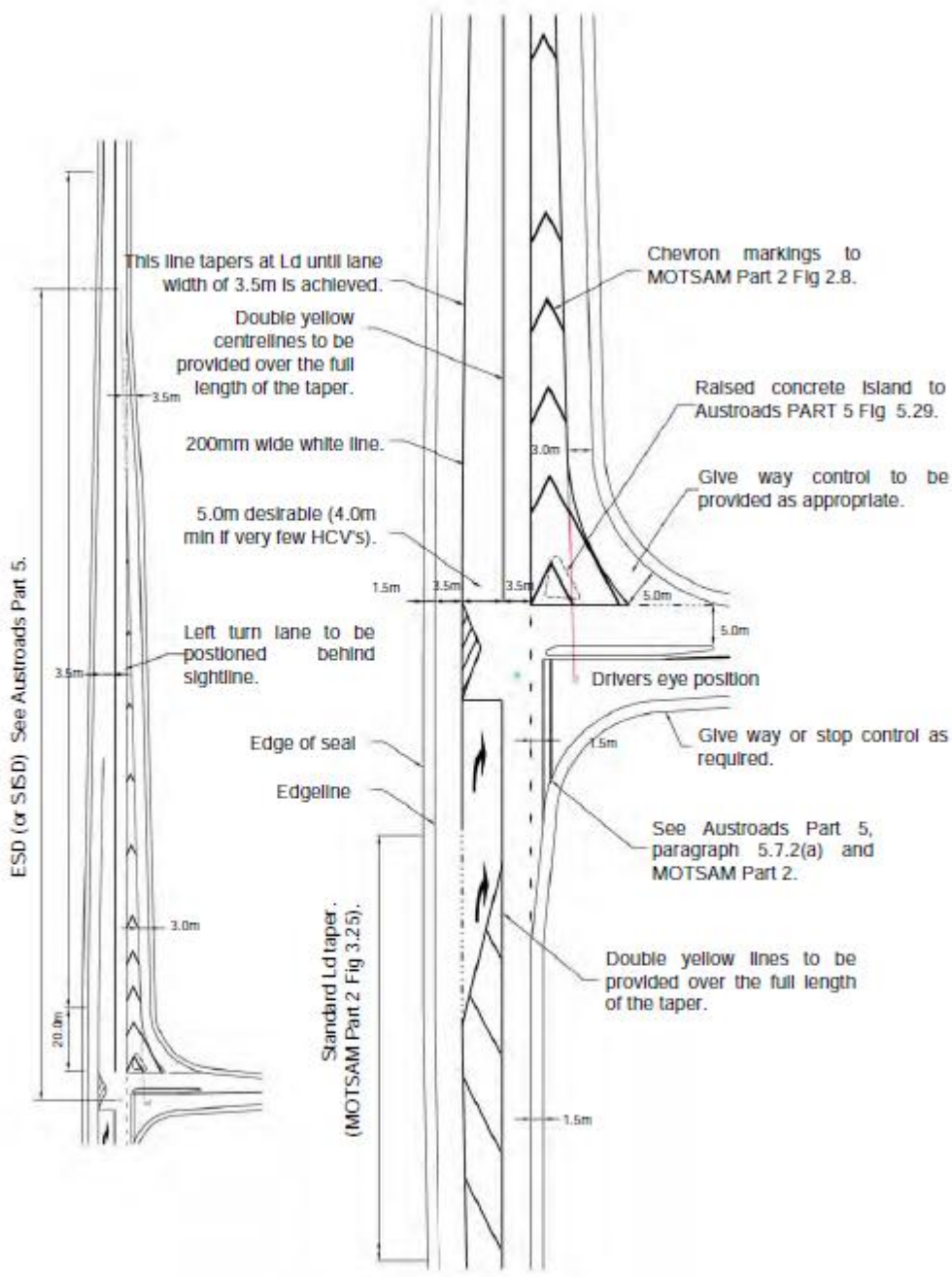


FIGURE 3.25a EXAMPLE OF GOOD PRACTICE