APPENDICES VOLUME 2

Appendix C-F

Great Western Highway upgrade, Kelso

Review of Environmental Factors

Appendix C

Consultation

KELSO DUAL CARRIAGEWAY PROJECT

Great Western Highway, Kelso

Report on preliminary options consultation

MARCH 2011

NSW GOVERNMENT
Transport
Roads & Traffic Authority

Great Western Highway upgrade at Kelso, NSW

Preliminary options consultation report

Prepared for the NSW Government, Transport, Roads and Traffic Authority

by

Kerry Morrison
Kerry Morrison & Associates
PO Box 135, Camperdown, NSW, 1450

TABLE OF CONTENTS

1.0 Background

In May 2010 the Minister for Roads announced that community consultation would commence for the proposed upgrade of a section of the Great Western Highway through Kelso.

The area under investigation covers a length of approximately 2.4 kilometres, commencing just west of the Stockland Drive intersection in Kelso near Raglan Creek, and extending approximately 250m east of Ashworth Drive, near the Gold Panner Motor Inn.

The proposal is to widen the highway to four lanes, improve intersections and separate opposing directions of traffic. The existing 2.4 kilometre length of the Great Western Highway is generally a two lane highway with eight traffic light controlled and uncontrolled intersections.

A community update outlining the proposal and preliminary intersection options was distributed by letterbox drop September 2010 to businesses and residents in Kelso, Bathurst, Oberon and surrounding areas. The community was invited to comment on the options through a feedback form, email, post, or phone until early November 2010. A staffed display and two community workshops were held to provide information and seek feedback.

This report documents the first stage of community consultation undertaken for the proposed upgrade of the Great Western Highway at Kelso.

2.0 Key issues

The key issues identified from the workshops, meetings and other feedback are:

- The project to upgrade the highway through Kelso is long overdue.
- Installing a raised concrete median would have a significant impact by limiting right turn movements to and from residences and businesses, and this would need to be addressed.
- There are existing traffic congestion problems on the highway and at intersections, particularly Stockland Drive and Littlebourne Street.
- There is limited network of side streets available to provide an alternative route, particularly on the southern side of the highway.
- Different suggestions for the most suitable treatment for intersections.
- Improved facilities/access for pedestrians and cyclists is needed.
- Desire for of an eastern 'gateway' to Bathurst to be created.
- Possible construction traffic delays and access restrictions to businesses and residences.

Key issues raised about other access issues in the Kelso area include:

- Requests to extend the project east with a dual carriageway to Raglan or, as a minimum, an overtaking lane up Raglan Hill; and/or to the intersection with Napoleon Street and continue out past the airport to the 100 km/h zone.
- Suggestions of new roads to link the Kelso industrial area and Raglan on the southern side of the highway.
- Suggestions for a bypass of the town centre from Raglan to Kelso and Bathurst, connecting the three industrial areas.

Sections 4 and 5 of this report provide more discussion of these issues.

3.0 Consultation

The objectives of the community and stakeholder consultation were to:

- Inform the community of the RTA's proposal to upgrade the road.
- Invite comments from the community about the preliminary options.
- Seek feedback on the preliminary options plan through feedback forms, emails and phone calls, a staffed display and two community workshops.
- Gain input, comments and issues about the existing use of the road, the project and proposed upgrade.
- Provide advice to directly affected stakeholders of the proposal and potential impacts.
- Advise stakeholders how they could obtain information or communicate concerns, issues and suggestions.

3.1 Community update and feedback

A community update was letterbox dropped to over 17,000 businesses and households in late September 2010. The distribution area included Bathurst, Kelso, Oberon and surrounding areas. The community update included a feedback form and project contact details including a 1800 toll free telephone number, email and postal addresses.

Nearly 200 feedback forms, emails and phone calls were received from businesses and residents in Kelso, Bathurst and surrounding areas by the due date of 12 November 2010.

3.2 Public displays

Two static public displays were established at the Bathurst Region Council office foyer and the RTA's Bathurst Motor Registry, comprising a copy of the preliminary options plan, information on the project, and a supply of feedback forms as a means for the local community to provide input. The display period was from 5 October to 2 November 2010.

The public displays were advertised in the community update letterbox dropped to individual properties, as well as in the Bathurst Western Advocate newspaper. A copy of the preliminary options plan was also displayed at the Kelso Hotel.

3.3 Staffed public display

During the public display period, members of the Kelso project team staffed the display at the Kelso Hotel on 19 October 2010. Over 60 people visited the display over the eight hour period.

The staffed display provided the opportunity for one-on-one conversations with members of the community and business owners and operators, enabling RTA project team members to explain the preliminary options, answer questions and receive issues and/or suggestions regarding the project.

3.4 Community workshops

Two community workshops were held on 26 October 2010 at the Bathurst Entertainment Memorial Centre. The first workshop was held from 10am to 1pm and the second from 6pm to 9pm, each providing opportunity for community members to attend during or after business hours. Both workshops were attended by a broad cross-section of local business and community participants, with 12 at the first and 11 at the second. The workshops facilitated discussion of the preliminary options plan, intersection treatments, ideas, alternatives, and suggestions, and were featured on Prime TV news that evening.

3.5 Stakeholder meetings

Individual meetings were held with a number of business owners and operators along the Great Western Highway to advise them of the project and the consultation process. Information was obtained about business operations as input into the project. Future stakeholder meetings will be held as the project progresses.

3.6 RTA Website

The RTA's project website was visited by 421 people between 23 September and 23 November 2010. There were 237 downloads of the September community update and/or feedback form.

3.7 Advertising

A newspaper advertisement appeared in the Bathurst Western Advocate on 29 September, 1 and 6 October 2010, the Bathurst Western Times on 29 September and the Oberon Review on 30 September 2010. The advertisement invited the community to view the public display, attend the staffed display, the community workshops, and provide written comments.

4.0 Community issues raised regarding the upgrade

Respondents identified a number of existing traffic problems and access issues on the Great Western Highway through Kelso, as well as commenting on the intersection treatments. The following issues were raised by community and business respondents at meetings, the community workshops, staffed display, feedback forms and emails.

4.1 Traffic volumes

The highway is the only east-west access through Kelso. High traffic volumes are the result of the majority of vehicles being forced to use the highway due to lack of or limited alternative routes on side streets, particularly on the southern side of the highway. The traffic movement on the highway includes distinct weekday morning and afternoon peak periods, a high demand for right-hand turns into properties (businesses and houses) and at intersections, and high levels of congestion and delay when a disruption (e.g. crash or road works) occurs on the highway.

Many respondents described traffic volumes during peak periods as a 'continuous flow of traffic', making it difficult to turn right onto and off the highway from properties and side streets, not just during Bathurst 1000 race weekend, but on a daily basis. The traffic build-up and delays during peak hours were a frequent comment.

Concerns were raised about 'bottlenecks' occurring where two lanes merge into one lane, particularly during peak traffic flow times, which are generally 8am to 9:30am and 3:30pm to 5pm weekdays.

Comments were also made that when road maintenance on the highway or flooding occurs, traffic flows are significantly disrupted. On occasions the eastbound queue of vehicles was described as up to 1.5 kilometres long back to Raglan, with the associated extended travel time causing driver frustration and anxiety.

One resident living on the northern side of the highway, described going 'around the block' via View Street and Boyd Street to rejoin the highway at the Boyd Street lights to go west. This route was preferred during peak traffic periods, rather than the more direct right turn across the highway to travel west to Bathurst.

4.2 Existing intersection problems

Comments and feedback received included opinions about the existing intersections and problems people experience, particularly road safety.

<u>Stockland Drive</u>: The right turn across the highway from Stockland Drive, heading east, was identified by many respondents as being a particularly difficult manoeuvre, and at times "very dangerous", due to the traffic volumes on the highway and limited breaks in the traffic flow. Alternative manoeuvres to travel east reported by respondents were to turn left and use Lions Club Drive to turn around, or crossing the westbound lane and waiting on the painted median for a gap in the eastbound traffic to merge. Another respondent suggested that a left turn merge lane be included in the upgrade for easier access west.

<u>Gilmour Street and Boyd Street traffic lights</u>: Concerns were raised that the traffic lights at Gilmour and Boyd streets are too close together causing increased congestion. In addition, the lights are not synchronised and some vehicles turn right out of Boyd Street and do not stop at the red traffic light at Gilmour Street.

Some cyclists mentioned they "take their life in their hands" when drivers, heading east, turn left and "roar up Boyd Street" cutting them off.

Gilmour Street: As Main Road 54 (part of the state road network) this is a main access road, not only to Kelso residential areas, but also to other towns and villages north of Bathurst such as Sofala, Wattle Flat and on to Mudgee. In addition it links to shops, residential areas, two primary schools, and is a school bus route. It is also used as an alternative access from Kelso residential area into Bathurst, on those occasions when the Hereford Street bridge is flooded.

Boyd Street: This is the other main access route to the Kelso residential area and a main access to Kelso High School, public playing fields, and a major bus route. The existing intersection does not allow a right turn off the highway due to the current design. Westbound traffic uses View Street or Gilmour Street for access to the northern side of the highway, the Kelso residential area and Limekilns Road.

Lee Street: The closure of the eastbound right turn into Lee Street, some years ago, remains a source of frustration for drivers seeking a more direct access to that area. From the west, traffic access to Lee Street is by turning off early at Stockland Drive, with non-local drivers finding it necessary to turn around and go back to Lee Street, using property driveways or another intersection such as Littlebourne Street to turn around.

View Street: This road is described as being very well used by Kelso residents travelling from Littlebourne Street and other westbound traffic wishing to access the residential area on the northern side of the highway, and other community facilities. View Street is also used as an access to Limekilns Road by cars and buses.

Some respondents described the right turn into View Street as "very dangerous" at busy times of the day with others commenting that vehicles stopping to turn right were the cause of rear-end crashes and many near misses. The line-of-sight at the intersection for vehicles turning right onto the highway was also described as "dangerous".

Littlebourne Street: This road is Main Road 253 (part of the state network) and well used. It is the main access to the Kelso industrial area, and town/villages such as O'Connell and Oberon. Many respondents highlighted congestion issues at the intersection for all traffic movements. Concerns included that the traffic backs up to the railway overbridge, the right turn bay on the highway is not long enough for traffic queues and highway traffic is stopped until the right turn at the traffic lights change (particularly during peak hours) and that the turn time is too short.

Some respondents said that when travelling from the west, rather than try to turn right into a business or property on the southern side of the highway, they turn right into Littlebourne Street, and turn around in a driveway and back onto the highway and west, to the businesses or property. This manoeuvre is to avoid stopping on the highway and trying to turn directly into a property whilst waiting for a gap in the high volume of through traffic.
Rk

Pat O'Leary Drive: At present, Pat O'Leary Drive is a cul-de-sac and one of the key stakeholders, the Kelso fire station, is located on this street. A proposed private development on the western corner block includes a fast food outlet (expected to be constructed within the next 2 years), will increase local pedestrian and vehicle traffic at the intersection.

Ashworth Drive: Respondents raised concerns that the westbound right turn onto the highway is difficult, at times, due to traffic volumes and traffic speed (cited as 80 km/h down the Raglan hill).

Although it is in the 60 km/h zone, many expressed frustration that some motorists were not abiding to the speed limit.

A number of respondents also raised the need for an extension of Ashworth Drive to connect to Bonnor Street to provide an improved level of connectivity to the Kelso residential area. This connection is effectively under construction and is part of the conditions of approval for a private developer residential subdivision.

Other busy driveways: The highway is also the main access for several large businesses that employ up to 200 people including shift workers (Devro and Downer EDI). The location of the driveways on the highway results in vehicles stopping to turn right and can cause traffic congestion and delays, particularly if another vehicle is parked in the shoulder/parking lane and the through traffic is unable to pass the stopped car.

Bridge widening: Several respondents commented that the Boyd Creek bridge near Pat O'Leary Drive needed to be widened to eliminate the existing bottleneck at that location on the highway.

4.3 Crashes and road safety

In addition to intersection issues, a number of respondents commented that they have seen many 'near misses' and 'rear-enders' due to vehicles stopping to turn right into a business, residence or side street, and the vehicle behind not seeing the vehicle stop. Some access to businesses were identified as particularly bad locations for 'rear-enders' due to their popularity and high level of trade.

This problem was described as being exacerbated when vehicles are parked in the shoulder lane so that cars cannot use the shoulder/parking lane to go around the stopped vehicle waiting to turn right.

Some respondents suggested that 'no parking' or 'no standing' signs be installed, particularly for the morning and afternoon peak traffic periods (effectively providing a clearway), allowing traffic to pass safely on the left, rather than wait for the vehicle to turn.

Contrary to the 'no parking' request, a number of respondents commented that road side parking is integral to their business operations and needs to be maintained as part of the overall design of the upgrade.

In addition, some residents living in houses on the highway in Kelso were concerned about their future access onto the highway. In particular, questions were raised as to whether they would be able to reverse out of their driveways into a shoulder lane and/or what changes would be made to ensure they can continue to exit their properties safely.

4.4 Proposed raised median

An integral element of the proposed Kelso upgrade is the separation of opposing flows of traffic by constructing a raised concrete median. Some respondents were totally opposed to the proposal citing concerns about hindering access to businesses and residential properties. Business concerns included loss of trade and economic impacts. Other respondents requested that a gap be provided in the median to allow access for the high number of employees and delivery vehicles at key locations or key businesses. Other respondents did not raise concerns or agreed it was a good solution to reduce 'rear-end' car accidents.

A couple of respondents suggested that the raised median be abandoned in favour of a central two way right turn lane, as exists in Dubbo.

Comments were also received regarding the width of the median, with a number of respondents requesting a narrow median to allow more lane space for cars, where others suggested wide medians to allow landscape planting to improve the area and enhance the visual amenity of the eastern 'gateway' to Bathurst.

Conversely, many respondents requested no median plantings to maximise motorist visibility, particularly in areas where pedestrians cross the road. The median plantings in parts of Bathurst town centre were cited as examples of inappropriate selections and/or plantings resulting in poor visibility for motorists, and near misses of pedestrians.

4.5 Traffic lights versus roundabouts

The higher proportion of respondents suggested a combination of intersection options combining both traffic lights and roundabouts to enable vehicle movements to travel both north-south and east-west, and access existing businesses despite the central median.

Some respondents favoured installing traffic lights at all intersections to control traffic flow, particularly during morning and afternoon peak traffic periods (morning: 8am to 9am; afternoon: 3.30pm to 5pm), and during the Bathurst 1000 race weekend. Traffic lights were perceived to best manage traffic and provide a break in traffic flows, providing drivers with a "fair go" to enter the traffic. Comments were made that the traffic lights could be synchronised to provide better traffic flows.

Other respondents favoured installing roundabouts at as many intersections as possible, as the perceived best means of maintaining good traffic flows, with concerns that traffic signals create too much of a stop-start to traffic flow, thus extending travel times.

Key concerns with roundabouts were that some drivers do not know how to use a roundabout and delay traffic flow due to indecision, with others concerned that vehicles on a roundabout would not provide enough of a gap in the traffic flow for vehicles from the side streets to enter the roundabout, particularly during peak traffic flow periods.

A number of respondents felt that roundabouts should not be on main roads, and concerns were also expressed that roundabouts "are useless for trucks", "unworkable during busy times", and are "difficult for vehicles without power steering and for trucks". Also, "roundabouts take up too much space" and traffic lights would be better.

Suggestions were made that the roundabouts be two lanes wide for improved traffic flows and able to accommodate heavy vehicles without affecting car traffic. Requests were also received for 'intelligent' traffic lights to be included on roundabouts to manage traffic flows during busy periods.

4.6 Comments on proposed intersection treatments

The preliminary options plan elicited a range of comments regarding the treatment of each intersection. The following is a summary of the feedback regarding intersection treatments. A copy of the preliminary options plan is included as Appendix A.

4.6.1 Stockland Drive

The preliminary options plan showed a roundabout at Stockland Drive.

A roundabout at Stockland Drive was considered preferable to the existing situation, with some respondents favouring traffic lights and some suggesting an alternative treatment that provided a right turn waiting bay for eastbound traffic. The key concern was safety when crossing the westbound lanes on the highway to travel east.

4.6.2 Gilmour Street intersection (MR54)

The preliminary options plan proposals were to retain traffic lights at Gilmour Street or remove traffic lights to become left-in left-out at Gilmour Street.

The most frequent comment from respondents was that Gilmour Street traffic lights must be, or should be, retained and not replaced with a left-in left-out configuration. The key reasons were that Gilmour Street is a main road providing access to schools and residential areas, and other residential villages such as Eglinton, and to Bathurst when the Hereford Street low level bridge is flooded. Several respondents also suggested that the upgraded traffic lights also include a pedestrian crossing in addition to the Boyd Street crossing, and to ensure the phasing and synchronisation of these traffic lights with those nearby at Boyd Street.

4.6.3 Boyd Street

The preliminary options plan proposed the realignment of the intersection with traffic lights and a protected right turn bay into Boyd Street, or a new roundabout at Boyd Street.

Many respondents favoured retaining the traffic lights at Boyd Street and providing a protected right turn bay. The key reasons were that the road provides access to a range of community facilities, schools, shops and Kelso residential areas.

Some respondents favoured a roundabout at Boyd Street with the suggestion that it could include Lee Street and provide north-south access across the highway at this location.

Alternatively, some suggested that Boyd Street be realigned to provide a four-way intersection with Lee Street to provide improved access to properties and areas off Lee Street.

4.6.4 Lee Street

The preliminary options plan retained the left-in left-out arrangement at Lee Street.

Respondents were generally in favour of retaining the left-in left-out arrangement at Lee Street. However, some respondents requested that Lee Street be re-opened to provide an eastbound right turn from the highway to enable easier access to the businesses and residential properties in that area. A number of respondents suggested that Lee Street be re-opened to cross the railway with a second overbridge to reduce the congestion and bottleneck at Littlebourne Street.

4.6.5 Littlebourne Street (MR253)

The preliminary options plan proposed upgrading the traffic lights at Littlebourne Street, or replacing the traffic lights with a new roundabout.

Strong views were expressed in favour of either upgrading the traffic lights or installing a roundabout. The majority preference was to retain and upgrade the traffic lights at Littlebourne Street with fewer suggesting installation of a roundabout.

Objections to a roundabout were predominantly that traffic needs to be controlled with signals as vehicles would not be able to get onto the highway from Littlebourne Street due to the continuous flow of traffic on the highway, and that traffic congestion on Littlebourne Street would be worse than currently experienced.

4.6.6 View Street

The preliminary options plan proposed that the intersection be changed to left-in left-out at View Street.

A higher number of respondents favoured retaining the westbound right turn at View Street, with about half that number favouring changing View Street to left-in left out.

A number of respondents were concerned that a proposed change to a left-in/left-out intersection would eliminate their access to the Kelso residential area. It became clear that these respondents did not understand that the Boyd Street intersection would be upgraded to include a right turn movement where none currently exists, should View Street become left-in and left-out only.

Many respondents were also concerned that the left-in/left-out configuration would extend emergency services response time and access.

In addition, respondents were concerned about the additional travel time to access residential areas (via Boyd Street) rather than directly up View Street. Also concerns were raised that additional traffic on Boyd Street would put "lives in danger" due to the number of schools and other public facilities along Boyd Street.

Signals and roundabouts were also suggested as alternative intersection treatments by some respondents to maintain the westbound right turn at this location.

4.6.7 Pat O'Leary Drive

The preliminary options plan proposed a protected right turn bay at Pat O'Leary Drive, with signals installed subject to future development proceeding.

The proposal to install a protected right turn bay at Pat O'Leary Drive was generally accepted, although some respondents raised concerns about access for the fire brigade, and that the right turn bay would be inadequate when the proposed fast food development was operating. Some suggested that traffic signals should be installed sooner rather than later to cater for the fast food development.

With the change of land use to include a fast food business as part of the upcoming site development, the issue of pedestrian access and safety also arose at this location, and the need for a pedestrian crossing.

Another suggestion was that a small roundabout be installed to provide easier access to the BP Service station at this location.

4.6.8 Ashworth Drive

The preliminary options plan proposed a new roundabout at Ashworth Drive, with access to the proposed Intermodal terminal subject to the future development proceeding.

Many respondents favoured a roundabout at Ashworth Drive although a small number commented that it would be difficult for large vehicles or cars with caravans or trailers to join the high speed traffic on the highway at that location, so traffic lights were preferred.

A small number of respondents also commented that the development of the Intermodal Terminal project, with the main access opposite Ashworth Drive, would require signals to ensure traffic is managed appropriately.

4.7 Pedestrian access

Providing formalised paths on both sides of the highway was the clear preference, particularly given that for much of the project length, no formal pathway exists. Improvements to existing pedestrian paths were also suggested, with a preference for a continuous path on the northern side (eastbound) of the highway, if land availability prohibits a path on both sides.

Comments were made by respondents that all existing signalised pedestrian crossings need to be improved and installed at all traffic signal locations, including Gilmour Street. In particular, pedestrian crossings need to cater for disabled access, both physically and vision impaired pedestrians, with appropriate ramps, location of buttons and crossing sounds.

Suggestions were made to ensure that pedestrian crossings were provided opposite the BP service station, the fish 'n' chip shop, and at the end of the pedestrian walkway from the Kelso residential area, as adults and children are frequently seen crossing the highway at various levels of safety at this location. One respondent suggested that a fence be constructed on the median to stop "dangerous pedestrian crossings".

A path for disabled access from Raglan to Bathurst was requested by several respondents.

4.8 Cyclists

A number of respondents requested that a cycle path be included in the upgrade to cater for local cyclists and particularly for commuters cycling between Bathurst and Raglan. Some requested a separate cycle path away from the traffic.

4.9 'Gateway' to Bathurst

A number of respondents commented that the proposed upgrade provides a unique opportunity to create an eastern 'gateway' to Bathurst. Some respondents described the area as 'unkempt' and in need of improvement through landscape design and plantings.

4.10 Construction phase

Business and community members were interested to know how and when the upgrade would be constructed.

Concerns were raised about disruption to businesses due to changed access during the construction phase. Some were concerned that access would be blocked to their property for periods of time during the construction phase, which is particularly important for many businesses operating along the highway.

In addition, as there are few side streets, people were very concerned about construction works causing long traffic delays on the highway, as congestion occurs when any maintenance work is undertaken on the existing highway. The delays cause problems for people travelling to work and arriving on time (several respondents raised this issue) and truck operators were concerned about timely delivery of goods.

Some suggested the work be carried out at night, to minimise impacts on traffic flows. Others were strongly opposed to continuous night works.

Several respondents suggested a solution to traffic delays would be establishing temporary access routes during the construction phase. The suggestions included:

- Connecting Lee Street across the rail line with a temporary at grade road, or a bridge to Stockland Drive to provide a temporary access into Bathurst during the construction period.
- Providing access to and from the industrial area to Bathurst via Toronto Street with a bridge over the creek.

5.0 Community issues raised regarding alternative access

The following issues were raised by respondents are considered outside the scope of the project. However the issues are noted so as to capture other suggestions and ideas that reflect the need for improvements to access and traffic issues in the Kelso or broader Bathurst area.

5.1 Link roads and bypass

A number of respondents highlighted the lack of interconnectedness between the Kelso industrial area and other businesses on the south side of the highway, due to few roads and the railway line. Respondents suggested other roads need to be built to link areas where no road currently exists. The purpose would be to provide options for motorists, rather than forcing all traffic down the highway. The suggestions were particularly focussed on access to or within the Kelso industrial area. The suggestions included:

- A link road between Littlebourne Street and Lee Street.
- A second rail crossing at Lee Street (overbridge).
- A connection from the eastern extremity of the industrial area across the railway line to the factories in Raglan.
- A link road from the western extremity of the industrial area to the Gormans Hill area crossing the river.
- A link road between Durham Street, Toronto Street and Acheron Street including a low level bridge to connect the Kelso industrial area and Littlebourne Street.
- A Bathurst bypass (loosely described as the southern ring road) that would connect the three industrial areas.
- A link road from Mars Petcare to Littlebourne Street and preferably extended to Bathurst.

These suggestions have been raised with Bathurst City Council.

5.2 Extend the project east

Several respondents suggested that the project be extended to the east to widen the highway to four lanes through to Raglan. The key concern is that there was no slow or passing lane for heavy vehicles which causes eastbound traffic to back-up along the highway. Delays to emergency service vehicles were also cited by some respondents as a major cause for concern.

6.0 Issues to be addressed

A number of issues were raised that will be addressed during the detailed design phase of the project. These include, in no particular order, and are not limited to:

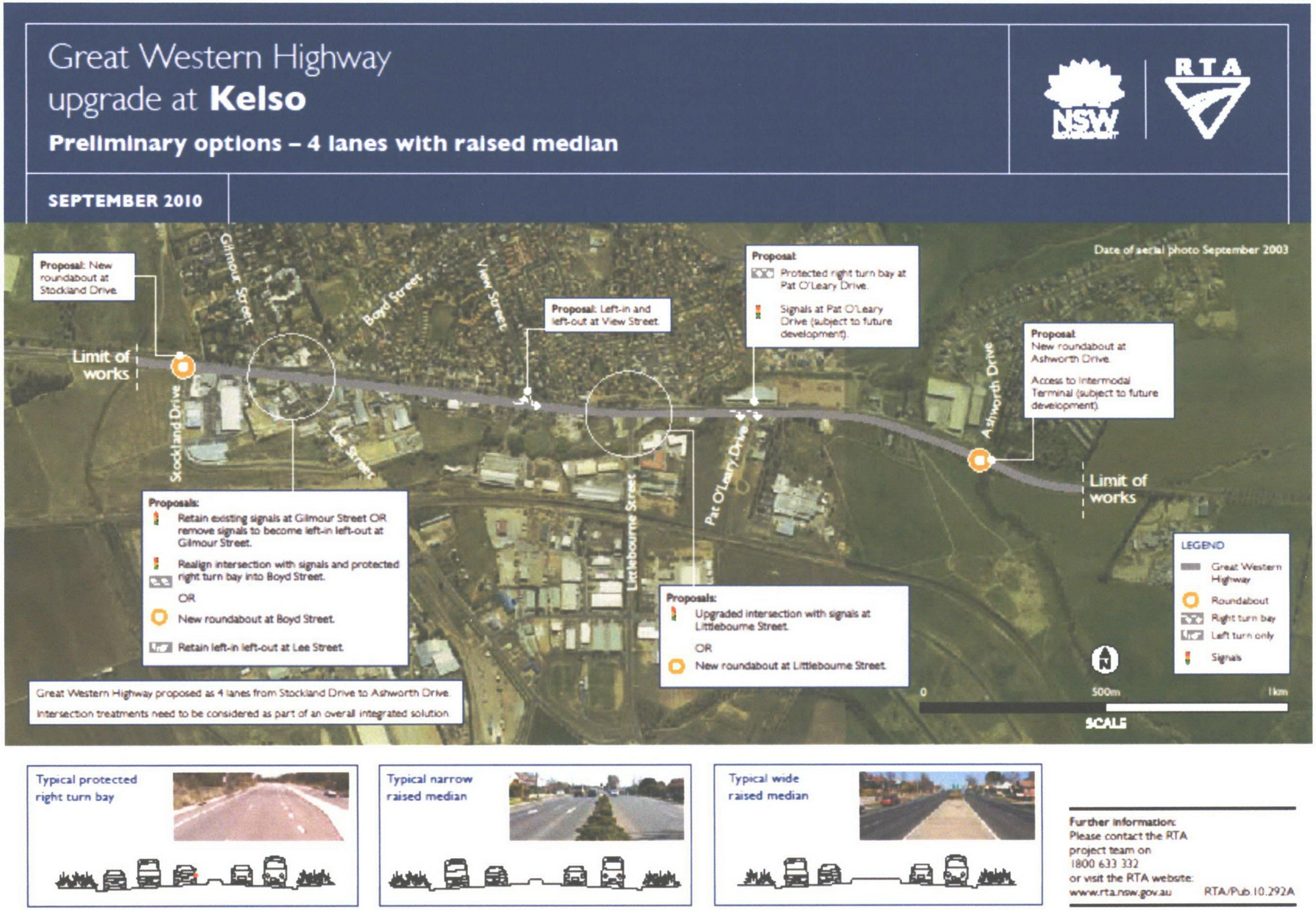
- Detailed urban design, landscaping and plantings to create an eastern 'gateway' to Bathurst through Kelso including reference to the Bathurst Regional Council's local Vegetation Management Plan.
- Pedestrian access including the location of footpaths, pedestrian crossings and crossing design.
- Design and arrangements for emergency service access from Pat O'Leary Drive to View Street and the Kelso residential area.
- Property boundary adjustment details (where required).
- Design of driveways and access to properties affected by the upgrade.
- Details of intersection treatments and road realignments (where required).
- Truck traffic noise.
- Street lighting.
- Access and impact on shops opposite Pat O'Leary Drive.
- Bus stop locations (where required) and bus routes.
- Environmental assessment of the proposed upgrade.
- Kelso urban heritage and effects of the upgrade.
- Cyclist safety and cycleways.
- Construction phase management.

7.0 Next steps

The next steps will include:

- Preparing a preferred concept design.
- Conducting follow-up meetings with property owners, businesses and stakeholders.
- Providing public information through household letter and RTA website.
- Seeking feedback from community on the preferred concept.

Appendix A – Preliminary options plan – September 2010



Transport
Roads & Maritime
Services

GREAT WESTERN HIGHWAY UPGRADE, KELSO

Report on preferred concept design consultation

FEBRUARY 2012

ISBN 978-1-922040-35-0 **RMS 12.032**

Great Western Highway upgrade at Kelso, NSW

Preferred concept design consultation report

Prepared for the NSW Government, Roads and Maritime Services

by

Kerry Morrison
Kerry Morrison & Associates
PO Box 135, Camperdown, NSW, 2050

Kelso project
Preferred concept option consultation report

1.0 Introduction

In May 2010 the then Minister for Roads announced that community consultation would start for the proposed upgrade of a section of the Great Western Highway through Kelso.

The area under investigation covers a length of about 2.4 kilometres, starting just west of the Stockland Drive intersection in Kelso near Raglan Creek, and extending about 250 metres east of Ashworth Drive, near the Gold Panner Motor Inn.

The proposal is to widen the road to four lanes, improve intersections and separate opposing directions of traffic. The existing 2.4 kilometre length of the Great Western Highway is generally a two lane highway with eight intersections, with three traffic light controlled and five uncontrolled intersections.

1.1 Preliminary options consultation

Preliminary options consultation was undertaken from September to November 2010 with a report published in March 2011 describing the consultation process, issues raised and feedback from respondents. The report is available on the RMS project web page.

In March 2011 a letter was distributed to residents and businesses advising of the report availability and main issues that were raised. The main issues were:

- Upgrading the highway at Kelso is long overdue and generally welcomed.
- Highway traffic is congested with problems at intersections and 'rear-end' crashes.
- Maintaining access to homes, businesses, schools, public facilities and nearby villages is important.
- Improved access to the Kelso industrial area is needed.
- The proposed highway median would impact on access for businesses and residents.
- There are opposing views about the best way to improve the intersections.
- Providing or improving pedestrian and cycle paths is important.
- There is an opportunity to plan for an 'eastern gateway' to Bathurst.
- Construction planning for this project must consider traffic delays and access to properties.

Comments received regarding particular intersections were:

- Boyd Street and View Street access to the Kelso residential area: Respondents requested a protected right turn bay at Boyd Street and/or View Street be provided for westbound traffic to maintain access to the Kelso residential area and surrounds.
- Gilmour Street access: Respondents asked that the direct right turn into Gilmour Street be maintained for westbound traffic access to schools, shops and surrounding areas.

The report also addressed other specific issues raised, including:

- Traffic volumes on the highway, particularly during morning and afternoon peak traffic periods, not just during the Bathurst 1000 race weekend.
- Existing intersection problems particularly:
    - The eastbound right turn from Stockland Drive.
    - The proximity and synchronisation of traffic lights at Gilmour and Boyd streets.
    - Gilmour, Boyd and View streets are main access routes to residential areas and other villages and all turning movements need to be retained or improved.
    - The access difficulties associated with the closure of the eastbound right turn into Lee Street from the highway.
    - The westbound right turn into View Street during peak hours.
    - The traffic queues during peak periods at Littlebourne Street – both along Littlebourne Street and the right turn bay.
    - The new fast food outlet and the access needs for the Kelso fire station at Pat O'Leary Drive.
    - The westbound right turn from Ashworth Drive onto the highway due to traffic volumes and vehicle speed down the Raglan hill.
- Busy driveways at key businesses (Devro and Downer EDI) need protected right turn bays.
- Need to widen bridge over Boyd Creek.
- Frequency of near-misses and rear-end crashes due to parked cars and vehicle right turns into properties.
- Proposed raised concrete median benefits and problems for businesses.
- Traffic lights versus roundabouts at each intersection and opposing comments on each of the proposed intersection treatments.
- Pedestrian access requirements.
- Cyclist requirements.
- Need for an 'eastern gateway' to Bathurst through landscape design and plantings.
- Construction phase concerns and issues due to significant traffic delays when any work occurs on the existing highway.

Many design alternatives, suggestions and ideas were provided by over 200 respondents. These ranged from local road connections to improve local access and connectivity in and around Kelso to bypass options, link road alternatives, and extending the project east, to Raglan.

Following the completion of the first consultation phase, the RMS project team undertook other tasks and studies to address issues and obtain additional background information as part of the development of a preferred concept design. These were:

- Collection of new traffic data on the highway (March 2011).
- Completion of detailed ground survey of property boundaries.
- Mapping land use, landscape, pedestrian access and utility services locations.
- Meetings with Bathurst Regional Council (BRC) to discuss future development area plans to estimate future traffic growth on the highway.
- Completion of a pedestrian mobility access study.
- Preparation of draft urban design and landscape concept plans for discussion and input from council and the community.
- Refinement of the width of the proposed raised median and pedestrian and cycle paths, including reference to BRC draft bicycle plan.

1.2 Preferred concept design consultation

This report documents the second phase of consultation undertaken for preferred concept design of the proposed upgrade of the Great Western Highway at Kelso. It describes the consultation activities undertaken from October to December 2011 and the feedback raised on the preferred concept design by respondents.

The concept design provides:

- An additional two lanes to improve traffic flow on the highway.
- Upgraded intersections at Stockland Drive, Boyd, View and Littlebourne streets, Pat O'Leary and Ashworth drives.
- A concrete median separating opposing traffic and reducing the number of rear-end crashes by controlling where vehicles can turn right.
- Opportunities for drivers to change direction to access premises and side streets on either side of the road at roundabouts, and a dedicated u-turn facility.
- Retained left-in and left-out driveway access.
- Retained road side parking.
- New and improved pedestrian and cyclist access along and across the highway including a pedestrian refuge west of View Street.
- Improved landscaping to enhance the visual appeal of the eastern gateway to Bathurst.
- No direct impacts on heritage buildings.
- Improved intersections:
    - Stockland Drive – new traffic lights and u-turn bay.
    - Gilmour Street – retained right turn.
    - Boyd Street – new protected right turn bay.
    - View Street – new protected right turn bay.
    - Littlebourne Street – new two lane roundabout.
    - Pat O'Leary Drive – new traffic lights and protected right turn bay.
    - Ashworth Drive – new two lane roundabout.

A copy of the preferred concept is provided in Appendix A.

2.0 Consultation

The objectives of the community and stakeholder consultation were to:

- Inform the community of the proposed highway upgrade and the preferred concept design.
- Invite comments, seek feedback from the community on the preferred concept design through a feedback form, emails, phone calls and staffed displays.
- Provide advice and information to directly affected stakeholders.
- Advise stakeholders how to obtain information or communicate concerns, issues and suggestions.

The following sections detail the consultation activities that were undertaken.

2.1 Community update and feedback

The preferred concept design community update (October 2011) was distributed to all businesses and households in Kelso and mailed or emailed to the database of respondents collated from 2010 consultation. The community update included a feedback form and project contact details including the RMS 1800 toll free telephone number, email and postal addresses. The community update provided details of the studies and investigations that had been undertaken, how the design had been developed, the features included in the concept design and intersection treatments, and how RMS responded to feedback provided during the 2010 consultation. A plan of the preferred concept design was included and a detachable feedback form.

Over 65 feedback forms, emails and phone calls were received from businesses and residents in Kelso, Bathurst and surrounding areas by the due date of 25 November 2011.

2.2 Public displays

Three static public displays were established in the Kelso and Bathurst to provide community access to larger scale plans. The static displays were located at the Bathurst Regional Council office foyer, RMS Bathurst Motor Registry and the Kelso Hotel. The displays comprised a copy of the preferred concept design, information on the project, and a supply of feedback forms as a means for the local community to provide input. The display period was from 24 October to 18 November 2011.

The public displays were advertised in the community update, The Western Advocate newspaper and local radio station.

2.3 Staffed public displays

During the public display period, members of the Kelso project team staffed two displays held at the Bathurst Visitor Information Centre on Monday 7 November and Tuesday 15 November 2011.

The staffed display provided the opportunity for one-on-one conversations with members of the community and business owners and operators, enabling project team members to explain the preferred concept design, answer questions, discuss concerns and take on board issues and/or suggestions regarding the project. Each session was visited by 10 people over the four hour display periods.

2.4 Stakeholder meetings

Key stakeholders identified during the 2010 consultation were contacted before the public display of the preferred concept design in October 2011. These included Bathurst Regional Council, Kelso business owners and operators, and a group called 'United Forum'.

Several meetings were held with Bathurst Regional Council during the development of the preferred concept design to discuss issues, obtain information, such as future residential areas (to enable prediction of future traffic volumes) and obtain feedback on matters such as the urban design and landscape concept plans.

Meetings were also held with a number of business owners and operators before the public display of the preferred concept design. The purpose of the meetings was to advise the groups and individuals that a preferred concept design had been identified, the details of the preferred concept and of the opportunity to view more detailed plans during the display period and provide written feedback. The businesses included directly and indirectly effected business, with follow-up meeting held with a number of business owners to initiate discussions regarding land acquisition. The business owners included small and large businesses and industrial developers. Further meetings are expected to be held with these businesses and all property owners along the highway during the next phase of the project.

Two meetings were held during 2011 with the 'United Forum', a group comprising members of Greening Bathurst, Bathurst National Trust and local heritage interest groups. The first meeting in May 2011 focussed on creating an 'eastern gateway' to Bathurst with discussion of the opportunity to include heritage values in the urban design and landscaping improvements. The draft concept urban design and landscape plans were presented to the group at a meeting in November 2011 resulting in positive feedback from attendees. The group will have another opportunity to comment on the draft concept plans with the public display of the Review of Environmental Factors (REF).

In addition to the arranged meetings, businesses and residents were contacted by phone, or visited without pre-arranged meeting times. Each contact included discussion of the project and consultation process with emphasis on the opportunity for on-going discussions.

The issues raised from these meetings are included in section 3.0 of this report with the exception of specific property matters. Future stakeholder meetings will be held as the project progresses.

2.5 RMS website

The RMS project website was update to reflect the progress of the project and the preferred concept design consultation phase. This included the addition of the October 2011 community update and feedback form. The website pages provided internet access to project information for other interested groups, individuals, the community and stakeholders who may not have received the letterbox drop or be registered on the project database.

2.6 Advertising

A newspaper advertisement appeared in local paper, The Western Advocate, on 24 and 27 October, and 3 and 4 November 2011. The advertisement invited the community to view the public display, attend the staffed display, the community workshops, and provide written comments.

Radio advertising occurred on 25 and 26 October during the breakfast and drive time segments on 3 local stations: 2BS 1503 Gold, B Rock FM and ABC Central West.

2.7 Media

During October and November 2011 there were five articles related to, or referring to, the Great Western Highway upgrade through Kelso.

Overall the stories supported the proposed upgrade. One included Paul Toole, MP promoting the public display of the preferred concept design. Others included comments from some residents about the potential for disruption and delays during the construction phase, impacts on residents and businesses, suggestions regarding traffic management during the construction phase, including a detour, and that minor road works, which closed a 100 metre section of one lane, increased travel time through Kelso, from 10 minutes to 40 minutes.

3.0 Community issues raised about the upgrade

Many of the issues raised by respondents during the preliminary options consultation (2010) were addressed by the preferred concept design which resulted in a smaller number of responses from residents, the community and stakeholders.

The majority of respondents were in favour of the upgrade and agreed with the preferred concept option, while others were generally positive but questioned particular intersection treatments. A number primarily focussed on the potential for delays during the construction phase and some suggested temporary alternative traffic routes be built for use during the construction phase. A small number of respondents strongly disagreed with the need for the upgrade or strongly opposed a particular intersection treatment. Some respondents were very concerned about the potential loss of business trade due to the raised median.

The following is a summary of issues raised by community and business respondents at meetings, staffed displays, feedback forms and emails, and responses.

Summary of main community issues raised on the preferred concept option

Issues raised	Response
3.1 Preferred concept design	
• The preferred concept design is the best possible solution of all the options provided. • Proposal looks fantastic! We certainly look forward to the work beginning.	The majority of the 65 responses received from the preferred concept design consultation expressed sentiments of this nature.
3.2 Intersections	
3.2.1 Stockland Drive	
• Stockland Drive should be a roundabout not traffic lights to allow easier access across both highway traffic lanes. • Would prefer a roundabout rather than traffic lights for easier westbound traffic turn around, rather than the u-turn bay, which will not work and be confusing to traffic. • Would prefer Stockland Drive be a roundabout to solve highway flood issues and improve traffic flows through u-turn opportunities.	The intersection designs have been subject to traffic modelling based on predicted traffic volumes and growth for at least 20 years after opening. Each intersection design provides a design life for at least 20 years after opening. A roundabout at Stockland Drive would provide about 12 years service before running into trouble at peak traffic times. Investigations and work at Raglan Creek to solve highway flooding are a separate project. RMS and BRC proposed to construct a diversion channel from Raglan Creek down to the Macquarie River.

Issues raised	Response
3.2.2 Gilmour Street	
• Was a roundabout considered at Gilmour Street (that could possibly incorporate Lee Street) as there is a vacant property on the 'T' of the intersection?	A roundabout was considered at Gilmour and Lee streets. With the proximity of Boyd Street, and the nearby heritage buildings, there was insufficient room for a large two lane roundabout.
3.2.3 Lee Street	
• Please re-open the right turn access into and out of Lee Street as access to the Kelso Hotel can be difficult.	Right turns at Lee Street caused traffic congestion and queues. The restriction posed by the nearby heritage buildings means further widening of the highway is not an option, and the proximity of Gilmour Street means there is not enough room for a protected turn bay. Traffic lights at Stockland Drive would improve access via a slightly longer route and provide a safe eastbound right turn.
• Would like to see Lee Street open to provide better access to the Kelso industrial area.	Re-opening Lee Street includes crossing the railway which would need to be an overbridge. However, as a temporary measure during construction to ease traffic flows through the project, the re-opening of the level crossing is being investigated with rail authorities.
3.2.4 Boyd Street	
• Need a roundabout at Boyd Street to allow traffic to gain access to Lee Street and the Kelso Hotel.	There is insufficient space for a large two lane roundabout at Boyd Street without buying a number of properties, or putting a 'kink' in the highway.
• Left turn into Boyd Street – cars turn too early and come up inside of you before the actual left turn lane – sixty percent of the time.	Methods of making the area safer for cyclists will be taken into consideration during the detailed design phase.
• Kelso resident does not agree with a right turn into Boyd Street heading into Bathurst.	The right turn will provide improved access to the Kelso residential area, and provide a safe alternative when traffic is heavy, for those not comfortable waiting to turn right into View Street.

Issues raised	Response
3.2.5 View Street	
• New westbound right turn into View Street is excellent. • Will there be enough space for trucks to overtake cars turning right into View Street.	The highway upgrade is two lanes in each direction with parking lanes. View Street is designed with a protected right turn bay meaning vehicles can wait clear of the highway traffic, which is not the case at the present time.
• Are you going to change the gradient in View Street for right turn westbound traffic?	Some change to the gradient in View Street may be required, but it is recognised View Street will remain quite steep.
• Need traffic lights at View Street to enable right turn onto the highway. If not traffic conflicts will increase at the intersection of View Street and Boyd Street.	The traffic modelling undertaken suggests traffic lights are not warranted at View Street. With respect to the intersection of View and Boyd streets in the Kelso residential area, this issue will be taken to BRC traffic committee meeting for discussion.
3.2.6 Littlebourne Street	
• Retain traffic lights at Littlebourne Street – do not replace with a roundabout. • Traffic lights on Littlebourne Street are required to manage traffic flows at 6.30am-9am and 3pm-5pm, as traffic can be banked back to Ashworth Drive.	Predicted traffic volume increases through to 2035 support either traffic lights or a roundabout. Both methods handle the peak periods, however a roundabout suits the non-peak flows better than traffic lights at this location. In addition, traffic lights would not allow a u-turn movement for heavy vehicles. Further, the roundabout provides better manoeuvrability for drivers to turn back (u-turn) to access properties on the other side of the highway. It also allows retention and improvement of the right turn into View Street, which was a strong point during the preliminary options consultation feedback. A roundabout can be constructed with less impact on nearby properties than the traffic lights option.
• A roundabout will slow traffic due to the high traffic volumes using the intersection and large trucks from Oberon. • Heavy traffic volumes will make it impossible for traffic to enter onto the highway from Littlebourne Street using a roundabout, particularly at peak periods. • A roundabout will cause traffic from O'Connell, Oberon, the industrial area and other schools and businesses to bank up during peak periods. • Through traffic will be delayed by	A specialist traffic engineering report and extensive traffic modelling was undertaken by engineering consulting firm Cardno on behalf of RMS. The summary of this report can be found on the RMS project website. The report provides detailed explanation of the factors that were considered in selecting the various intersections including design life, coping with traffic growth, allowing for future capacity, balancing the competing needs of providing an efficient route for through traffic with local access across the project length to

vehicles	
Issues raised	**Response**
3.2.6 Littlebourne Street (continued)	
using the roundabout at Littlebourne Street.	residences and nearby businesses. (Refer to summary traffic report on RMS project website).
• There is insufficient space for an adequately sized roundabout.	A large two lane 60 metre diameter roundabout can be built with only minor property acquisitions.
• Retain and improve the 'left turn any time with care' from Littlebourne Street onto the highway. • Need a longer westbound merging lane on the highway	The roundabout will provide a left turn and longer westbound merging lane.
• Pedestrians will not be able to cross safely if there is a roundabout at Littlebourne Street as traffic will move faster.	Islands on the approach legs to the roundabout will enable suitable pedestrian facilities to safely cross the highway.
• Roundabout at Littlebourne Street is valuable due to the raised median. Roundabout at Littlebourne Street needs to be as big as possible.	The roundabout will allow vehicles to turn back to access properties on the other side of the road.
• Need a longer lane for the eastbound right turn into Littlebourne Street.	The roundabout removes the need for an eastbound protected right turn lane.
3.2.7 Pat O'Leary Drive	
• Why lights at Pat O'Leary Drive? • Would prefer a roundabout at Pat O'Leary Drive – better option. Do not need traffic lights.	Traffic lights are a condition of approval of the developments at Pat O'Leary Drive and are required to manage pedestrian and traffic access across the highway.

Issues raised	Response
3.2.8 Ashworth Drive	
• Why were the traffic lights, as shown on the proposed concept design changed to a roundabout? • Roundabout is a bad idea and would be better served with an 'on demand' traffic light system. • Very concerned about heavily laden trucks approaching the roundabout at speed from the east on a downhill grade and the danger to drivers turning right out of Ashworth Drive. Roundabout fails on traffic safety and timely traffic flows during peak periods for the next 20 years. Traffic lights preferable. • Traffic speeds down the hill from Raglan are too fast (100 - 110 km/h) and with such speeds a roundabout would be dangerous for traffic entering the highway from Ashworth Drive. Change to lights as a roundabout is too dangerous. • Strongly feel that traffic lights are needed at Ashworth Drive as there are more houses planned. The heavy traffic on the highway means there should be lights at Ashworth Drive. • I expect that the roundabout at Ashworth Drive will need to be removed in the near future as it will quickly become a black spot for crashes.	The options displayed in 2010 also showed a roundabout at Ashworth Drive. The updated modelling confirmed the suitability of a roundabout at this intersection. A specialist traffic engineering report and extensive traffic modelling was undertaken by engineering consulting firm Cardno on behalf of RMS. The summary of this report can be found on the project website. The report provides detailed explanation of the factors that were considered in selecting the various intersections including design life, coping with traffic growth, allowing for future capacity, balancing the competing needs of providing an efficient route for through traffic with local access across the project length to residences and nearby businesses. (Refer summary traffic report on project website) The section from Raglan to Bathurst is posted at 80 km/h, not 100 km/h. The 60 km/h and 80 km/h signs may need to be moved further east to ensure the appropriate distance from the 60 km/h sign to the roundabout.
• Roundabout at Ashworth Drive will slow truck speeds as they climb up the hill to Raglan and is likely to produce frustration in other drivers.	Extension of the project further east by adding a slow lane up Raglan Hill or four lanes through the airport is considered an appropriate next stage of the highway upgrade.

Issues raised	Response
3.3 Raised median	
• Concern about the loss of right turn to property. • Definitely need a concrete median strip to stop people turning into businesses. • Median strip should be similar to that in Stewart Street minus the signs on corners which can block vision of traffic. • Opposed to the median and the disruption it will cause for large businesses with multiple employees and deliveries.	The raised median is necessary to separate the opposing flows of traffic to improve traffic safety on the highway. The elimination of multiple conflict points reduces the likelihood of rear end crashes, which are occurring at high rates. The layout would bring this section of highway in line with the cross-section through the rest of Bathurst (along Durham and Stewart streets). The roundabouts and u-turn bays will allow access as vehicles are not able to go around the block to access premises as they do in Stewart and Durham streets.
3.4 Roundabout issues	
• Concern that large trucks (semi-trailers and B-doubles) will take up two lanes when using the roundabouts which will slow traffic flows. • Need wide lanes on roundabouts to accommodate heavy vehicles. • Agree with roundabouts as they speed up the flow of traffic. • Concern that roundabouts will be completely covered in vegetation.	The large two lane roundabout is designed to allow two trucks to turn safely while remaining within their respective lanes. The roundabouts will be vegetated with small shrubs (for example) to provide some visual amenity, but not so much as to obscure vision for motorists, cyclists or pedestrians.
3.5 Traffic light issues	
• Do not agree with three sets of traffic lights in a very short space and would prefer a roundabout at Stockland Drive for even flow of traffic. • Why not replace lights at Gilmour and Boyd streets with one set of traffic lights. • There are too many traffic lights and drivers will look for alternative routes to travel to avoid the traffic lights. Concern that this will increase traffic in Marsden Lane/Limekilns Road and Boyd Street which will impact on pedestrians – particularly children and seniors.	Traffic modelling studies have shown that traffic lights are preferable at Stockland Drive. Detailed information is provided in the traffic study. The three intersections will be phased to work in combination with one another.
• If three sets of traffic lights, can they be synchronised?	The traffic lights will be synchronised.

Issues raised	Response
3.6 Boyd Creek Bridge	
• Bridge replacement and widening to four lanes is not mentioned in the upgrade.	The Boyd Creek bridge will be duplicated as part of the highway upgrade, making it four lanes wide.
3.7 Pedestrian access	
• Need pedestrian crossings at Stockland Drive, Gilmour Street (west side), Boyd Street, west of View Street, both sides of Littlebourne Street, Pat O'Leary Drive and Ashworth Drive.	Signalised pedestrian crossings will be provided at all intersections with traffic lights. For other intersections there will be pedestrian refuges in the middle of the road to enable safe passage. Alternating pedestrian paths and shared pedestrian-cycle paths are designed for both sides of the highway upgrade.
• Would prefer a pedestrian overbridge to promote safe access to the takeaway and service station.	An overbridge has been considered but is not deemed a suitable design solution for this project.
• Need a pedestrian refuge opposite the fruit shop.	The detailed design will continue to consider the needs of pedestrian movements along the project length, including this location. A signalised pedestrian crossing at Pat O'Leary Drive will provide a safe crossing nearby.
• Littlebourne Street – need pedestrian crossing points due to regular usage by pedestrians. Would prefer lights were retained.	Detailed design of the pedestrian crossings at the roundabouts in Littlebourne Street will be further developed during the detailed design phase.
• Boyd Street to Littlebourne Street – need pedestrian crossings or overhead or underground crossing points.	A pedestrian refuge has been incorporated in the concept design opposite the fish and chip shop that is between Boyd and Littlebourne streets.
3.8 Cycling	
• Cycling is popular in Bathurst so please ensure there is enough space for cyclists. • Improvements will reduce cyclist feeling of vulnerability between Devro and View Street. • Will the cycleway be on the north side or the south side? Will the cycle lane change to the south side of the highway?	Off road cycle paths are provided on alternating sides of the highway along the project length for the casual cyclist. For the commuter or on-road cyclist, the project is designed with a 3 metre shoulder / parking lane for the majority of the project length where space permits.
• Is there any way of crossing from Bunnings to the north side for cyclists?	Yes, signalised pedestrian crossings are designed at the traffic lights at each of Stockland, Gilmour and Boyd streets.

Issues raised	Response
3.9 Bus stops and shelters	
• Need to provide a bus shelter on the west side of Stockland Drive with a safe laneway off the highway. • Concerns about bus users needing to cross the road at Ashworth Drive roundabout at the current designated stop.	RMS is discussing bus stop and shelter locations with bus companies. Bus users will be able to cross the highway near Ashworth Drive and other places on the highway using pedestrian crossing facilities or the median.
3.10 Landscape and urban design	
• Request for suitable landscaping and lighting to be included with the project implementation. • Street lights need to be in keeping with our 'heritage' look. • The streetscape needs to be improved to give a good impression to travellers coming into Bathurst. • Landscape plan and ideas is generally in keeping with the Bathurst Vegetation Management Plan. Disappointed that the narrow medians do not have softening content. Likes the avenue of trees theme, inclusion of brick retaining wall in keeping with heritage values. • Need to reduce trees around the giant Goldpanner so travellers can continue to stop and photograph.	Concept landscape plans have been produced as part of this process and have been refined with feedback from BRC and local heritage groups. More details on the proposed urban design and landscape concept for the project area, undertaken in consult with Bathurst Regional Council are provided in the REF. The REF is due to be displayed in early 2012 for public comment and submissions.
• Electricity lines etc need to be put underground – need underground power to remove clutter in the streetscape. • Ok to include electronic signage on median strips.	Consideration is being given to relocating powerlines underground. Negotiations are ongoing.
3.11 Noise mitigation	
• What is the situation regarding noise walls? They are essential for houses close to the highway.	Detailed noise investigations are being undertaken as part of the REF. Noise walls are unlikely to form part of the ultimate solution. Noise mitigation issues will be addressed.

Issues raised	Response
3.12 Heritage	
• The proposed 'u' turn bay for Littlebourne Street must not compromise or damage the Cobb & Co structure nearby.	No u-turn bay is proposed at this location under the preferred concept design.
3.13 Consultation	
• Has not been consulted and has not been provided with information as requested.	Consultation is an ongoing part of the project development. Future contact will be made with all businesses and residents impacted by the highway upgrade.
3.14 Construction phase	
• Concerned about likely gridlock on the highway during the construction phase, particularly at peak times. • What is planned to minimise disruption to traffic during the upgrade? • Upgrade needs to be completed efficiently and quickly with minimal impacts on users.	RMS is applying significant resources to plan the staging of the works to minimise the delays during construction, in particular the staging and how to keep traffic moving along the GWH. It is anticipated that construction would involve targeting specific early works to enable traffic to be switched from one side to the other, as well as staging manageable sections of work in a coordinated manner. More information will be provided to the community and stakeholders as it becomes available.
• Suggestion to open up the railway crossing in Lee Street to eliminate congestion during peak times during the construction phase. • There needs to be another access made through Lee Street to ease congestion on the highway while the upgrade is taking place. • Lee Street to the industrial park needs to reopen.	RMS acknowledges that the lack of alternate routes will place added pressure on ensuring the construction staging and traffic management is well planned and actively managed. The option of using Lee St as potential detour will be investigated with rail authorities.
• Suggestion to construct a new road from Ashworth Drive all the way to Boyd Street to allow highway traffic to be diverted during the construction phase. Would require council and RMS cost arrangement	The various options for managing traffic during construction will continue to be developed and refined.

Issues raised	Response
3.15 Other access	
• The upgrade construction should not start before the Ashworth Drive access to Kelso is complete.	The Ashworth Drive link is expected to be completed in early 2012.
• Concerns about emergency services access and travel time to an incident.	Provision will be made for efficient passage of emergency services during construction.
• Devro needs a second exit/entrance built off Pat O'Leary Drive to service employee and other vehicles. Devro needs a right turn lane off the highway.	RMS is discussing specific access needs with Devro.
• Need to provide a pull in area for travellers who want to photograph the giant Goldpanner.	Noted.
• Need a new access road to connect Pat O'Leary Drive and Littlebourne Street. Need an access road behind the Macdonald and new petrol station development.	Noted.
• Please consider extending road works to include traffic entering Learmonth Park – hockey fields –due to heavy traffic volumes during summer with nearby Berry Park area and caravan and tourist use as a rest area	Intersection safety at this location will be forwarded via the traffic committee to BRC for joint consideration by RMS and BRC.
• Highway flooding at Raglan Creek needs to be addressed together with an alternative bypass route. Need a flood proof highway.	Investigations and work at Raglan Creek to solve highway flooding are under a separate project. RMS and BRC are planning to construct a diversion channel from Raglan Creek down to the Macquarie River to manage high intensity rainfall events.
• Will need a bypass in the long term as Bathurst cannot continue to rely on one single road and one single river crossing. Hereford Street does not provide an alternative to any problems east of Gilmour Street.	The project as proposed does not rule out a bypass at a future time. The project is necessary as scoped, to address deteriorating pavement, safety issues with a high number of rear-end crashes and capacity issues due to the ongoing growth of the area.
• Extend highway upgrade to four lanes from Gold Panner Motel to Raglan and airport.	RMS considers this a potential next stage or a future project.

4.0 Issues to be addressed

A number of issues were raised that will be addressed in the Review of Environmental Factors (REF) and during the detailed design phase of the project. These include, in no particular order, and are not limited to:

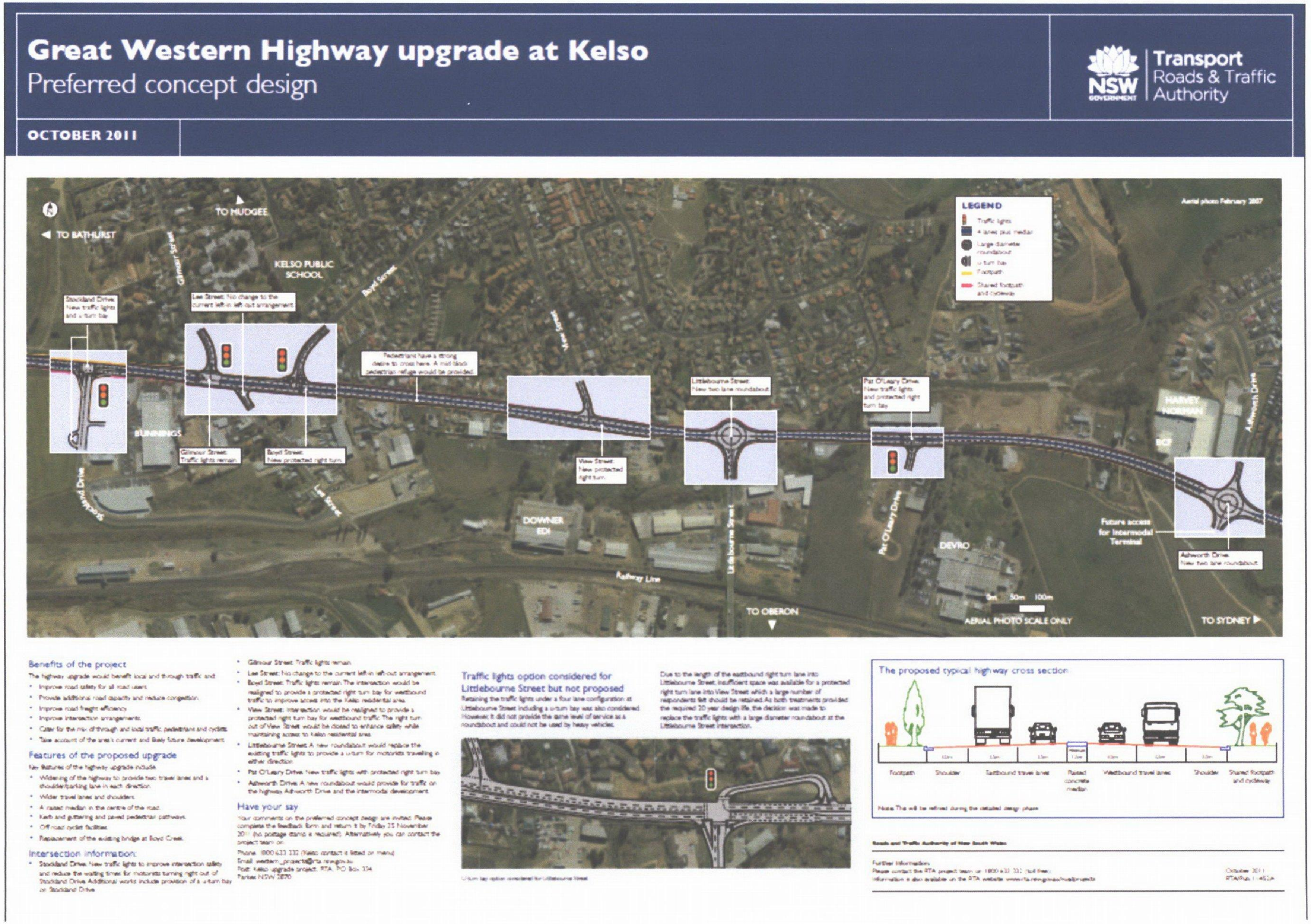
- Property boundary adjustment details (where required).
- Design of driveways and access to properties affected by the upgrade.
- Traffic noise and mitigation measures.
- Street lighting and underground power.
- Bus stop locations and bus routes.
- Impacts on waterways.
- Kelso heritage precinct and effects of the upgrade.
- Construction phase management.

5.0 Next steps

The next steps will include:

- Public display of the REF and feedback from the community in early 2012.
- REF determination expected in mid-2012.
- Detailed road and bridge design throughout 2012 to early 2013.
- On-going constructability investigations to reduce impacts and manage traffic throughout construction period.
- Ongoing consultation and communication with stakeholders, residents and the community.

Appendix A – Preferred concept option – October 2011



Transport
Roads & Traffic Authority

22nd September

General Manager
Bathurst Regional Council
158 Russell Street
Bathurst NSW 2795

Dear General Manager

RE: Consultation regarding proposed duplication of the Great Western Highway through Kelso.

The RTA is proposing to undertake works for the duplication of the Great Western Highway through Kelso between Stockland Drive and 420 metres east of Ashworth Drive.

Under the State Environmental Planning Policy (Infrastructure) 2007, the RTA is required to consult with Bathurst Regional Council under Clause 13(1) b, e and f due to the potential impacts on council infrastructure relating to traffic, temporary structures and road and footpath excavations.

A brief outline of the project is attached to this letter.

It would be appreciated if you could provide any comments regarding this proposal by 15th October 2011

The RTA would be pleased to provide further information if required. In this regard Raphael Morgan on behalf of the RTA may be contacted on 02 8202 8302 or by email raphael.m@nghenvironmental.com.au.

Yours faithfully,

Raphael Morgan on behalf of the RTA
Manager (Sydney) nghenvironmental

The objectives of the proposal are to:

- Improve road safety for motorists and pedestrians, and improve road freight efficiency.
- Cater for the mix of through, local and tourist traffic.
- Provide a well engineered, safe, aesthetically pleasing, and environmentally acceptable road transport facility.
- Reduce delays and improve economic efficiency through increased capacity and appropriate intersection treatments.
- Include off road facilities for pedestrians and cyclists by provision of one or more shared paths.
- Be sensitive to local stakeholders, businesses, residents and the local community.
- Take account of the area's built and natural environment, and heritage.

The proposal is located in Kelso within the Bathurst LGA (Figure 1). Kelso includes a mix of residential areas to the north of the Great Western Highway and industrial areas to the south.

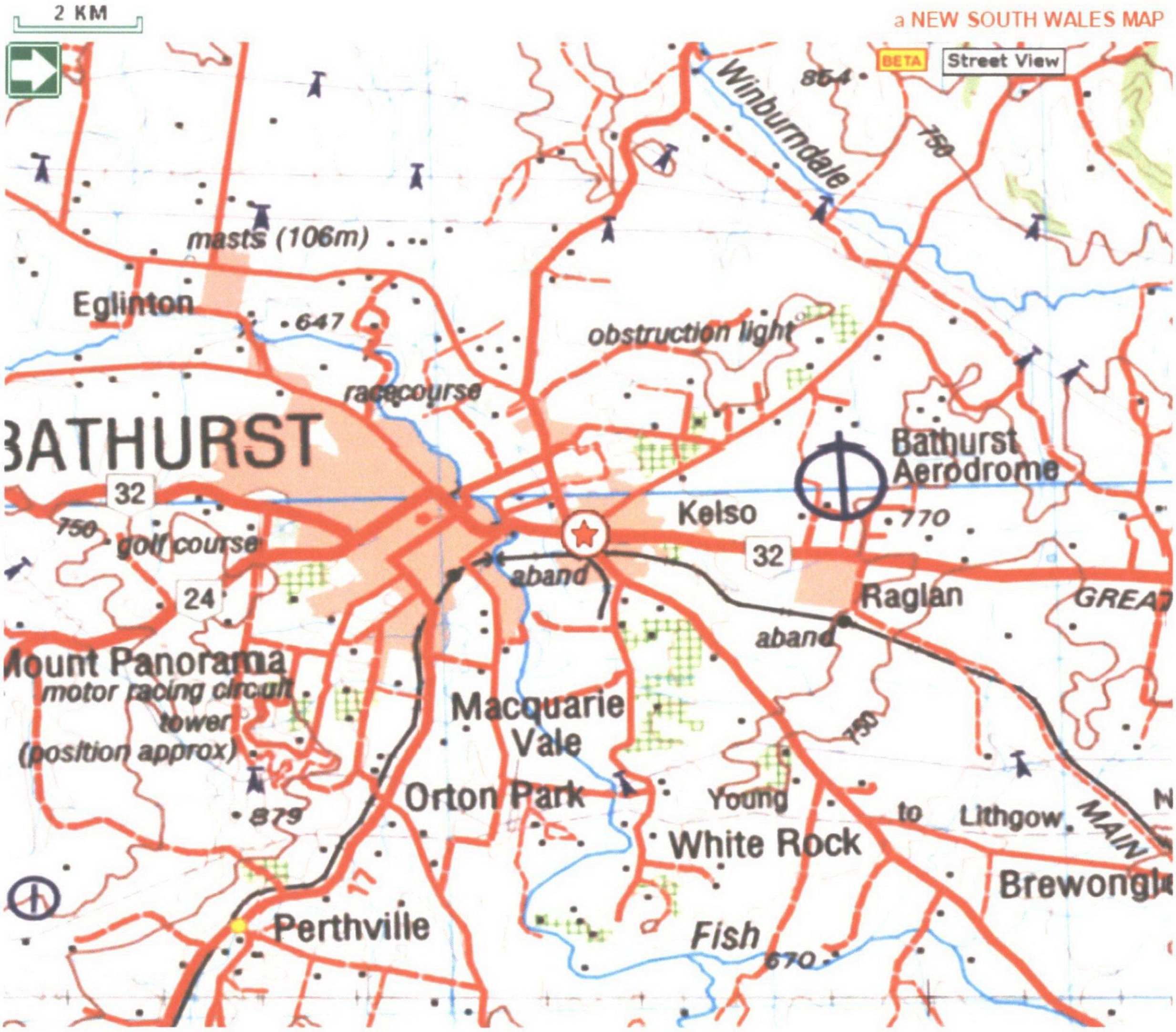


Figure 1. Location of proposal.

A concept design is attached for your information.

The proposal would involve

- A dual carriageway with two lanes in each direction and a central median for the entire length.
- Four intersections with traffic signals at Stockland Drive, Gilmore Street, Boyd Street and Pat O'Leary Drive.
- Two Intersections with roundabouts at Littlebourne Street and Ashworth Drive.
- One un-signalled intersection at View Street.
- One u-turn facility in Stockland Drive.
- Movement of a 420 metre section of drainage line at Ashworth Drive around 30 meters south of its existing location. This would involve reclamation of existing section of drainage line and excavations works to create new section of drainage line.
- Demolition of existing bridge and construction of a new single span bridge over Boyd Creek. The new bridge would operate as a road with four lanes, each 3.5 metres in width, with two lanes carrying traffic in each direction.
- Construction of new culverts 160 metres west of Ashworth Drive and at the extension of the intermodal terminal.
- Shared pedestrian and cycle paths on both sides of the highway.
- Adjustments to public utilities along the route.

Dredging and reclamation works would be required in Boyds Creek and its tributaries along the proposal site.

Night works would also be required.

The proposed works would require the use of the following construction plant:

General	
Cranes	Light commercial and passenger vehicles
Excavators	Water pumps
Bulldozers	Hand tools
Road sweepers	Welding equipment
Water carts	Haulage trucks
Semi-trailers and large delivery trucks	Bobcats
Air compressors & attachments	Float
Cherry picker	Plate compactor
Rock hammer	
Road embankment and drainage construction	
Scrapers	Backhoes
Graders	Trenching machines
Vibrating and static rollers	Piling equipment
Shoring boxes	Wheel Loader
K&G Laying machine	Backhoe
Road pavement construction	
Milling machine	Bitumen spraying and asphalt paver
Concrete agitator trucks	Bitumen trucks
Concrete pumps	Kerb extruding machine

Concrete paver	Linemarking machine
Concrete vibrators	Lighting tower
Road suction sweeper	Roller multi tyred pneumatic
Vacuum suction truck	
Structures including bridges	
Piling rigs	Excavators
Concrete pumps	Trucks
Cranes	Small equipment
Traffic management and control	
Trailer mounted traffic lights	Trailer mounted VMS boards
Attenuation vehicle	Water filled and concrete barriers

As part of the REF Environmental safeguards such as erosion and sedimentation controls, traffic controls would be developed to avoid or minimise impacts. Disturbed areas would be rehabilitated and landscape design would be incorporated into the concept design.

Transport
Roads & Traffic
Authority

22nd October 2011

General Manager
Bathurst Regional Council
158 Russell Street
Bathurst NSW 2795

Dear General Manager,

RE: Consultation regarding proposed duplication of the Great Western Highway through Kelso.

The RTA is proposing to undertake works for the duplication of the Great Western Highway through Kelso between Stockland Drive and 420 metres east of Ashworth Drive. It has been determined that this proposal may have more than a minor or inconsequential impact upon the identified local heritage items at 138 Sydney Road (All Nations Hotel (former); currently part of GWH Kitchens) and 67 Sydney Road (Former convent building).

Under the State Environmental Planning Policy (Infrastructure) 2007 Clause 14, the RTA is required to consult with Bathurst Regional Council regarding this proposal. A brief outline of the project is attached to this letter as well as a copy of the Heritage Assessment that has been prepared to determine the possible impacts.

It would be appreciated if you could provide any comments regarding this proposal by 9 November 2011.

The RTA would be pleased to provide further information if required. In this regard Raphael Morgan on behalf of the RTA may be contacted on 02 8202 8302 or by email raphael.m@nghenvironmental.com.au.

Yours faithfully,

Raphael Morgan on behalf of the RTA
Manager (Sydney) nghenvironmental

Duplication of Great Western Highway, Kelso

The objectives of the proposal are to:

- Improve road safety for motorists and pedestrians, and improve road freight efficiency.
- Cater for the mix of through, local and tourist traffic.
- Provide a well engineered, safe, aesthetically pleasing, and environmentally acceptable road transport facility.
- Reduce delays and improve economic efficiency through increased capacity and appropriate intersection treatments.
- Include off road facilities for pedestrians and cyclists by provision of one or more shared paths.
- Be sensitive to local stakeholders, businesses, residents and the local community.
- Take account of the area's built and natural environment, and heritage.

The proposal is located in Kelso within the Bathurst LGA (Figure 1). Kelso includes a mix of residential areas to the north of the Great Western Highway and industrial areas to the south.

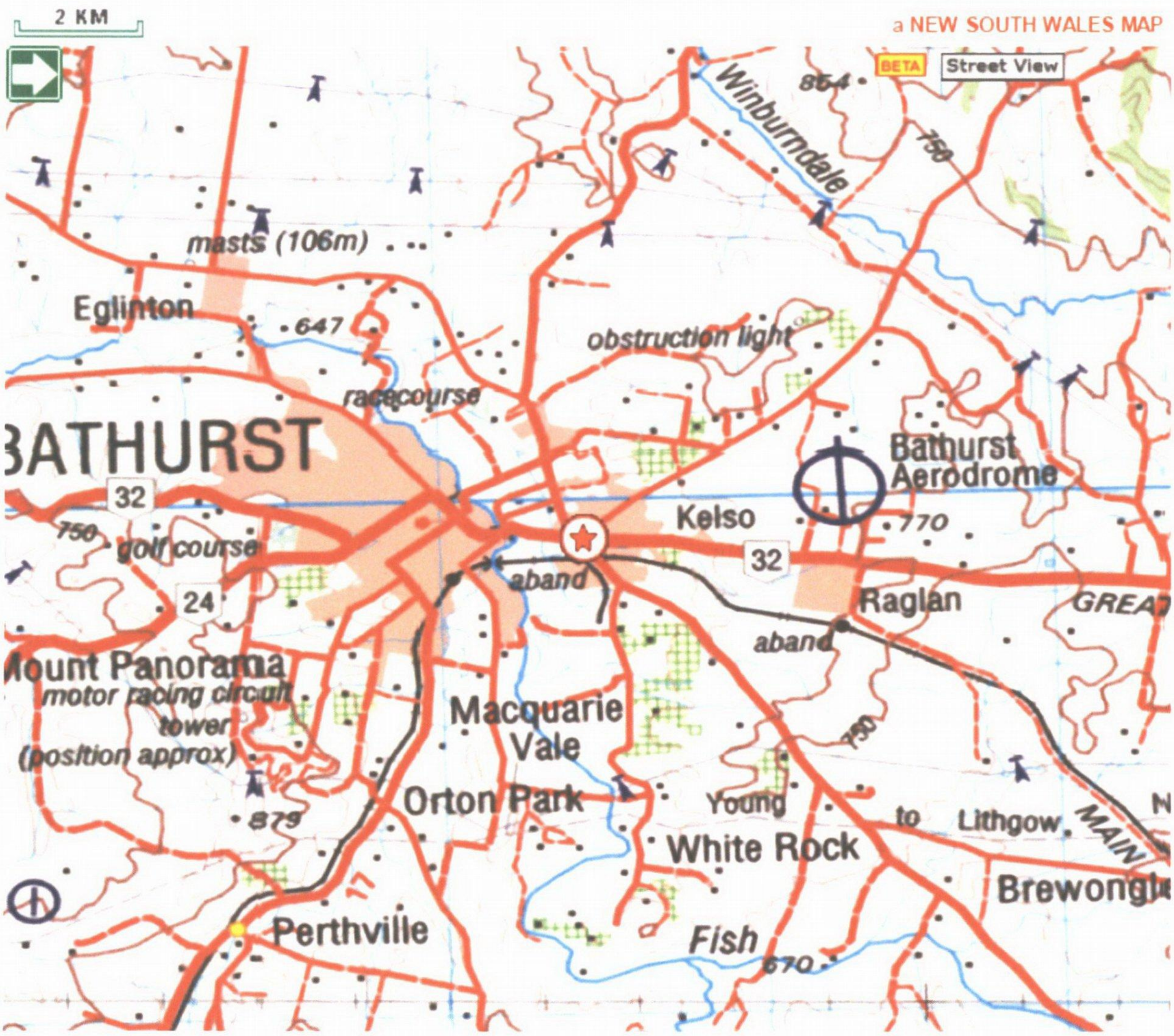


Figure 1. Location of proposal.

A concept design is attached for your information.

The proposal would involve

- A dual carriageway with two lanes in each direction and a central median for the entire length.
- Four intersections with traffic signals at Stockland Drive, Gilmore Street, Boyd Street and Pat O'Leary Drive.
- Two Intersections with roundabouts at Littlebourne Street and Ashworth Drive.
- One un-signalled intersection at View Street.
- One u-turn facility in Stockland Drive.
- Movement of a 420 metre section of drainage line at Ashworth Drive around 30 meters south of its existing location. This would involve reclamation of existing section of drainage line and excavations works to create new section of drainage line.
- Demolition of existing bridge and construction of a new single span bridge over Boyd Creek. The new bridge would operate as a road with four lanes, each 3.5 metres in width, with two lanes carrying traffic in each direction.
- Construction of new culverts 160 metres west of Ashworth Drive and at the extension of the intermodal terminal.
- Shared pedestrian and cycle paths on both sides of the highway.
- Adjustments to public utilities along the route.

Dredging and reclamation works would be required in Boyds Creek and its tributaries along the proposal site.

Night works would also be required.

The proposed works would require the use of the following construction plant:

General	
Cranes	Light commercial and passenger vehicles
Excavators	Water pumps
Bulldozers	Hand tools
Road sweepers	Welding equipment
Water carts	Haulage trucks
Semi-trailers and large delivery trucks	Bobcats
Air compressors & attachments	Float
Cherry picker	Plate compactor
Rock hammer	
Road embankment and drainage construction	
Scrapers	Backhoes
Graders	Trenching machines
Vibrating and static rollers	Piling equipment
Shoring boxes	Wheel Loader
K&G Laying machine	Backhoe
Road pavement construction	
Milling machine	Bitumen spraying and asphalt paver
Concrete agitator trucks	Bitumen trucks
Concrete pumps	Kerb extruding machine
Concrete paver	Linemarking machine
Concrete vibrators	Lighting tower

Road suction sweeper	Roller multi tyred pneumatic
Vacuum suction truck	
Structures including bridges	
Piling rigs	Excavators
Concrete pumps	Trucks
Cranes	Small equipment
Traffic management and control	
Trailer mounted traffic lights	Trailer mounted VMS boards
Attenuation vehicle	Water filled and concrete barriers

As part of the REF Environmental safeguards such as erosion and sedimentation controls, traffic controls would be developed to avoid or minimise impacts. Disturbed areas would be rehabilitated and landscape design would be incorporated into the concept design.

22nd September 2011

Director General of the Department of Premier and Cabinet
NSW Office of Environment and Heritage
Level 2 203-209 Russell Street
Bathurst NSW 2795

Dear Director General

Invitation to comment – proposed duplication of the Great Western Highway through Kelso

The Roads and Traffic Authority of NSW (RTA) is proposing to undertake works for the duplication of the Great Western Highway through Kelso between Stockland Drive and 420 metres east of Ashworth Drive (the proposal). A review of environmental factors (REF) is currently being prepared to assess the likely impacts of the proposal under Part 5 of the *Environmental Planning and Assessment Act, 1979*. The RTA invites your organisation to comment and advise of any interests, concerns or statutory requirements relating to the proposal. Comments received will be considered in the REF.

The objectives of the proposal are to:

- Improve road safety for motorists and pedestrians, and improve road freight efficiency.
- Cater for the mix of through, local and tourist traffic.
- Provide a well engineered, safe, aesthetically pleasing, and environmentally acceptable road transport facility.
- Reduce delays and improve economic efficiency through increased capacity and appropriate intersection treatments.
- Include off road facilities for pedestrians and cyclists by provision of one or more shared paths.
- Be sensitive to local stakeholders, businesses, residents and the local community.
- Take account of the area's built and natural environment, and heritage.

The proposal is located in Kelso within the Bathurst LGA (Figure 1). Kelso includes a mix of residential areas to the north of the Great Western Highway and industrial areas to the south.

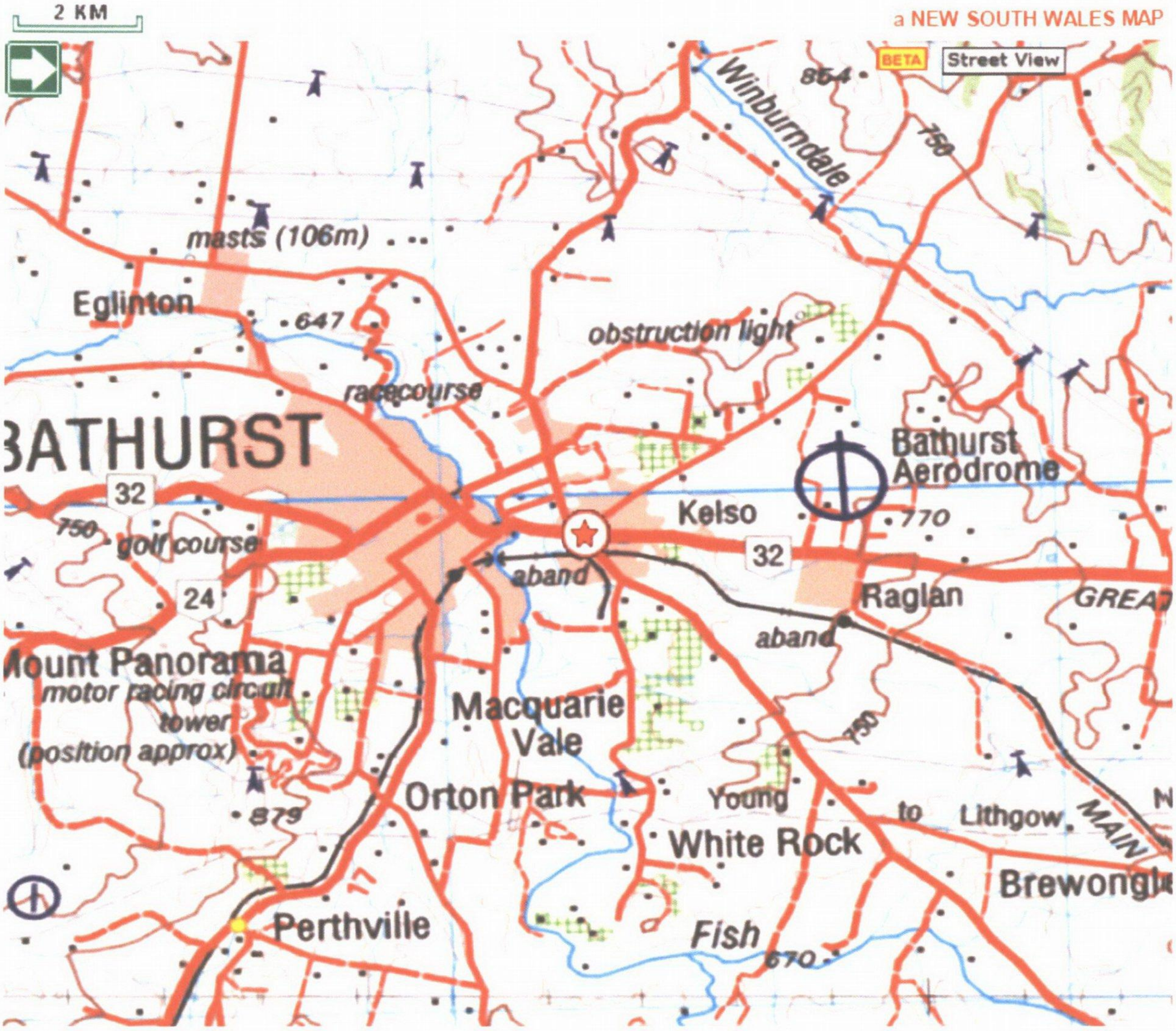


Figure 1. Location of proposal.

A concept design is attached for your information.

The proposal would involve

- A dual carriageway with two lanes in each direction and a central median for the entire length.
- Four intersections with traffic signals at Stockland Drive, Gilmore Street, Boyd Street and Pat O'Leary Drive.
- Two Intersections with roundabouts at Littlebourne Street and Ashworth Drive.
- One un-signalled intersection at View Street.
- One u-turn facility in Stockland Drive.
- Movement of a 420 metre section of drainage line at Ashworth Drive around 30 meters south of its existing location. This would involve reclamation of existing section of drainage line and excavations works to create new section of drainage line.
- Demolition of existing bridge and construction of a new single span bridge over Boyd Creek. The new bridge would operate as a road with four lanes, each 3.5 metres in width, with two lanes carrying traffic in each direction.
- Construction of new culverts 160 metres west of Ashworth Drive and at the extension of the intermodal terminal.
- Shared pedestrian and cycle paths on both sides of the highway.
- Adjustments to public utilities along the route.

Dredging and reclamation works would be required in Boyds Creek and its tributaries along the proposal site.

Night works would also be required.

The proposed works would require the use of the following construction plant:

General	
Cranes	Light commercial and passenger vehicles
Excavators	Water pumps
Bulldozers	Hand tools
Road sweepers	Welding equipment
Water carts	Haulage trucks
Semi-trailers and large delivery trucks	Bobcats
Air compressors & attachments	Float
Cherry picker	Plate compactor
Rock hammer	
Road embankment and drainage construction	
Scrapers	Backhoes
Graders	Trenching machines
Vibrating and static rollers	Piling equipment
Shoring boxes	Wheel Loader
K&G Laying machine	Backhoe
Road pavement construction	
Milling machine	Bitumen spraying and asphalt paver
Concrete agitator trucks	Bitumen trucks
Concrete pumps	Kerb extruding machine
Concrete paver	Linemarking machine
Concrete vibrators	Lighting tower
Road suction sweeper	Roller multi tyred pneumatic
Vacuum suction truck	
Structures including bridges	
Piling rigs	Excavators
Concrete pumps	Trucks
Cranes	Small equipment
Traffic management and control	
Trailer mounted traffic lights	Trailer mounted VMS boards
Attenuation vehicle	Water filled and concrete barriers

As part of the REF Environmental safeguards such as erosion and sedimentation controls, traffic controls would be developed to avoid or minimise impacts. Disturbed areas would be rehabilitated and landscape design would be incorporated into the concept design.

To enable consideration of your comments in the REF, a written response would be appreciated by 15th October 2011. I would be pleased to provide further information if required. Raphael Morgan on behalf of the RTA may be contacted on 02 8202 8302 or by email raphael.m@nghenvironmental.com.au.

Yours faithfully,

Raphael Morgan on behalf of the RTA
Manager (Sydney) nghenvironmental

Transport
Roads & Traffic
Authority

22nd September 2011

Director General of the Department of Primary Industries
NSW Department of Primary Industries (Fisheries)
161 Kite Street
Orange NSW 2800

Dear Director General

Invitation to comment – proposed duplication of the Great Western Highway through Kelso

The Roads and Traffic Authority of NSW (RTA) is proposing to undertake works for the duplication of the Great Western Highway through Kelso between Stockland Drive and 420 metres east of Ashworth Drive (the proposal). A review of environmental factors (REF) is currently being prepared to assess the likely impacts of the proposal under Part 5 of the *Environmental Planning and Assessment Act, 1979*. For the purpose of Section 199 of the Fisheries Management Act the RTA invites your organisation to comment and advise of any interests, concerns or statutory requirements relating to the proposal. Comments received will be considered in the REF.

The objectives of the proposal are to:

- Improve road safety for motorists and pedestrians, and improve road freight efficiency.
- Cater for the mix of through, local and tourist traffic.
- Provide a well engineered, safe, aesthetically pleasing, and environmentally acceptable road transport facility.
- Reduce delays and improve economic efficiency through increased capacity and appropriate intersection treatments.
- Include off road facilities for pedestrians and cyclists by provision of one or more shared paths.
- Be sensitive to local stakeholders, businesses, residents and the local community.
- Take account of the area's built and natural environment, and heritage.

The proposal is located in Kelso within the Bathurst LGA (Figure 1). Kelso includes a mix of residential areas to the north of the Great Western Highway and industrial areas to the south.

nghenvironmental on behalf of the RTA
18/21 Mary Street, Surry Hills, NSW 2010
T 02 8202 8333

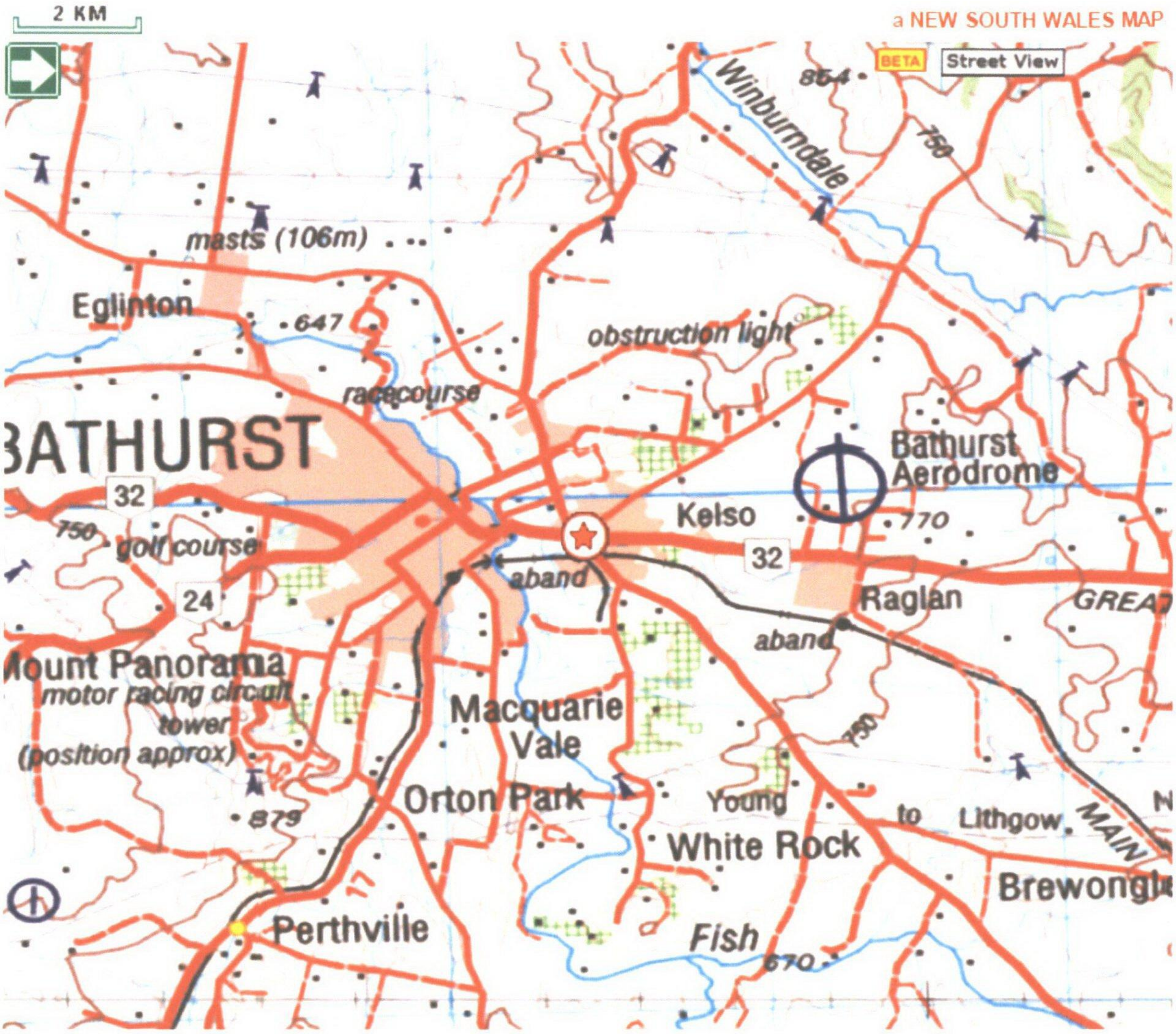


Figure 1. Location of proposal.

A concept design is attached for your information.

The proposal would involve

- A dual carriageway with two lanes in each direction and a central median for the entire length.
- Four intersections with traffic signals at Stockland Drive, Gilmore Street, Boyd Street and Pat O'Leary Drive.
- Two Intersections with roundabouts at Littlebourne Street and Ashworth Drive.
- One un-signalled intersection at View Street.
- One u-turn facility in Stockland Drive.
- Movement of a 420 metre section of drainage line at Ashworth Drive around 30 meters south of its existing location. This would involve reclamation of existing section of drainage line and excavations works to create new section of drainage line.
- Demolition of existing bridge and construction of a new single span bridge over Boyd Creek. The new bridge would operate as a road with four lanes, each 3.5 metres in width, with two lanes carrying traffic in each direction.
- Construction of new culverts 160 metres west of Ashworth Drive and at the extension of the intermodal terminal.
- Shared pedestrian and cycle paths on both sides of the highway.
- Adjustments to public utilities along the route.

Dredging and reclamation works would be required in Boyds Creek and its tributaries along the proposal site.

Night works would also be required.

The proposed works would require the use of the following construction plant:

General	
Cranes	Light commercial and passenger vehicles
Excavators	Water pumps
Bulldozers	Hand tools
Road sweepers	Welding equipment
Water carts	Haulage trucks
Semi-trailers and large delivery trucks	Bobcats
Air compressors & attachments	Float
Cherry picker	Plate compactor
Rock hammer	
Road embankment and drainage construction	
Scrapers	Backhoes
Graders	Trenching machines
Vibrating and static rollers	Piling equipment
Shoring boxes	Wheel Loader
K&G Laying machine	Backhoe
Road pavement construction	
Milling machine	Bitumen spraying and asphalt paver
Concrete agitator trucks	Bitumen trucks
Concrete pumps	Kerb extruding machine
Concrete paver	Linemarking machine
Concrete vibrators	Lighting tower
Road suction sweeper	Roller multi tyred pneumatic
Vacuum suction truck	
Structures including bridges	
Piling rigs	Excavators
Concrete pumps	Trucks
Cranes	Small equipment
Traffic management and control	
Trailer mounted traffic lights	Trailer mounted VMS boards
Attenuation vehicle	Water filled and concrete barriers

As part of the REF Environmental safeguards such as erosion and sedimentation controls, traffic controls would be developed to avoid or minimise impacts. Disturbed areas would be rehabilitated and landscape design would be incorporated into the concept design.

To enable consideration of your comments in the REF, a written response would be appreciated by 15th October 2011. I would be pleased to provide further information if required. Raphael Morgan on behalf of the RTA may be contacted on 02 8202 8302 or by email raphael.m@nghenvironmental.com.au.

Yours faithfully,

Raphael Morgan on behalf of the RTA
Manager (Sydney) nghenvironmental

Transport
Roads & Traffic
Authority

22nd September 2011

Regional Manager
Rural Fire Services
Shop 3 Lovell Pl, Lovell Street
Young NSW 2594

Dear Regional Manager

Invitation to comment – proposed duplication of the Great Western Highway through Kelso

The Roads and Traffic Authority of NSW (RTA) is proposing to undertake works for the duplication of the Great Western Highway through Kelso between Stockland Drive and 420 metres east of Ashworth Drive (the proposal). A review of environmental factors (REF) is currently being prepared to assess the likely impacts of the proposal under Part 5 of the *Environmental Planning and Assessment Act, 1979.* The RTA invites your organisation to comment and advise of any interests, concerns or statutory requirements relating to the proposal. Comments received will be considered in the REF.

The objectives of the proposal are to:

- Improve road safety for motorists and pedestrians, and improve road freight efficiency.
- Cater for the mix of through, local and tourist traffic.
- Provide a well engineered, safe, aesthetically pleasing, and environmentally acceptable road transport facility.
- Reduce delays and improve economic efficiency through increased capacity and appropriate intersection treatments.
- Include off road facilities for pedestrians and cyclists by provision of one or more shared paths.
- Be sensitive to local stakeholders, businesses, residents and the local community.
- Take account of the area's built and natural environment, and heritage.

The proposal is located in Kelso within the Bathurst LGA (Figure 1). Kelso includes a mix of residential areas to the north of the Great Western Highway and industrial areas to the south.

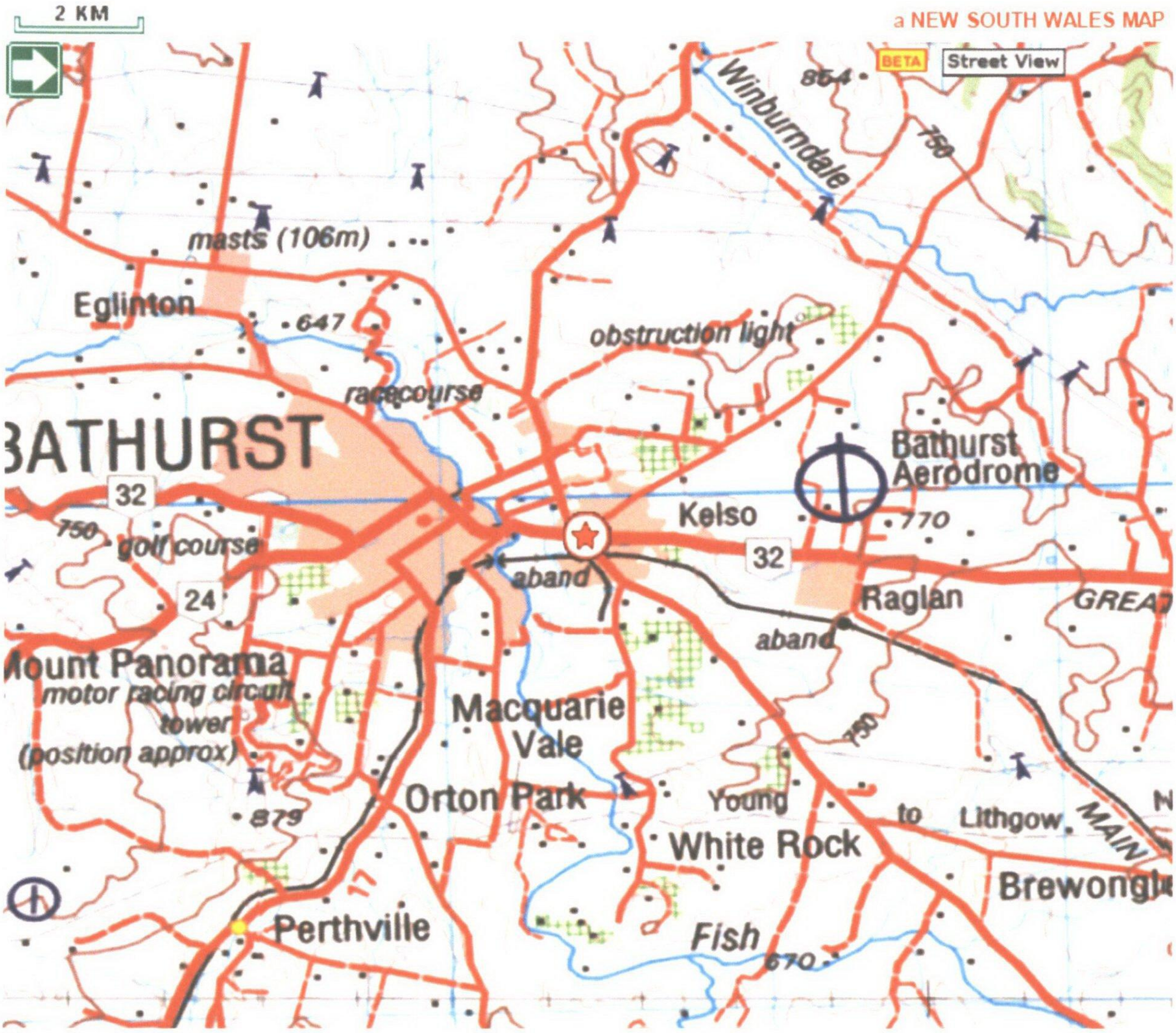


Figure 1. Location of proposal.

A concept design is attached for your information.

The proposal would involve

- A dual carriageway with two lanes in each direction and a central median for the entire length.
- Four intersections with traffic signals at Stockland Drive, Gilmore Street, Boyd Street and Pat O'Leary Drive.
- Two Intersections with roundabouts at Littlebourne Street and Ashworth Drive.
- One un-signalled intersection at View Street.
- One u-turn facility in Stockland Drive.
- Movement of a 420 metre section of drainage line at Ashworth Drive around 30 meters south of its existing location. This would involve reclamation of existing section of drainage line and excavations works to create new section of drainage line.
- Demolition of existing bridge and construction of a new single span bridge over Boyd Creek. The new bridge would operate as a road with four lanes, each 3.5 metres in width, with two lanes carrying traffic in each direction.
- Construction of new culverts 160 metres west of Ashworth Drive and at the extension of the intermodal terminal.
- Shared pedestrian and cycle paths on both sides of the highway.
- Adjustments to public utilities along the route.

Dredging and reclamation works would be required in Boyds Creek and its tributaries along the proposal site.

Night works would also be required.

The proposed works would require the use of the following construction plant:

General	
Cranes	Light commercial and passenger vehicles
Excavators	Water pumps
Bulldozers	Hand tools
Road sweepers	Welding equipment
Water carts	Haulage trucks
Semi-trailers and large delivery trucks	Bobcats
Air compressors & attachments	Float
Cherry picker	Plate compactor
Rock hammer	
Road embankment and drainage construction	
Scrapers	Backhoes
Graders	Trenching machines
Vibrating and static rollers	Piling equipment
Shoring boxes	Wheel Loader
K&G Laying machine	Backhoe
Road pavement construction	
Milling machine	Bitumen spraying and asphalt paver
Concrete agitator trucks	Bitumen trucks
Concrete pumps	Kerb extruding machine
Concrete paver	Linemarking machine
Concrete vibrators	Lighting tower
Road suction sweeper	Roller multi tyred pneumatic
Vacuum suction truck	
Structures including bridges	
Piling rigs	Excavators
Concrete pumps	Trucks
Cranes	Small equipment
Traffic management and control	
Trailer mounted traffic lights	Trailer mounted VMS boards
Attenuation vehicle	Water filled and concrete barriers

As part of the REF Environmental safeguards such as erosion and sedimentation controls, traffic controls would be developed to avoid or minimise impacts. Disturbed areas would be rehabilitated and landscape design would be incorporated into the concept design.

To enable consideration of your comments in the REF, a written response would be appreciated by 15th October 2011. I would be pleased to provide further information if required. Raphael Morgan on behalf of the RTA may be contacted on 02 8202 8302 or by email raphael.m@nghenvironmental.com.au.

Yours faithfully,

Raphael Morgan on behalf of the RTA
Manager (Sydney) nghenvironmental

NSW GOVERNMENT | Transport Roads & Traffic Authority

22nd September 2011

Manager
Bathurst Police Station
139 Rankin Street
Bathurst NSW 2795

Dear Manager

Invitation to comment – proposed duplication of the Great Western Highway through Kelso

The Roads and Traffic Authority of NSW (RTA) is proposing to undertake works for the duplication of the Great Western Highway through Kelso between Stockland Drive and 420 metres east of Ashworth Drive (the proposal). A review of environmental factors (REF) is currently being prepared to assess the likely impacts of the proposal under Part 5 of the *Environmental Planning and Assessment Act, 1979*. The RTA invites your organisation to comment and advise of any interests, concerns or statutory requirements relating to the proposal. Comments received will be considered in the REF.

The objectives of the proposal are to:

- Improve road safety for motorists and pedestrians, and improve road freight efficiency.
- Cater for the mix of through, local and tourist traffic.
- Provide a well engineered, safe, aesthetically pleasing, and environmentally acceptable road transport facility.
- Reduce delays and improve economic efficiency through increased capacity and appropriate intersection treatments.
- Include off road facilities for pedestrians and cyclists by provision of one or more shared paths.
- Be sensitive to local stakeholders, businesses, residents and the local community.
- Take account of the area's built and natural environment, and heritage.

The proposal is located in Kelso within the Bathurst LGA (Figure 1). Kelso includes a mix of residential areas to the north of the Great Western Highway and industrial areas to the south.

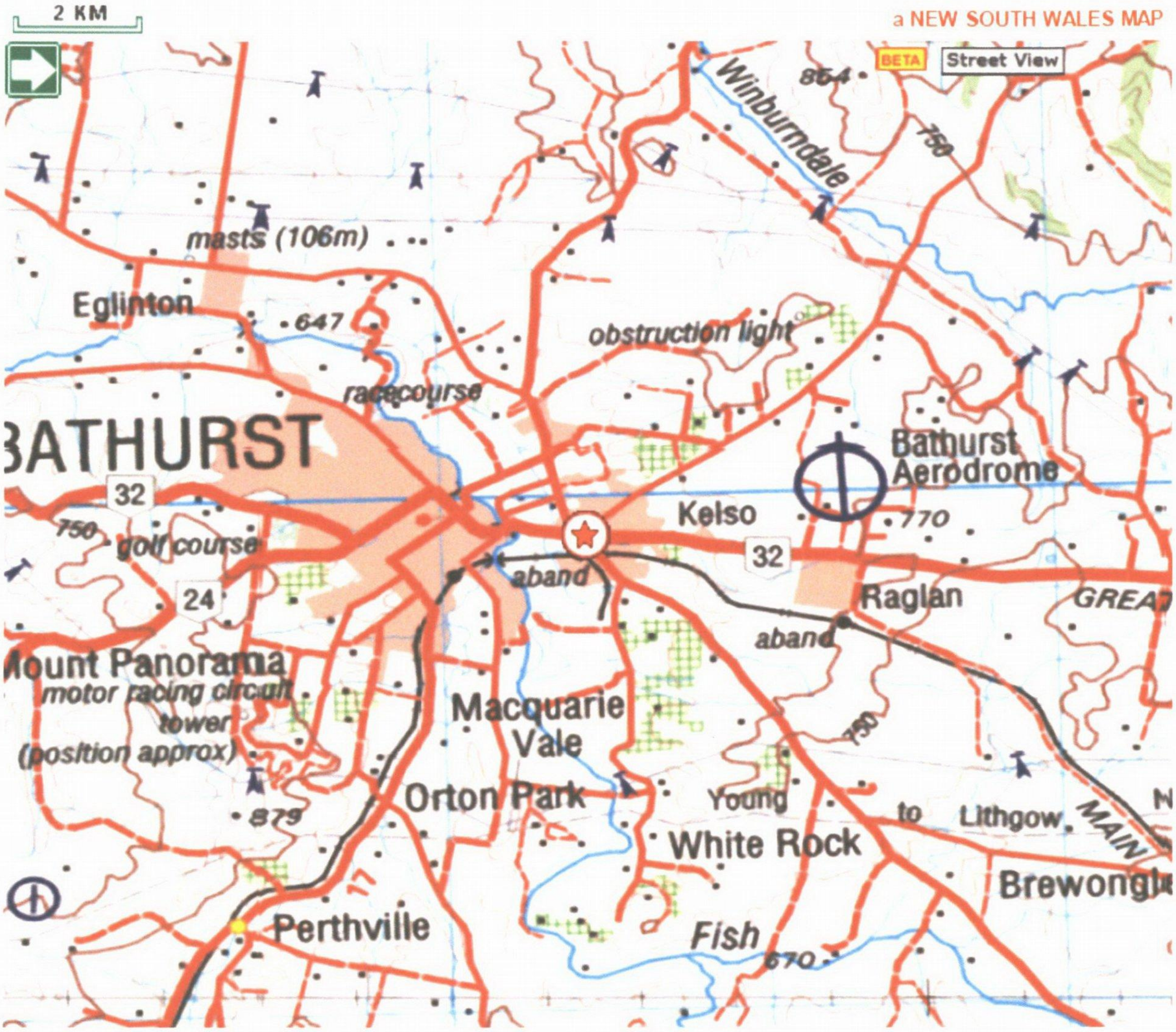


Figure 1. Location of proposal.

A concept design is attached for your information.

The proposal would involve

- A dual carriageway with two lanes in each direction and a central median for the entire length.
- Four intersections with traffic signals at Stockland Drive, Gilmore Street, Boyd Street and Pat O'Leary Drive.
- Two Intersections with roundabouts at Littlebourne Street and Ashworth Drive.
- One un-signalled intersection at View Street.
- One u-turn facility in Stockland Drive.
- Movement of a 420 metre section of drainage line at Ashworth Drive around 30 meters south of its existing location. This would involve reclamation of existing section of drainage line and excavations works to create new section of drainage line.
- Demolition of existing bridge and construction of a new single span bridge over Boyd Creek. The new bridge would operate as a road with four lanes, each 3.5 metres in width, with two lanes carrying traffic in each direction.
- Construction of new culverts 160 metres west of Ashworth Drive and at the extension of the intermodal terminal.
- Shared pedestrian and cycle paths on both sides of the highway.
- Adjustments to public utilities along the route.

Dredging and reclamation works would be required in Boyds Creek and its tributaries along the proposal site.

Night works would also be required.

The proposed works would require the use of the following construction plant:

General	
Cranes	Light commercial and passenger vehicles
Excavators	Water pumps
Bulldozers	Hand tools
Road sweepers	Welding equipment
Water carts	Haulage trucks
Semi-trailers and large delivery trucks	Bobcats
Air compressors & attachments	Float
Cherry picker	Plate compactor
Rock hammer	
Road embankment and drainage construction	
Scrapers	Backhoes
Graders	Trenching machines
Vibrating and static rollers	Piling equipment
Shoring boxes	Wheel Loader
K&G Laying machine	Backhoe
Road pavement construction	
Milling machine	Bitumen spraying and asphalt paver
Concrete agitator trucks	Bitumen trucks
Concrete pumps	Kerb extruding machine
Concrete paver	Linemarking machine
Concrete vibrators	Lighting tower
Road suction sweeper	Roller multi tyred pneumatic
Vacuum suction truck	
Structures including bridges	
Piling rigs	Excavators
Concrete pumps	Trucks
Cranes	Small equipment
Traffic management and control	
Trailer mounted traffic lights	Trailer mounted VMS boards
Attenuation vehicle	Water filled and concrete barriers

As part of the REF Environmental safeguards such as erosion and sedimentation controls, traffic controls would be developed to avoid or minimise impacts. Disturbed areas would be rehabilitated and landscape design would be incorporated into the concept design.

To enable consideration of your comments in the REF, a written response would be appreciated by 15th October 2011. I would be pleased to provide further information if required. Raphael Morgan on behalf of the RTA may be contacted on 02 8202 8302 or by email raphael.m@nghenvironmental.com.au.

Yours faithfully,

Raphael Morgan on behalf of the RTA
Manager (Sydney) nghenvironmental

Transport
Roads & Traffic Authority

22nd September 2011

Manager
State Emergency Services
79 Corporation Avenue
Bathurst NSW 2795

Dear Manager

Invitation to comment – proposed duplication of the Great Western Highway through Kelso

The Roads and Traffic Authority of NSW (RTA) is proposing to undertake works for the duplication of the Great Western Highway through Kelso between Stockland Drive and 420 metres east of Ashworth Drive (the proposal). A review of environmental factors (REF) is currently being prepared to assess the likely impacts of the proposal under Part 5 of the *Environmental Planning and Assessment Act, 1979*. The RTA invites your organisation to comment and advise of any interests, concerns or statutory requirements relating to the proposal. Comments received will be considered in the REF.

The objectives of the proposal are to:

- Improve road safety for motorists and pedestrians, and improve road freight efficiency.
- Cater for the mix of through, local and tourist traffic.
- Provide a well engineered, safe, aesthetically pleasing, and environmentally acceptable road transport facility.
- Reduce delays and improve economic efficiency through increased capacity and appropriate intersection treatments.
- Include off road facilities for pedestrians and cyclists by provision of one or more shared paths.
- Be sensitive to local stakeholders, businesses, residents and the local community.
- Take account of the area's built and natural environment, and heritage.

The proposal is located in Kelso within the Bathurst LGA (Figure 1). Kelso includes a mix of residential areas to the north of the Great Western Highway and industrial areas to the south.

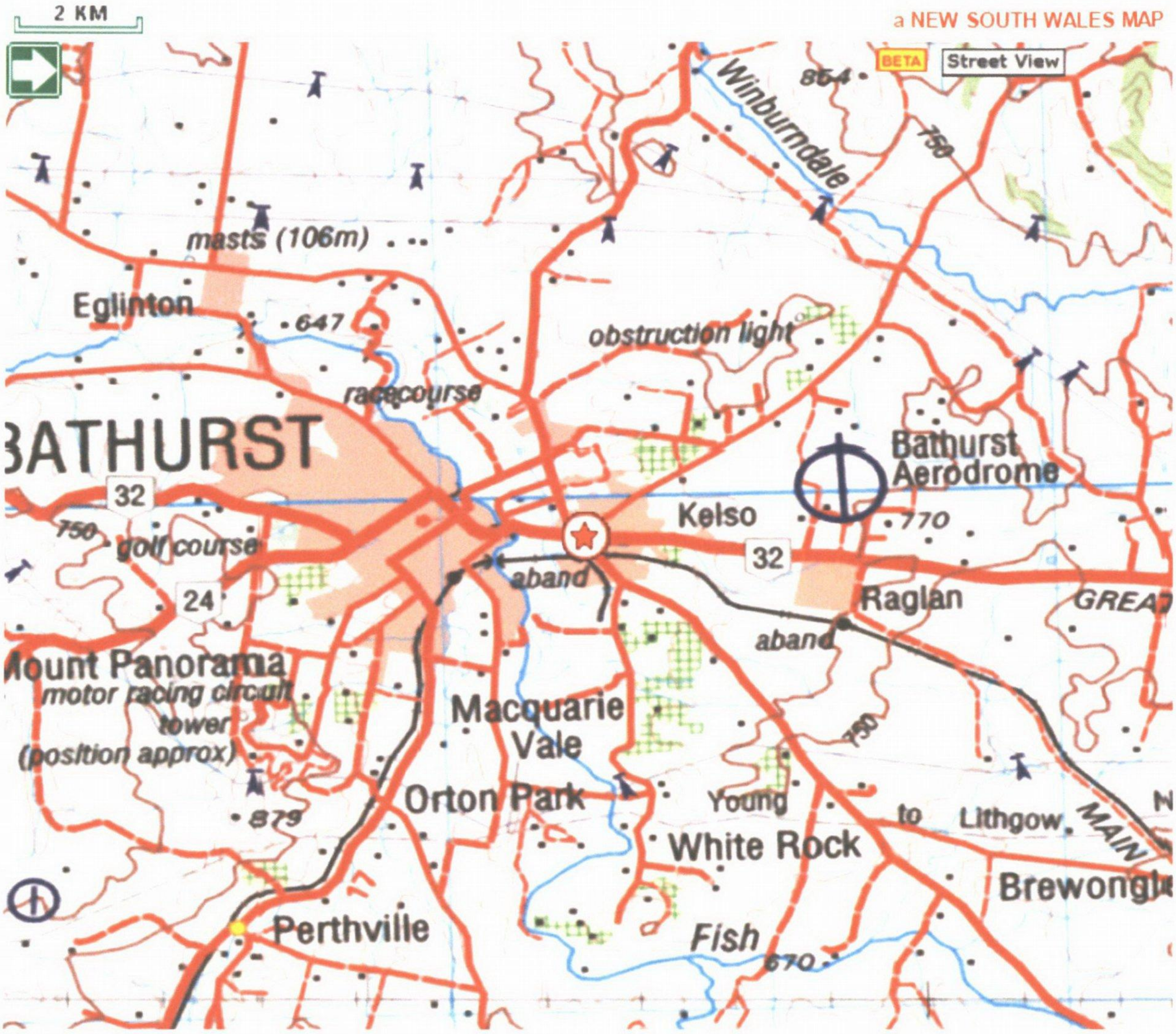


Figure 1. Location of proposal.

A concept design is attached for your information.

The proposal would involve

- A dual carriageway with two lanes in each direction and a central median for the entire length.
- Four intersections with traffic signals at Stockland Drive, Gilmore Street, Boyd Street and Pat O'Leary Drive.
- Two Intersections with roundabouts at Littlebourne Street and Ashworth Drive.
- One un-signalled intersection at View Street.
- One u-turn facility in Stockland Drive.
- Movement of a 420 metre section of drainage line at Ashworth Drive around 30 meters south of its existing location. This would involve reclamation of existing section of drainage line and excavations works to create new section of drainage line.
- Demolition of existing bridge and construction of a new single span bridge over Boyd Creek. The new bridge would operate as a road with four lanes, each 3.5 metres in width, with two lanes carrying traffic in each direction.
- Construction of new culverts 160 metres west of Ashworth Drive and at the extension of the intermodal terminal.
- Shared pedestrian and cycle paths on both sides of the highway.
- Adjustments to public utilities along the route.

Dredging and reclamation works would be required in Boyds Creek and its tributaries along the proposal site.

Night works would also be required.

The proposed works would require the use of the following construction plant:

General	
Cranes	Light commercial and passenger vehicles
Excavators	Water pumps
Bulldozers	Hand tools
Road sweepers	Welding equipment
Water carts	Haulage trucks
Semi-trailers and large delivery trucks	Bobcats
Air compressors & attachments	Float
Cherry picker	Plate compactor
Rock hammer	
Road embankment and drainage construction	
Scrapers	Backhoes
Graders	Trenching machines
Vibrating and static rollers	Piling equipment
Shoring boxes	Wheel Loader
K&G Laying machine	Backhoe
Road pavement construction	
Milling machine	Bitumen spraying and asphalt paver
Concrete agitator trucks	Bitumen trucks
Concrete pumps	Kerb extruding machine
Concrete paver	Linemarking machine
Concrete vibrators	Lighting tower
Road suction sweeper	Roller multi tyred pneumatic
Vacuum suction truck	
Structures including bridges	
Piling rigs	Excavators
Concrete pumps	Trucks
Cranes	Small equipment
Traffic management and control	
Trailer mounted traffic lights	Trailer mounted VMS boards
Attenuation vehicle	Water filled and concrete barriers

As part of the REF Environmental safeguards such as erosion and sedimentation controls, traffic controls would be developed to avoid or minimise impacts. Disturbed areas would be rehabilitated and landscape design would be incorporated into the concept design.

To enable consideration of your comments in the REF, a written response would be appreciated by 15th October 2011. I would be pleased to provide further information if required. Raphael Morgan on behalf of the RTA may be contacted on 02 8202 8302 or by email raphael.m@nghenvironmental.com.au.

Yours faithfully,

Raphael Morgan on behalf of the RTA
Manager (Sydney) nghenvironmental

BATHURST
REGIONAL COUNCIL

Civic Centre
158 Russell Street
Private Mail Bag 17
Bathurst NSW 2795

Telephone 02 6333 6111
Facsimile 02 6331 7211
council@bathurst.nsw.gov.au
www.bathurstregion.com.au

6 October 2011

Mr R Morgan
Manager (Sydney) nghenvironmental
Roads and Traffic Authority
18/21 Mary Street
SURRY HILLS NSW 2010

Dear Mr Morgan

Great Western Highway Reconstruction – Kelso

I refer to your letter dated 22 September 2011 regarding consultation with Council for the above proposed improvement works on the Great Western Highway.

Council has been in consultation and liaison with the RTA during the process of project development and is supportive of the endeavours to progress this proposal.

In relation to the proposal for the construction of a turn around area on Stockland Drive, please note that any filling required on the adjacent flood plain will require Development Approval including the completion of a flood impact assessment.

Additionally your attention is drawn to the intersection of Stockland Drive and the Great Western Highway, as high intensity storm events result in flooding of the highway and the inundation of this intersection, making access impossible. This flooding issue has been the subject of separate correspondence to the RTA Western Region.

Council supports the proposal in principle and will continue to work in consultation with the RTA to have the design work finalised and construction commencement expedited.

Yours faithfully

Doug Patterson
DIRECTOR
ENGINEERING SERVICES

Reference: DP:DR 25.00018-02/100
Enquiries: Mr Doug Patterson 02 6333 6221

NSW GOVERNMENT
Environment, Climate Change & Water

Our reference: FIL08/7503-02 & DOC11/45278
Contact: Sheridan Ledger, (02) 6332 7608

The Manager
Nghenvironmental
18/21 Mary Street
Surry Hills NSW 2010

6 October 2011

Dear Mr Morgan

I refer to your letter of 22 September 2011 to the Office of Environment and Heritage (OEH) seeking comment on the requirements for the Review of Environmental Factors (REF) for the proposed duplication of the Great Western Highway through Kelso, Bathurst.

I wish to advise that the proposal is not a Scheduled Activity under Schedule 1 of the Protection of the Environment Operations Act 1997 (POEO Act) and therefore is not required to hold an Environment Protection Licence (EPL). While a licence is not required, as the activity is being undertaken by a public authority, OEH is the appropriate regulatory authority (ARA) for the activity under the POEO Act.

It should be noted that during the construction activities must comply with the requirements of the POEO Act including, but not limited too:

- Section 115 and 116;
- Section 120;
- Section 124 and 126;
- Section 139; and
- Section 167.

Water Quality Impacts – Construction

The REF should address potential impacts to surface waters from construction activities and identify appropriate pollution control systems such as erosion and sediment controls during construction and the rehabilitation stage and the inclusion of permanent erosion and sediment controls where required.

It is recommended that priority should be given to achieving a high standard of erosion and sediment control and general site management. The proponent, or any contractor engaged by the proponent, should develop and implement controls associated with the proposal in accordance with relevant guidelines, particularly the OEH endorsed publication *"Managing Urban Stormwater – Soils and Construction " 4th Edition March 2004* prepared by Landcom.

PO Box 1388 Bathurst NSW 2795
203-209 Russell Street Bathurst NSW
Tel: (02) 6332 7600 Fax: (02) 6332 7630
ABN 30 841 387 271
www.environment.nsw.gov.au

Environmental Impacts - General

In addition to water management, OEH recommends that the following issues also be addressed by the REF:

- **Noise** – identify potential noise impacts during construction and operation and identify mitigation strategies to be incorporated to minimise noise and comply with NSW policies and legislation on noise control;
- **Odour/Air** – identify impacts from dust during the construction period and identify mitigation measures to minimise dust emissions;
- **Contaminated Land** – identify if the soils in the area of the proposal are contaminated and if so, identify remediation actions that will be undertaken;
- **Water Quality Impacts Construction** – identify potential impacts to surface waters from construction activities and identify appropriate pollution control systems such as erosion and sediment controls during construction and the rehabilitation stage and the inclusion of permanent erosion and sediment controls where required;
- **Waste Management** – options and strategies for waste minimisation; reuse and recycling should be assessed;
- **Storage of Chemicals/Fuels** - ensure adequate control measures are in place for storages to reduce risk of spills contaminating waterways and land; and
- **Incident Management Procedures** - adequate procedures should to be established including notification requirements to the ARA for incidents that cause material harm to the environment (refer s147-153 Protection of the Environment Operations Act).

Please find at Attachment 1 OEH's general guidance material to assist with the determination of the issues identified above.

Aboriginal Cultural Heritage

The REF needs to address Aboriginal Cultural Heritage (ACH) matters in the area of the proposal in accordance with the requirements of the National Parks and Wildlife Act 1974 and appropriate guidelines as detailed in Attachment 2. It is expected that the ACH assessment will be undertaken for the entire the footprint of the disturbance area, including the areas disturbed as part of the installation of all pipelines.

Depending on the outcome of the archaeological surveys, Council may require a Section 87 permit or Section 90 permit under the National Parks and Wildlife Act 1974 to disturb or destroy Aboriginal objects. If a Section 90 permit is required from OEH, the proposal becomes an Integrated Development Application (IDA) under Section 91 of the Environmental Planning and Assessment Act 1979.

Biodiversity – Flora and Fauna

OEH has responsibilities under the:

- Native Vegetation Act 2003 - an important aspect of the Act is that it aims to prevent broadscale clearing of vegetation, unless the clearing improves or maintains environmental outcomes (i.e. suitable offsets for the loss of lawfully cleared native vegetation);
- National Parks and Wildlife Act 1974 - namely the protection and care of native flora and fauna and the protection and management of reserves; and the
- Threatened Species Conservation Act 1995 - which aims to conserve threatened species of flora and fauna, populations and ecological communities to promote their recovery and manage processes that threaten them;

The REF needs to address biodiversity related matters in the area of the proposal (i.e. the footprint of the proposal and associated construction areas) in accordance with the requirements of the Environmental Planning and Assessment Act 1979, the Native Vegetation Act 2003 and the Threatened Species Conservation Act 1995.

Attachment 1 provides details regarding OEH's Environmental Assessment Guidelines for biodiversity related matters. The guidelines are designed for environmental impact assessment documents and therefore their content is relevant to the REF.

Should you have any enquiries in relation to this matter please contact Andrew Helms at the Bathurst Office of OEH by telephoning (02) 6332 7604.

Yours sincerely

DARRYL CLIFT
Head Regional Operations Bathurst
Environment Protection and Regulation
Office of Environment and Heritage
Department of Premier and Cabinet

Attachment 1: OEH guidance material.

ATTACHMENT 1 - GUIDANCE MATERIAL

Assessing Aboriginal Cultural Heritage Impacts

- Due diligence code of practice for protection for Aboriginal objects in NSW;
- Guide to investigating, assessing and reporting on Aboriginal cultural heritage in NSW; and
- Aboriginal cultural heritage consultation requirements for proponents 2010.

These documents can be located at the following URL:

http://www.environment.nsw.gov.au/licences/investassessreport.htm

Assessing Biodiversity – Flora and Fauna Impacts

- Field Survey Methods (DECCW, 2009); and
- Threatened Species Assessment Guidelines: The Assessment of Significance (DECC, 2007);

These documents can be located at the following URL:

- http://www.environment.nsw.gov.au/resources/threatenedspecies/tsaguide07393.pdf

Assessing Noise Impacts

- Construction: Interim Construction Noise Guideline (DECC, 2009).
- Operational: NSW Industrial Noise Policy (EPA, 2000).

These documents can be located at the following URL:

- http://www.environment.nsw.gov.au/noise/

Assessing Dust Impacts

No guidance material exists for the control of dust from construction sites.

Consideration should be given for to the Protection of the Environment Operations Act 1997.

Assessing Contaminated Land Impacts

- National Environment Protection (Assessment of Site Contamination) Measure 1999.

Assessing Water Quality Impacts

- Managing Urban Stormwater – Soils and Construction, 4th Edition (Landcom, 2004, revised 2006).

Assessing Waste Impacts

- Waste Classification Guidelines (DECCW, 2009).

This document can be located at the following URL:

http://www.environment.nsw.gov.au/waste/classification.htm

NSW GOVERNMENT | Primary Industries

V11/3002
OUT11/20171

28th October 2011
Raphael Morgan
RTA
18/21 Mary Street
Surry Hills NSW 2010

Dear Raphael,

Re: Proposed Duplication of the Great Western Highway through Kelso

Thank you for providing New South Wales Primary Industries (Fisheries) the opportunity to provide input into the REF.

New South Wales Primary Industries (Fisheries) are responsible for ensuring that fish stocks are conserved and that there is "no net loss" of key fish habitats upon which they depend. To achieve this, the Department ensures that developments comply with the requirements of the *Fisheries Management Act 1994* (namely the aquatic habitat protection and threatened species conservation provisions in Parts 7 and 7A of the Act respectively) and the associated *Policy and Guidelines for Aquatic Habitat Management and Fish Conservation (1999).* In addition the Department is responsible for ensuring the sustainable management of commercial and recreational fishing and aquaculture within NSW.

In relation to required approvals/permits the Minister for the department (or delegate) must be notified of any proposed **dredging and reclamation** works in 'waterland' (construction of temporary crossings/sidetracks, bridges, creek diversions, geotechnical investigations, excavating or reclaiming the bed or banks of any waterways, etc) in order to grant concurrence for the work in accordance with sections 198-203 of the *Fisheries Management Act 1994*. The REF should describe the type and extent of such proposed works.

A permit is required to temporarily or permanently **block fish passage** under section 219 of the Act. Such works may include the bunding of waterways during works, use of silt fences across waterways and other similar works. The REF should describe the type, extent and duration of such works.

Specifically, Primary Industries (Fisheries) requests that the following issues are addressed in the REF for the proposed bridge replacement works;

1. **Blockages to fish Passage** - Primary Industries (Fisheries) requests that the REF needs to consider whether the demolition and construction of a new bridge over Boyd Creek is likely to impede the free passage of fish. The publication *"Why do fish need to cross the road? . Fish Passage*

FISHERIES CONSERVATION & AQUACULTURE BRANCH
TAMWORTH AGRICULTURAL INSTITUTE
4 Marsden Park Road
CALALA NSW 2340

www.industry.nsw.gov.au

Tel: 02 6763 1255
Fax: 02 6763 1265

Requirements for Waterway Crossings" on the website outlines important considerations when designing or constructing waterway crossings.

2. **Maintenance or Improvement to the Cross-sectional Area of a Waterway** – The REF should describe the proposed works in relation to the cross-sectional area of the waterway, particularly with regards excavation work to create a new section of drainage line, and also the construction of the new single span bridge over Boyd Creek. A description of the need for the proposed works, and the likely construction methods should be provided. Primary Industries (Fisheries) requests that constriction of waterways or the use of scour protection within the bed of waterways be avoided where possible, as such works are likely to have a detrimental impact on floodwater velocities which can have significant impacts on fish and fish habitat.
3. **Rehabilitation of Sites** - Primary Industries (Fisheries) requests that any bed and bank rehabilitation works be completed immediately after the completion of works. Proposals to ensure replacement of aquatic and riparian vegetation with native/endemic species are encouraged.
4. **Sedimentation and Erosion Controls** - Primary Industries (Fisheries) requests that information on proposed sedimentation and erosion controls be included in the REF.
5. **Threatened species** –The REF must address the threatened species provisions of the *Fisheries Management Act 1994* for species, populations or communities listed under schedules 4 and 5 whose historical geographical distribution extends to the area of works. The proposal should address whether there are likely to be any significant impacts on the listed threatened species.

If you have any queries do not hesitate to call me on 6763 1255 or 0429 908 856.

Yours faithfully

David Ward
Fisheries Conservation Manager (Greater Darling)

KILLIBY Dion

From: ARROW Mark A
Sent: Thursday, 17 February 2011 3:01 PM
To: KILLIBY Dion
Cc: CHARLTON Jeffery W
Subject: Kelso Dual Carriageway

Jeff Charlton (RTA Aboriginal Cultural Heritage Advisor) inspected the Kelso site today.

Survey conditions were poor in the undisturbed areas due to the dense vegetation.

Nothing of interest was found.

Regards,

Mark Arrow
Senior Environmental Officer
Environmental Services Section
RTA Western Region
Ph: 02 6861 1628
Fax: 02 6861 1415
Mob: 0417 435 839

KILLIBY Dion

From: ARROW Mark A
Sent: Wednesday, 16 February 2011 9:43 AM
To: KILLIBY Dion
Cc: CHARLTON Jeffery W; SCHULTZ Carl D
Subject: RE: AHIMS search results Kelso

Dion,
Have double checked the location of these sites and come up with the same results ie the sites are 1km to 1.2km south of the eastern end of the project, between the railway and MR253 (Oberon/Jenolan Caves Road), well away from our work. They need no further inspection and need only a mention in the Aboriginal Heritage Study (who is the consultant for this?)

Jeff wants to look around, so have arranged a Field Inspection for tomorrow.
Can you send me some plans (no need to be large scale, say on a few A3's) of the proposal so far particularly in relation to the creek (where it is most likely that a site may exist).....

Thanks & Regards,
Mark

From: KILLIBY Dion
Sent: Tuesday, 8 February 2011 5:33 PM
To: ARROW Mark A
Subject: FW: AHIMS search results Kelso

Mark
If you see Jeff around can you give him a hurry up on this one - its been a few weeks now
cheers

dion.killiby@rta.nsw.gov.au

From: Natascha [mailto:natascha.a@nghenvironmental.com.au]
Sent: Tuesday, 8 February 2011 4:12 PM
To: CHARLTON Jeffery W
Cc: KILLIBY Dion
Subject: Fwd: AHIMS search results Kelso

Hi Jeff

How are you going with looking at requirements for the Kelso job as per my email below.

Regards
Natascha

-------- Original Message --------
Subject: AHIMS search results Kelso
Date: Thu, 27 Jan 2011 08:30:30 +1100

From: Natascha <natascha.a@nghenvironmental.com.au>
To: Jeff_Charlton@rta.nsw.gov.au, KILLIBY Dion <Dion_KILLIBY@rta.nsw.gov.au>

HI Dion and Jeff

Attached is a quick map of the closest (within 1km and centred on the alignment) of the AHIMS search results for your reference and obviously internal use only. There are two sites, not affected by the alignment, both are open camp sites. Jeff I need to chat to you about moving through PACCHI and get advice on the next steps.
I am mostly in the office this week if you could give me a call on 82028301 or 0418432500.

Cheers
Natascha

--

Natascha Arens CEnvP
Director
RABQSA International certified auditor

nghenvironmental
www.nghenvironmental.com.au

18/21 mary street surry hills nsw 2010 australia
tel +61 (0)2 8202 8333
dir +61 (0)2 8202 8301
mob +61 (0)418 432 500
fax +61 (0)2 9211 1374

Appendix D

Consideration of clause 228(2) factors and matters of national environmental significance

Clause 228(2) Checklist

In addition to the requirements of the *Is an EIS required?* guideline as detailed in the REF, the following factors, listed in clause 228(2) of the *Environmental Planning and Assessment Regulation 2000*, have also been considered to assess the likely impacts of the proposal on the natural and built environment.

Factor	Impact
a. **Any environmental impact on a community?** The proposal would improve the safety of the highway through the introduction of a concrete median, dedicated right turn bays from the highway to side streets and provision of footpaths and shared paths along the full length of the proposal site. Accesses to businesses and residential properties would be impeded by the median but provision of roundabouts and u-turn facilities at strategic locations would minimise potential impacts. Traffic flows would be improved through the duplication of the highway. Construction activities have the potential to impact businesses and accesses and the road users may experience temporary delays. The proposal would be staged as described in section 3.3 to help minimise impacts. Construction noise also has the potential to impact businesses and residents but mitigation measures would be put in place to minimise impacts.	Long term positive and negative Short term negative
b. **Any transformation of a locality?** The proposal is for the purpose of a road upgrade and would see the duplication of an existing highway. The duplication of the highway would improve travel times in the locality as well as improve safety. Access would be altered as right turn movements from the highway into businesses and residential properties would be impeded by the proposed median. A section of Boyd Creek and its unnamed tributary would also need to be either relocated or piped near Ashworth Drive. Management measures outlined in chapter 7 would avoid or minimise any potential negative impacts.	Long term positive and negative
c. **Any environmental impact on the ecosystems of the locality?** The terrestrial and aquatic ecosystems in the locality are highly disturbed due to current industrial and urban land uses. The proposal would require the removal of riparian vegetation and street trees, most exotic. Potential impacts to waterway may also result from erosion and sedimentation during earthworks. Impacts are however, likely to be minor (refer to section 6.6 for assessment). The proposal would see the rehabilitation of waterways which would improve their condition and planting of street trees. This has the potential to improve to a minor level the ecosystems of the locality.	Short term negative Long term positive

Factor	Impact
d. **Any reduction of the aesthetic, recreational, scientific or other environmental quality or value of a locality?** The proposal includes an urban design concept plan which has taken into consideration the various land uses along the proposal site. The proposal would improve the visual amenity of highway through improved landscaping and urban design principles as assessed in section 6.9.	Long term positive
e. **Any effect on a locality, place or building having aesthetic, anthropological, archaeological, architectural, cultural, historical, scientific or social significance or other special value for present or future generations?** Twelve heritage buildings and the Kelso Conservation Area of local significance are located along the proposal site. The assessment of impacts (section 6.5) has concluded that impacts to these would be minor. None would need to be removed. There is potential for indirect impacts through vibrations. The urban design concept plan has also taken into consideration the heritage character of the site. However, safeguards outlined in section 6.5 would avoid or minimise impacts.	Nil
f. **Any impact on the habitat of protected fauna (within the meaning of the *National Parks and Wildlife Act 1974*)?** The proposal would require the removal of streets trees and riparian vegetation. Most of the vegetation to be removed is exotic. The proposal would include revegetation and rehabilitation of riparian zones and planting of street trees which would improve habitat potential.	Short term negative Long term positive
g. **Any endangering of any species of animal, plant or other form of life, whether living on land, in water or in the air?** The terrestrial and aquatic environment at the proposal site is highly disturbed due to industrial and urban land uses. It currently offers minimal habitat for flora and fauna. The proposal would see the rehabilitation of waterways as well as landscaping which may improve habitat potential.	Nil
h. **Any long-term effects on the environment?** The proposal would improve the safety of the highway through the introduction of a median, dedicated right turn bays from the highway to local side streets and the provision of footpaths and shared paths. The duplication of the highway would improve traffic flows.	Long term positive
i. **Any degradation of the quality of the environment?** The proposal may require the piping of a section of Boyd Creek and its tributary which would remove some highly disturbed aquatic habitat. Landscape and urban design would improve the streetscape.	Minor negative Long term positive

Factor	Impact
j. **Any risk to the safety of the environment?** The construction works has the potential to temporarily decrease safety due to road works along the highway and movement of construction plant. The proposal would see the introduction of a median along the highway, footpaths and shared paths along the full length of the proposal site, dedicated right turn bays from the highway to site streets. These all have the potential to improve safety.	Short term negative Long term positive
k. **Any reduction in the range of beneficial uses of the environment?** A section of Boyd Creek and its unnamed tributary in proximity of Ashworth Drive may need to be piped as a result of the proposed works. This would alter the landscape to some degree impacting on visual amenity and the aquatic habitats. This impact would be minor due to the highly degraded state of this section of creek and the limited habitat value it provides. If the relocation of this section of creek is required instead this may impact the approved concept plan for the future intermodal site.	Potential long term negative
l. **Any pollution of the environment?** There is potential for accidental spills as well as erosion and sedimentation to occur which could impact waterways and land uses along the proposal site. These are would be managed through appropriate erosion and sedimentation controls and the requirements to prepare spill management plans.	Potential short term negative.
m. **Any environmental problems associated with the disposal of waste?** Contaminated waste may occur at the proposal site and would need to be managed according to safeguards outlined in this REF in order to avoid or minimise potential impacts to the environment.	Potential short term negative
n. **Any increased demands on resources (natural or otherwise) that are, or are likely to become, in short supply?** The proposal would require a number of resources as described in chapter 3. None are to put pressure on resources or are likely to become in short supply as a result of the proposal. Resource use management measures are provided which would include reuse and recycling when feasible (section 6.11).	Nil

Factor	Impact
o. Any cumulative environmental effect with other existing or likely future activities? The REF has assessed that there are potential cumulative construction noise and traffic impacts to occur should works along the Great Western Highway or in the Kelso area be undertaken concurrently. Furthermore, the relocation or piping of Boyd Creek and its unnamed tributary has the potential to impact on the future land use of the proposed intermodal site. Safeguards have been proposed to minimise these impacts (section 6.14).	Potential short term and long term negative
p. any impact on coastal processes and coastal hazards, including those under projected climate change conditions. Kelso is located beyond the Blue Mountains and there would be no impacts to coastal processes and coastal hazards as a result of the proposal.	Nil

Matters of national environmental significance

Under the environmental assessment provisions of the *Environment Protection and Biodiversity Conservation Act 1999*, the following matters of national environmental significance and impacts on Commonwealth land are required to be considered to assist in determining whether the proposal should be referred to the Australian Government Department of the Environment, Water, Heritage and the Arts.

Factor	Impact
a. **Any impact on a World Heritage property?** There are no World Heritage properties in the locality of the proposal site.	Nil
b. **Any impact on a National Heritage place?** There are no National Heritage Places in the locality of the proposal site.	Nil
c. **Any impact on a wetland of international importance?** There are no wetlands of international importance in the locality of the proposal site.	Nil
d. **Any impact on a listed threatened species or communities?** The threatened Green and Golden Bell Frog has the potential to occur at the site. An assessment of significance has determined there would be no significant impacts to the species. No other listed threatened species or communities would be impacted.	Nil
e. **Any impacts on listed migratory species?** There would be no impacts to listed migratory species	Nil
d. **Any impact on a Commonwealth marine area?** There are no Commonwealth marine areas in the locality.	Nil
g. **Does the proposal involve a nuclear action (including uranium mining)?** The proposal does not involve a nuclear action.	Nil
Additionally, any impact (direct or indirect) on Commonwealth land? There would be no impacts on Commonwealth land.	Nil

Appendix E

Traffic assessment (Cardno 2011)

Cardno
Shaping the Future

GREAT WESTERN HIGHWAY UPGRADE, KELSO
TRAFFIC ASSESSMENT

FINAL DRAFT REPORT

Prepared for

Roads and Traffic Authority Western Region

transportation | traffic | engineering | planning

15 September 2011

Cardno (NSW/ACT) Pty Ltd

Traffic and Transport

ABN 95 001 145 035

Level 3, 910 Pacific Highway, Gordon

New South Wales 2072 Australia

Telephone: 02 9496 7700

Facsimile: 02 9499 3902

International: +61 2 9496 7700

www.cardno.com.au

DOCUMENT CONTROL

Great Western Highway Upgrade, Kelso Traffic Assessment – Final Draft Report					
Version	Date	Author		Reviewer	
		Name	Initials	Name	Initials
1	14 June 2011	Clement Lim	CL	Anissa Levy	AL
2	1 Sep 2011	Jon Busch Ronan Powell Kieron Hendicott	JB RP KH	Anissa Levy	AL
3	15 Sep 2011	Ronan Powell Anissa Levy	RP AL	Anissa Levy	AL

TABLE OF CONTENTS

Appendices

List of Figures

List of Tables

1 INTRODUCTION

The Great Western Highway (GWH), through the urban area of Bathurst, is generally dual carriageway with four (4) travel lanes and two (2) parking lanes. Bathurst is a growing rural city and commercial and residential development has expanded to the east, beyond the dual carriageway. Traffic volumes in this area are approaching those of the dual carriageway section and are continuing to grow as the development activity and city expansion continues.

This project will extend the dual carriageway of the Great Western Highway to the east through the suburb of Kelso. The project study area is a 2.4km section of the Great Western Highway through Kelso, just east of Bathurst (Figure 1.1). The proposed upgrade will extend from west of the Stockland Drive intersection in Kelso to east of Ashworth Drive, near the Gold Panner Motor Inn.

The existing section of the Great Western Highway within the study area is generally two lanes with a speed limit of 60 km/h and includes eight intersections. The intersections at Littlebourne Street, Boyd Street and Gilmour Street are signalised.

The RTA has proposed the upgrade because:

- There is significant congestion at peak times on the highway.
- Bathurst and Kelso continue to expand.
- Future commercial and industrial development is anticipated in the area.
- The existing road surface throughout the section is reaching the end of its useful life and will soon require replacement.

The upgrade is proposed to:

- Improve road safety for all road users including pedestrians and cyclists.
- Provide additional road capacity and reduce congestion.
- Improve road freight efficiency.
- Offer improved intersection arrangements.
- Cater for a mix of through, local and tourist traffic.
- Take account of the area's current and likely future development.

Key features of the upgrade will include:

- Widening of the carriageway to provide two additional travel lanes and a shoulder / parking lane in each direction.
- Widening of travel lanes and shoulders.
- Variable median widths, with some sections of the carriageway separated by a raised median.
- Kerb and guttering, and paved pedestrian pathways.
- Provision for cyclists.
- Replacement of the existing bridge at Boyd Creek and widening of various culverts.

The RTA has been developing concept design options and preparing the associated review of environmental factors (REF) for the carriageway widening and intersection upgrades treatments at eight (8) intersections. A key outcome for the concept design is not only to provide improvements to performance and safety of the intersections into the future but also to balance the access and connectivity needs of the local Kelso residents and businesses.

Cardno
Shaping the Future

Cardno
Shaping the Future

Figure 1.1

STUDY AREA

Legend

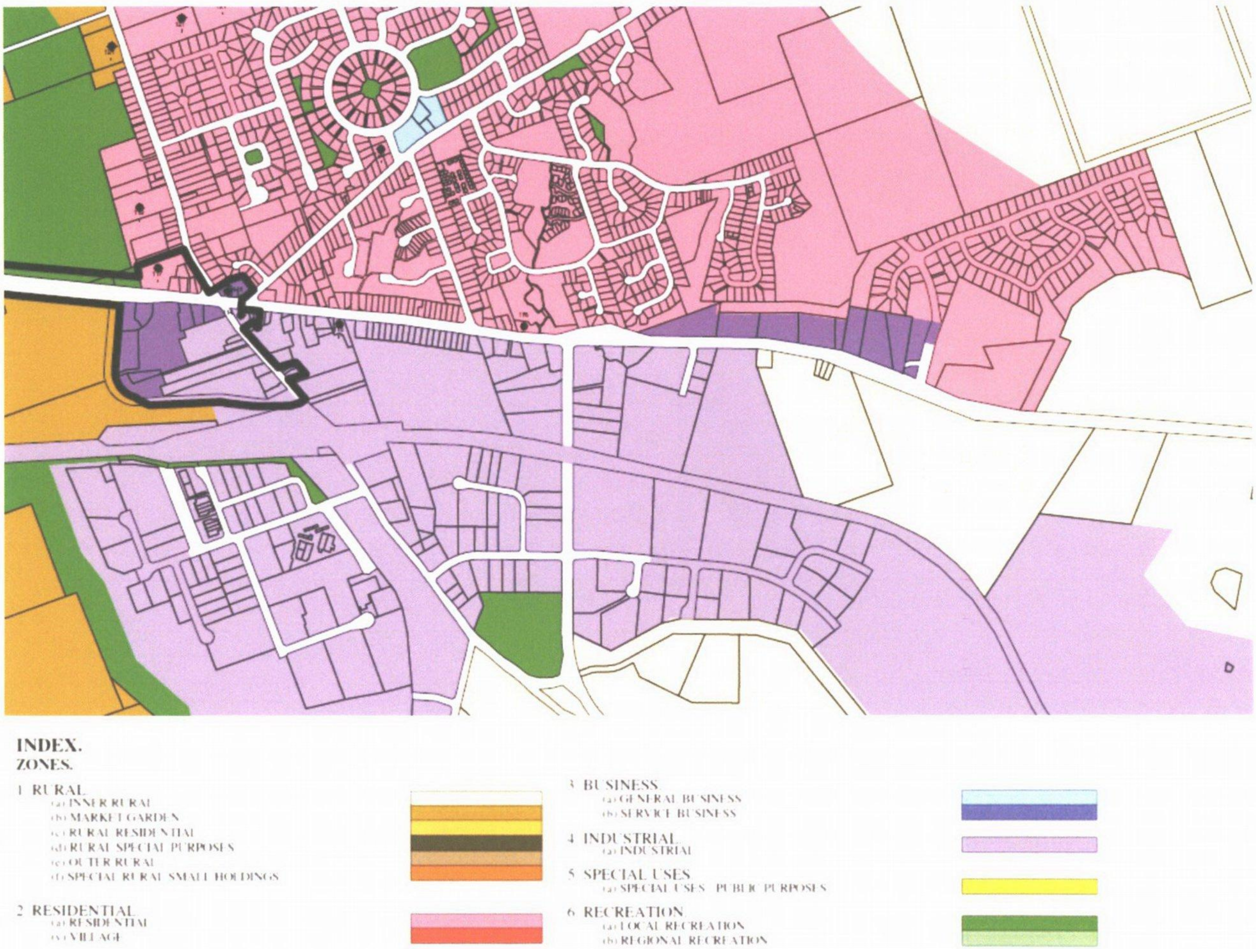
Great Western Highway Upgrade, Kelso CES01211

2 EXISTING ROAD NETWORK

2.1 SURROUNDING LAND USES

This section of the Great Western Highway passes through a number of different land use types and experiences increasing urban intensity heading west. As such, the character of the highway transitions from typically rural in nature to urban when travelling east to west. The zoning is shown in the extract from the Bathurst LEP 2005, reproduced in Figure 2.1.

Figure 2.1 Land use zoning



Source: BATHURST REGIONAL (INTERIM) LOCAL ENVIRONMENTAL PLAN 2005.

The southern side of the highway at the western end of Kelso is generally rural in nature with undeveloped large blocks of land. Heading east, this changes to industrial zoned land with a mix of different business types. On the northern side of the highway, the western end has a number of bulky goods retail developments within the service business zoned land; the remainder is predominantly residential.

2.2 ROAD NETWORK CHARACTERISTICS

2.2.1 Great Western Highway

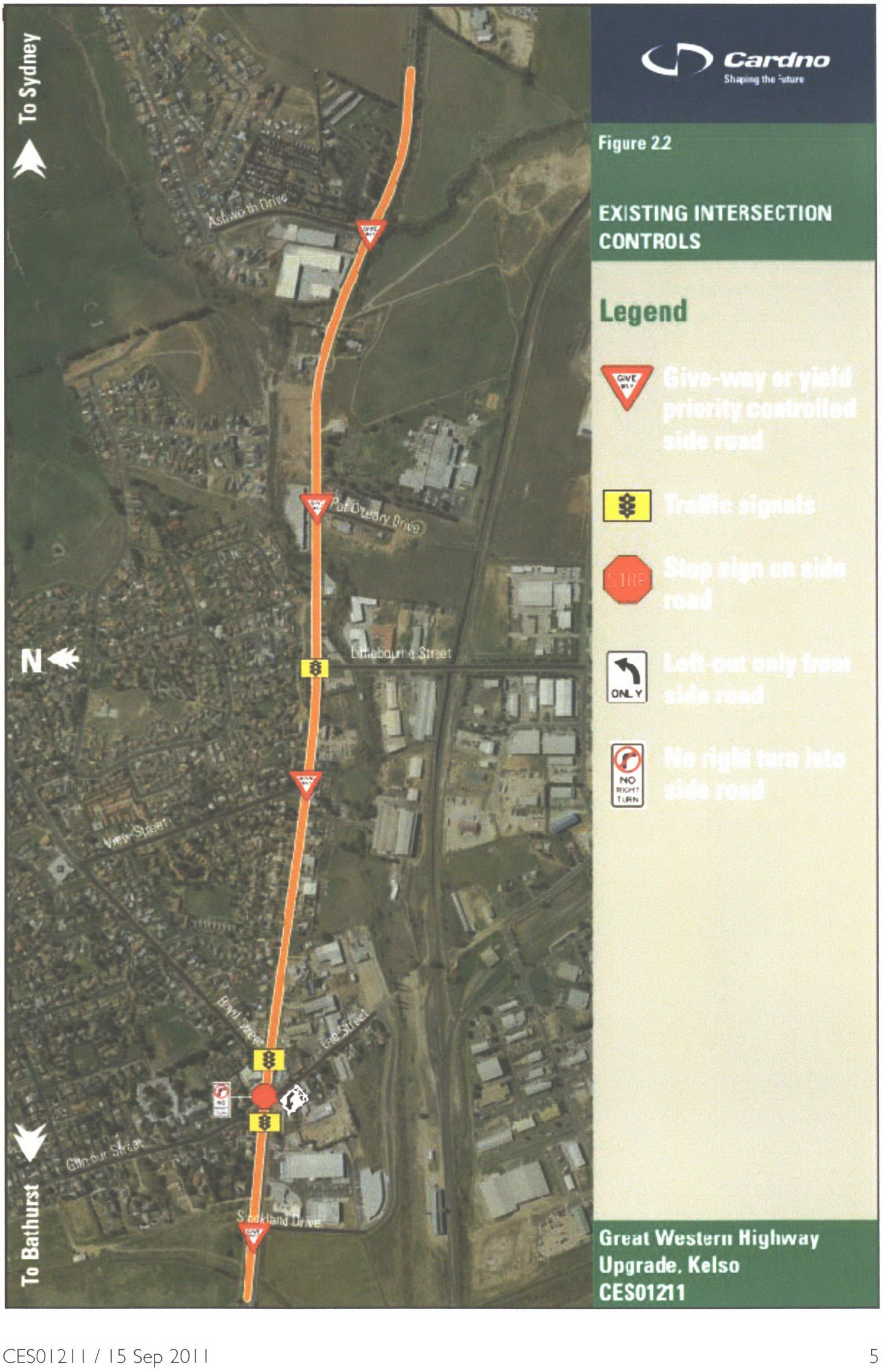
The Great Western Highway provides the main road link across the Blue Mountains between Sydney and the Central West of New South Wales.

The existing section of the Great Western Highway within the study area is generally two lanes with a speed limit of 60 km/h. The highway widens to four lanes west of Boyd Street on approach to Bathurst. This section of the highway includes eight intersections, plus a number of driveway accesses to residential properties (predominantly on the northern side of the highway) and businesses (mostly to the south).

The current intersection controls are detailed in Table 2.1 and presented in Figure 2.2.

Table 2.1 Existing intersection controls

Intersection	Current intersection type
Ashworth Drive	Give-way controlled intersection, with priority on the highway and all movements permitted. A dedicated left turn bay is provided on the highway for left turns into Ashworth Drive and a protected acceleration lane is provide on the highway for vehicles turning left onto the highway.
Devro	Access driveway to DEVRO site, with all movements permitted
Pat O'Leary Drive	Give-way controlled intersection, with priority on the highway and all movements permitted
Littlebourne Street	Traffic Signals with all movements permitted, dedicated turn bays are provided on the highway for left and right turns into Littlebourne Street. A left-turn slip is provided on Littlebourne Street.
Downer's EDI Rail	Access driveway to EDI Rail site, with all movements permitted
View Street	Give-way controlled intersection, with priority on the highway and all movements permitted
Boyd Street	Traffic Signals, with no right turn into Boyd Street – all other movements permitted. A dedicated turn lane is provided for left turns into Boyd Street.
Lee Street	Left in/left out movements to Lee Street only due to median on the highway
Gilmour Street	Traffic Signals with all movements permitted, dedicated turn lanes are provided for left and right turns into Gilmour Street.
Stockland Drive	Give-way controlled intersection, with priority on the highway and all movements permitted. A dedicated turn bay is provided on the highway for right turns into Stockland Drive.


To Sydney
Ashworth Drive
Pat O'Leary Drive
Littlebourne Street
View Street
Boyd Street
Lee Street
Gilmour Street
Stockland Drive
N
To Bathurst
Cardno
Shaping the Future
Figure 2.2
EXISTING INTERSECTION CONTROLS
Legend
Give-way or yield priority controlled side road
Traffic signals
Stop sign on side road
Left-out only from side road
No right turn into side road
Great Western Highway Upgrade, Kelso
CES01211

2.2.2 Side roads

The roads with access onto the highway through Kelso are:

- **Ashworth Drive** – Two-way local road on the northern side of the Great Western Highway that provides access to an industrial park and residential lots. The road is 400m in length, and is connected to several minor local access roads. On-street parking is permitted for the majority of its length. The speed limit is 50km/hr and there are no dedicated pedestrian footpaths.
- **Pat O'Leary Drive** – Two-way local road on the southern side of the Great Western Highway that serves an industrial region. The road is 200m in length, and does not serve any other roads. The speed limit is 50km/hr and there are no dedicated pedestrian footpaths. In the future, Pat O'Leary Drive will provide access to a number of bulky goods, service centre and fast food outlets.
- **Littlebourne Street** – Two-way regional road on the southern side of the Great Western Highway that provides access to the Hampden Park Industrial area, White Rock, and O'Connell. The road changes into O'Connell Road, which is more than 40km long and connects to Oberon in the south-east. The speed limit is typically 60km/hr with several school zones. There are no dedicated pedestrian footpaths.
- **View Street** – Two-way local road on the northern side of the Great Western Highway that provides access to several minor local roads, as well as connecting onto Boyd Street. The area surrounding View Street is residential. The speed limit is 50km/hr and there are no dedicated pedestrian footpaths.
- **Boyd Street** – Two-way collector road on the northern side of the Great Western Highway that provides access to several minor local roads, and View St. Boyd Street changes into Limekins Road that connects several northern suburbs, including Forest Grove and Yarras. The speed limit is 50km/hr and there are several school zones along its length. The first 1.3km of road within the study area have paved pedestrian footpaths.
- **Lee Street** – Two-way local road on the southern side of the Great Western Highway that provides access to an industrial estate. Lee Street terminates after 350m, at the connection with Stockland Drive. The speed limit is 50km/hr and there is a paved pedestrian footpath on the western side of the road.
- **Gilmour Street** – Two-way collector road on the northern side of the Great Western Highway that provides access to Laffing Waters, Peel, Wattle Flat and Eglinton. Gilmour Street is the primary road northbound out of Kelso and Bathurst. To the north Gilmour Street connects with Hereford Street, which provides the only alternate access into Bathurst east of the river. The speed limit is 50km/hr and has several school zones along its length. The eastern side of the road provides a paved pedestrian footpath.
- **Stockland Drive** – Two-way local road on the southern side of the Great Western Highway that provides access to an industrial estate. The speed limit is 50km/hr and a paved pedestrian footpath is provided on the eastern side.

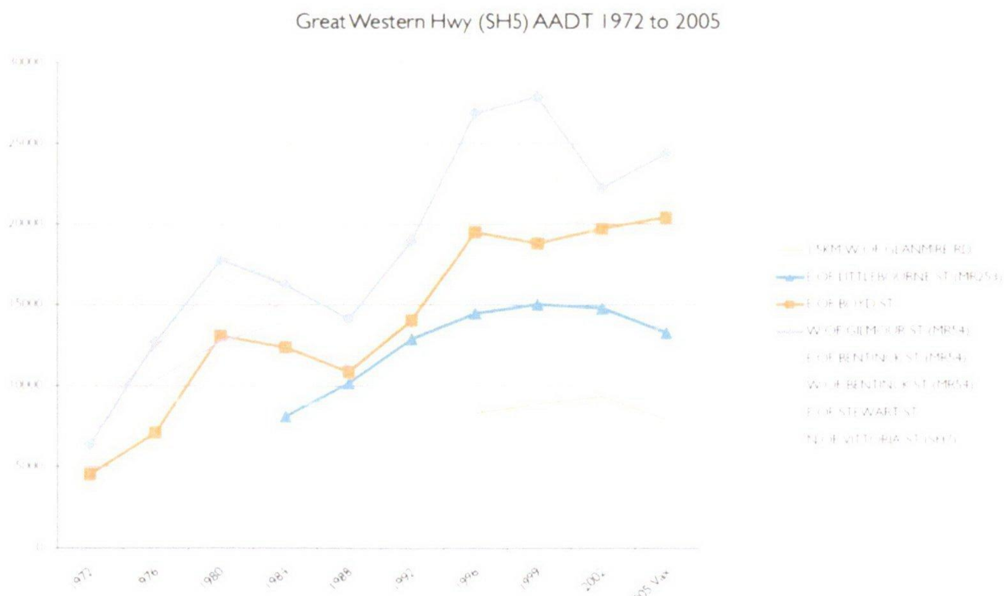
2.3 ANNUAL AVERAGE DAILY TRAFFIC VOLUMES

The Annual Average Daily Traffic (AADT) volumes along the key existing routes through the study area were obtained from RTA published data. Table 2.2 presents the most relevant historical AADT data for the study area where available. Figure 2.3 presents graphically the historical AADT traffic volumes along the Great Western Highway through Raglan, Kelso and Bathurst

Table 2.2 AADT summary

Location	1984	1988	1992	1996	1999	2002	2005
Great Western Highway (SH5)							
1.5km west of Glanmire Road				8307	8872	9340	7934
East of Airport Road		5702	5816				
East of Littlebourne Street (MR253)	8120	10172	12901	14479	15034	14805	13296
East of Boyd Street	12380	10854	14024	19491	18801	19713	20422
West of Gilmour Street (MR54)	16250	14138	18965	26881	27891	22242	24378
East of Bentinck Street (MR54)	14580						
West of Bentinck Street (MR54)	16430			24403	24438	18611	19213
East of Stewart Street	13980	11226					
North of Vittoria Street (SH7)	8700	9256	12102	11188	12391	11225	13896
Gilmour Street (MR54)							
North of Sydney Road (SH5)	2410	3370	3543	4908		4311	4877
Lee Street							
South of Sydney Road (SH5)	2980	3974	143	6445	569	878	302
Littlebourne Street (MR253)							
South of Lee St				2424		2750	8131

Figure 2.3 Great Western Highway (SH5) AADT 1972 to 2005

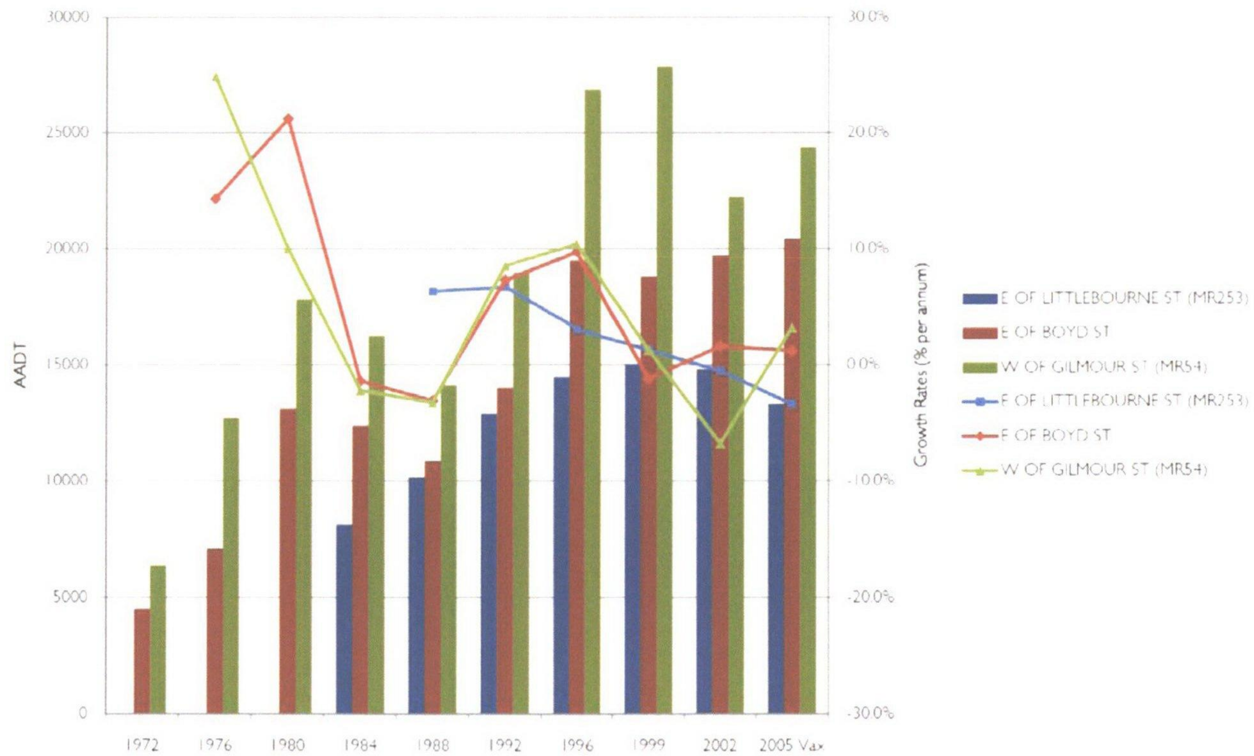


Annual average growth rates have been determined by analysing the historical AADT data. Table 2.3 provides an assessment of the changes in traffic volumes for the AADT figures and provides an indication of the annual changes in traffic volumes from preceding survey years to the latest available figures (2005) as a percentage change per annum.

Table 2.3 AADT growth rates 1996 to 2005

Location	Growth rates per annum (linear)			
	1984 to 2005	1992 to 2005	1996 to 2005	2002 to 2005
Great Western Highway (SH5)				
1.5km west of Glanmire Road			-0.50%	-5.02%
East of Littlebourne Street (MR253)	3.04%	0.24%	-0.91%	-3.40%
East of Boyd Street	3.09%	3.51%	0.53%	1.20%
West of Gilmour Street (MR54)	2.38%	2.20%	-1.03%	3.20%
West of Bentinck Street (MR54)	0.81%		-2.36%	1.08%
North of Vittoria Street (SH7)	2.84%	1.14%	2.69%	7.93%
Gilmour Street (MR54)				
North of Sydney Road (SH5)	4.87%	2.90%	-0.07%	4.38%
Lee Street				
South of Sydney Road (SH5)	-4.28%	8.55%	-10.59%	-21.87%
Littlebourne Street (MR253)				
South of Lee St			26.16%	65.22%

Figure 2.4 Great Western Highway (SH5) at Kelso, AADT growth rates 1972 to 2005*



* Growth rates shown are relative to the previous period i.e. growth rates shown for 1996 represents the linear annual growth from 1992 to 1996

The growth rates shown in Table 2.3 and Figure 2.4 indicate that while some sections of road in the study area have experienced moderate to significant traffic growth in the past, there is generally minimal growth or a decline in traffic volumes in later years (since 1996).

2.4 TRAFFIC FLOWS AND COMPOSITION

2.4.1 Data collection

A range of traffic data, collected since 2007, was been relied upon for this study. The types of data collected are:

- Intersection Turning Counts.
- Classification Counts.
- Origin Destination Survey.
- Field Observations.

The survey locations are shown on Figure 2.5.

Classification Counts

In May/June 2007 and August 2010 full classification tube counts were undertaken at two locations on the Great Western Highway in the study area. These surveys recorded traffic volumes (passenger cars and heavy vehicle movements) by direction, vehicle type and hour over a period of a week. Heavy vehicle movements are recorded by number of axle pairs.

Intersection Turning Counts

Intersection turning counts were undertaken during the AM and PM peak periods in March 2011. All turning movements by vehicle class, as well as the number of pedestrian movements, were recorded for the survey period.

Origin Destination Survey

A number plate survey was undertaken for all vehicles travelling along the Great Western Highway entering or exiting the study area. These surveys were undertaken during the AM and PM peak periods in June 2011. Video cameras were used to record the number plate of all vehicles entering or exiting the study area. The total volume of traffic entering and exiting the study area were then established. Number plate matching software was used to determine the proportion of vehicles that passed through the study area.

Field Observations

Additional field observations were undertaken on 3 separate occasions to consider:

- Queuing at intersections.
- Travel times through the study area.
- Turn movements out of private properties along the highway.


To Sydney
Ashworth Drive
Pat O'Leary Drive
Littlebourne Street
View Street
Bryce Street
Gilmour Street
N
To Bathurst
Cardno
Shaping the Future
Figure 2.5
TRAFFIC SURVEY LOCATIONS
Legend
1 Mid block classification counts (June 2007)
2 Mid block classification counts (August 2010)
Intersection surveys (March 2011)
Origin-destination number plate survey (June 2011)
Great Western Highway Upgrade, Kelso
CES01211

2.4.2 Daily traffic flows

A summary of the average daily traffic volumes is presented in Table 2.4. The average daily volumes represent the five day average of weekday daily traffic volumes.

Table 2.4 Average weekday daily traffic volumes (AWDT)

Location	Date	AWDT (vehicles per day)		
		East/North-bound	West/East-bound	Total
Great Western Highway (SH5)				
At Raglan Creek (west of Stockland Dr)	August 2010	12,905	13,668	26,574
At BP Kelso (east of Boyd St)	August 2010	10,452	10,226	20,678
West of Littlebourne Street	May-June 2007	9,868	9,710	19,578
East of Littlebourne Street	May-June 2007	6,909	6,969	13,879
Littlebourne Street (MR253)				
North of rail crossing	May-June 2007	4,401	4,438	8,789

Traffic volumes along the Great Western Highway vary significantly, from less than 14,000 vehicles per day at the eastern end to almost 27,000 vehicles per day at the western end (near Bathurst). Littlebourne Road (MR253) carries approximately 8,800 vehicles per day south of the highway.

2.4.3 Proportion of heavy vehicles

Heavy vehicle movements were recorded by number of axle pairs where the vehicles are classified as per Austroads vehicle classifications. Generally classes 1-2 are light vehicles, classes 3-5 are considered heavy rigid vehicles (HRV), and classes 6-13 are considered articulated vehicles (AV).

A summary of the proportion of heavy vehicles during an average weekday is presented in Table 2.5. The heavy vehicle proportions are shown as a percentage of total volumes for two-way average weekday daily traffic volumes.

Table 2.5 Average weekday daily heavy vehicle proportions (AWD)

Location	Date	Average weekday			
		%HRV*	%AV^	Tot HV~	%AV of HV
Great Western Highway (SH5)					
At Raglan Creek (west of Stockland Dr)	August 2010	6.4%	6.5%	12.9%	50.4%
At BP Kelso (east of Boyd St)	August 2010	7.0%	5.2%	12.2%	42.8%
West of Littlebourne Street	May-June 2007	6.4%	4.8%	11.2%	43.0%
East of Littlebourne Street	May-June 2007	7.1%	6.8%	13.9%	49.1%
Littlebourne Street (MR253)					
North of rail crossing	May-June 2007	10.1%	5.4%	15.5%	34.9%

* HRV = Heavy Rigid Vehicles ^ AV = Articulated Vehicles ~HV = Total Heavy Vehicles

The route within the study area carrying the highest proportion of heavy vehicles was shown to be Littlebourne Street; where south of the highway over 15 per cent of the daily traffic consisted of heavy vehicles. However, the Great Western Highway generally carries slightly higher proportions of articulated vehicles.

It is important to note that the proportion of heavy vehicles varies greatly by time of day. The daily profiles of heavy vehicle proportions are presented in Figure 2.6 to Figure 2.10 for the four sites along the Great Western Highway and one site on Littlebourne Street.

Figure 2.6 Great Western Highway (SH5) Raglan Creek, Kelso – 2010 AWDT heavy vehicles

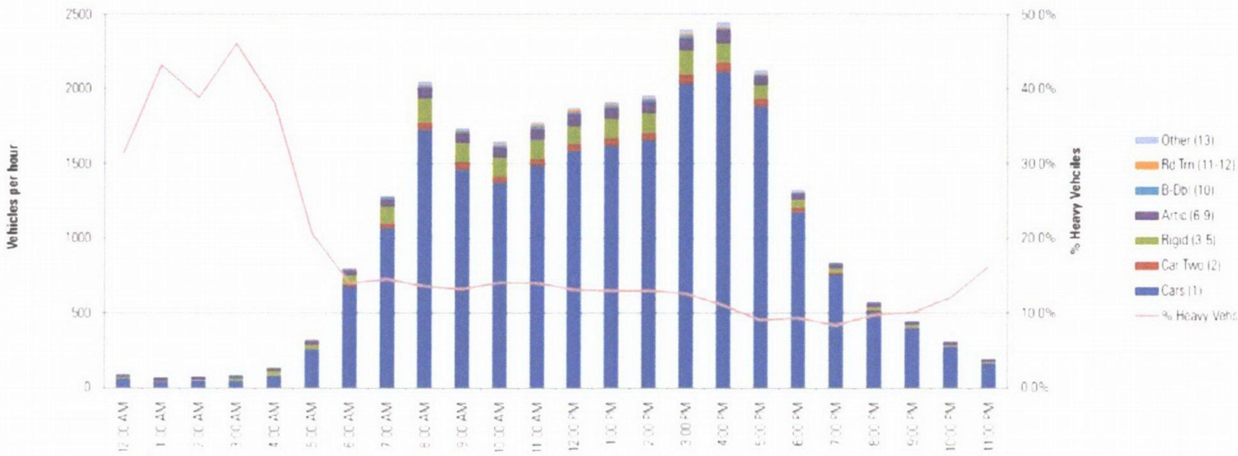


Figure 2.7 Great Western Highway (SH5) BP, Kelso – 2010 AWDT heavy vehicles

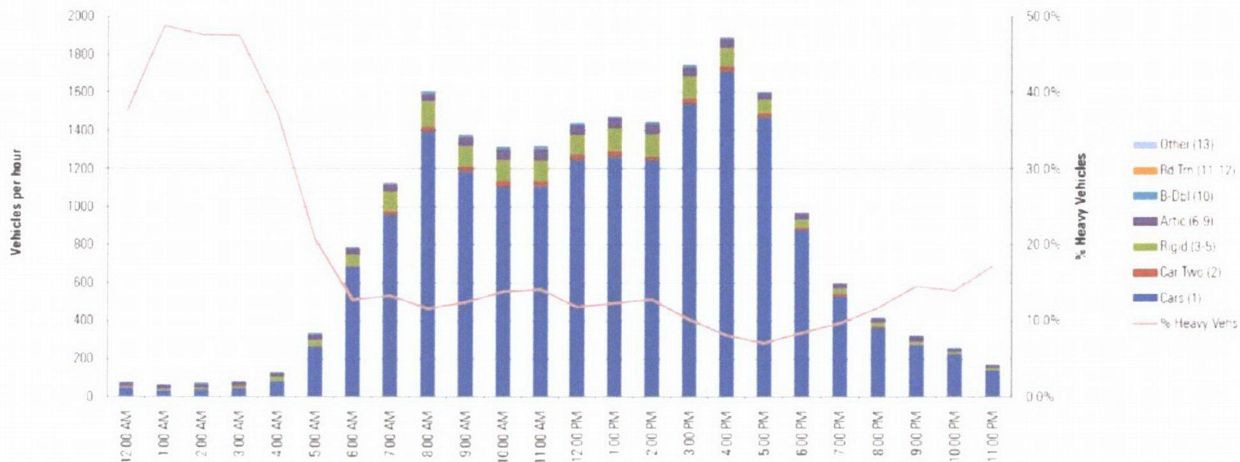


Figure 2.8 Great Western Highway (SH5) West of Littlebourne Street, Kelso – 2007 AWDT heavy vehicles

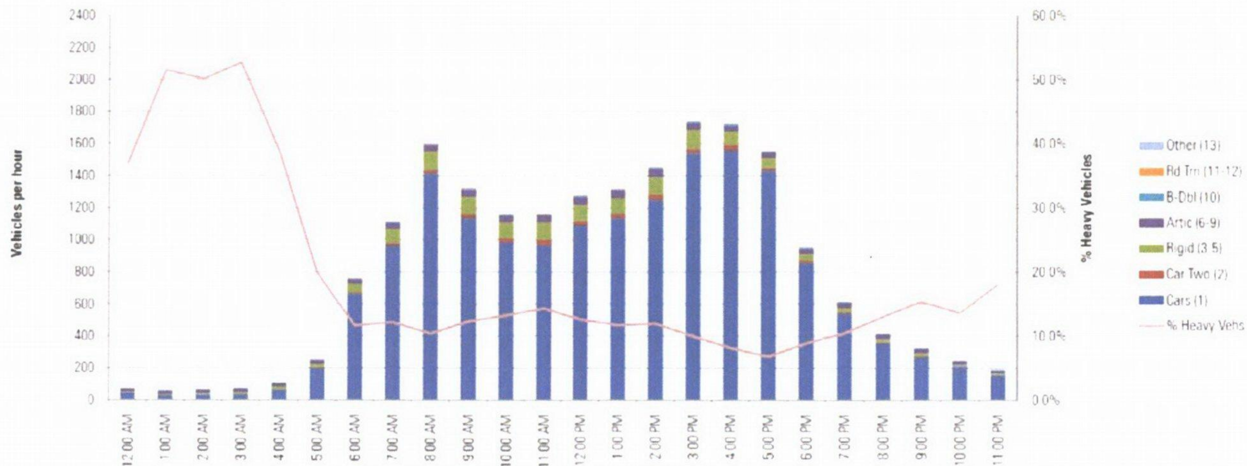


Figure 2.9 Great Western Highway (SH5) East of Littlebourne Street, Kelso – 2007 AWDT heavy vehicles

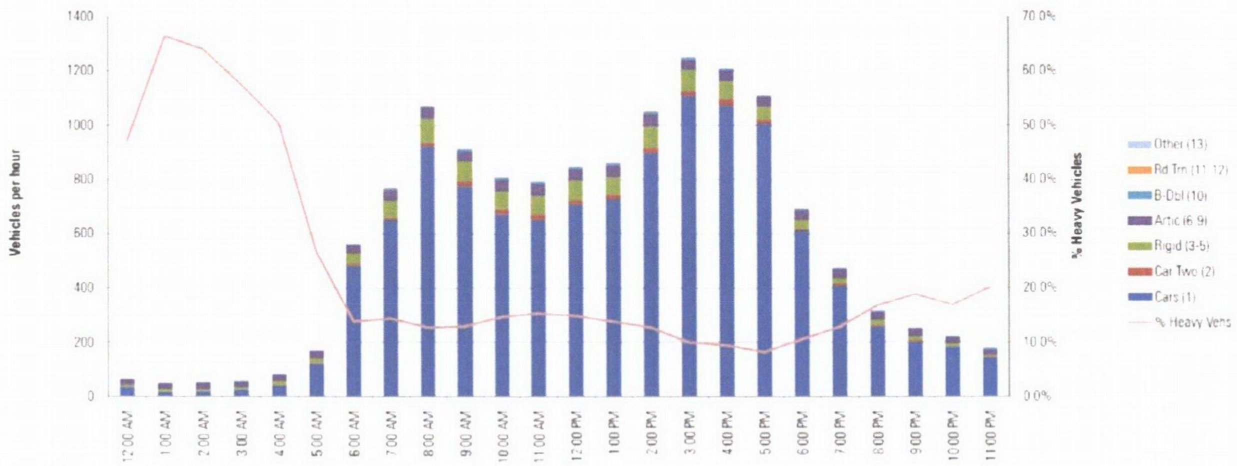


Figure 2.10 Littlebourne Street (MR253) North of rail crossing, Kelso – 2007 AWDT heavy vehicles

2.4.4 Peak traffic flows

The daily distribution of traffic is summarised in Figure 2.11 to Figure 2.15 for four sites along the Great Western Highway and one site on Littlebourne Street. This data shows that generally the afternoon peak is higher and longer.

A summary of the average morning peak traffic volumes is presented in Table 2.6. The morning peak was generally found to be between 8am and 9am across most sites. The 8 to 9am hourly traffic volumes have been provided for consistency across all routes.

A summary of the average afternoon peak traffic volumes is presented in Table 2.7. The afternoon peak was generally found to be between 3pm and 6pm across most sites with 4 to 5pm generally the highest. The 4 to 5pm hourly traffic volumes have been provided for consistency across all routes.

Figure 2.11 Great Western Highway (SH5) Raglan Creek, Kelso – 2010 AWDT

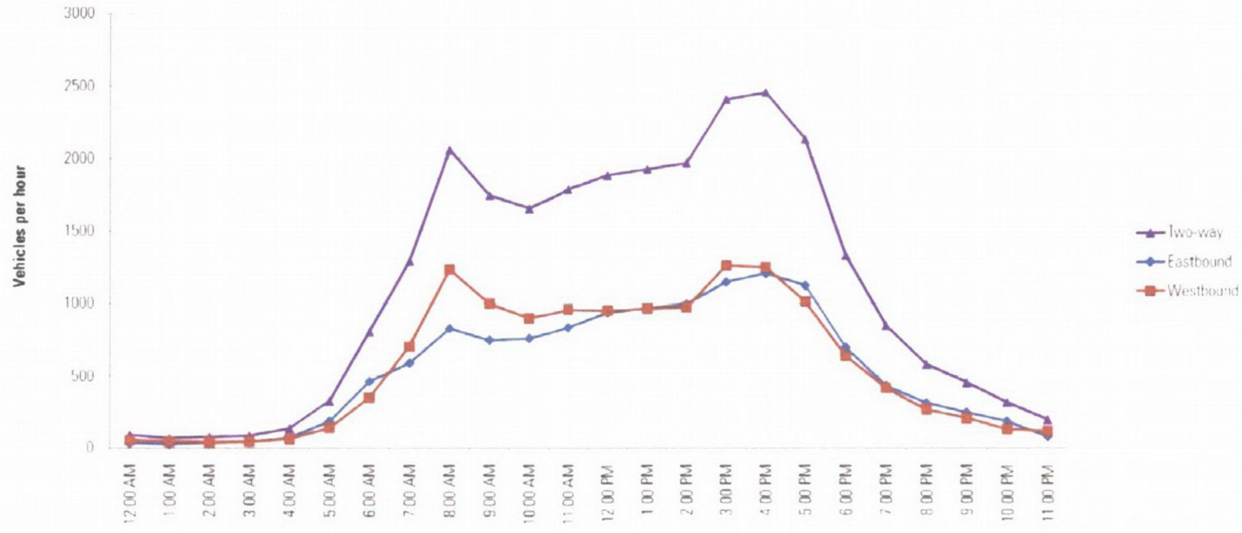


Figure 2.12 Great Western Highway (SH5) BP, Kelso – 2010 AWDT

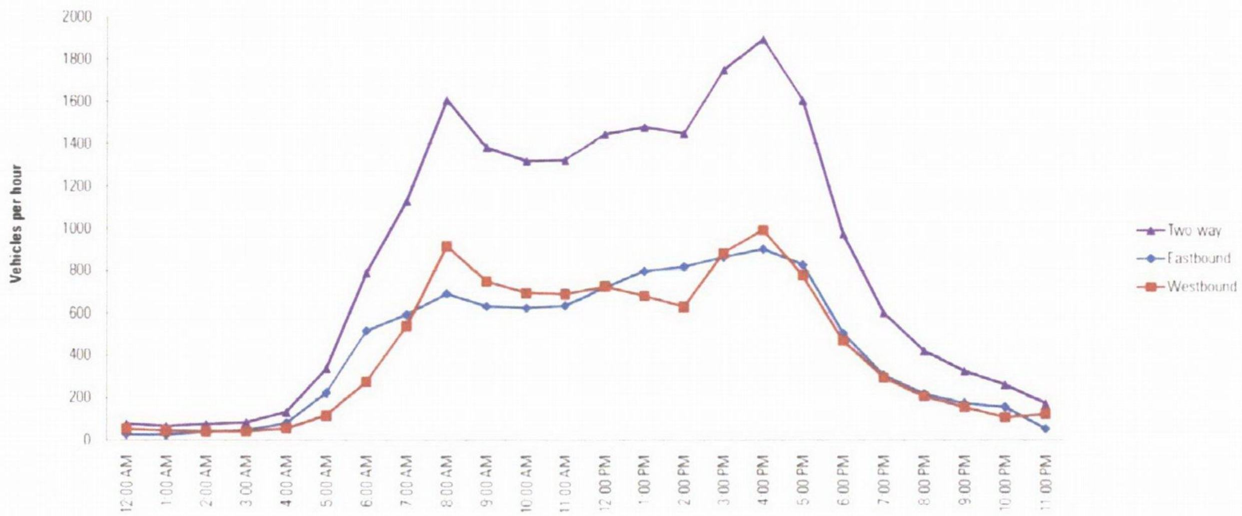


Figure 2.13 Great Western Highway (SH5) West of Littlebourne Street, Kelso – 2007 AWDT

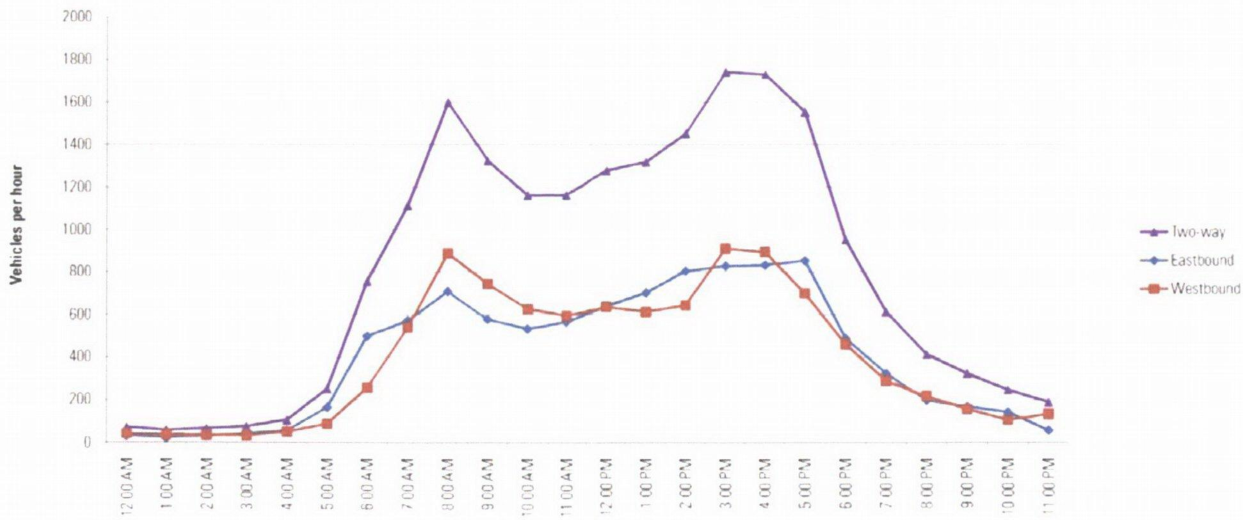


Figure 2.14 Great Western Highway (SH5) East of Littlebourne Street, Kelso – 2007 AWDT

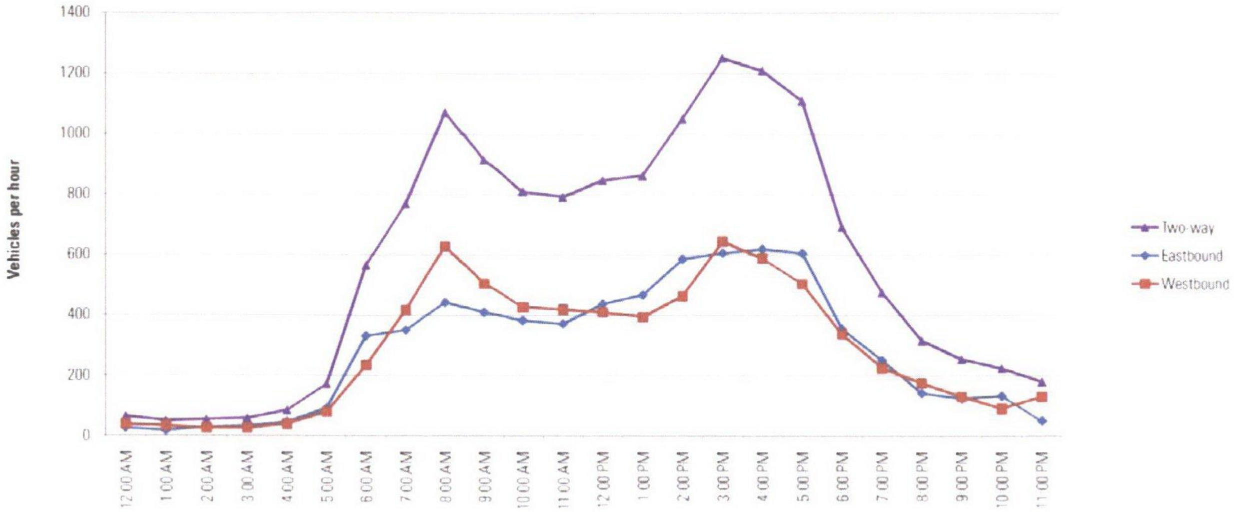


Figure 2.15 Littlebourne Street (MR253) North of rail crossing, Kelso – 2007 AWDT

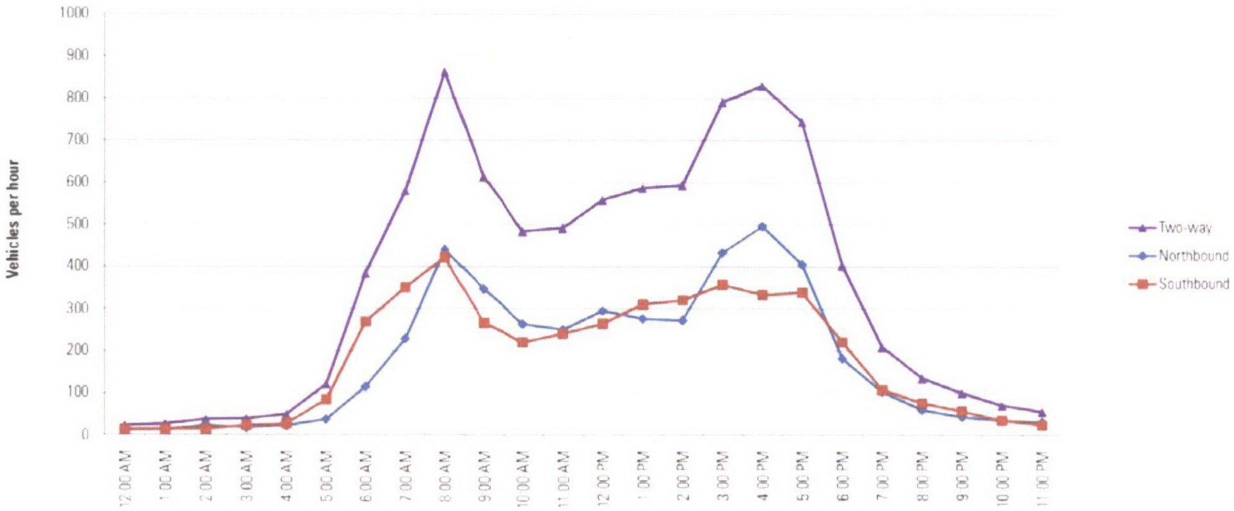


Table 2.6 Average weekday AM peak volumes

Location	Average weekday volumes 8—9am (veh/h)			
	East/North-bound	West/South-bound	Total	Peak Direction Split*
Great Western Highway (SH5)				
At Raglan Creek (west of Stockland Dr)	825	1,232	2,057	60% W/B
At BP Kelso (east of Boyd St)	691	915	1,606	57% W/B
West of Littlebourne Street	711	889	1,600	56% W/B
East of Littlebourne Street	443	629	1,072	59% W/B
Littlebourne Street (MR253)				
North of rail crossing	441	422	863	51% N/B

* E/B = Eastbound W/B = Westbound N/B = Northbound S/B Southbound

Table 2.7 Average weekday PM peak volumes

Location	Average weekday volumes 4—5pm (veh/h)			
	East/North-bound	West/South-bound	Total	Peak direction split*
Great Western Highway (SH5)				
At Raglan Creek (west of Stockland Dr)	1,205	1,247	2,451	51% W/B
At BP Kelso (east of Boyd St)	902	992	1,894	52% W/B
West of Littlebourne Street	834	896	1,731	52% W/B
East of Littlebourne Street	620	589	1,208	51% E/B
Littlebourne Street (MR253)				
North of rail crossing	496	334	829	60% N/B

* E/B = Eastbound W/B = Westbound N/B = Northbound S/B Southbound

2.4.5 Through traffic volumes

The proportion of through traffic travelling along the Great Western Highway (traffic travelling through the study area with no destinations along the highway or to any side roads) was estimated from a number plate matching survey undertaken at each end of the study area. The results are summarised in Table 2.8 and Table 2.9 for the AM and PM peak periods respectively.

Table 2.8 Great Western Highway through traffic volumes AM peak (8.15am – 9.15am)

Direction	Location	Peak hour volumes (veh/hr)			Per cent through traffic
		Total	Internal	External (through)	
Eastbound	Great Western Highway, west of Stockland Dr	832	566	266	32.0%
	Great Western Highway, east of Ashworth Dr	372	106		71.5%
Westbound	Great Western Highway, west of Stockland Dr	1454	1052	402	27.6%
	Great Western Highway, east of Ashworth Dr	604	202		66.6%

The above table shows that approximately 32 per cent of the AM peak eastbound entering traffic (west of Stockland Drive) continues along the highway and exits west of Ashworth Drive (where it is approximately 72 per cent of the departing traffic). Approximately 67 per cent of the AM peak westbound entering traffic (west of Ashworth Drive) continues along the highway and exits west of Stockland Drive (where it is approximately 28 per cent of the departing traffic).

Table 2.9 Great Western Highway through traffic volumes PM peak (4pm – 5pm)

Direction	Location	Peak hour volumes (veh/hr)			Per cent through traffic
		Total	Internal	External (through)	
Eastbound	Great Western Highway, west of Stockland Dr	1115	747	368	33.0%
	Great Western Highway, east of Ashworth Dr	480	112		76.7%
Westbound	Great Western Highway, west of Stockland Dr	1195	875	320	26.8%
	Great Western Highway, east of Ashworth Dr	466	146		68.7%

The above table shows that approximately 33 per cent of the PM peak eastbound entering traffic (west of Stockland Drive) continues along the highway and exits west of Ashworth Drive (where it is approximately 77 per cent of the departing traffic). Approximately 69 per cent of the AM peak westbound entering traffic (west of Ashworth Drive) continues along the highway and exits west of Stockland Drive (where it is approximately 27 per cent of the departing traffic).

2.5 ROAD NETWORK PERFORMANCE ASSESSMENT CRITERIA

LoS is an index of the operational efficiency of a roadway or intersection. The analysis is essential in the planning and design of the transport network and can influence the number of lanes provided or the arrangement of a traffic control system under study.

LoS can be measured at mid-block or at intersections. As a mid block measure, LoS is a qualitative measure describing the operational conditions on a road and their perception by a driver. At intersections, LoS is considered in terms of average delay experienced by drivers.

2.5.1 Urban roads mid-block capacity

The capacity of major streets within an urban area can be based on an assessment of their operating LoS. LoS is defined by AUSTROADS *Guide to Traffic Engineering Practice – Part 2 Roadway Capacity* 1988) as a qualitative measure of the effects of a number of features, which include speed and travel time, traffic interruptions, freedom to manoeuvre, safety, driving comfort and convenience, and operating costs.

The typical mid-block capacities for urban roads with interrupted flow are provided in Table 2.10.

Table 2.10 Typical mid-block capacities for urban roads with interrupted flow

Type of road		One-way mid-block lane capacity (pcu/hr)
Median or inner lane:	Divided Road	1,000
	Undivided Road	900
Outer or kerb lane:	With Adjacent Parking Lane	900
	Clearway Conditions	900
	Occasional Parked Cars	600
4 lane undivided:	Occasional Parked Cars	1,500
	Clearway Conditions	1,800
4 lane divided:	Clearway Conditions	1,900

Source: RTA Guide to Traffic Generating Developments

LoS is designated from A to F from best (free flow conditions) to worst (forced flow with stop start operation, long queues and delays) as follows:

- Los A: Free flow (almost no delays) - A condition of free flow in which individual drivers are virtually unaffected by the presence of others in the traffic stream. Freedom to select desired speeds and to manoeuvre within the traffic stream is extremely high, and the general level of comfort and convenience provided is excellent.
- Los B: Stable flow (slight delays) - In the zone of stable flow and drivers still have the reasonable freedom to select their desired speed and to manoeuvre within the traffic stream, although the general level of comfort and convenience is a little less than with LOS A.

- **Los C: Stable flow (acceptable delays)** - Also in the zone of stable flow, but most drivers are restricted to some extent in their freedom to select their desired speed and to manoeuvre within the traffic stream. The general level of comfort and convenience declines noticeably at this level.
- **Los D: Approaching unstable flow (tolerable delays)** - Close to the limit of stable flow and is approaching unstable flow. All drivers are severely restricted in their freedom to select their desired speed and to manoeuvre within the traffic stream. The general level of comfort and convenience is poor, and small increases in traffic flow will generally cause operational problems.
- **Los E: Unstable flow (congestion; intolerable delays)** - Occurs when traffic volumes are at or close to capacity, and there is virtually no freedom to select desired speeds or to manoeuvre within the traffic stream. Flow is unstable and minor disturbances within the traffic stream will cause break-down.
- **Los F: Forced flow (jammed).**

The typical capacity of urban lanes with interrupted flow is provided in Table 2.11 for each LoS, as defined in the RTA Guide to Traffic Generating Developments. These capacities may increase when priority is given to the major traffic flow at intersections or if there is flaring at intersections to accommodate more traffic. The spacing of intersections will differ with the hierarchy and function of the road.

Table 2.11 Urban road peak hour flows per direction

Level of service	Hourly flows (veh/hr)	
	One lane	Two Lanes
A	200	900
B	380	1400
C	600	1800
D	900	2200
E	1400	2800
F	1400	2800

Source: RTA Guide to Traffic Generating Developments

A service volume, as defined by AUSTROADS, is the maximum number of vehicles that can pass over a given section of roadway in one direction during one hour while operating conditions are maintained at a specified LoS. It is suggested that ideally, arterial and sub-arterial roads should not exceed service volumes at LoS C. At this level, whilst most drivers are restricted in their freedom to manoeuvre, operating speeds are still reasonable and acceptable delays experienced. However, in urban situations, arterial and sub-arterial roads operating at LoS D are still considered adequate. It is acceptable to provide road capacity at Level of Service 'D' in the peak hour since overprovision of road capacity is not conducive to promoting alternative transport modes to the car.

2.5.2 Uninterrupted two-lane rural road capacity

Uninterrupted Two-Lane Two-Way rural roads have one lane for use by traffic travelling in each direction. Overtaking of slower vehicles requires the use of the opposing traffic lane when sight distance and gaps in the opposing traffic stream permit. The term 'uninterrupted' describes the flow facilities where traffic flow conditions are the result of interactions between vehicles in the traffic stream, and between vehicles and the geometric and environmental characteristics of the road, and not the result of traffic controls. The Uninterrupted Two-Lane Two-Way roadway capacity is affected by factors such as, terrain, sight distance, lane widths, percentage of heavy vehicles, and directional distribution.

The roadway capacity for an uninterrupted two-lane two-way road is calculated using the following equation[1]:

$$SF_i \quad = \quad 2{,}800\ (v/c)_i\ f_d\ f_w\ f_{HV}$$

Where:

SF_i	=	Total service flow rate in vehicles per hour in both directions under prevailing roadway and traffic conditions for level of service 'i'
$(v/c)_i$	=	Maximum volume/capacity ratio which can be accommodated at level of service 'i' for a given terrain and percent of length with no overtaking
f_d	=	Adjustment factor for directional distribution of traffic
f_w	=	Adjustment factor for narrow lanes and shoulders
f_{HV}	=	Adjustment factor for heavy vehicles

2.5.3 Intersection performance criteria

The capacity of an urban road network is controlled by the capacity of the intersections within that network. Average delay is commonly used to assess the actual performance of intersections, with LoS used as an index. The average vehicle delay provides a measure of the operational performance of an intersection as, which relates AVD to LOS. The AVD's should be taken as a guide only as longer delays could be tolerated in some locations (i.e. inner city conditions) and on some roads (i.e. minor side street intersecting with a major arterial route). For traffic signals, the average delay over all movements should be taken. For roundabouts and priority control intersections (sign control) the critical movement for LoS assessment should be the movement with the highest average delay.

The key indicator of intersection performance is LoS, where results are placed on a continuum from 'A' to 'F', as shown in Table 2.12.

Table 2.12 Intersection level of service

Level of service	Average delay per vehicle (secs/veh)	Traffic Signal / Roundabout	Give way / stop sign / T-junction control
A	< 14	Good operation	Good operation
B	15 to 28	Good with acceptable delays and spare capacity	Acceptable delays and spare capacity
C	29 to 42	Satisfactory	Satisfactory, but accident study required
D	43 to 56	Operating near capacity	Near capacity & accident study required
E	57 to 70	At capacity, at signals incidents will cause excessive delays.	At capacity, requires other control mode
F	>70	Unsatisfactory and requires additional capacity, Roundabouts require other control mode	At capacity, requires other control mode

Source: RTA Guide to Traffic Generating Developments

[1] Austroads Guide to Traffic Engineering Practice, PART 2, Roadway Capacity, Section 3 Uninterrupted Two-Lane Two-Way Roads

The degree of saturation (DS) is another measure of the operational performance of individual intersections. For intersections controlled by traffic signals, both queue length and delay increase rapidly as DS approaches one (1). It is usual to attempt to keep DS to less than 0.9. Degrees of Saturation in the order of 0.7 generally represent satisfactory intersection operation. When DS exceed 0.9, queues can be anticipated.

2.6 MID-BLOCK PERFORMANCE

The mid-block performance of the existing road network has been assessed for the AM and PM peak hours in terms of:

- Level of service (LoS).
- Volume to capacity ratio (v/c).
- Average and 85th percentile travel speeds (at locations where classification counts were undertaken).

A summary of the results is presented in Table 2.13 and Table 2.14 for the AM and PM peak periods respectively. More detailed results are provided in Figure 2.16 to Figure 2.19 and in Appendix A.

It is noted that in the existing situation the highway was assessed as a rural road east of Littlebourne Road, the remainder was assessed as an interrupted urban road.

The analysis shows the section of the highway between Littlebourne Street and Boyd Street is generally operating at or above capacity:

- AM Peak eastbound: LoS D with v/c ratios between 0.8 and 1.0.
- AM Peak westbound: LoS E with v/c ratios greater than 1.0.
- PM Peak eastbound: LoS E with v/c ratios greater than 1.0.
- PM Peak westbound: LoS E with v/c ratios greater than 1.0.

Most other sections operate at LoS C or better with the exception of the section of the highway east of Littlebourne Street eastbound during the PM Peak.

Table 2.13 Existing AM peak mid-block performance

Location	Urban/Rural environment	Carriageway type	Speed limit (km/h)	No. of Lanes (per direction)	LoS		V/C Ratio		Observed Speed (km/hr) Average		Observed Speed (km/hr) 85%ile	
					E/N bound	W/S Bound	E/N bound	W/S Bound	E/N bound	W/S Bound	E/N bound	W/S Bound
Great Western Highway												
At Raglan Creek	Urban	U4LD	60	2	A	B	0.4	0.6	67.8	66.4	74.0	72.4
West of Stockland Dr	Urban	U4LD	60	2	B	C	0.5	0.7				
East of Stockland Dr	Urban	U4LD	60	2	A	B	0.5	0.7				
West of Gilmour St	Urban	U4LD	60	2	A	B	0.5	0.7				
East of Gilmour St	Urban	U4LD	60	2	A	B	0.5	0.7				
West of Lee St	Urban	U4LD	60	2	A	B	0.5	0.7				
East of Lee St	Urban	U4LD	60	2	A	B	0.5	0.7				
West of Boyd St	Urban	U4LD	60	2	A	B	0.5	0.7				
East of Boyd St	Urban	U2L	60	1	D	E	0.8	1.1				
At BP Kelso	Urban	U2L	60	1	D	E	0.8	1.0	53.7	49.9	62.9	54.9
West of View St	Urban	U2L	60	1	D	E	0.8	1.1				
East of View St	Urban	U2L	60	1	D	E	1.0	1.2				
West of Littlebourne St	Urban	U2L	60	1	D	E	0.9	1.2				
West of Littlebourne St	Urban	U2L	60	1	D	D	0.8	1.0	53.5	52.0	62.7	57.4
East of Littlebourne St	Rural	R2L	60	1	D	D	0.5	0.7	58.6	53.6	66.4	59.7
East of Littlebourne St	Rural	R2L	60	1	D	D	0.5	0.7				
West of Pat O'Leary Dr	Rural	R2L	60	1	D	D	0.5	0.7				
East of Pat O'Leary Dr	Rural	R2L	60	1	D	D	0.5	0.7				
West of Ashworth Dr	Rural	R2L	60	1	D	D	0.5	0.7				
East of Ashworth Dr	Rural	R2L	60	1	D	D	0.4	0.6				
Other Roads												
Stockland Dr, south of GWH	Urban	U2L	60	1	A	A	0.1	0.1				
Gilmour St, north of GWH	Urban	U2L	60	1	A	B	0.2	0.4				
Lee St, south of GWH	Urban	U2L	60	1	A	A	0.0	0.0				
Boyd St, north of GWH	Urban	U2L	60	1	A	B	0.2	0.4				
View St, north of GWH	Urban	U2L	60	1	A	A	0.1	0.2				
Littlebourne St, south of GWH	Urban	U2L	60	1	C	C	0.6	0.5				
Littlebourne St, north of rail crossing	Urban	U2L	60	1	C	C	0.5	0.5	56.9	55.0	65.5	62.6
Pat O'Leary Dr, south of GWH	Urban	U2L	60	1	A	A	0.0	0.0				
Ashworth Dr, south of GWH	Urban	U2L	60	1	A	A	0.1	0.1				

D Highlight locations with LoS D
E Highlight locations with LoS E
F Highlight locations with LoS E

0.9 Highlights locations with v/c ratio between 0.8 and 0.9
1.0 Highlights locations with v/c ratio between >= 1

Table 2.14 Existing PM peak mid-block performance

Location	Urban/Rural environment	Carriageway type	Speed limit (km/h)	No. of lanes (per direction)	LoS		V/C ratio		Observed speed (km/hr)			
									Average		85%ile	
					E/N bound	W/S bound	E/N bound	W/S bound	E/N bound	W/S bound	E/N bound	W/S bound
Great Western Highway												
At Raglan Creek	Urban	U2L	60	2	B	B	0.6	0.7	64.7	65.9	69.9	71.8
West of Stockland Dr	Urban	U4LD	60	2	B	B	0.7	0.7				
East of Stockland Dr	Urban	U4LD	60	2	B	B	0.7	0.7				
West of Gilmour St	Urban	U4LD	60	2	B	B	0.7	0.7				
East of Gilmour St	Urban	U4LD	60	2	B	B	0.7	0.7				
West of Lee St	Urban	U4LD	60	2	B	B	0.7	0.7				
East of Lee St	Urban	U4LD	60	2	B	B	0.7	0.7				
West of Boyd St	Urban	U4LD	60	2	B	B	0.7	0.7				
East of Boyd St	Urban	U2L	60	1	E	E	1.3	1.3				
At BP Kelso	Urban	U2L	60	1	E	E	1.0	1.1	51.1	49.4	57.7	54.4
West of View St	Urban	U2L	60	1	E	E	1.2	1.2				
East of View St	Urban	U2L	60	1	E	E	1.3	1.3				
West of Littlebourne Street	Urban	U2L	60	1	E	E	1.3	1.3				
West of Littlebourne Street	Urban	U2L	60	1	D	D	0.9	1.0	50.9	50.0	57.7	56.4
East of Littlebourne Street	Rural	U2L	60	1	D	D	0.7	0.7	56.6	54.3	62.4	60.4
East of Littlebourne Street	Rural	R2L	60	1	E	E	1.0	0.9				
West of Pat O'Leary Dr	Rural	R2L	60	1	E	E	1.0	0.8				
East of Pat O'Leary Dr	Rural	R2L	60	1	E	E	1.0	0.8				
West of Ashworth Dr	Rural	R2L	60	1	E	E	1.0	0.8				
East of Ashworth Dr	Rural	R2L	60	1	E	E	0.9	0.8				
Other Roads												
Stockland Dr, south of GWH	Urban	U2L	60	1	A	A	0.2	0.1				
Gilmour St, north of GWH	Urban	U2L	60	1	B	B	0.3	0.3				
Lee St, south of GWH	Urban	U2L	60	1	A	A	0.0	0.0				
Boyd St, north of GWH	Urban	U2L	60	1	B	B	0.3	0.3				
View St, north of GWH	Urban	U2L	60	1	A	A	0.1	0.1				
Littlebourne St, south of GWH	Urban	U2L	60	1	C	C	0.6	0.5				
Littlebourne St, north of rail crossing	Urban	U2L	60	1	C	B	0.6	0.4	57.6	55.8	63.2	63.2
Pat O'Leary Dr, south of GWH	Urban	U2L	60	1	A	A	0.0	0.0				
Ashworth Dr, south of GWH	Urban	U2L	60	1	A	A	0.1	0.1				

D — Highlight locations with LoS D
E — Highlight locations with LoS E
F — Highlight locations with LoS E
0.9 — Highlights locations with v/c ratio between 0.8 and 0.9
1.0 — Highlights locations with v/c ratio between >= 1

Figure 2.16 Existing mid-block performance - AM peak East/Northbound

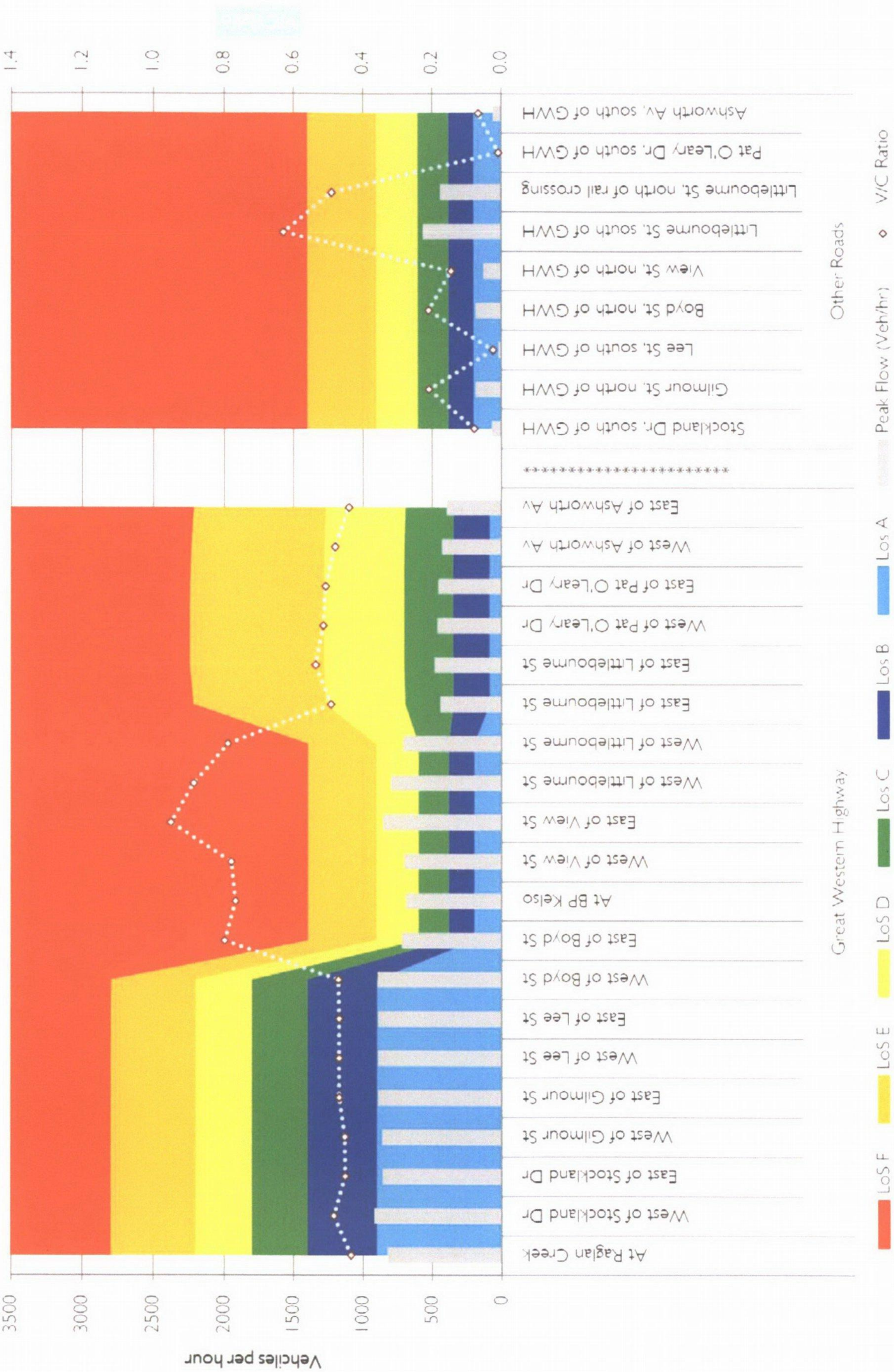


Figure 2.17 Existing mid-block performance - AM peak West/Southbound

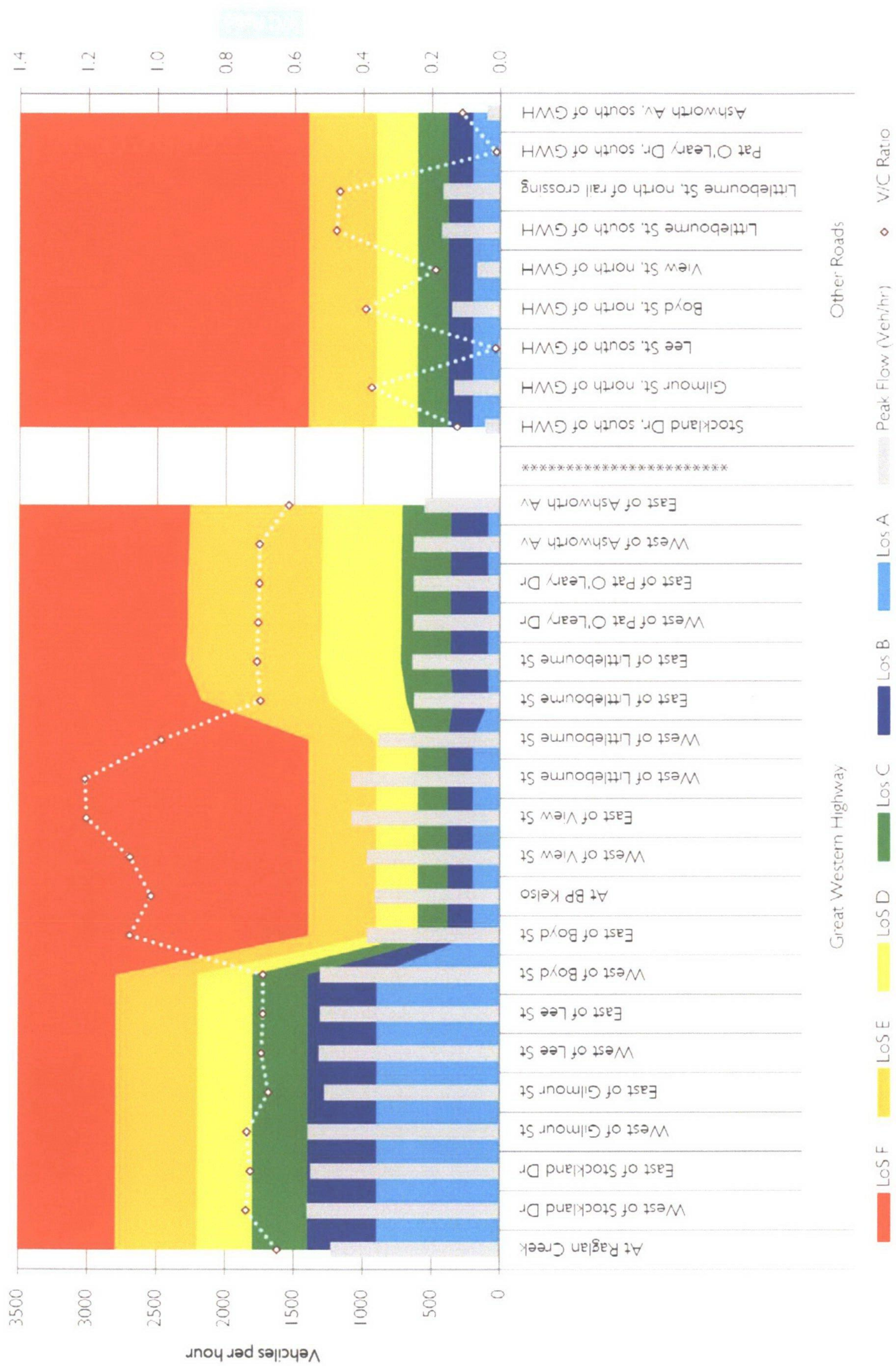


Figure 2.18 Existing mid-block performance - PM peak East/Northbound

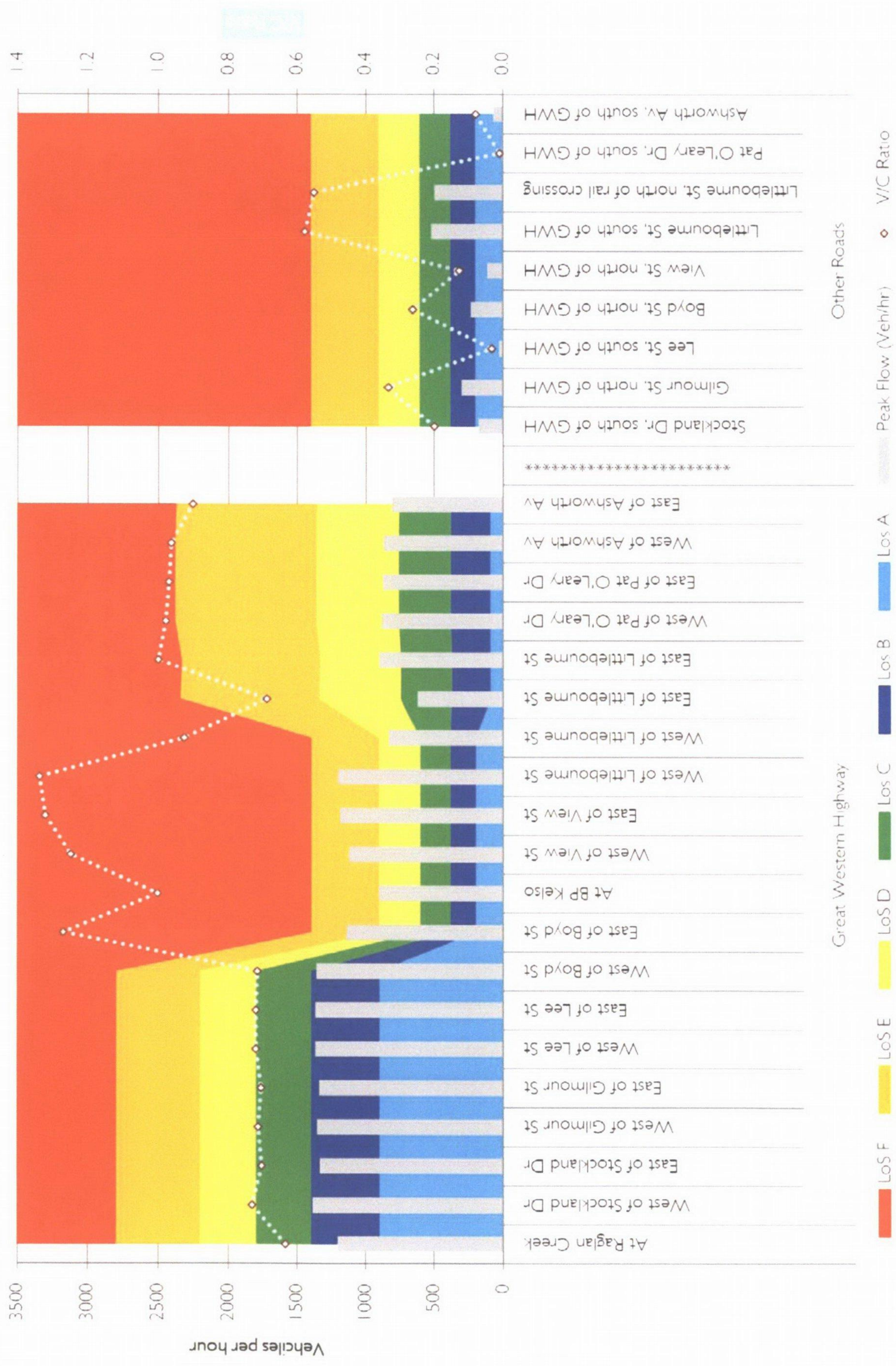
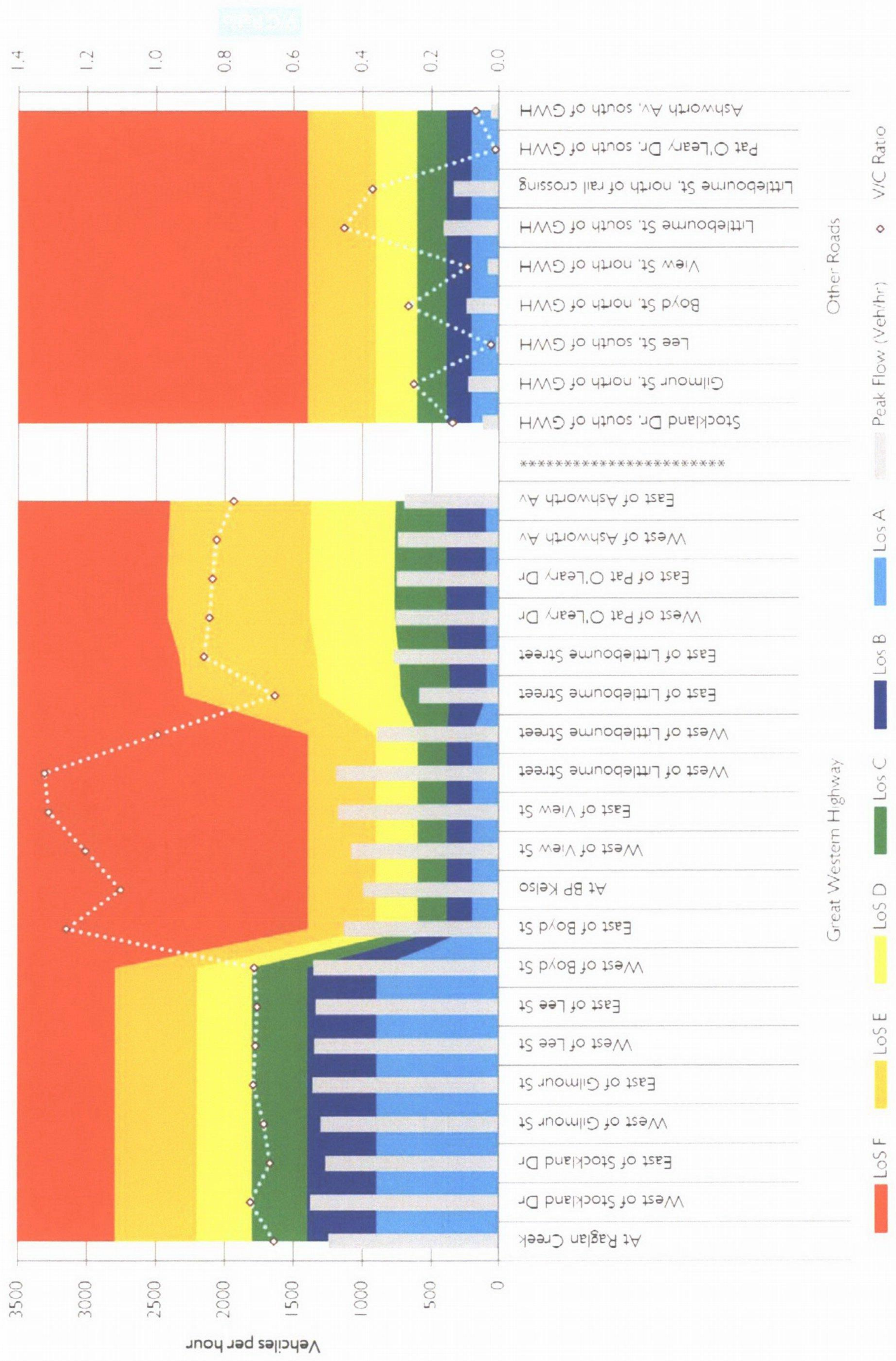


Figure 2.19 Existing mid-block performance - PM peak West/Southbound



2.7 INTERSECTION PERFORMANCE

The operating performance of intersections has been assessed using the SIDRA software package to determine the degree of saturation (DS), average vehicle delay (AVD in seconds), LoS and queue lengths at each intersection. The existing AM and PM peak hour intersection turning volumes are provided in Figure 2.20 and Figure 2.21.

The intersections were analysed to determine the operating characteristics under the existing traffic conditions with existing traffic volumes. The intersections were analysed using the existing intersection layout. The analysis results are summarised in Table 2.15 and Table 2.16 for the AM and PM peak hours respectively. Full result summaries are provided in Appendix B and Appendix C for the AM and PM peak hours respectively.

Table 2.15 Summary of 2011 AM peak hour SIDRA analysis

Intersection of GWH with	Control*		Degree of saturation	LoS	Average delay (sec/veh)	Max queue (m)	Comment
Stockland Dr	Give-way	Average	0.36	A	4.5	-	Worst movement is the right turn out of Stockland Dr
		Worst	0.04	A	10.9	-	
Gilmour St	Traffic signals	Average	0.57	B	16.2	83	Right turn movement into Gilmour is LoS C approaching D
Lee St	Stop / Left-out only / No right turn	Average	0.35	A	0.2	-	Worst movement is the left turn out of Lee St
		Worst	0.08	B	18.2	-	
Boyd St	Traffic signals	Average	0.66	B	14.6	106	Worst movement is the right turn out of Boyd St
View St	Give-way	Average	0.57	A	5.1	61	Worst movement are the left and right turns out of View St
		Worst	0.57	B	23.7	28	
Littlebourne St	Traffic signals	Average	0.82	B	23.2	187	Right turn movement out of Littlebourne is LoS D approaching E. The longest queues are on the GWH westbound.
Pat O'Leary Dr	Give-way	Average	0.34	A	1.4	12	Worst movement are the left and right turns out of Pat O'Leary Dr
		Worst	0.00	B	15.5	0	
Ashworth Dr	Give-way	Average	0.29	B	1.7	6	Worst movement is the right turn out of Ashworth Dr
		Worst	0.22	B	15.2	6	

* For priority controlled and roundabout junctions the overall LoS is based on the LoS of the worst movement

Give-way or yield priority controlled side road; Stop sign on side road; Round about; Traffic signals

Left-out only from side road; No right turn into side road; U-turn facility provided

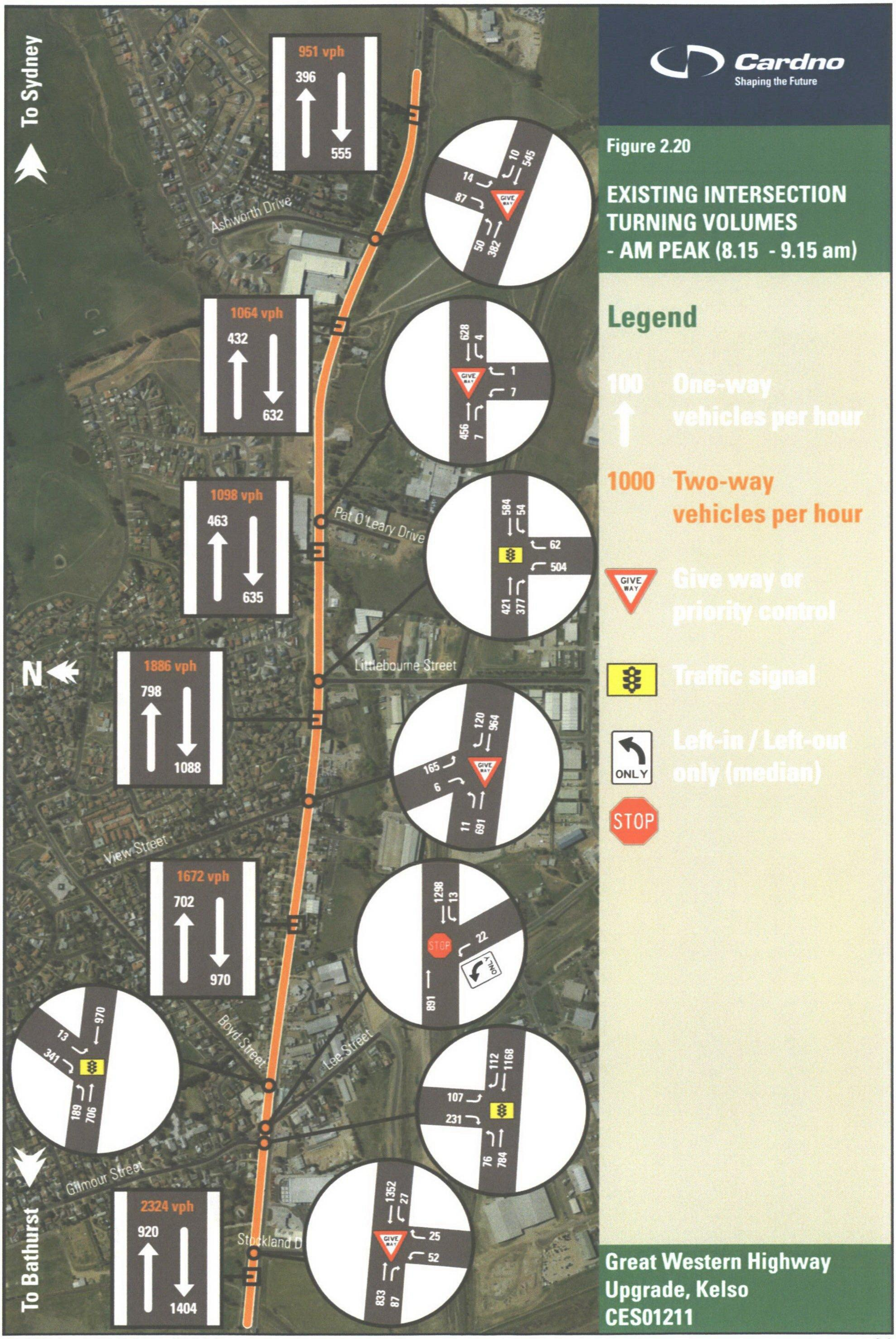


Figure 2.20

EXISTING INTERSECTION TURNING VOLUMES - AM PEAK (8.15 - 9.15 am)

Figure 2.21

EXISTING INTERSECTION TURNING VOLUMES - PM PEAK (4.00 - 5.00 pm)

Legend

100 One-way vehicles per hour

1000 Two-way vehicles per hour

GIVE WAY Give way or priority control

Traffic signal

ONLY Left-in / Left-out only (median)

STOP

Great Western Highway Upgrade, Kelso CES01211

Table 2.16 Summary of 2011 PM peak hour SIDRA analysis

Intersection of GWH with	Control		Degree of saturation	LoS	Average delay (sec/veh)	Max queue (m)	Comment
Stockland Dr	Priority	Average	0.35	A	3.9	-	Worst movement is the right turn out of Stockland Dr
		Worst	0.14	B	15.2	-	
Gilmour St	Signals	Average	0.70	A	14.3	113	Right turn movements into and out of Gilmour St are LoS C approaching D. The longest queues are on the GWH eastbound.
Lee St	Priority	Average	0.37	A	0.3	-	Worst movement is the left turn out of Lee St
		Worst	0.12	B	18.9	-	
Boyd St	Signals	Average	0.77	B	15.6	142	Worst movement is the right turn out of Boyd St, with the longest queues on the GWH westbound.
View St	Priority	Average	0.55	A	5.4	67	The critical movement (longest delays and queues) is the right turn into View St
		Worst	0.55	B	20.6	67	
Littlebourne St	Signals	Average	0.86	B	22.3	231	Right turn movement out of Littlebourne St is LoS D approaching E. The longest queues are on the GWH westbound.
Pat O'Leary Dr	Priority	Average	0.01	B	26.2	-	Worst movement is the right turn out of Pat O'Leary Dr
		Worst	0.41	A	3.0	38	
Ashworth Dr	Priority	Average	0.27	B	27.1	6	Worst movement is the right turn out of Ashworth Dr
		Worst	0.43	A	1.3	6	

2.8 CRASH ANALYSIS

RTA crash data was supplied for the study area for the five year period from 2006 to 201P. This data was used in a crash investigation of the existing road network. Generally crash data is categorised as; tow-away, injury and fatality.

Definitions

These crash statistics along with traffic volume counts (where available) were used to calculate crash rates, casualty rates and fatality rates. The following definitions were used in these calculations:

- Road Crash: An apparent, unpremeditated event which results in death or injury to a person, or vehicle or property damage and is attributable to the movement of a road vehicle(s) on a public road.
- Casualty Crash: A crash involving either an injury or a fatality.
- Crash Rate: The number of crashes per 100 million vehicle kilometres travelled (MVKT).
- Casualty Rate: The number of casualties (number of people injured or killed) per 100 MVKT.
- Fatality Rate: The number of fatalities (number of people killed) per 100 MVKT.

- Severity Index: An index value relating the severity of crashes to their respective amounts. The following weightings are used for each crash type:
  - Tow-away crashes 1.0
  - Injury crashes 1.5
  - Fatality crashes 3.0
- Critical Crash Rate: A statistically derived number based on the sample data for each section of road. It provides a 95 per cent confidence limit crash rate to compare against the crash rates for each sub-section. Any casualty crash rate above this limit suggests a high priority road length. The following formula was used to calculate the limit:

$$CR = A + 1.645\sqrt{\frac{A}{M}} + \frac{1}{2M}$$

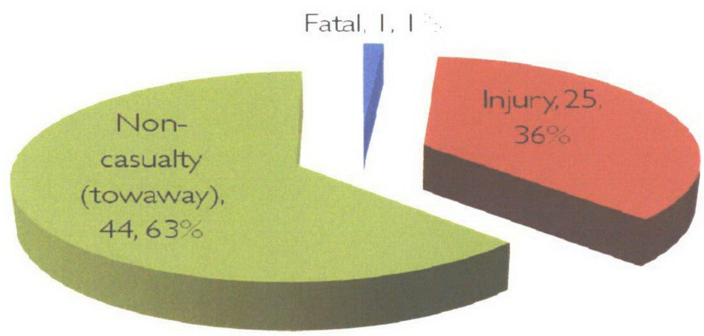
Where: A is the average casualty crash rate for the length of road.

M is the 100 MVKT for the length of road.

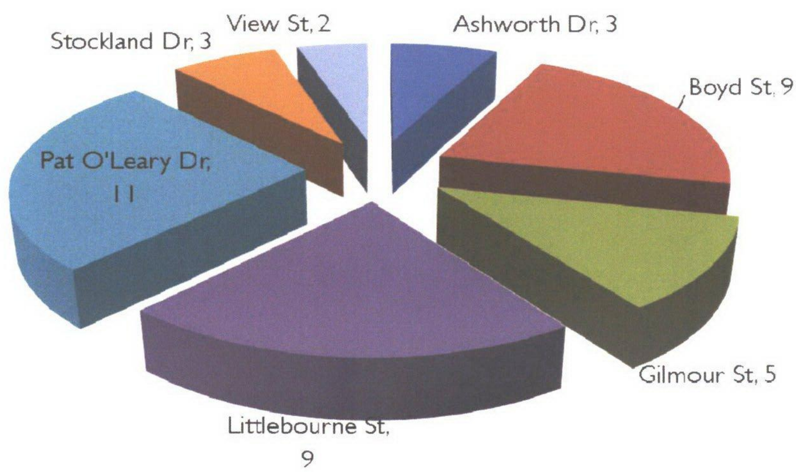
Crash overview

A brief overview of crash statistics for the Great Western Highway through the study area follows:

- There were a total of 70 crashes with an overall severity index of 1.2:



  - 25 injury crashes resulted in 29 injuries.
  - One (1) fatal crash resulted in one (1) death.
- 42 crashes occurred at intersections, more than half occurred at the three signalised intersections:



  - The majority of the injuries (76 per cent) occurred at intersections.

- Of the 70 crashes:
  - 21 crashes (30 per cent) involved heavy vehicles.
  - 3 crashes (4.3 per cent) involved motorcycles resulting in 1 injury.
  - 4 crashes (5.7 per cent) involved bicycles resulting in 4 injuries.
  - 2 crashes (2.9 per cent) involved pedestrians resulting in 1 injury and 1 pedestrian death.

An overview of crashes along the highway by section is provided in Table 2.17, showing length, average weekday traffic volume (AWD), percentage heavy vehicle traffic (%HV) and millions of vehicle kilometres travelled (MVKT) for each sub-section of road.

Table 2.17 Road crash summary by section (2006-2010)

Section	Length (km)	ADT	% HV	100 MVKT	No crashes by crash type				Severity index*	No. casualties by crash type		%HV crashes^
					Tow (T)	Injury (I)	Fatality (F)	Total		Injury (I)	Fatality (F)	
West of Stockland	0.20	29915	6.6%	0.022	0	0	0	0	0.00	0	0	0.0%
Stockland to Gilmour	0.15	28453	6.9%	0.015	0	3	0	3	1.50	4	0	0.0%
Gilmour to Boyd	0.07	28655	6.9%	0.007	4	0	1	5	1.40	0	1	40.0%
Boyd to View	0.38	23358	9.4%	0.033	6	8	0	14	1.29	10	0	21.4%
View to Littlebourne	0.17	25407	9.4%	0.015	6	3	0	9	1.17	3	0	33.3%
Littlebourne to Pat O'Leary	0.21	16957	10.9%	0.013	16	6	0	22	1.14	6	0	27.3%
Pat O'Leary to Ashworth	0.38	16364	8.6%	0.023	11	3	0	14	1.11	3	0	50.0%
East of Ashworth	0.20	14863	9.6%	0.011	1	2	0	3	1.33	3	0	0.0%
Sub-Total/Average	**1.76**	**21670**	**8.6%**	**0.139**	**44**	**25**	**1**	**70**	**1.21**	**29**	**1**	**30.0%**

* Weightings for Severity Index (T = 1.0, I = 1.5, F = 3.0)

Severity index and crash rates

The number of incidents and their severities were assessed along with a severity index and the number of casualties for each sub-section of road. Whilst the sections of the highway between Boyd Street and Ashworth Drive had the highest number of crashes, the section between Stockland Drive and Boyd Street had the highest severity indices.

The proportion of heavy vehicle crashes per sub-section was compared to the corresponding percentage of heavy vehicle movements. The percentage of crashes involving heavy vehicles relative to the percentage of heavy vehicle volumes was high. Overall 30 per cent of crashes involved heavy vehicles, yet the heavy vehicles represented less than 10 per cent of traffic by volume.

The crash statistics in Table 2.17 were used to calculate the casualty rates, fatality rates and crash rates for each sub-section of road. These values are presented in Table 2.18. Comparisons between the critical crash rates and crash rates for each length of road and the respective sub-sections emphasise which areas include crash clusters.

Table 2.18 Crash rates on key road sections (2004 to 2008)

Section	Casualty rate (per 100MVKT)	Fatality rate (per 100MVKT)	Crash rates (per 100MVKT)					Critical crash rates (per 100MVKT)
			T	I	F	Total	Casualty^	
West of Stockland	0.00	0.00	0.0	0.0	0.0	0.0	0.0	
Stockland to Gilmour	52.58	0.00	0.0	39.4	0.0	39.4	39.4	
Gilmour to Boyd	27.51	27.51	110.1	0.0	27.5	137.6	27.5	
Boyd to View	61.35	0.00	36.8	49.1	0.0	85.9	49.1	
View to Littlebourne	38.86	0.00	77.7	38.9	0.0	116.6	38.9	
Littlebourne to Pat O'Leary	91.63	0.00	244.3	91.6	0.0	336.0	91.6	
Pat O'Leary to Ashworth	26.16	0.00	95.9	26.2	0.0	122.1	26.2	
East of Ashworth	55.30	0.00	18.4	36.9	0.0	55.3	36.9	
Sub-Total/Average	**43.09**	**1.44**	**63.2**	**35.9**	**1.4**	**100.5**	**37.3**	**67.9**

^ 111 Sites where the individual casualty crash rate exceeds the critical crash rate for the section.

The section of highway between Littlebourne ST and Pat O'Leary Drive had a casualty crash rates exceeding the critical crash rate of 67.9 for the whole section.

The RTA's State Plan has a target of *"reducing road fatalities to 0.7 per 100 million vehicle kilometres travelled by 2016"*. The whole length of the Great Western Highway through the study area **has a fatality rate of 1.4 per 100 million vehicle kilometres travelled – almost double the target figure.** However, it is noted that there is only one fatal accident within the period, which is skewing the results.

The overall crash rate (fatal, injury and tow-away) for the Great Western Highway, through the study area, over the same period is 37.3 per 100 million vehicle kilometres travelled.

In 2004 the RTA published typical rural crash rates by road stereotypes based on data for the period 1997 to 2001. The data was collected from a sample of 10,000 km of main road across NSW – a sample considered an adequate representation of all rural roads in NSW. In the category 'two lane non-divided carriageway, with auxiliary lanes':

- The stereotypical fatal crash rate for major roads was calculated to be 1.3 per 100 million vehicle kilometres travelled, only marginally lower than the overall crash rate for the Great Western Highway through the study area (1.4 per 100 million vehicle kilometres travelled).
- The stereotypical overall crash rate (fatal, injury and tow-away) in this category is 30.4 per 100 million vehicle kilometres travelled. The overall crash rate for the Great Western through the study area (37.3 per 100 million vehicle kilometres travelled) is 23 per cent higher.

3 MODELLING OVERVIEW

As part of the assessment of the Great Western Highway through Kelso Paramics traffic modelling was undertaken. The purpose of this assessment process is to identify optimal intersection treatments for proposed future upgrades along the section of highway proposed for upgrade.

This section provides a summary of the Paramics Base Modelling for 2011 AM and PM Peak hour, showing how the current year models for 2011 have been calibrated and validated to achieve a good representation of existing conditions in the first instance, before any future year modelling is carried out. The calibration and validation of both AM and PM peak hour models have exceeded industry guidelines for traffic modelling.

This Paramics modelling follows previous SIDRA modelling which has already been completed. The purpose of the Paramics modelling is to achieve closure between both SIDRA and Paramics for robust checking and also to test the future proposed upgrades in a network which can visually and simultaneously demonstrate the impacts that the proposed changes could likely have along this section of the Great Western Highway in the future. Paramics has the added advantage that it will clearly show how changes at one junction will impact not just that, but also any others within the study area.

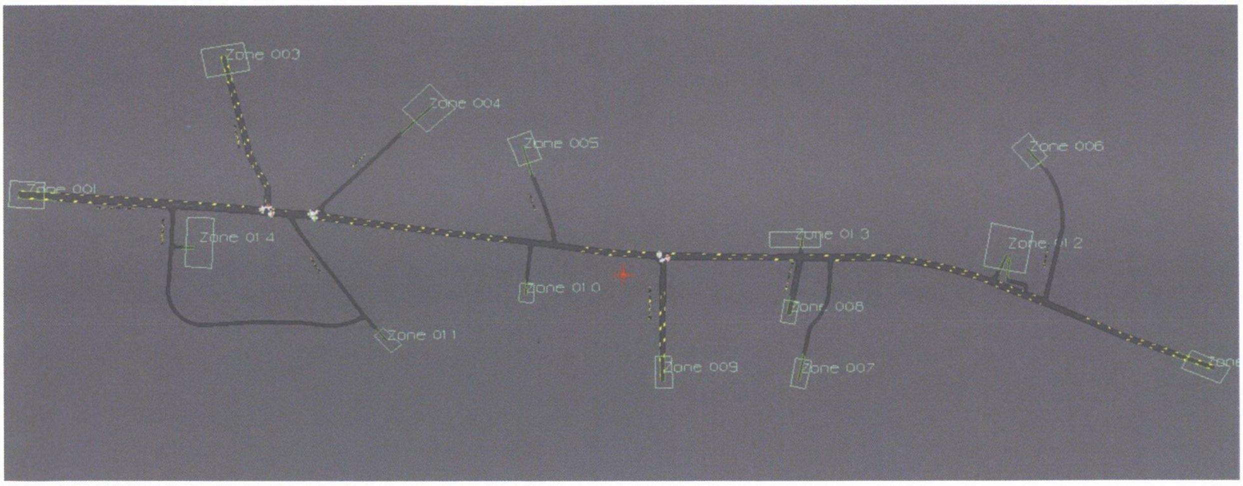
A detailed base model calibration report has been prepared and is provided in Appendix D.

3.1 MODEL STUDY AREA

The extent of the study area being modelled is shown in Figure 3.1, a 2.4km section of the Great Western Highway just east of Bathurst at Kelso. The extent of the Paramics model network, as developed for this study is shown Figure 3.2.

Figure 3.1 Paramics study area

Figure 3.2 Paramics modelled network



Within this model area there are currently:

- Three (3) signalised intersections:
  - Great Western Highway/Gilmour Street.
  - Great Western Highway/Boyd Street
  - Great Western Highway/Littlebourne Street.
- Eight (8) priority-controlled junctions:
  - Great Western Highway/Stockland Drive
  - Great Western Highway/Lee Street
  - Great Western Highway/EDI Rail Entrance/Exit
  - Great Western Highway/View Street
  - Great Western Highway/Pat O'Leary Drive
  - Great Western Highway/Devro Entrance/Exit
  - Great Western Highway/Bathurst Homemakers' Centre Entrance/Exit
  - Great Western Highway/Ashworth Drive

3.2 BASE MODEL CALIBRATION AND VALIDATION

Paramics models were calibrated and validated to represent average weekday conditions for the current conditions during the AM and PM peak hours in 2011. A current model is simply one that gives a good approximation of the average existing conditions for a designated period.

Paramics models which represent the existing conditions as at March 2011 (named in this report as Base Scenario) were built to represent the following peak hour time periods:

- 2011 current AM peak 08:15 to 09:15 (full model period: 07:15-09:15).
- 2011 current PM peak 16:00 to 17:00 (full model period: 15:00-18:00).

All models have been calibrated and validated to provide a robust representation of existing conditions. The criteria and results for which are provided in the calibration report in Appendix D. Existing observed characteristics were compared to modelled characteristics to demonstrate the robustness of the model:

- Calibration to traffic volumes.
- Validation to:
  - Travel times.
  - Queue lengths.

3.2.1 Traffic volume calibration

Table 3.1 and Table 3.2 show the calibration summary for each of the existing models developed. As can be seen, the calibration criteria have been exceeded significantly for each hour of each model, with 100 per cent of flows having a GEH < 5. In the AM model 100 per cent of GEH values were less than 2. Detailed modelled flows and GEH statistics are attached in the calibration report in Appendix D.

Table 3.1 AM peak calibration results summary

Data Type	GEH < 2	GEH < 5
Intersection Counts	100%	100%
Link Counts	100%	100%
Overall		100%

Table 3.2 PM peak calibration results summary

Data Type	GEH < 2	GEH < 5
Intersection Counts	93%	100%
Link Counts	100%	100%
Overall		100%

3.2.2 Travel time validation

The required criterion for travel time validation was:

- 85 per cent of movements to have modelled travel times within 15 per cent (or 1 minute, whichever is higher) of the observed travel times.

In this case, where a corridor model is built, we aimed to have travel times eastbound and westbound through the model to be within 15 per cent or 1 minute whichever was greater. Model travel times on Great Western Highway were therefore compared with the actual times as recorded on site. As with calibration, the validation was carried out for each modelled hour using the average of 5 seed runs, in each of the existing AM and PM peak hours.

The sections that were subject to travel time validation tests were:

- Vehicles travelling eastbound on Great Western Highway from Stockland Drive intersection to Ashworth Drive intersection.
- Vehicles travelling westbound on Great Western Highway from Ashworth Drive intersection to Stockland Drive intersection.

The model validation outputs for each of the AM and PM Peak models were robust, with travel times in both directions giving a solid representation. A summary of the validation results for each of the models is described in Table 3.3 and Table 3.4 for the eastbound and westbound travel respectively. The validation results have exceeded the validation criteria.

Table 3.3 Eastbound travel time validation results summary (mm:ss)

Great Western Highway eastbound from Stockland Drive to Ashworth Drive	Travel time (mm:ss)	
	AM	PM
Averaged Observed Time (mins)	02:36	03:10
Averaged Model Time (mins)	02:43	03:01
Averaged Difference (mins)	00:07	00:09
Averaged Travel Time Difference (%)	4.5%	4.7%

Table 3.4 Westbound travel time validation results Summary (mm:ss)

Great Western Highway westbound from Ashworth Drive to Stockland Drive	Travel time (mm:ss)	
	AM	PM
Averaged Observed Time (mins)	02:45	03:00
Averaged Model Time (mins)	02:54	03:08
Averaged Difference (mins)	00:09	00:08
Averaged Travel Time Difference (%)	5.5%	4.4%

3.2.3 Queue length validation

A final validation check was to compare modelled queue lengths along Great Western Highway with observed queues on site for the signalised approaches at the following intersections:

- Great Western Highway/Gilmour Street.
- Great Western Highway/Boyd Street.
- Great Western Highway/Littlebourne Street.

This additional validation was carried for each modelled peak hour using the average of 5 seed runs, in the existing AM and PM peak hours. The model validation queuing checks for each of the AM and PM Peak models were robust with the maximum observed queue lengths and modelled queue lengths broadly comparing well.

A summary of the results for queue length validation are illustrated in Table 3.5 and Table 3.6.

As can be seen from the results, there is generally good representation between the actual queues and the modelled queues in terms of operation. These queues should also be considered in light of the solid travel time representations and the fact that all GEHs are below 5.

Table 3.5 AM peak maximum queue lengths on approach (number of vehicles)

Intersection	Approach	Observed maximum queue	Modelled maximum queue (average of 5 Seeds)
Great Western Highway/Gilmour Street	GWH (W) - Eastbound	17	20
	GWH (E) - Westbound	20	24
	Gilmour Street	20	23
Great Western Highway/Boyd Street	GWH (W) - Eastbound	23	29
	GWH (E) - Westbound	27	32
	Boyd Street	9	12
Great Western Highway/Littlebourne Street	GWH (W) - Eastbound	44	50
	GWH (E) - Westbound	22	31
	Littlebourne Street	15	17

Table 3.6 PM peak maximum queue lengths on approach (number of vehicles)

Intersection	Approach	Observed maximum queue	Modelled maximum queue (average of 5 Seeds)
Great Western Highway/Gilmour Street	GWH (W) - Eastbound	36	42
	GWH (E) - Westbound	25	30
	Gilmour Street	10	9
Great Western Highway/Boyd Street	GWH (W) - Eastbound	27	33
	GWH (E) - Westbound	33	39
	Boyd Street	8	10
Great Western Highway/Littlebourne Street	GWH (W) - Eastbound	48	56
	GWH (E) - Westbound	40	46
	Littlebourne Street	14	15

3.2.4 Summary

The matching of modelled and observed traffic volumes as well as travel times and queue lengths to these levels, provides robust calibration and validation results, which show that the models are good representations of existing conditions within the study area.

3.3 BASE MODEL OUTCOMES

The following are brief descriptions of areas in the current year base models in 2011, where there are issues from a traffic operational perspective:

- Heavy queues for the right turning movement from Great Western Highway onto Littlebourne Street. The right turn bay is at capacity during the AM and PM peak period. In general the intersection of Littlebourne Street experiences the greatest levels of traffic. This is the case as Littlebourne Street serves the Industrial areas of Kelso as well as providing a route to Oberon.
- Relatively heavy congestion is experienced by eastbound and westbound traffic along the Great Western Highway but queues are generally cleared within one traffic signal cycle.

4 FUTURE DEVELOPMENT

The traffic volumes on the Great Western Highway in the future must be assessed to consider if the proposed upgrades will be sufficient to accommodate the traffic growth well into the future. Assuming that the upgrades were complete in 2015, we have assessed a twenty year forecast scenario to evaluate the performance of the highway in 2035. To do this we must assess the potential growth in the surrounding areas.

The growth in traffic on the highway will come from three main sources:

- Regional growth – general background growth in traffic on the highway as a result of growth in surrounding areas such as Bathurst and through traffic on the highway.
- Residential growth – resulting from the development of new residential land areas in Kelso.
- Employment growth – resulting from the development of new or intensified employment land in Kelso.

The assumptions about future development and the resulting growth in traffic volumes are discussed following.

4.1 REGIONAL GROWTH

Based on the historical assessment on highway growth it was assumed that regional (or through) traffic would continue to grow at a rate of 1.5 per cent per annum (compound).

This growth rate was applied to the through traffic volumes on the highway (traffic travelling straight through the study area either to the end to end or to Littlebourne Street (which has a regional function).

The 2011 peak through traffic volumes are highlighted in Table 4.1, the estimated additional through peak traffic volumes between 2011 and 2035 are shown in Table 4.2. The resulting 2035 peak through traffic volumes are shown in Table 4.3.

Table 4.1 Great Western Highway 2011 through traffic (veh/hour)

From / To			To							
			AM peak				PM peak			
			A	B	C	Tot	A	B	C	Tot
FROM	A	Great Western Highway, west of Stockland Drive	0	294	114	408	0	458	184	642
FROM	B	Great Western Highway, east of Ashworth Drive	388	0	16	404	369	0	17	386
FROM	C	Littlebourne Street, south of the railway line	237	29	0	266	138	21	0	159
	TOTAL		625	323	130	1078	507	479	201	1187

Table 4.2 Great Western Highway 2011 to 2035 additional through traffic (veh/hour)

From / To			To							
			AM Peak				PM Peak			
			A	B	C	Tot	A	B	C	Tot
FROM	A	Great Western Highway, west of Stockland Drive	0	126	49	175	0	197	79	276
	B	Great Western Highway, east of Ashworth Drive	167	0	7	174	158	0	7	165
	C	Littlebourne Street, south of the railway line	102	13	0	115	59	9	0	68
	TOTAL		269	139	56	464	217	206	86	509

Table 4.3 Great Western Highway 2035 through traffic (veh/hour)

From / To			To							
			AM Peak				PM Peak			
			A	B	C	Tot	A	B	C	Tot
FROM	A	Great Western Highway, west of Stockland Drive	0	420	163	583	0	655	263	918
	B	Great Western Highway, east of Ashworth Drive	555	0	23	578	527	0	24	551
	C	Littlebourne Street, south of the railway line	339	42	0	381	197	30	0	227
	TOTAL		894	462	186	1542	724	685	287	1696

4.2 RESIDENTIAL DEVELOPMENT

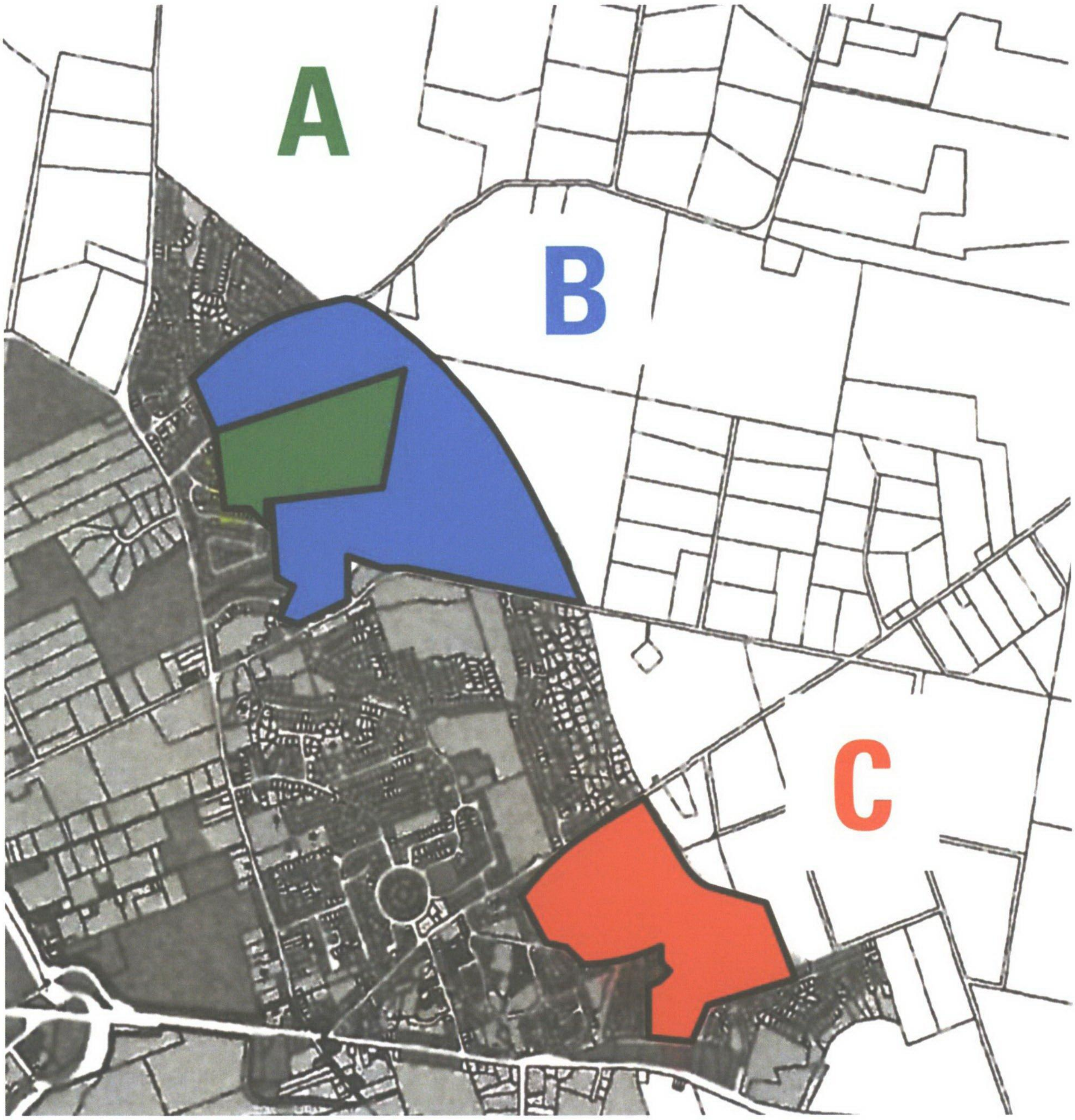
Two key residential growth areas were identified as likely to be developed and hence generate additional traffic on the Great Western Highway by 2035. These regions are identified in Figure 4.1:

- Marsden Heights/North Hereford Residential Area (site A/B) – split into two parts to reflect the area that has already been subject to a rezoning application (Marsden Heights - site A) and the remainder of the site.
- The vacant land north of Ashworth Drive/Boyd Street area (site C).

The anticipated lot yield for these precincts was assumed to reflect the lot density in the surrounding residential areas. GIS mapping was used to determine the current lot yield, which was approximately 1340m^2 per lot (or 7.5 lots per Hectare).

For the Marsden Heights subdivision (part of DP1064148), the most recent Traffic Impact Assessment[2] assumes an indicative dwelling yield of 250 dwellings for Lot 1 with a balance of 47.32 ha of undeveloped land. The total precinct area for DP1064148 was 113ha. To calculate the total traffic generation for this subdivision, it was assumed that the total site was developed at the rate of 1340m^2 per dwelling, giving an overall yield of 843 dwellings. Hence the remainder of the development area (Site B) was assumed to be 593 dwellings.

Figure 4.1 Residential growth regions



2 *Statement of Environmental Effects for Proposed Subdivision into 250 Lots at Marsden Lane, Kelso*, prepared by Anthony Daintith Town Planning Pty Ltd in March 2011 (ADTP, Mar 2011).

Marsden Heights Subdivision, Kelso Traffic Impact Study, prepared by Parsons Brinckerhoff Australia Pty Limited Pty Ltd in March 2011 (PB, Mar 2011).

This average lot yield (1340m² per lot) was applied directly to Site C (as per Figure 4.1) with an area of 45.7ha, hence 341 dwellings.

The traffic generation rate that was applied was 0.85 peak hour vehicle trips per dwelling as stated in the RTA Guide to Traffic Generating Developments. The outbound splits in the AM and PM were assumed to be 80 per cent and 20 per cent, respectively. Table 4.4 indicates the peak hour vehicle trips from the three residential development regions.

Table 4.4 Great Western Highway 2011 to 2035 additional residential traffic generation (veh/hour)

		North Hereford residential area		Ashworth/ Boyd residential (C)	Total
		(A)	(B)		
Area (Hectares)		28.33	84.67	45.70	158.70
Yield (lots)		250	593	341	1184
Trip Generation					
Generation rate (veh trips/lot/hr)		*0.85*			
Total peak vehicle trips (veh trips/hr)		213	504	290	1007
AM peak split	Inbound	20%	20%	20%	20%
	Outbound	80%	80%	80%	80%
PM peak split	Inbound	80%	80%	80%	80%
	Outbound	20%	20%	20%	20%
AM peak traffic (veh trips/hr)	Inbound	43	101	58	**202**
	Outbound	170	403	232	**805**
PM peak traffic (veh trips/hr)	Inbound	170	403	232	**805**
	Outbound	43	101	58	**202**

The ultimate destination of the residential traffic was assumed to reflect the existing behaviour in the study area. This yielded an eastbound split of 31 per cent in the AM peak period and 39 per cent in the PM peak period. The westbound splits were 69 per cent and 61 per cent in the AM and PM respectively.

The traffic generated in the North Hereford Residential development areas (Site A and Site B) was assumed to use Hereford Drive, Gilmour Street and Boyd Street in proportions shown in Table 4.5. Hereford Drive was considered a priority for westbound residents. The traffic from Site C was assumed to use Ashworth Drive as a preference as well as View Street and Boyd Street in proportions shown in Table 4.5.

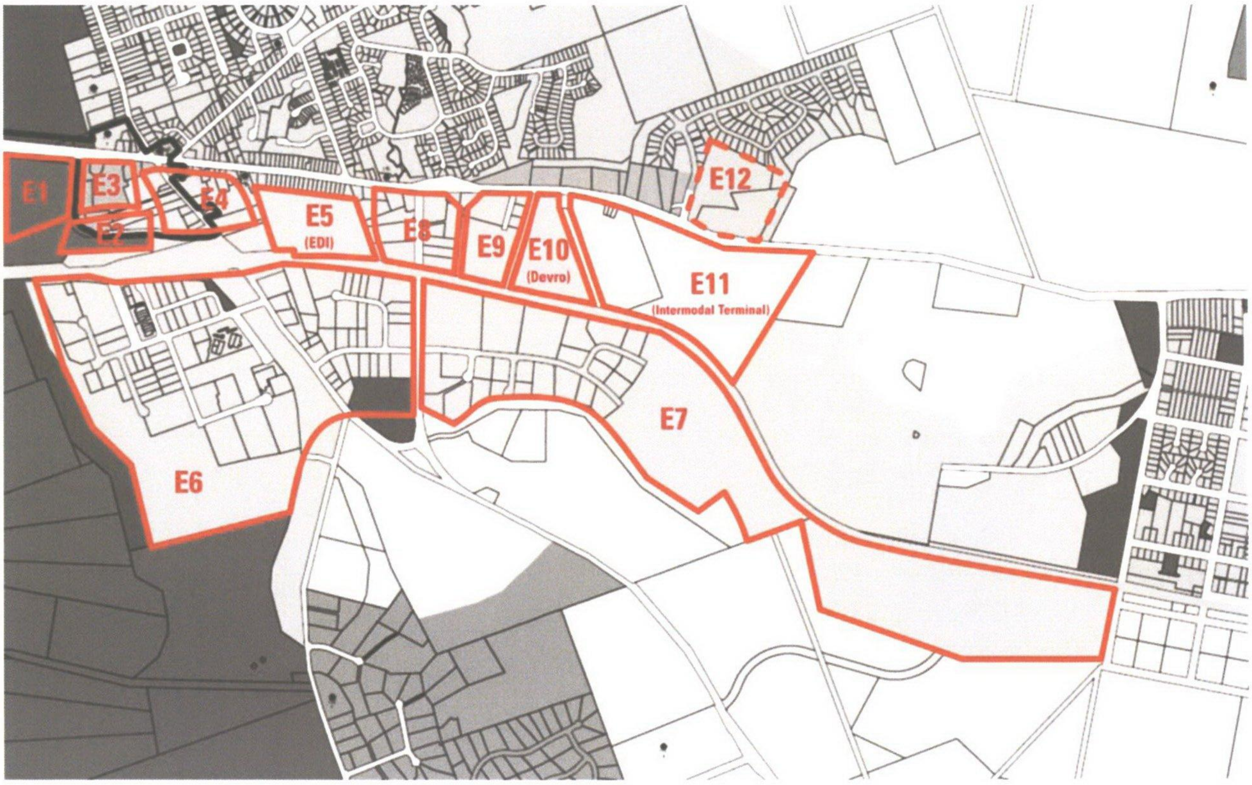
Table 4.5 Residential traffic directional distribution

	Eastbound			Westbound		
	Site A	Site B	Site C	Site A	Site B	Site C
Directional Split						
AM Peak Trips		31%			69%	
PM Peak Trips		39%			61%	
Distribution by Route						
Using Hereford Drive (not part of study area)	80%	80%	-	70%	70%	-
Gilmour Street	20%	20%	-	20%	20%	-
Boyd Street	-	-	-	10%	10%	33%
View Street	-	-	33%	-	-	-
Ashworth Drive	-	-	67%	-	-	67%

4.3 EMPLOYMENT DEVELOPMENT

The potential future employment traffic generating developments were broken into 12 precincts which were generally on the southern side of the Great Western Highway. These precincts are shown in Figure 4.2.

Figure 4.2 Employment precincts layout



4.3.1 Employment Precincts

Precinct E1 – Vacant land on western side of Stockland Dr

Precinct E1 was assumed to not have developed due to the floodplain.

Precinct E2 – Vacant land on the southern portion of Stockland Dr

Precinct E2 was assumed to develop to the same density as the other industrial sites along Stockland Drive. The area is approximately 15 per cent of the current developed area and hence the traffic generation was taken to be 15 per cent of the current Stockland Drive traffic. It was assumed that this additional traffic would be distributed as per the existing turn movements at Stockland Drive. (ie. existing inbound, outbound, eastbound and westbound splits).

Precinct E3 – Redevelopment of existing sites off Stockland Dr

The existing industrial sites on Stockland Drive were assumed to redevelop and increase in density over time. To account for this, a growth rate of 0.6 per cent per annum was applied to the existing traffic on Stockland Drive. It was assumed that this additional traffic would be distributed as per the existing turn movements at Stockland Drive.

Precinct E4 – Redevelopment of existing Sites off Lee St

The existing industrial sites on Lee Street were assumed to redevelop and increase in density over time. To account for this, a growth rate of 0.6 per cent per annum was applied to the existing traffic on Lee Street. It was assumed that this additional traffic would be distributed as per the existing turn movements at Lee Street.

Precinct E5 – EDI site

The EDI site traffic was assumed to double between 2015 and 2035. The site is not currently at full capacity. It was assumed that the additional traffic would be distributed as per the existing turn movements at the EDI access.

Precinct E6 – Hampden Park Road industrial area west of Littlebourne Street

The Hampden Road Industrial area west of Littlebourne Street has very little vacant land and was assumed to not increase in traffic generation during the study period.

Precinct E7 – Hampden Park Road industrial area east of Littlebourne Street

There are a number of vacant lots in the Hampden Park Road Industrial Area east of Littlebourne Street. It was assumed that the traffic generated by these developments is likely to double the existing traffic using Hampden Park Road (east). It was assumed that the additional traffic would be distributed as per the existing turn movements at Littlebourne Street and Hampden Park Road (east).

Precinct E8 – Regional growth of Littlebourne Street

It was assumed that there will be no further development of Precinct E8.

Precinct E9 – Pat O'Leary Drive mixed use retail development

As detailed in the Traffic Impact Assessment[3], the proposed development includes a bulky good section and a service station with a fast-food outlet. The traffic generated by the Mixed Retail development is anticipated to by 711 peak hour vehicle trips, which was assumed to be distributed in accordance with the current splits for Pat O'Leary Drive.

Precinct E10 – Devro

To account for the vacant land on the Devro site that may be developed, the traffic volume was anticipated to increase by 50 per cent from the existing counts. The additional peak hour vehicles were re-applied to the Pat O'Leary intersection to account for the installation of a median along the Great Western Highway that would prevent right turn movements.

Precinct E11 – Intermodal terminal

The traffic generation profile of the Intermodal Terminal was re-assessed to reflect more conservative assumptions than were applied in the associated Traffic Impact Assessments[4].

The floor area of the site from the current plans was 11,770m², the breakdown of which is described in Table 4.5 along with the associated traffic generating properties.

Table 4.6 Intermodal terminal traffic generation

Development type	Area (m^2)	Traffic generation rate* (vehicle trips per hour)		Peak hour traffic (vehicle trips per hour)	
		AM	PM	AM	PM
Bulky Goods	5,149	2.5/100m^2	0.5/100m^2	26	129
Warehouse	5,149	0.5/100m^2	0.5/100m^2	26	26
Fast Food	1,272	*	*	140	140
Service Station	200	N/A	N/A	-	-
Multi-Modal Freight Terminal	46,240	N/A	N/A	60	60
Total	58,010			251	354

*Traffic generation rate was determined in the CBHK Report.

In addition to the traffic generated it was assumed that an additional 120 vehicles per hour will drop into the site as passing trade.

---

3 *Traffic Impact Assessment for Pat O'Leary Drive*, Kelso, prepared by Thompson Stanbury Associates.

4 *Traffic Report Prepared for Bathurst Intermodal Terminal Proposed Modifications to Concept Approval*, prepared by Colston Budd Hunt and Kafes Pty Ltd in December 2008 (CBHK, Dec 2008).

Extracts from the *Slobobax Regional Road/Rail Facility, Kelso Director-General's Environmental Assessment Report.*

Extracts from the *EA Concept Plan -Road/Rail Freight Terminal, Great Western Highway, Bathurst* prepared by GSA Planning.

Traffic and Parking Report for the Central West Regional Road / Rail Freight Terminal at Great Western Highway, Kelso, Bathurst, prepared by GSA PLANNING PTY LTD Urban Design, Heritage, Environmental &Traffic Planners in January 2006 (GSA , Jan 2006)

The breakdown of the warehouse area was assumed to comprise of 50 per cent bulky goods and 50 per cent warehousing. The Fast Food component was assumed to demonstrate the same traffic generation rates as specified in the CBHK Traffic Impact Assessment, which was 140 vph in the peak hours. Not included in this figure is 120 drop in trips from the Great Western Highway. The service station traffic will be drop-in only (left-in left-out arrangement) in entrances not considered in this assessment, so the traffic generation will not affect our intersections.

The Multi-Modal Freight Terminal was regarded to generate 30vph in the CBHK report. It was assumed that the seasonal peak would be, conservatively, twice the average usage. It was assumed that this additional traffic would utilise Ashworth Drive (South). The outbound splits in the AM and PM were both 50 per cent.

Precinct E12 – Bulky goods off Ashworth Drive North

To account for the increase in density and development of the industrial/bulky goods lots off Ashworth Drive, the existing traffic utilising Ashworth Drive was doubled. It was assumed that this additional traffic would be distributed as per the existing turn movements at Ashworth Drive.

4.3.2 Employment traffic generation

A summary of the traffic generation assumed for each of the employment precincts is provided in Table 4.7.

Table 4.7 Great Western Highway 2011 to 2035 additional employment traffic generation (veh/hour)

Employment precinct		Trips (veh trips/hr)		AM split		PM split		Trips (veh trips/hr)			
								AM traffic		PM traffic	
		AM	PM	IN	OUT	IN	OUT	IN	OUT	IN	OUT
E1	Stockland Dr Western side	0	0	60%	40%	41%	59%	0	0	0	0
E2	Southern part of Stockland Dr	15	15	60%	40%	41%	59%	9	6	6	9
E3	Existing sites off Stockland Dr	29	47	60%	40%	41%	59%	17	12	19	28
E4	Existing Sites off Lee St	5	8	37%	63%	41%	59%	2	3	3	5
E5	EDI	16	16	32%	68%	38%	62%	5	11	6	10
E6	Hampden Road West	0	0	55%	45%	32%	68%	0	0	0	0
E7	Hampden Road East	118	118	69%	31%	16%	84%	81	37	19	99
E8	Existing Littlebourne St	0	0	43%	57%	44%	56%	0	0	0	0
E9	Pat O'Leary Dr Mixed Retail	711	712	58%	42%	50%	50%	412	299	356	356
E10	Devro	12	12	57%	43%	7%	93%	7	5	1	11
E11	Intermodal Terminal *	252	354	50%	50%	50%	50%	126	126	177	177
E12	Ashworth Nth Bulky Goods	73	73	53%	47%	36%	64%	39	34	26	47
	TOTAL	1231	1355					698	533	613	742

* Excludes 120 vehicles per hour passing trade (60 in and 60 out)

4.4 2035 TRAFFIC VOLUMES

As a result of the additional through trips, residential trips and employment trips, traffic volumes along the Great Western Highway through the study area will significantly increase by 2035.

A comparison of the 2011 and 2035 peak hour mid-block traffic volumes by section of road is provided in Figure 4.3 and Figure 4.4 for the AM and PM peak periods respectively. The 2035 intersection turning volumes are presented in Figure 4.5 and Figure 4.6 for the AM and PM peak periods respectively.

The additional traffic is a result of three key components:

- Residential growth.
- Employment growth.

A summary of the additional traffic is provided in Table 4.8.

Table 4.8 Great Western Highway 2011 to 2035 additional traffic (veh/hour)

Growth	AM peak traffic				PM peak traffic			
	IN	OUT	Total	%age	IN	OUT	Total	%age
Through Traffic	464		464	*17%*	509		509	*18%*
Residential Traffic	202	805	1007	*37%*	805	202	1007	*35%*
Employment Traffic	698	533	1231	*46%*	613	742	1355	*47%*
Total Traffic	1364	1802	2702	*100%*	1927	1453	2871	*100%*

This shows that generally through traffic accounts for around 17-18 per cent of the additional trips. The vast majority of additional trips are as a result of growth in residential (35-37 per cent) and employment traffic (46-47 per cent).

Through traffic generally results in additional trips along the full length of the Highway in the study area as they travel from end to end. The exception is regional traffic that enters from Littlebourne Street. However, the residential and employment trips start at local side roads and only travel along part of the route. As a result, the growth in traffic varies along different sections of the Highway. This also varies by peak period and by direction. A summary of the resulting 2035 traffic broken down into base traffic and additional traffic (through, residential and employment) is presented in Figure 4.7 to Figure 4.10 for the AM and PM peak periods by direction of travel.

These figures show that the average annual cumulative growth rates along the Great Western Highway from 2011 to 2035 will be:

- AM Peak: 2.1-3.8 per cent per annum.
- PM Peak: 1.6-2.8 per cent per annum.

The higher growth rates are generally noted east of Littlebourne Street as a result of the significant employment developments in this area (along Pat O'Leary Drive and the Intermodal Terminal).

It should be noted that growth is unlikely to grow in a steady increase over the 24 years but will have more notable jumps with the significant developments coming on line.

Figure 4.3 2011 and 2035 Mid-block traffic volumes AM peak

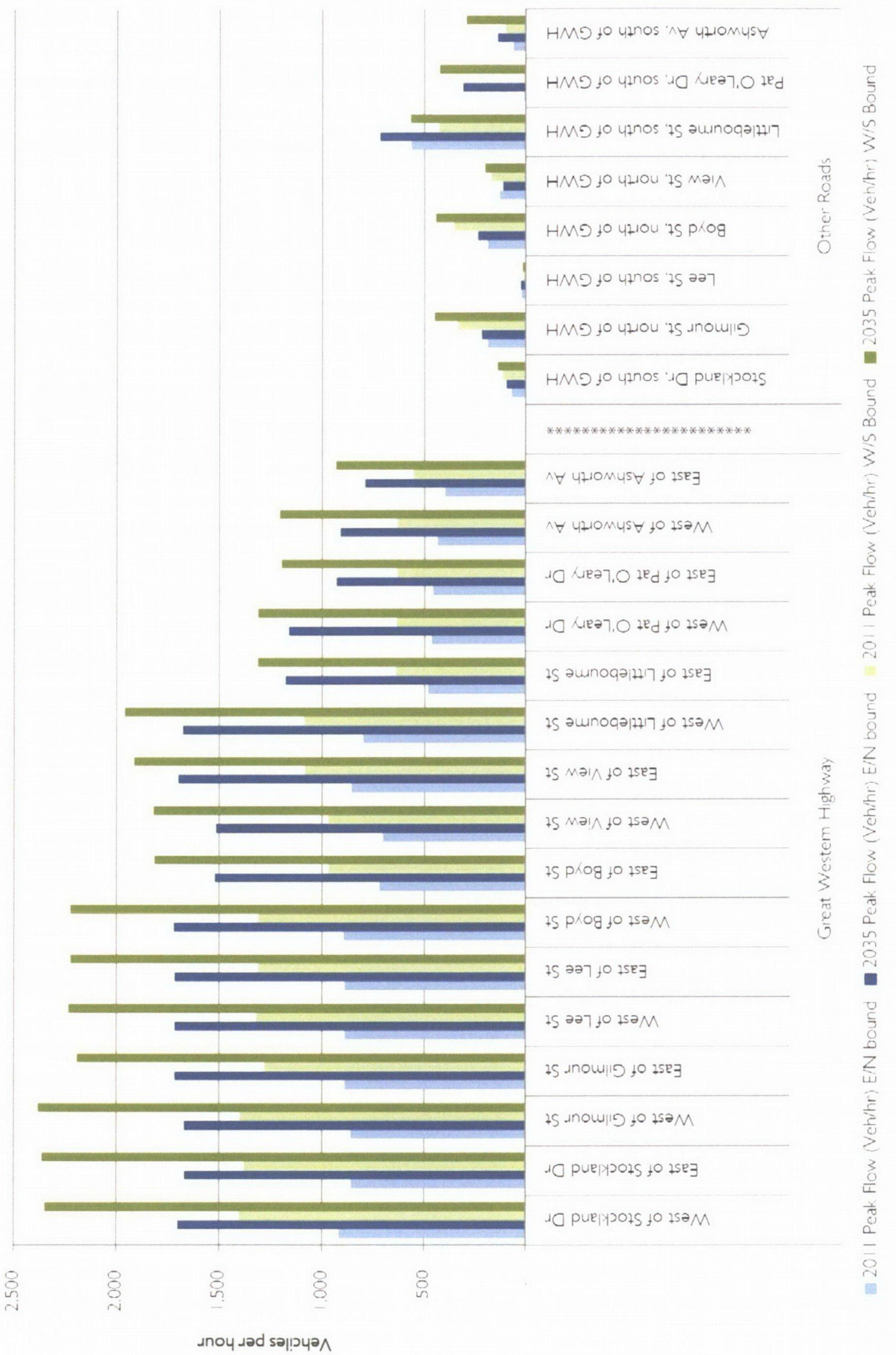
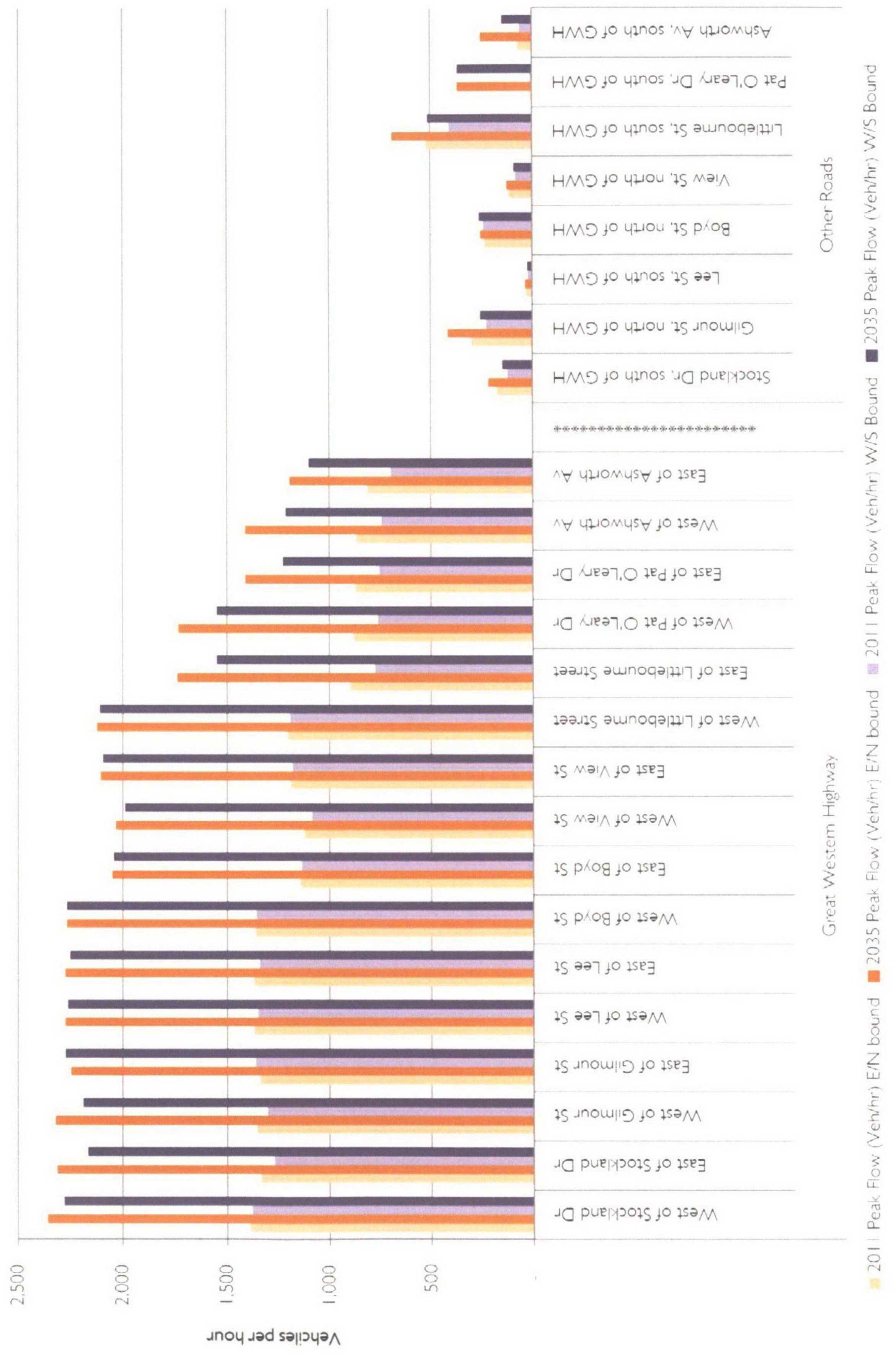
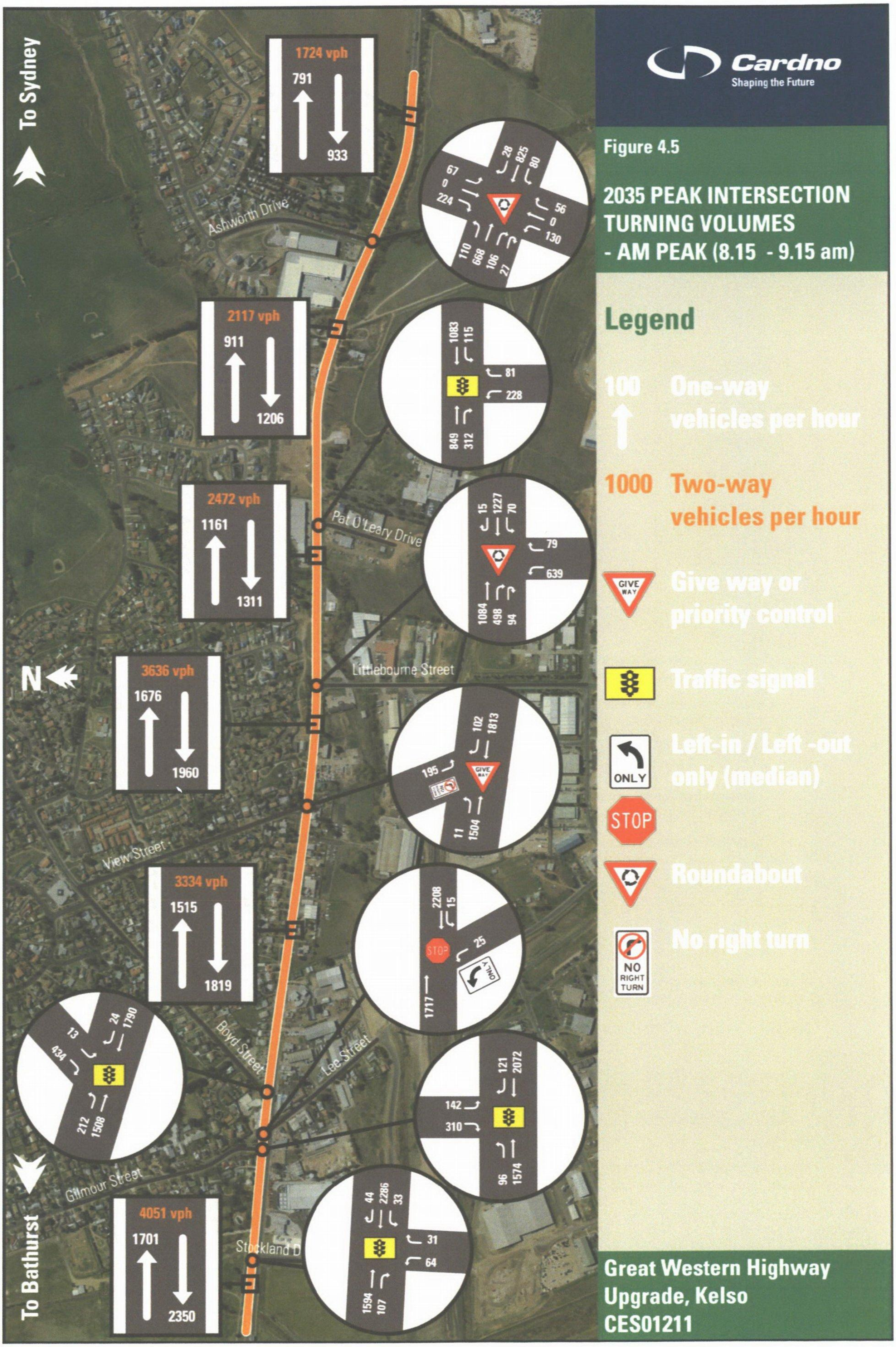


Figure 4.4 2011 and 2035 mid-block traffic volumes PM peak




Cardno
Shaping the Future
Figure 4.5
2035 PEAK INTERSECTION TURNING VOLUMES - AM PEAK (8.15 - 9.15 am)
Legend
100 One-way vehicles per hour
1000 Two-way vehicles per hour
Give way or priority control
Traffic signal
Left-in / Left -out only (median)
STOP
Roundabout
No right turn
Great Western Highway Upgrade, Kelso CES01211
To Sydney
To Bathurst
N
Ashworth Drive
Pat O'Leary Drive
Littlebourne Street
View Street
Boyd Street
Lee Street
Gilmour Street
Stockland D
1724 vph
791
933
2117 vph
911
1206
2472 vph
1161
1311
3636 vph
1676
1960
3334 vph
1515
1819
4051 vph
1701
2350

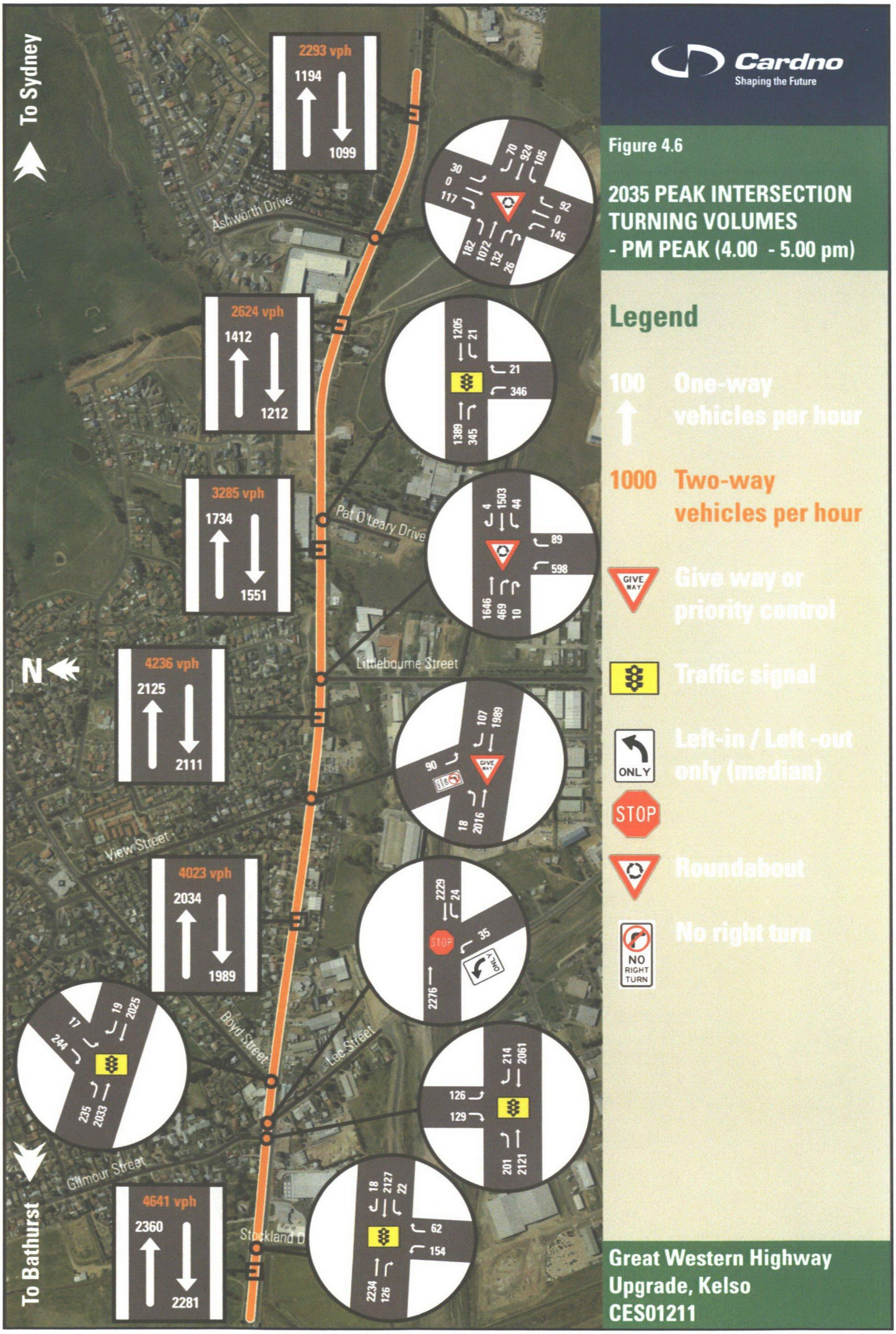

Cardno
Shaping the Future
Figure 4.6
2035 PEAK INTERSECTION TURNING VOLUMES - PM PEAK (4.00 - 5.00 pm)
Legend
100 One-way vehicles per hour
1000 Two-way vehicles per hour
Give way or priority control
Traffic signal
Left-in / Left -out only (median)
Roundabout
No right turn
Great Western Highway Upgrade, Kelso CES01211
To Sydney
To Bathurst
N
Ashworth Drive
Pat O'Leary Drive
Littlebourne Street
View Street
Boyd Street
Lee Street
Gilmour Street
Stockland D
2293 vph
1194
1099
2624 vph
1412
1212
3285 vph
1734
1551
4236 vph
2125
2111
4023 vph
2034
1989
4641 vph
2360
2281

Figure 4.7 2035 mid-block traffic growth AM peak eastbound

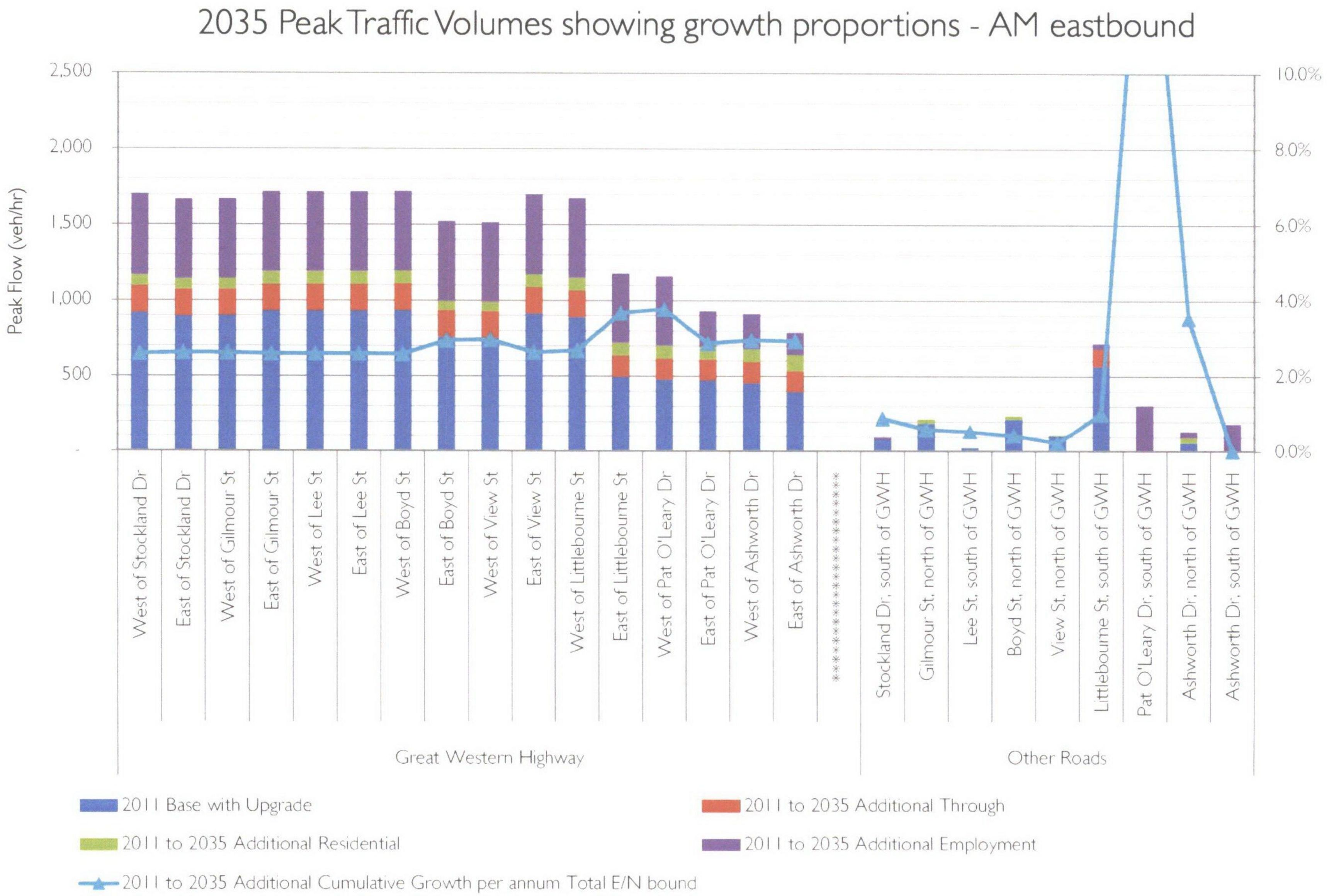


Figure 4.8 2035 peak mid-block traffic growth AM peak Westbound

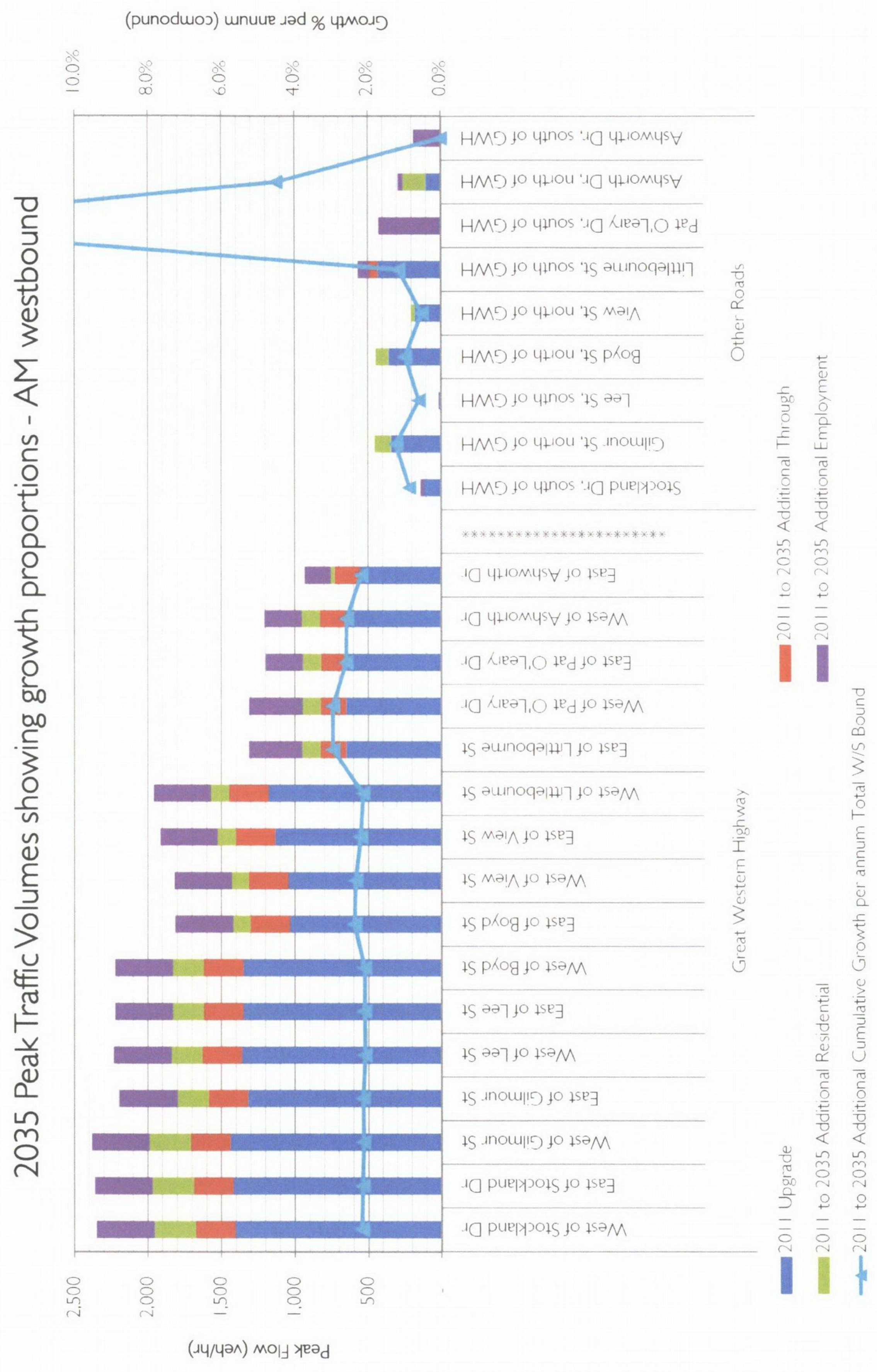
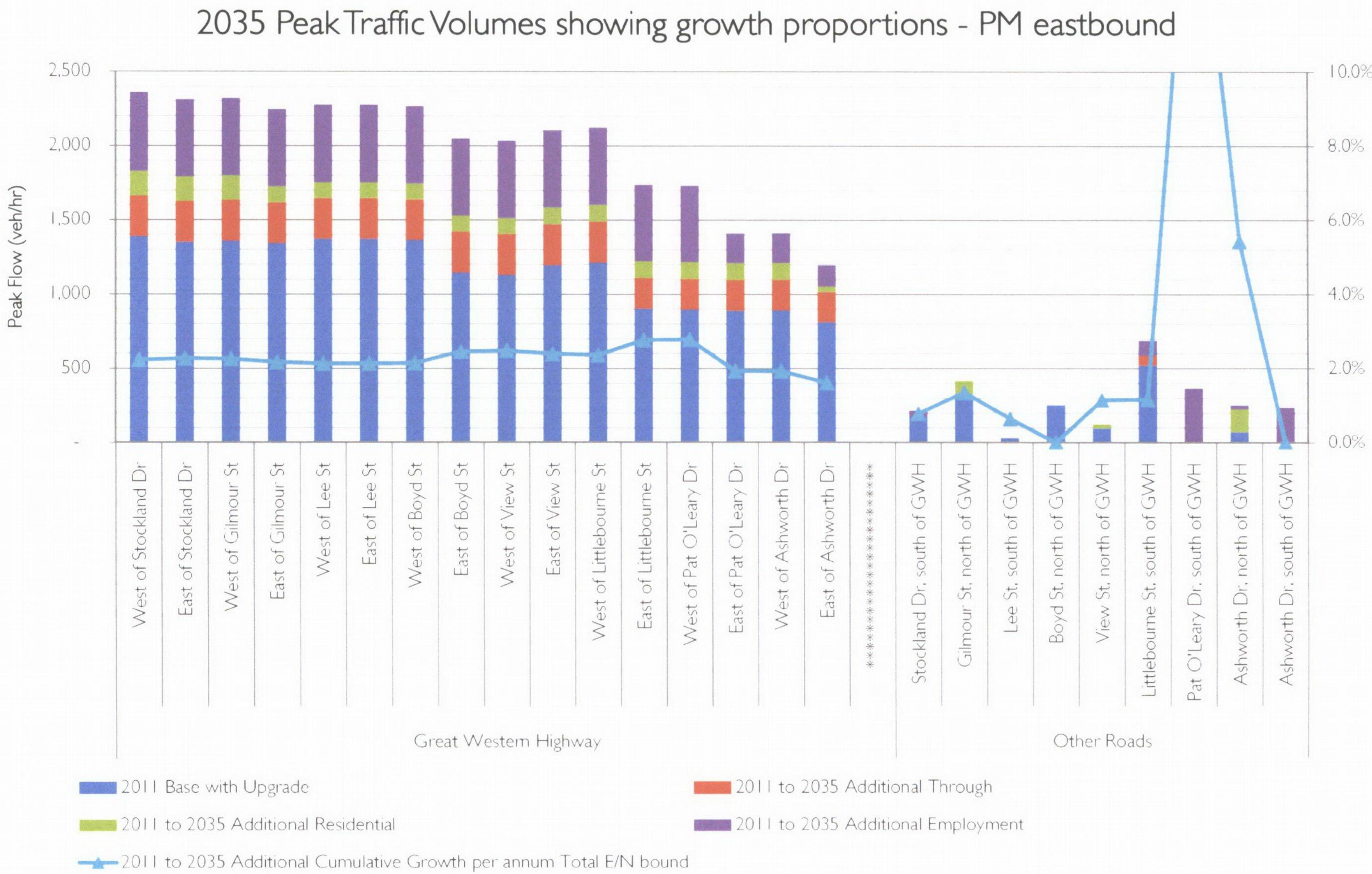
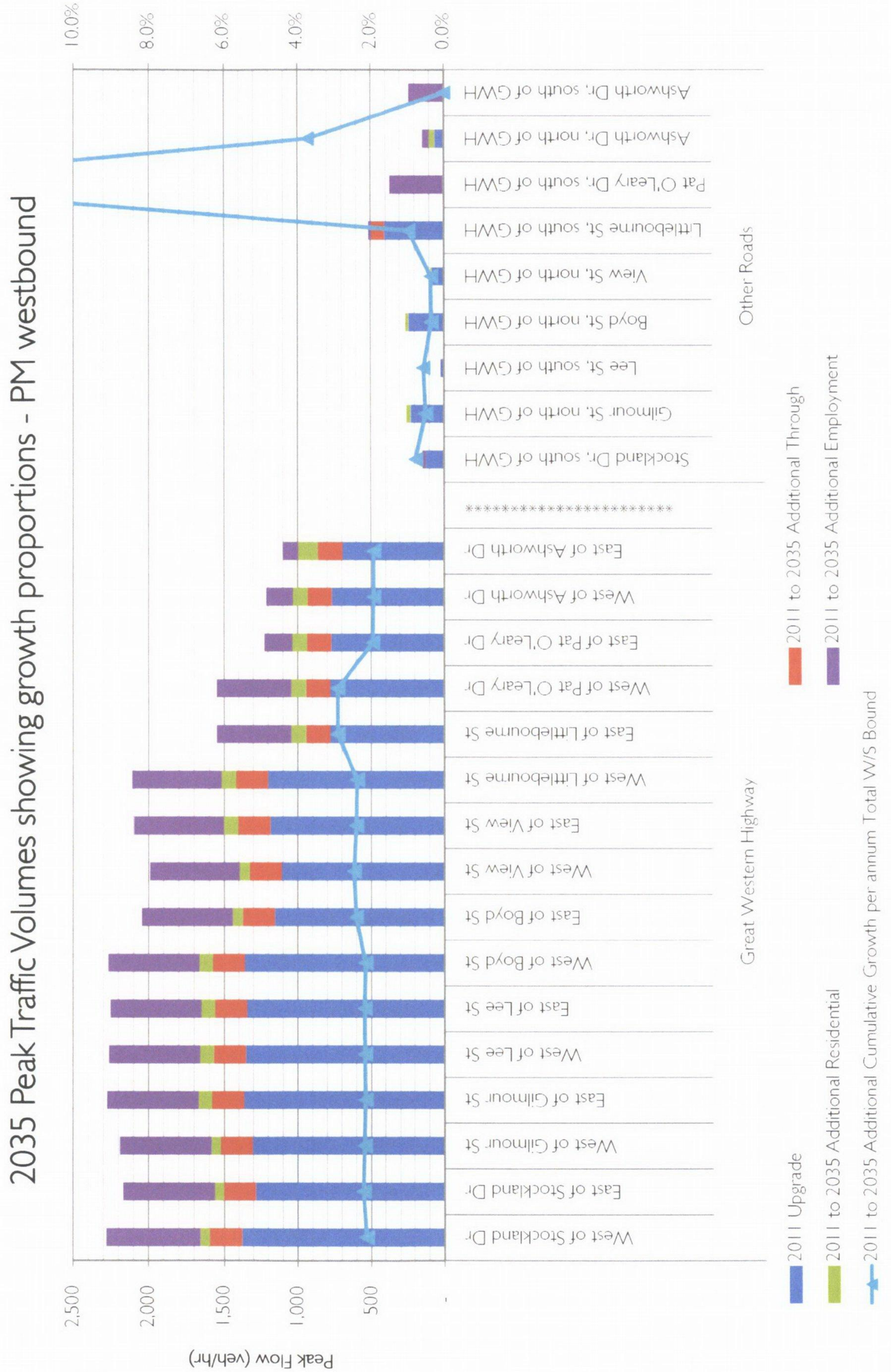


Figure 4.9 2035 peak mid-block traffic growth PM peak Eastbound



Cardno
Shaping the Future

Figure 4.10 2035 peak mid-block traffic growth PM peak Westbound

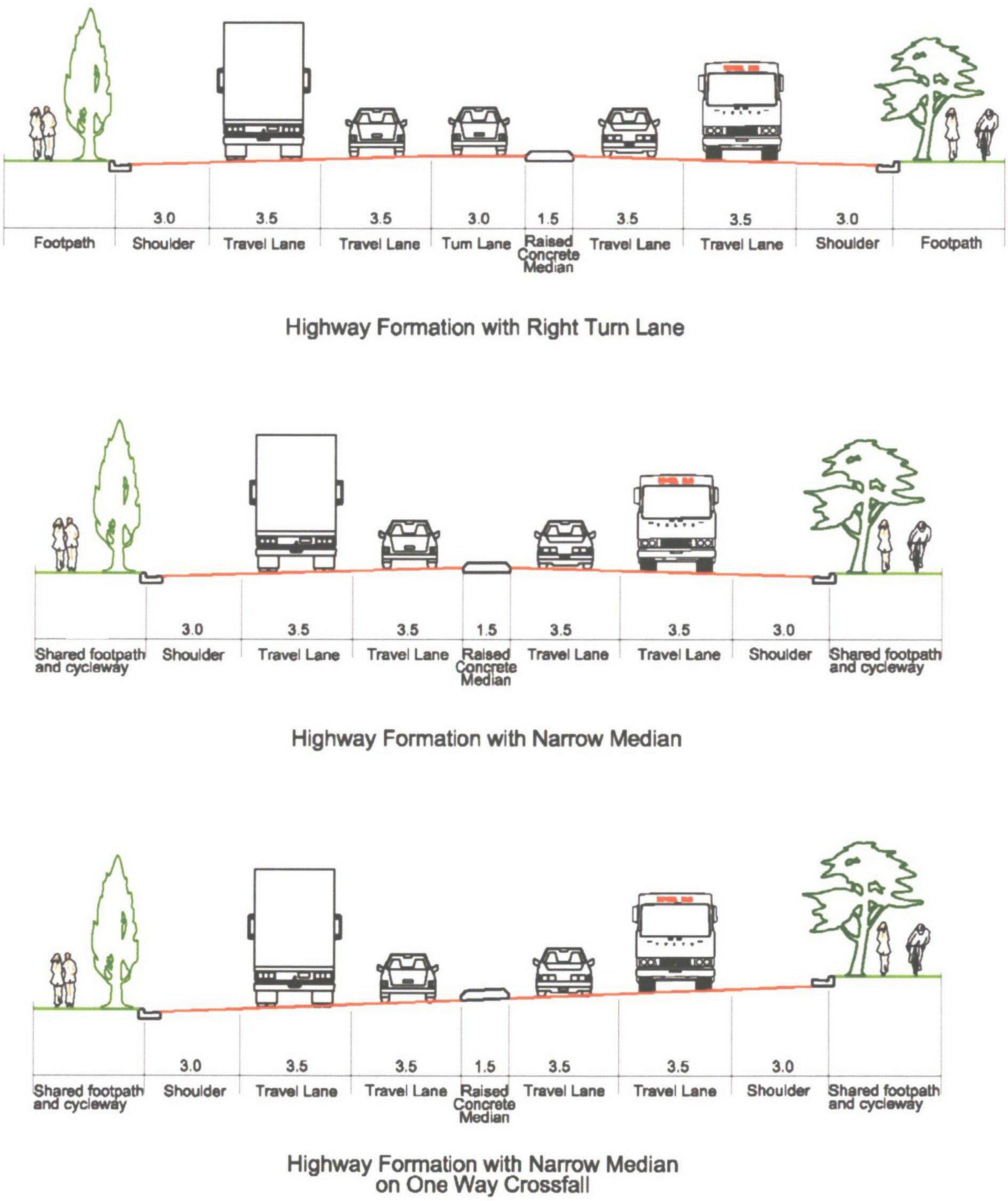


5 FUTURE ROAD NETWORK

5.1 PROPOSED ROAD CARRIAGEWAY

The future road network through the study area has been considered to be a four lane divided carriageway with two traffic lanes in each direction, a wide shoulder in each direction which can be used as a parking lane and a central median. Typical cross-sections are provided in Figure 5.1.

Figure 5.1 Typical cross sections



5.2 2035 MID-BLOCK PERFORMANCE

The mid-block performance of the proposed road network with 2035 traffic volumes has been assessed for the AM and PM peak hours in terms of:

- Level of service (LoS).
- Volume to capacity ratio (v/c).

A summary of the 2035 results are presented in Table 5.1 and Table 5.2 for the AM and PM peak periods respectively. More detailed results are provided in Figure 5.2 to Figure 5.5 and in Appendix E.

It is noted that in the highway was assessed as a interrupted urban road.

The analysis shows in 2035 that the section of the highway west of Littlebourne Street will generally operate at or above capacity:

- AM peak westbound: LoS D or E with v/c ratios of 1 or above.
- PM Peak eastbound: LoS E with v/c ratios greater than 1.0.
- PM Peak westbound: LoS E with v/c ratios greater than 1.0.

Other sections of the highway (east of Littlebourne Street) will operate at LoS C or better in 2035.

Table 5.1 2035 AM peak mid-block performance

Location	Urban/Rural environment	Carriageway type	Speed limit (km/h)	No. of lanes (per direction)	LoS		V/C ratio	
					E/N bound	W/S bound	E/N bound	W/S bound
Great Western Highway								
West of Stockland Dr	Urban	U4LD	60	2	C	E	0.9	1.2
East of Stockland Dr	Urban	U4LD	60	2	C	E	0.9	1.2
West of Gilmour St	Urban	U4LD	60	2	C	E	0.9	1.3
East of Gilmour St	Urban	U4LD	60	2	C	D	0.9	1.2
West of Lee St	Urban	U4LD	60	2	C	E	0.9	1.2
East of Lee St	Urban	U4LD	60	2	C	E	0.9	1.2
West of Boyd St	Urban	U4LD	60	2	C	E	0.9	1.2
East of Boyd St	Urban	U4LD	60	2	C	D	0.8	1.0
West of View St	Urban	U4LD	60	2	C	D	0.8	1.0
East of View St	Urban	U4LD	60	2	C	D	0.9	1.0
West of Littlebourne St	Urban	U4LD	60	2	C	D	0.9	1.0
East of Littlebourne St	Urban	U4LD	60	2	B	B	0.6	0.7
West of Pat O'Leary Dr	Urban	U4LD	60	2	B	B	0.6	0.7
East of Pat O'Leary Dr	Urban	U4LD	60	2	B	B	0.5	0.6
West of Ashworth Dr	Urban	U4LD	60	2	B	B	0.5	0.6
East of Ashworth Dr	Urban	U4LD	60	2	A	B	0.4	0.5
Other Roads								
Stockland Dr, south of GWH	Urban	U2L	60	1	A	A	0.1	0.2
Gilmour St, north of GWH	Urban	U2L	60	1	B	C	0.2	0.5
Lee St, south of GWH	Urban	U2L	60	1	A	A	0.0	0.0
Boyd St, north of GWH	Urban	U2L	60	1	B	C	0.3	0.5
View St, north of GWH	Urban	U2L	60	1	A	B	0.1	0.2
Littlebourne St, south of GWH	Urban	U2L	60	1	D	C	0.8	0.6
Pat O'Leary Dr, south of GWH	Urban	U2L	60	1	B	C	0.3	0.5
Ashworth Dr, south of GWH	Urban	U2L	60	1	A	B	0.2	0.3

D	Highlight locations with LoS D	E	Highlight locations with LoS E	F	Highlight locations with LoS E
0.9	Highlights locations with v/c ratio between 0.8 and 0.9	1.0	Highlights locations with v/c ratio between >= 1		

Cardno
Shaping the Future

Table 5.2 2035 PM peak mid-block performance

Location	Urban/Rural environment	Carriageway type	Speed limit (km/h)	No. of lanes (per direction)	LoS		V/C ratio	
					E/N bound	W/S bound	E/N bound	W/S bound
Great Western Highway								
West of Stockland Dr	Urban	U4LD	60	2	E	E	1.2	1.2
East of Stockland Dr	Urban	U4LD	60	2	E	D	1.2	1.1
West of Gilmour St	Urban	U4LD	60	2	E	D	1.2	1.2
East of Gilmour St	Urban	U4LD	60	2	E	E	1.2	1.2
West of Lee St	Urban	U4LD	60	2	E	E	1.2	1.2
East of Lee St	Urban	U4LD	60	2	E	E	1.2	1.2
West of Boyd St	Urban	U4LD	60	2	E	E	1.2	1.2
East of Boyd St	Urban	U4LD	60	2	D	D	1.1	1.1
West of View St	Urban	U4LD	60	2	D	D	1.1	1.0
East of View St	Urban	U4LD	60	2	D	D	1.1	1.1
West of Littlebourne Street	Urban	U4LD	60	2	D	D	1.1	1.1
East of Littlebourne Street	Urban	U4LD	60	2	C	C	0.9	0.8
West of Pat O'Leary Dr	Urban	U4LD	60	2	C	C	0.9	0.8
East of Pat O'Leary Dr	Urban	U4LD	60	2	C	B	0.7	0.6
West of Ashworth Dr	Urban	U4LD	60	2	C	B	0.7	0.6
East of Ashworth Dr	Urban	U4LD	60	2	B	B	0.6	0.6
Other Roads								
Stockland Dr, south of GWH	Urban	U2L	60	1	B	A	0.2	0.2
Gilmour St, north of GWH	Urban	U2L	60	1	C	B	0.5	0.3
Lee St, south of GWH	Urban	U2L	60	1	A	A	0.0	0.0
Boyd St, north of GWH	Urban	U2L	60	1	B	B	0.3	0.3
View St, north of GWH	Urban	U2L	60	1	A	A	0.1	0.1
Littlebourne St, south of GWH	Urban	U2L	60	1	D	C	0.8	0.6
Pat O'Leary Dr, south of GWH	Urban	U2L	60	1	B	B	0.4	0.4
Ashworth Dr, south of GWH	Urban	U2L	60	1	B	A	0.3	0.2

D Highlight locations with LoS D E Highlight locations with LoS E F Highlight locations with LoS E

0.9 Highlights locations with v/c ratio between 0.8 and 0.9 1.0 Highlights locations with v/c ratio between >= 1

Figure 5.2 2035 mid-block performance - AM peak East/Northbound

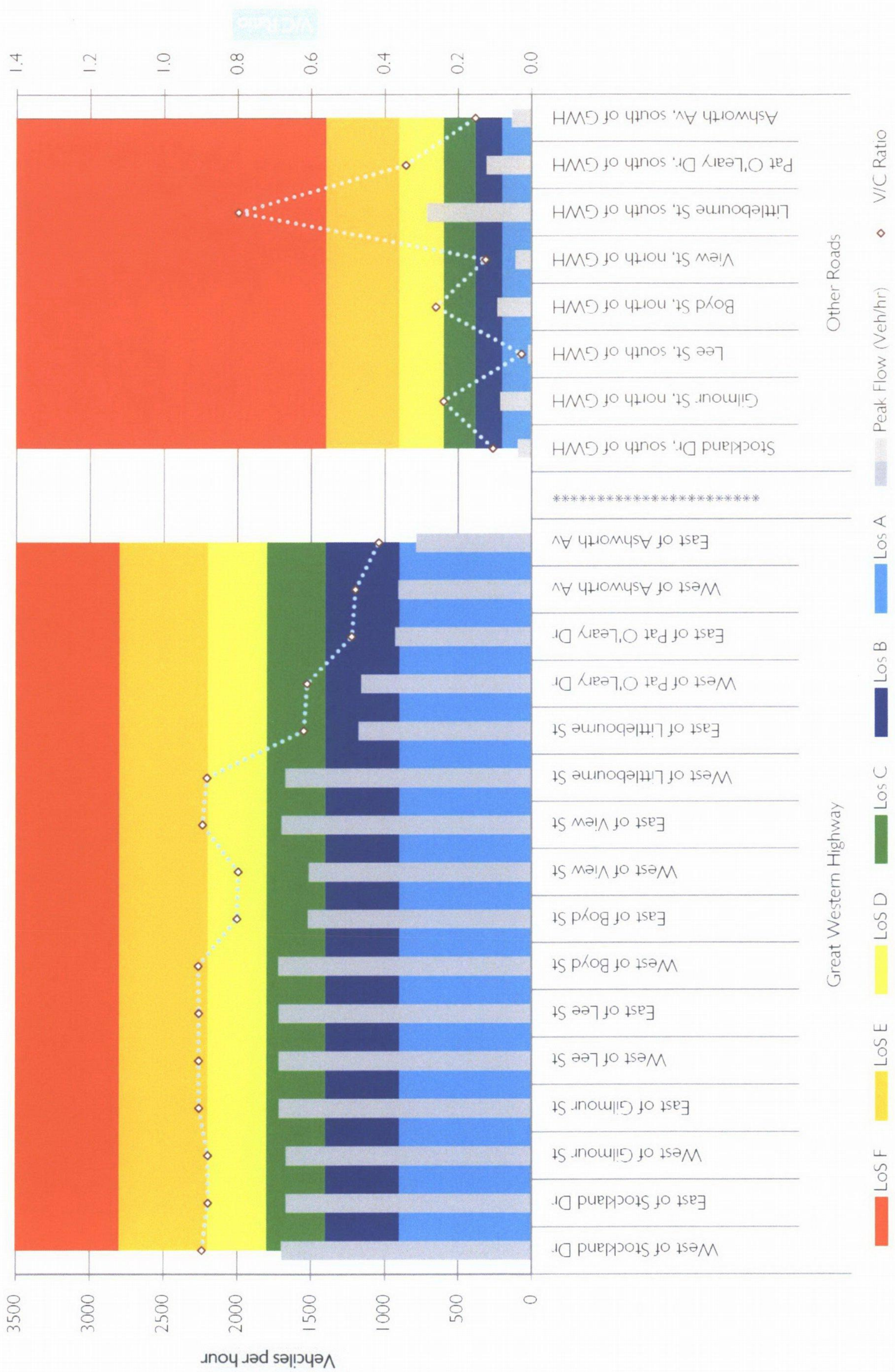


Figure 5.3 2035 mid-block performance - AM peak West/Southbound

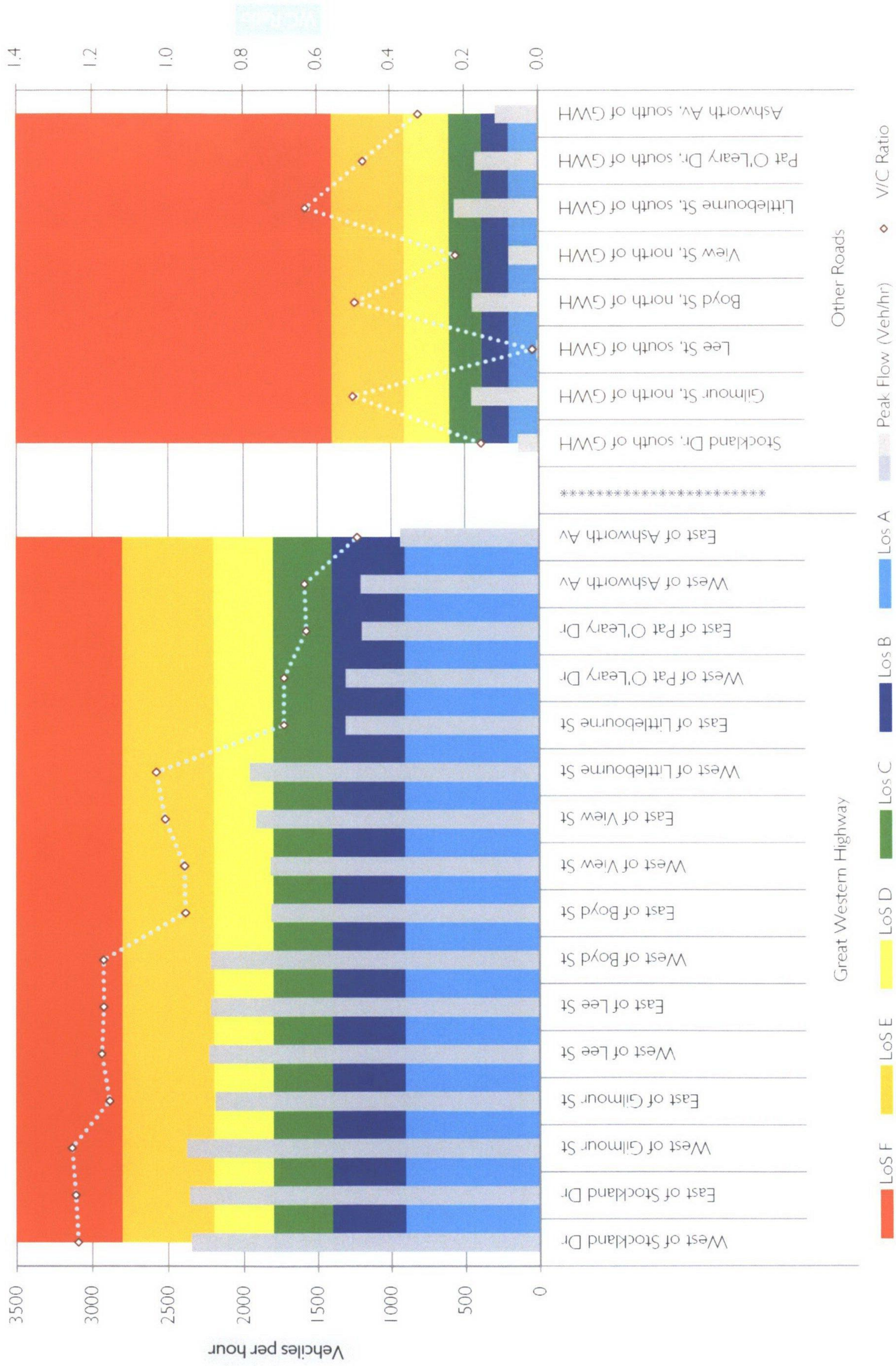


Figure 5.4 2035 mid-block performance - PM peak East/Northbound

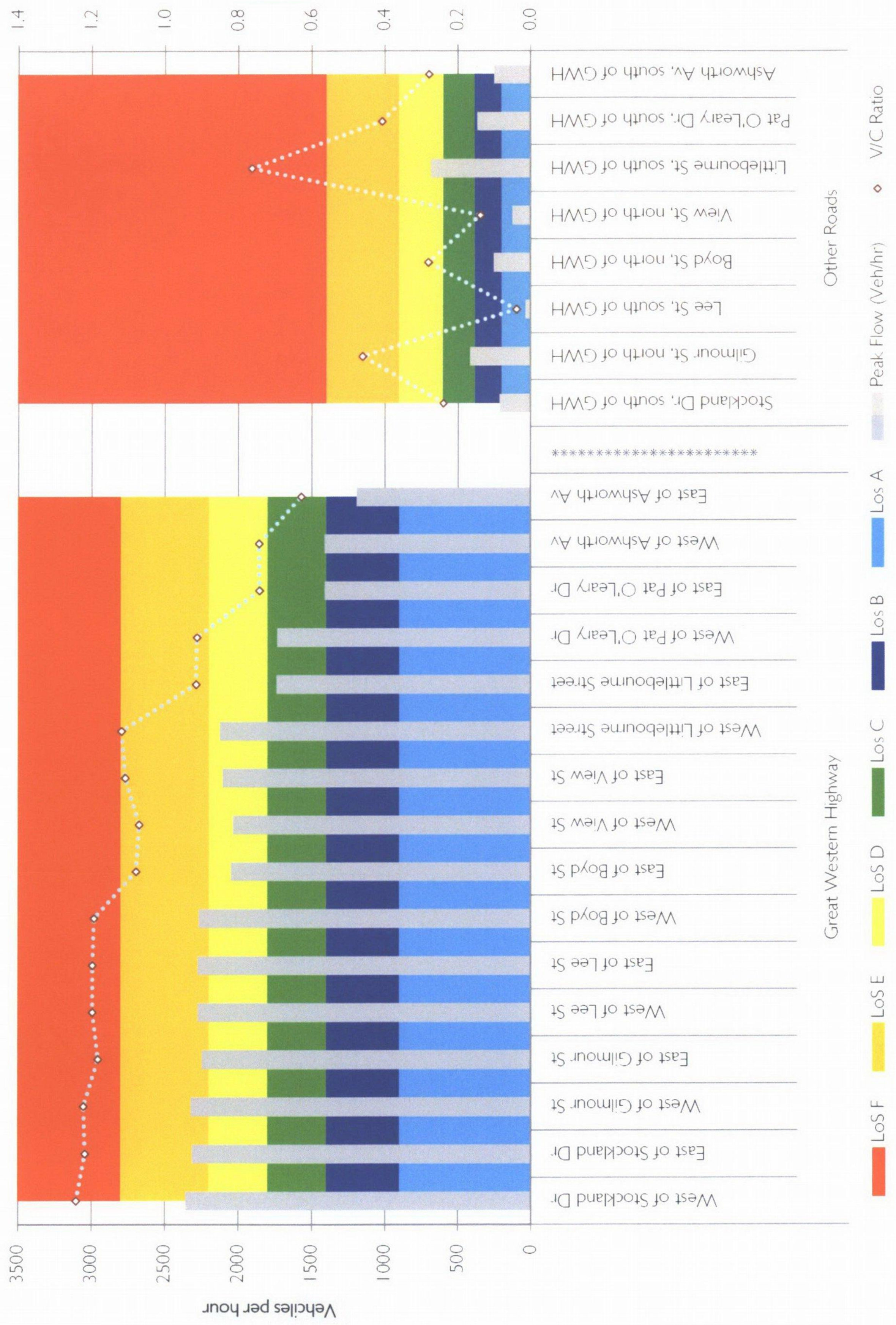
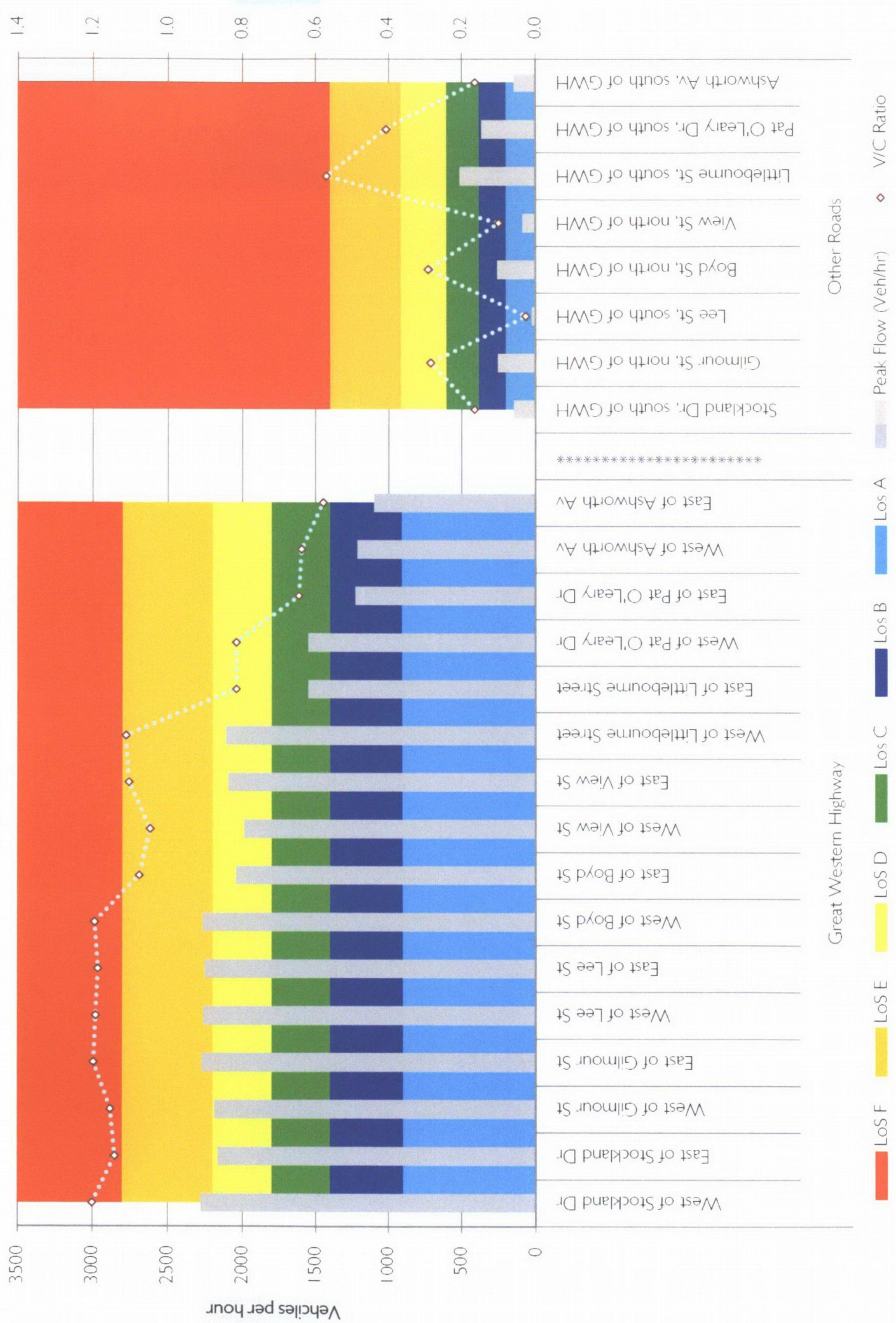


Figure 5.5 2035 mid-block performance - PM peak West/Southbound



5.3 PROPOSED INTERSECTION TREATMENT OPTIONS

Intersection treatment options have included a mixture of left-in/left-out restrictions, roundabouts and signalisation. Four proposals have been considered in this traffic assessment, as outlined in Table 5.3. Refer also to concept designs provided in Appendix F.

Table 5.3 Concept design intersection treatment options

Intersection	Current control	Intersection treatment			
		Proposal 'A'	Proposal 'B'	Proposal 'C1'	Proposal 'C2'
Ashworth Drive	Yield	Roundabout	Traffic signals with 'u-turn' facility on new southern leg	Roundabout	
Pat O'Leary Drive	Yield	Traffic signals			
Littlebourne Street	Traffic Signals	Roundabout	Traffic signals, add slip lanes, dedicated right turn bays and u-turn facility	Roundabout	Traffic signals, add slip lanes and dedicated right turn bays
View Street	Give-way	Give-way with no right turn out	Give-way with left-in/left-out only arrangement	Give-way with no right turn out	Give-way with left-in/left-out only arrangement
Boyd Street	Traffic Signals	Traffic signals, realign intersection, add right turn into Boyd Street heading west			
Lee Street	Stop with left-in/left-out only arrangement due to central median on highway				
Gilmour Street	Traffic Signals	Traffic signals with additional turn bays			
Stockland Drive	Yield	Roundabout	Traffic signals with 'u-turn' facility on Stockland Drive		

Each option was analysed to consider the performance of the intersection under future traffic volumes (2035) and with the proposed road modifications. The following analysis tools were utilised:

- SIDRA is an intersection analysis software program that considers the performance of an intersection in isolation to other intersections.
- PARAMICS a network micro-simulation modelling package that considers the movement of vehicles through a network of intersections.

Proposal 'A' and 'B' were considered initially in SIDRA and reported back to the study team. It was agreed that additional analysis would then be carried out on Proposal 'C' using PARAMICS followed by a SIDRA assessment of the results.

In summary the treatment options for each proposal are:

- Proposal 'A' generally includes roundabouts at Stockland Drive, Littlebourne Street and Ashworth Drive with new traffic signals provided at Pat O'Leary Drive and other minor improvements. Proposal 'A' was modelled in SIDRA only as per the concept plans for Proposal 'A' presented in Appendix A.
- Proposal 'B' generally new traffic signals at Stockland Drive, Littlebourne Street, Pat O'Leary Drive and Ashworth Drive with other minor improvements. Proposal 'B' was modelled in SIDRA only as per the concept plans for Proposal 'B' presented in Appendix A.
- Proposal 'C1' generally includes roundabouts at Littlebourne Street and Ashworth Drive with new traffic signals provided at Stockland Drive and Pat O'Leary Drive with other minor improvements. Proposal 'C1' was modelled in SIDRA and PARAMICS as per the concept plans for Proposal 'C' presented in Appendix A with the following modifications:
  - Pedestrian crossing included on the eastern approach to the Great Western Highway and Boyd Street intersection.
- Proposal 'C2' generally includes a roundabout at Ashworth Drive with new traffic signals provided at Stockland Drive, Littlebourne Street and Pat O'Leary Drive with other minor improvements. Proposal 'C2' was modelled in SIDRA and PARAMICS as per the concept plans for Proposal 'C' presented in Appendix A with the following modifications:
  - Pedestrian crossing included on the eastern approach to the Great Western Highway and Boyd Street intersection.
  - The intersection of the Great Western Highway with Littlebourne Street was modelled as a signalised intersection, similar to the one presented in Proposal 'B' without the 'u'-turn facility.
  - The intersection of Great Western Highway and View Street becomes left-in/left-out only as the median on the highway is extended beyond View Street, similar that presented in Proposal 'B'.

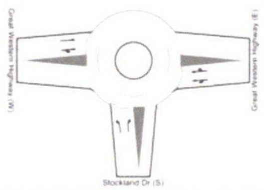
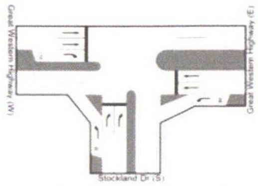
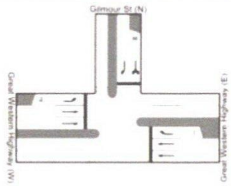
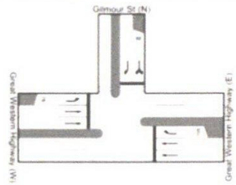
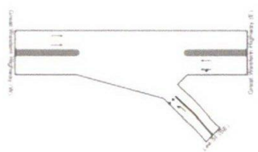
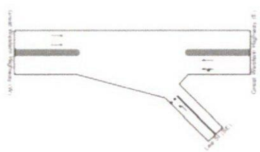
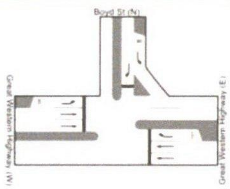
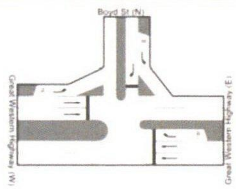
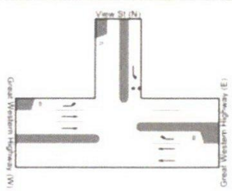
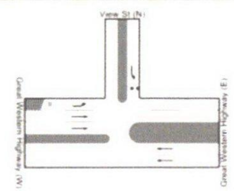
5.4 2035 INTERSECTION PERFORMANCE FOR PROPOSAL 'A' and 'B'

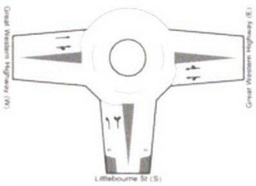
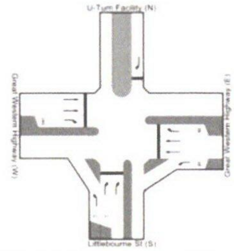
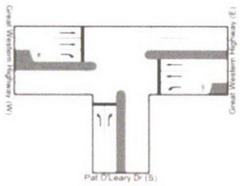
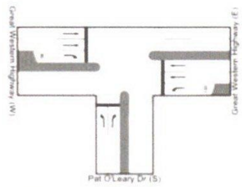
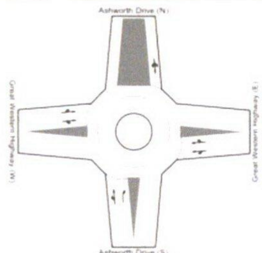
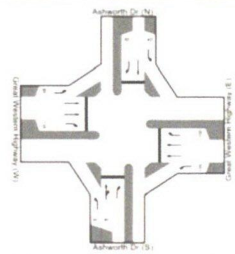
This following section outlines the results of the assessment of the intersection performance under the various intersection configurations outlined in Table 5.3. The assessment has been undertaken with the 2035 predicted traffic volumes as detailed in Section 4.4.

5.4.1 Intersection configuration

An overview of the intersection configurations used in the SIDRA modelling is provided in Table 5.4.

Table 5.4 Proposal 'A' and Proposal 'B' intersection configurations

Intersection of GWH with	Proposal 'A' Control*	Proposal 'A' Configuration	Proposal 'B' Control*	Proposal 'B' Configuration
Stockland Dr				
	Key difference: intersection control type			
Gilmour St				
	Key difference: Proposal 'B' ha s a longer right turn bay on GWH			
Lee St				
	No difference			
Boyd St				
	Key differences: Proposal 'B' has a dedicated slip lane into Boyd Street and a longer right turn bay on GWH			
View St				
	Key differences: Proposal 'B' does not allow for right turns into View Street			

Intersection of GWH with	Proposal 'A' Control*	Proposal 'A' Configuration	Proposal 'B' Control*	Proposal 'B' Configuration
Littlebourne St				
	Key difference: intersection control type			
Pat O'Leary Dr				
	No difference			
Ashworth Dr				
	Key difference: intersection control type			

*  Give-way or yield priority controlled side road  Stop sign on side road  Round about  Traffic signals

 Left-out only from side road  No right turn into side road  U-turn facility provided

5.4.2 Assessment results for proposal 'A'

Table 5.5 and Table 5.6 presents the results of the SIDRA assessment undertaken for the 2035 AM and PM peak period respectively under Proposal 'A' intersection controls. Full SIDRA movement summaries are attached in Appendix G and Appendix H.

Table 5.5 Summary of 2035 AM peak hour SIDRA analysis – Proposal 'A'

Intersection of GWH with	Control*		Degree of saturation	LoS	Average delay (sec/veh)	Max queue (m)	Comment
Stockland Dr	Round about	Average	1.087	D	100.7	>500	LOS F occurs as a roundabout, the critical movement is the GWH westbound. Delays on Stockland Dr are between 15 and 24 secs/veh.
		Worst	1.087	F	53.3	>500	
Gilmour St	Traffic signals	Average	0.809	B	21.1	313	Gilmour St approach experiences LoS E with delays over 60 secs/veh. Queues on the GWH extend to around 300m in each direction.
Lee St	Give-way; Left-out only; No right turn	Average	0.729	A	1.3	21	High LOS due to side road delay. No delays or queues on GWH.
		Worst	0.729	F	182.9	21	
Boyd St	Traffic signals	Average	0.894	C	31.5	384	Boyd St approach experiences LoS E with delays over 60 secs/veh for the right turn out. Queues on the GWH extend to over 300m in each direction.
View St	Give-way; Left-out only	Average	0.924	A	4.1	73	High LOS due to side road delay. No delays or queues on GWH.
		Worst	0.924	E	66.8	73	
Littlebourne St	Round about	Average	0.977	B	22.4	220	Acceptable performance as a roundabout. LoS C due to GWH westbound delays.
		Worst	0.977	D	50.2	220	
Pat O'Leary Dr	Traffic signals	Average	0.759	B	24.3	215	Good operation - worst delays occur right turn out of Pat O'Leary Dr (50secs/veh). Longest queues occur on GWH westbound (215m).
Ashworth Dr	Round about	Average	0.530	A	7.5	34	Acceptable performance as a roundabout.
		Worst	0.130	B	15.5	5	

* For priority controlled and roundabout junctions the overall LoS is based on the LoS of the worst movement

Give-way or yield priority controlled side road; Stop sign on side road; Round about; Traffic signals
Left-out only from side road; No right turn into side road; U-turn facility provided

Table 5.6 Summary of 2035 PM peak hour SIDRA analysis – Proposal 'A'

Intersection of GWH with	Control*		Degree of saturation	LoS	Average delay (sec/veh)	Max queue (m)	Comment
Stockland Dr	Roundabout	Average	1.024	B	26.0	>500	Acceptable performance as a roundabout. Queues on GWH eastbound extend beyond 500m and westbound beyond 300m. Delays on all approaches are acceptable (better than LoS C).
		Worst	1.024	C	38.0	>500	
Gilmour St	Traffic signals	Average	1.043	C	32.0	>500	Overall performance is good, however some individual movements experience notable delays, in particular the right turn into Gilmour St (>90 secs/veh). Queues on GWH eastbound extend beyond 500m and westbound beyond 300m.
Lee St	Give-way; Left-out only; No right turn	Average	0.837	A	1.6	28	High LOS due to side road delay. No delays or queues on GWH.
		Worst	0.841	F	>90	28	
Boyd St	Traffic signals	Average	0.946	C	30.3	>500	Boyd St approach experiences LoS E with delays of 58 secs/veh for the right turn out. Queues on GWH eastbound extend beyond 500m and westbound around 300m.
View St	Give-way; Left-out only	Average	0.677	A	1.8	26	Acceptable performance - LOS D due to side road delay. No delays or queues on GWH.
		Worst	0.677	D	54.9	26	
Littlebourne St	Roundabout	Average	1.007	B	28.0	293	Acceptable performance – LOS D as a roundabout.
		Worst	1.007	D	48.0	293	
Pat O'Leary Dr	Traffic signals	Average	0.862	B	27.3	271	Good operation - worst delays occur on right turns: out of Pat O'Leary Dr (50secs/veh); into Pat O'Leary Dr (51.2secs/veh). Longest queues occur on GWH westbound (270m).
Ashworth Dr	Roundabout	Average	0.665	A	7.1	49	Acceptable performance as a roundabout.
		Worst	0.339	B	15.6	14	

* For priority controlled and roundabout junctions the overall LoS is based on the LoS of the worst movement

Give-way or yield priority controlled side road; STOP Stop sign on side road; Round about; Traffic signals

ONLY Left-out only from side road; NO RIGHT TURN No right turn into side road; U TURN U-turn facility provided

5.4.3 Assessment results for proposal 'B'

Table 5.7 and Table 5.8 presents the results of the SIDRA assessment undertaken for the 2035 AM and PM peak period respectively under Proposal 'B' intersection controls. Full SIDRA movement summaries are attached in Appendix I and Appendix J.

Table 5.7 Summary of 2035 AM peak hour SIDRA analysis – Proposal 'B'

Intersection of GWH with	Control*		Degree of saturation	LoS	Average delay (sec/veh)	Max queue (m)	Comment
Stockland Dr	Traffic signals; U-turn	Average	1.034	E	59.0	>500	LOS E occurs – worst movement is GWH westbound with delays >90secs/veh and queues >500m. Optimisation of intersection required to achieve better performance.
Gilmour St	Traffic signals	Average	0.857	B	25.9	372	Right turn into Gilmour St experiences LoS E with delays of 58secs/veh. Queues on the GWH extend to > 300m in each direction.
Lee St	Give way; Left-out only; No right turn	Average	1.015	A	6.3	45	High LOS due to side road delay. No delays or queues on GWH through movements.
		Worst	1.015	F	>90	45	
Boyd St	Traffic signals	Average	0.894	C	32.9	384	Boyd St approach experiences LoS E with delays >60 secs/veh for the right turn out. GWH right turn into Boyd St experiences LoS F with delays >70 secs/veh. Queues on GWH extend to > 300m in each direction.
View St	Give way; Left-out only; No right turn	Average	1.866	D	44.8	489	High LOS due to side road delay. No delays or queues on GWH through movements.
		Worst	1.866	F	>90	489	
Littlebourne St	Traffic signals; U-turn	Average	1.000	D	49.6	362	Acceptable performance as signals, some individual movements experience significant delays: Littlebourne St right turn out (76secs/veh); GWH westbound (64secs/veh); GWH right turn into Littlebourne St (*>90secs/veh). Queues on the GWH extend to over 300m in each direction.
Pat O'Leary Dr	Traffic signals	Average	0.753	B	25.6	214	Good operation - worst delays occur for right turn into and out of Pat O'Leary Dr (around 50secs/veh). Longest queues occur on GWH westbound (214m).
Ashworth Dr	Traffic signals; U-turn	Average	0.833	D	45.6	218	Acceptable performance - worst delays occur for right turn movements on GWH (Los F).

* For priority controlled and roundabout junctions the overall LoS is based on the LoS of the worst movement

Give-way or yield priority controlled side road; Stop sign on side road; Round about; Traffic signals

Left-out only from side road; No right turn into side road; U-turn facility provided

Table 5.8 Summary of 2035 PM peak hour SIDRA analysis – Proposal 'B'

Intersection of GWH with	Control*		Degree of saturation	LoS	Average delay (sec/veh)	Max queue (m)	Comment
Stockland Dr		Average	1.000	C	35.8	>500	Acceptable performance – delays are notable on GWH for right turn into Stockland Dr (76secs/veh). Queues on GWH westbound extend beyond 500m and eastbound beyond 300m.
Gilmour St		Average	1.188	E	57.5	>500	Performance deteriorates at this intersection with overall Los E – long delays on GWH westbound (>90secs.veh) and long queues on GWH eastbound (>500m).
Lee St		Average	0.996	A	6.6	52	High LOS due to side road delay. No delays or queues on GWH through movements.
		Worst	0.996	F	>90	52	
Boyd St		Average	0.920	B	26.4	488	GWH right turn into Boyd experiences Los F (delays 72secs/veh) and Boyd St right turn out experiences LoS E (delays 65secs/veh). Queues on GWH eastbound extend to almost 500m and westbound around 300m.
View St		Average	1.579	A	14.0	210	High LOS due to side road delay. No delays or queues on GWH through movements.
		Worst	1.579	F	>90	210	
Littlebourne St		Average	1.041	E	68.1	>500	Poorer performance – LOS E.
Pat O'Leary Dr		Average	0.859	B	26.6	268	Good operation - worst delays occur on right turns: out of Pat O'Leary Dr (50secs/veh); into Pat O'Leary Dr (54secs/veh). Longest queues occur on GWH westbound (270m).
Ashworth Dr		Average	0.786	C	36.4	213	Acceptable performance as a roundabout.

* For priority controlled and roundabout junctions the overall LoS is based on the LoS of the worst movement

Give-way or yield priority controlled side road · Stop sign on side road · Round about · Traffic signals

Left-out only from side road · No right turn into side road · U-turn facility provided

5.4.4 Summary

During the analysis of Proposal 'A' and Proposal 'B' the following key issues were noted:

- Stockland Drive intersection:
  - Operates poorly in the AM peak as a roundabout (LoS F) under Proposal 'A'.
  - Better performance (Los E) was achieved in the AM peak as traffic signals under Proposal 'B'.
- Gilmour Street intersection:
  - Operates poorly (Los E) in the PM peak under Proposal 'B'.
  - The intersection is over capacity and the slight increase in volumes under Proposal 'B' due to the additional turn movements without the roundabouts has increased the average delay notably.
- Lee Street intersection:
  - Operates similarly under both proposals (LoS F due to side road delays).
- Boyd Street intersection:
  - Operates similarly (Los B or C) under both proposals.
  - Slightly better performance was observed in the PM peak under Proposal 'B'.
- View Street intersection:
  - Slightly better performance was observed in the both peak under Proposal 'A' (LoS D/E due to side road delays).
  - Operates at LoS F under Proposal 'B' due to side road delays.
- Littlebourne Street intersection:
  - Operates similarly (Los D) under both proposals during the AM peak period.
  - Better performance was observed in the PM peak as a roundabout under Proposal 'A' (LoS D) compared to Proposal 'B' (Los E).
- Pay O'Leary Drive intersection:
  - Operates similarly (Los B) under both proposals.
- Ashworth Drive intersection:
  - Operates better (Los B) as a roundabout under Proposal 'A' than as traffic signals (Los C or D).

After review and analysis of Proposal 'A' and Proposal 'B' by the study team it was recommended to go forward with a revised scenario with detailed analysis in Paramics followed by assessment of each intersection in SIDRA. The scenario was to generally be a hybrid of the above Proposals:

- Traffic signals at Stockland Drive, Gilmour Street, Boyd Street and Pat O'Leary Drive.
- Roundabout at Ashworth Drive.
- Littlebourne Street was to be tested as both traffic signals and a roundabout.

5.5 2035 NETWORK/ INTERSECTION PERFORMANCE PROPOSAL 'C'

The Proposal 'C' future upgrades were tested using Paramics traffic micro-simulation software, for the AM and PM 2035 peak-hour scenarios; 8:15-9:15am and 4-5pm respectively. Two-sub options were considered in the Paramics modelling:

- Option 1 (Proposal 'C1') upgrades, the most significant of which were as follows:
  - Signals at Stockland Drive.
  - Roundabout at Littlebourne Street.
  - Roundabout at Ashworth Drive.
- Option 2 (Proposal 'C2') is as per Option 1 but with the following changes:
  - Signals at Littlebourne Street instead of a roundabout.
  - Right-turn ban form Great Western Highway into View Street.

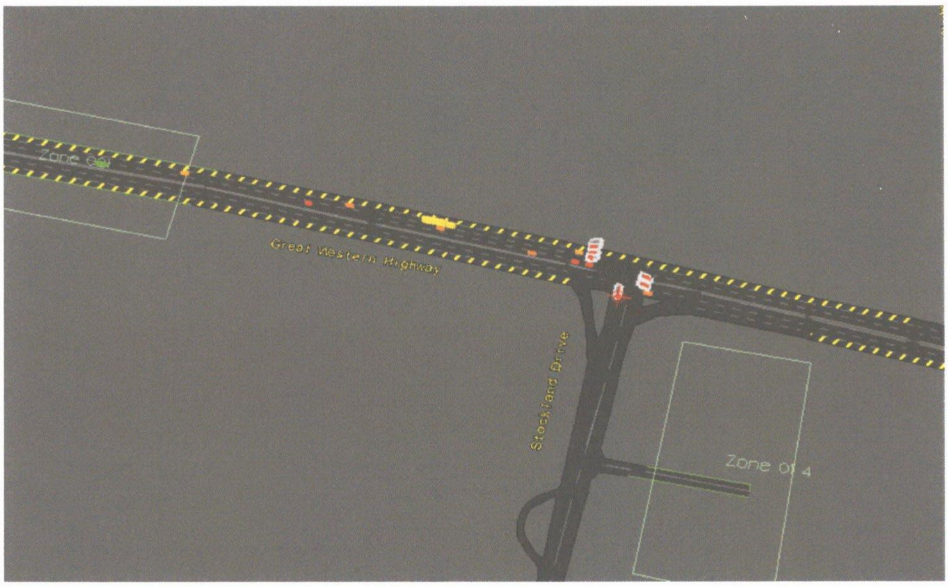
The study area (and model area) is illustrated in Figure 3.1.

5.5.1 2035 modelled intersection configuration

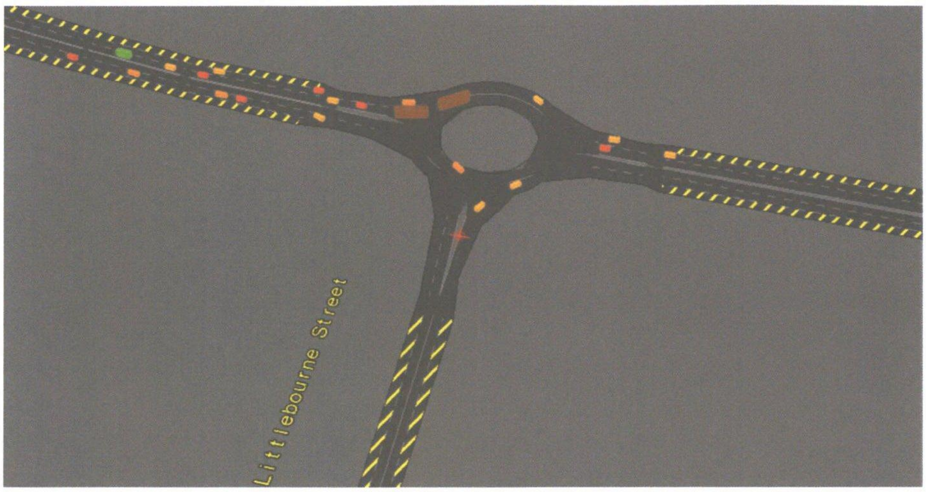
The 2035 models have been tested with a four lane divided carriageway and the major intersection changes as detailed in Section 5.3.

The following figures show the modelled intersection configurations for both Option 1 and Option 2.

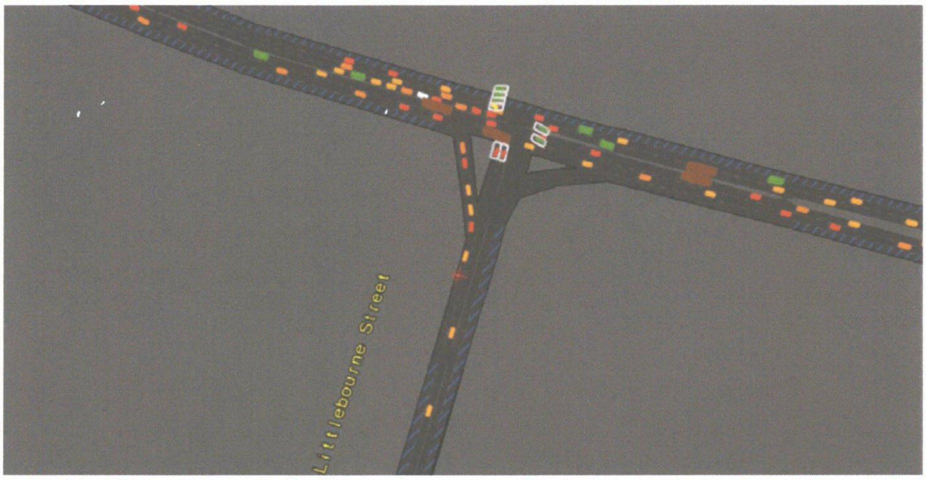
- Great Western Highway / Stockland Drive – signalised (options 1 and 2)



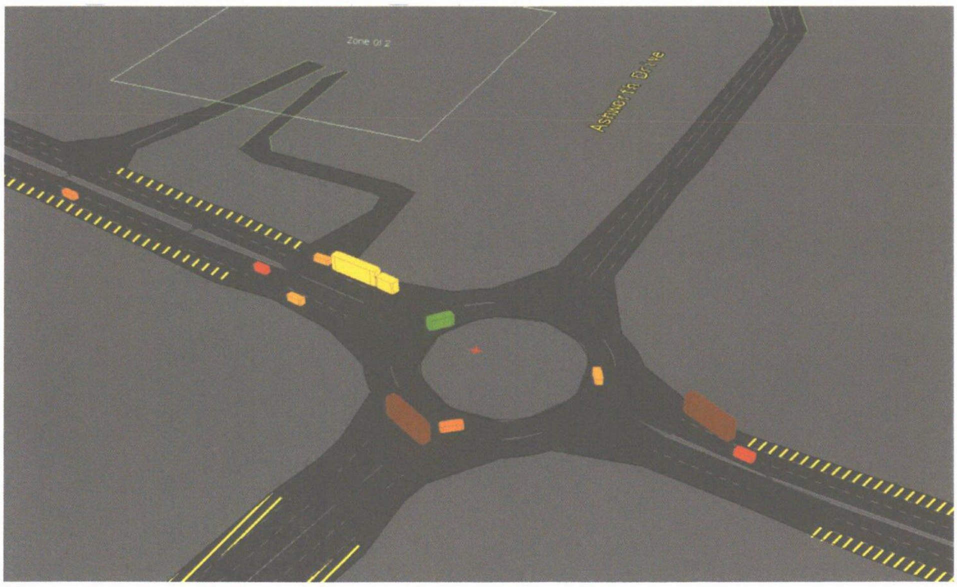
- Great Western Highway / Littlebourne Street – roundabout (Option 1)



- Great Western Highway / Littlebourne Street – signalised (Option 2)

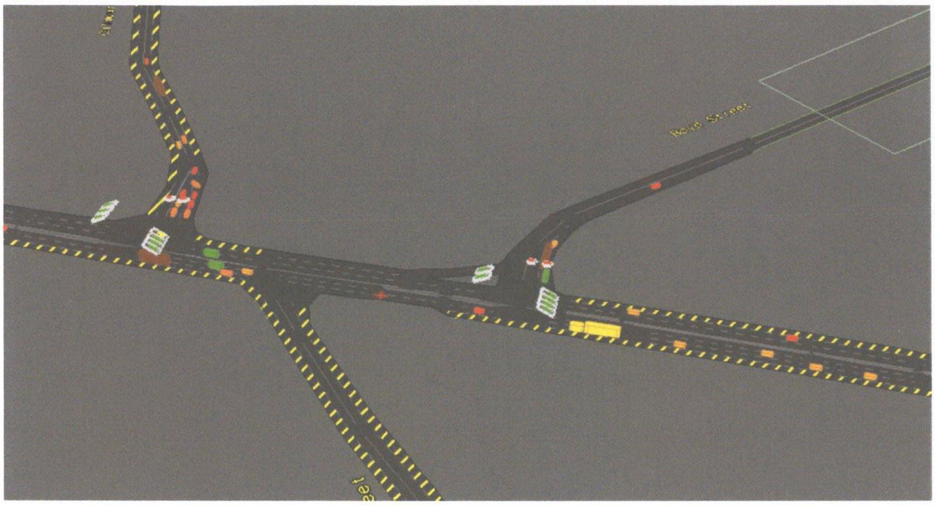


- Great Western Highway / Ashworth Drive – roundabout (Options 1 and 2)

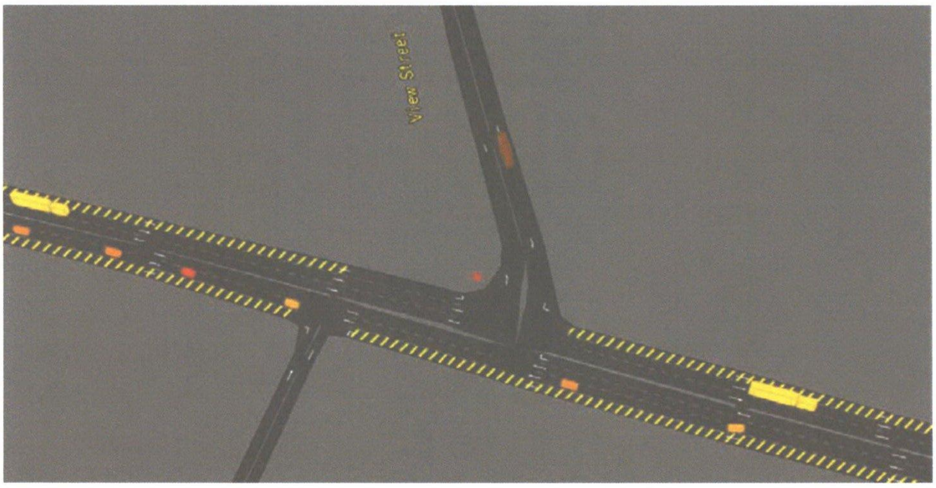


There were also additional configuration changes to supplement those above for 2035; these are illustrated in the following figures.

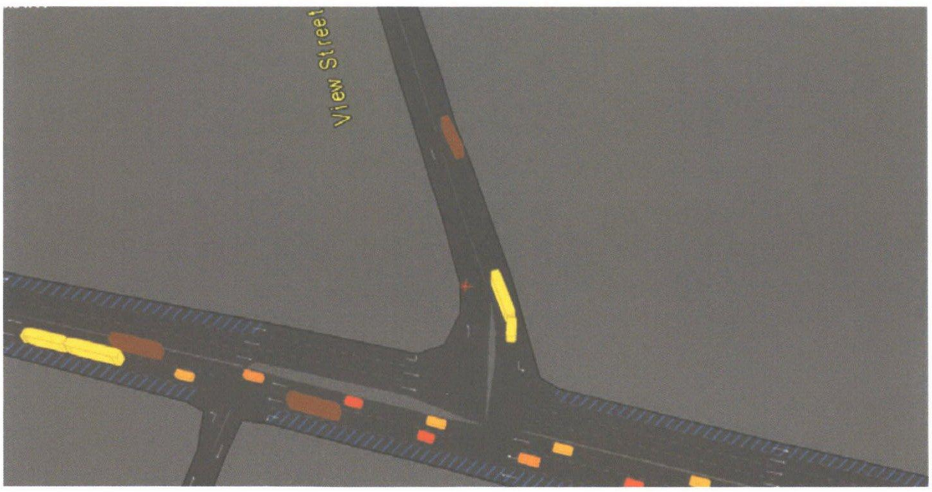
- Great Western Highway / Gilmour Street / Lee Street/ Boyd Street (Options 1 and 2)



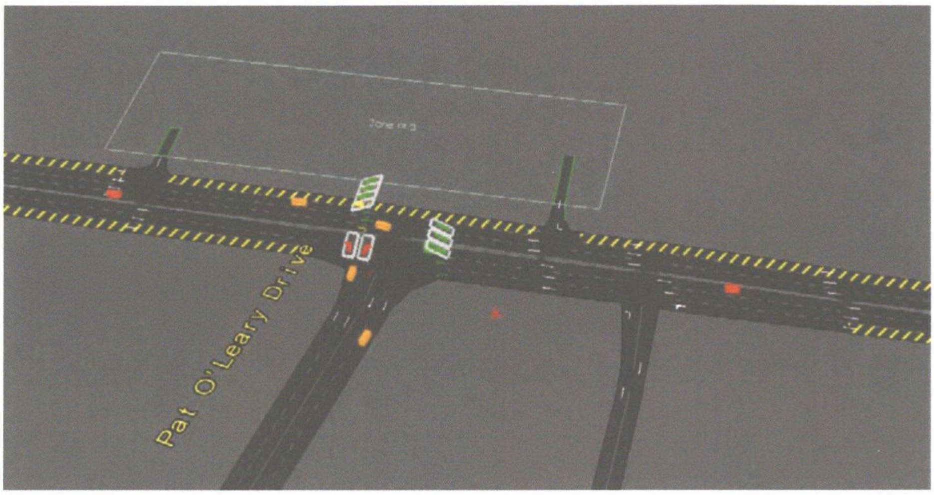
- Great Western Highway / View Street (Option 1)



- Great Western Highway / View Street (Right Turn Ban into View Street - Option 2)



- Great Western Highway / Pat O'Leary Drive



5.5.2 Assessment results for proposal 'C'

The performance of each of the AM and PM upgraded road network has been assessed visually for both options with signal optimisation also carried out on a fixed time basis along Great Western Highway between Stockland Drive / Gilmour Street / Boyd Street.

The assessment of Proposal 'C' was undertaken through the following analysis tools:

- Assessment of queue lengths presented visually.
- Assessment of network travel time outputs presented numerically.
- Assessment of intersection degree of saturation, delays and LoS through SIDRA analysis using the Paramics link and turn flows.

Option 1 (proposal 'C1') - 2035 AM peak Paramics visual analysis

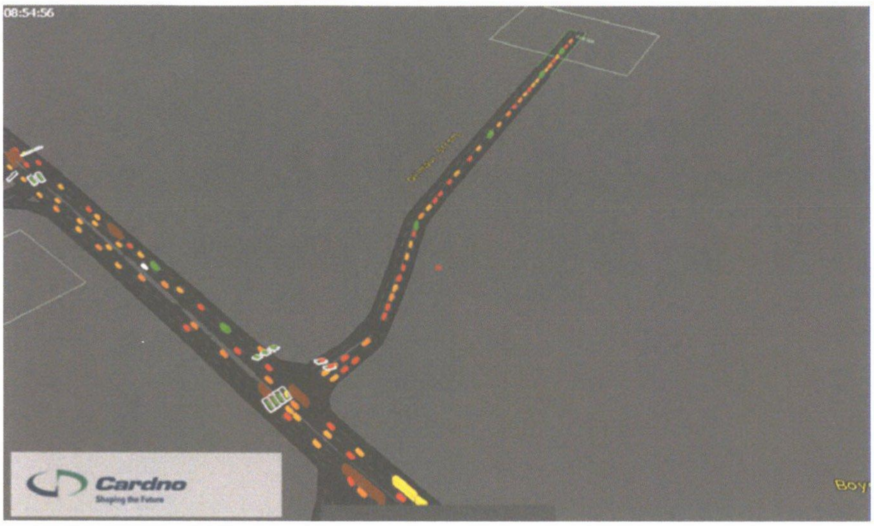
Generally in the Paramics modelling the Great Western Highway operates reasonably well under Option 1 upgrades, with all vehicles getting released into the road network at the eastern and western points of the model. Key observations include:

- Signalisation of **Stockland Drive** facilitates ample timings for all turning movements, including Great Western Highway in both directions.
- **Linked signalisation of Gilmour and Boyd Streets** also facilitates Great Western Highway to operate well; however long queues on both Gilmour and Boyd Streets occur as a result, extending for some 200+ metres back into the Paramics zones. A point to note however is that such extensive queuing would is likely to cause an additional shift of Bathurst-bound vehicles to Hereford Street over and above what has already been assumed especially for vehicles queuing on Gilmour Street.
- There are also queues on **Great Western Highway east of Boyd Street** on the approach to this intersection. These are operational in nature and given the high traffic volumes, clear well with the linked signal configurations.
- **Littlebourne Street roundabout** operates well. There are queues on the eastern leg towards the end of the AM peak hour largely due to right turners from Great Western Highway into Littlebourne and also U-turners on Great Western Highway; these queues extend to Pat O'Leary Drive and beyond.
- **Littlebourne Street and Pat O'Leary Drive** experience queuing on the approaches to Great Western Highway, although these do clear and are not excessive.
- There is also queuing on **Great Western Highway east of Pat O'Leary Drive** caused by signals; these are deemed to be operational and all queues do clear towards the end of the peak hour.

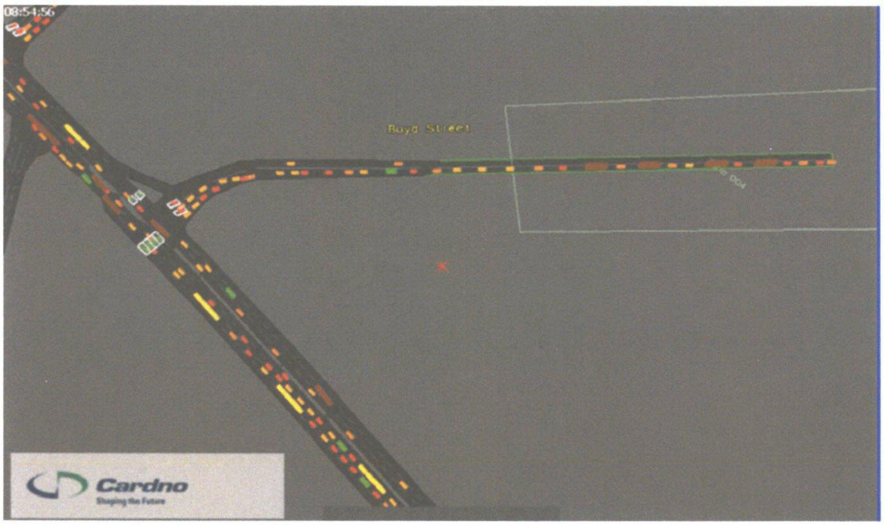
- The **Ashworth Drive** roundabout operates well.

Screenshots of queuing from the AM 2035 Paramics model for Option 1 are shown as follows.

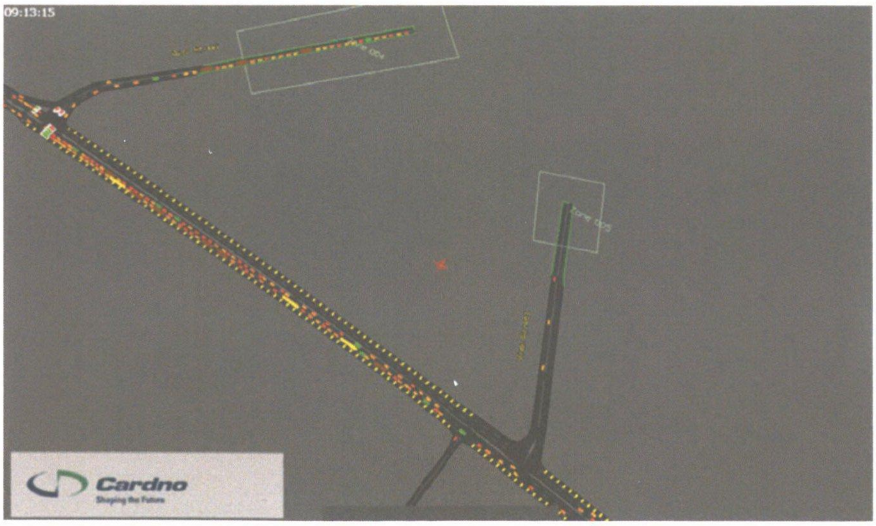
- Option 1: Gilmour Street @ 9am 2035



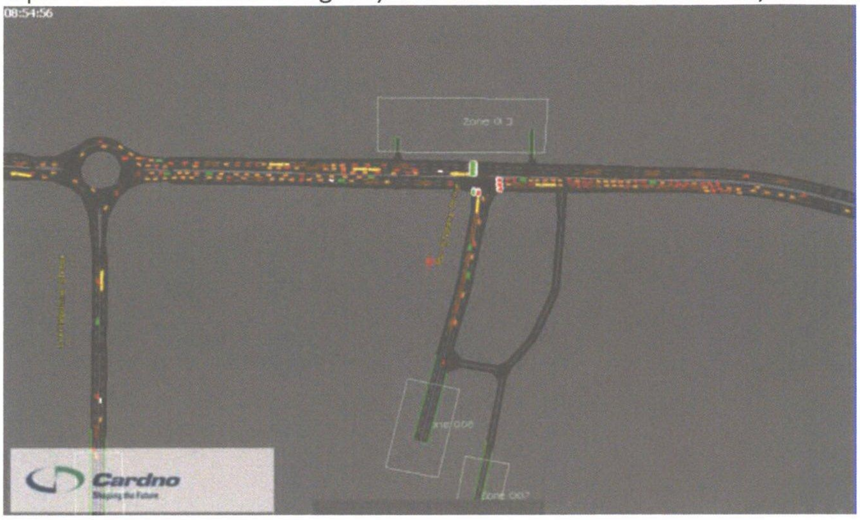
- Option 1: Boyd Street @ 9am 2035



- Option 1: Great Western Highway Approach to Boyd Street @ 9am 2035



- Option 1: Great Western Highway, Littlebourne Street & Pat O'Leary Street @ 9am 2035



Overall Great Western Highway itself operates well, with mostly operational queuing occurring at signalised junctions and the Littlebourne Street roundabout. Queues at signals usually clear in one cycle, and at worst two; the Littlebourne Street roundabout operates well especially for the high volume of right-turners from Great Western Highway into Littlebourne Street.

Gilmour and Boyd Streets do experience extended queues as a result of the optimisation of flows for Great Western Highway, which received priority as far as was practicable.

Option 2 (proposal 'C2') - 2035 AM peak Paramics visual analysis

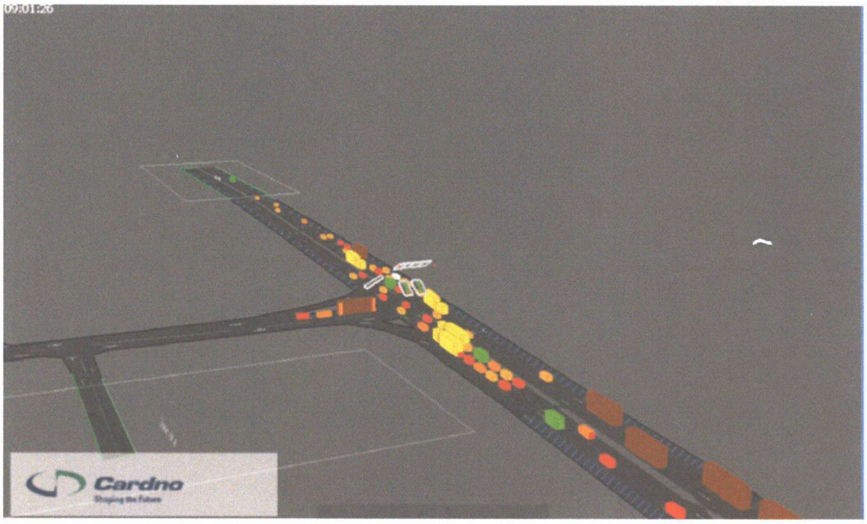
Key observations for the Paramics modelling of the Great Western Highway under Option 2 include:

- As with Option 1, signalisation of **Stockland Drive** facilitates reasonable timings for all turning movements, including Great Western Highway in both directions. As a result of the right turn ban into View Street, which is part of the package to configure signals at Littlebourne Street, there is a downstream challenge at Stockland Drive. There is a requirement therefore in Option 2 to provide adequate signal green time and additional capacity for vehicles from East of View Street, and bound for View Street, which now have to u-turn on Stockland Drive and travel back to View Street making a left turn in. Although signal optimisation of the network did get this to work reasonably well, pedestrian cross times were minimised in order to get this junction to work with the u-turn facility allowed. This is not ideal from a safety perspective, however it is unlikely in reality that the pedestrian phase would be called up for every cycle and therefore better optimisation could occur without the need to minimise cross times.
- Again, as was the case with Option 1, **linked signalisation of Gilmour and Boyd Streets** also facilitates Great Western Highway to operate well; however longer queues beyond those in Option 1, on both Gilmour and Boyd Streets are evident, extending back into the Paramics zones and blocking vehicles from entering the model. As was noted for Option 1, it is likely that such extensive queuing would likely cause an additional shift of Bathurst-bound vehicles to Hereford Street over and above what has already been assumed especially for vehicles queuing on Gilmour Street.
- There queues on **Great Western Highway east of Boyd Street** on the approach to this intersection are longer than those in Option 1, although they do clear by the end of the peak hour period. The same caution needs to be issued here however with regard to safety for pedestrians, as cross times were minimised in order to get this junction to work in Option 2.

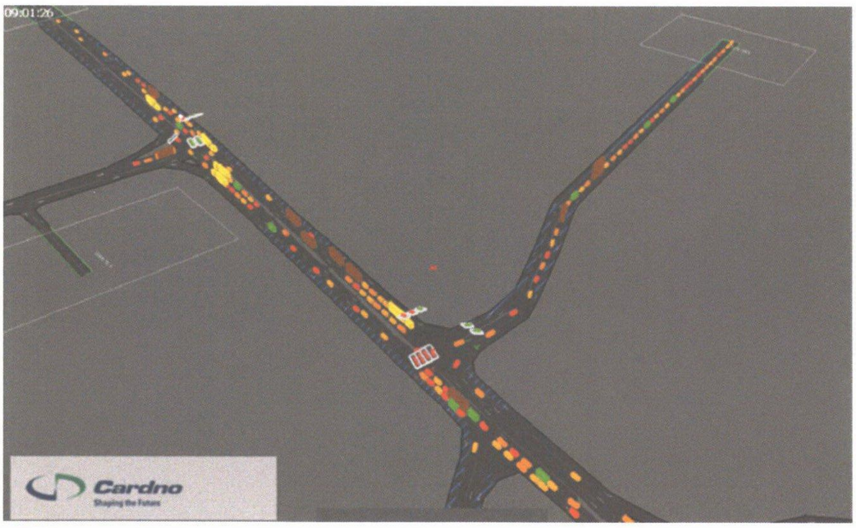
- **Littlebourne Street signalised** operates reasonably well mainly because of the through/right green time allocated to westbound vehicles and right turners into Littlebourne Street. An issue evident with the signalisation is that of higher delays (as also evident in SIDRA), which are largely as a result of the pedestrian crossing requirements at a signalised intersection. Whilst the signalised Littlebourne Street intersection does operate reasonably well, there are longer queues and delays than Option 1; these queues are notable on the eastern leg towards the end of the AM peak hour largely due to the long right green time required for right turners from Great Western Highway into Littlebourne Street. The queues extend to Pat O'Leary Drive and beyond, usually longer than those for Option 1.
- As with Option 1, the **Littlebourne Street and Pat O'Leary Drive** intersections in Option 2 AM experiences queuing on the approaches to Great Western Highway; they are longer than Option 1, though do clear and are not excessive.
- There is also queuing on **Great Western Highway east of Pat O'Leary Drive** caused by the signals; these are deemed to be operational and all queues do clear towards the end of the peak hour.
- The **Ashworth Drive** roundabout operates well.

Screenshots of queuing from the AM 2035 Paramics model for Option 2 are shown as follows:

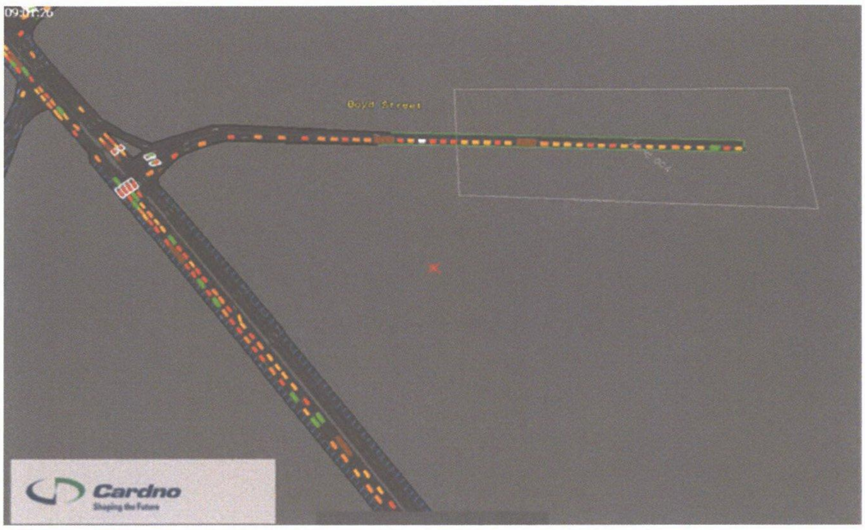
- Option 2: Stockland Avenue @ 9am 2035



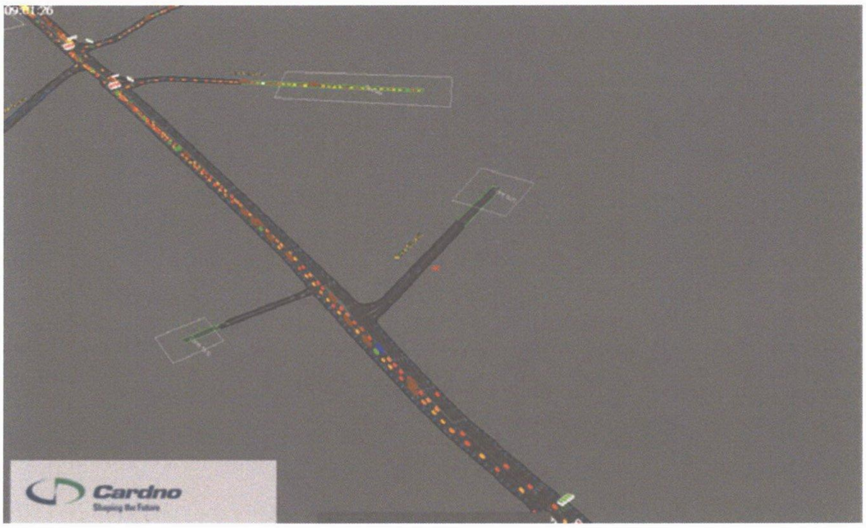
- Option 2: 2035 AM Gilmour Street @ 9am 2035



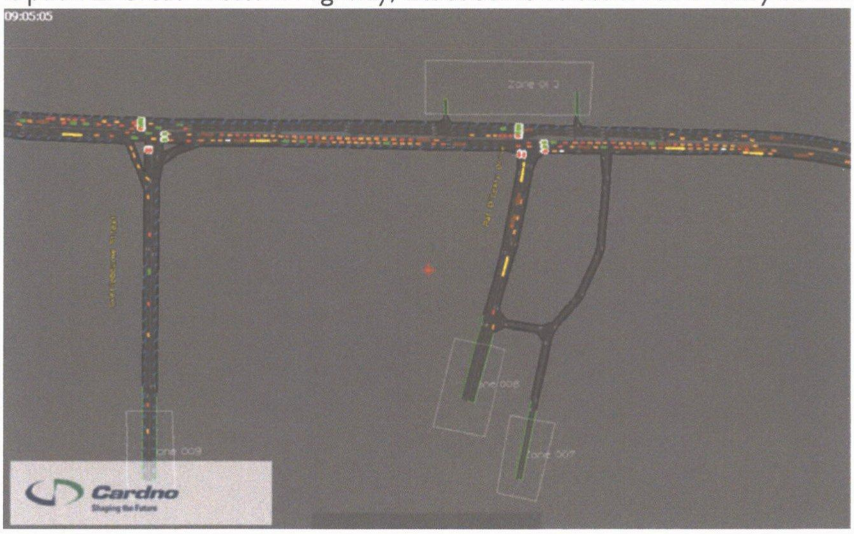
- Option 2: Boyd Street @ 9am 2035



- Option 2: Great Western Highway Approach to Boyd Street @ 9am 2035



- Option 2: Great Western Highway, Littlebourne Street & Pat O'Leary Street @ 9am 2035



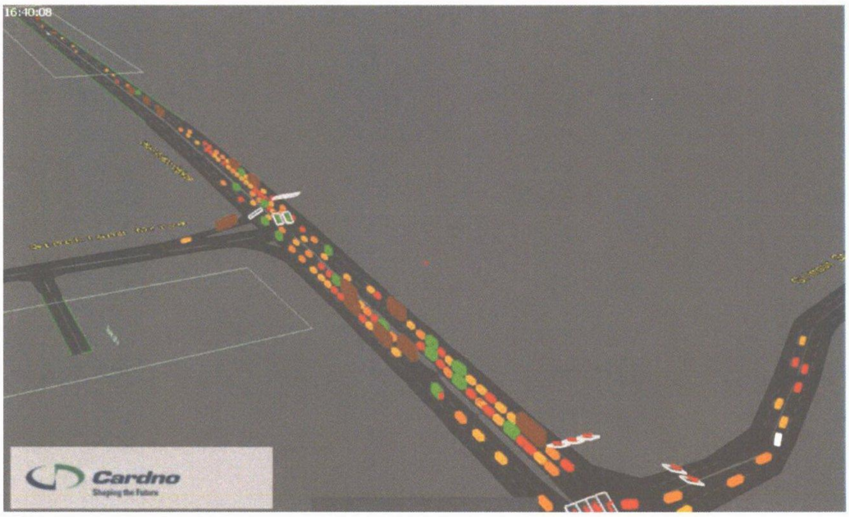
Option 1 (proposal 'C1') - 2035 PM peak Paramics visual analysis

In the PM peak hour, the Great Western Highway operates well under Option 1 with all vehicles getting released into the road network at every zone location and no major queuing due to signal optimisations. Following are the most notable points for Options 1:

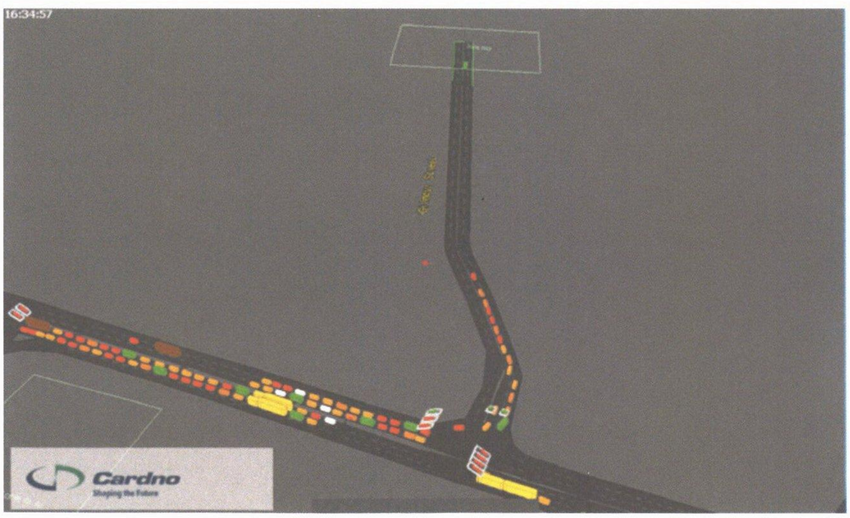
- As with Option 1 during the AM peak, signalisation of **Stockland Drive** also facilitates ample timings for all turning movements, including Great Western Highway in both directions during the PM peak hour.
- **Linked signalisation of Gilmore and Boyd Streets** also facilitates Great Western Highway to operate well. Unlike the AM however, there are no extended queues on either Gilmour or Boyd Streets as a result of the signal optimisations.
- **Littlebourne Street** roundabout operates well in the PM peak with only minor queues on the eastern leg of the intersection.
- **Littlebourne Street and Pat O'Leary Drive** intersections also operate well with minor queuing - clearing easily.
- The **Ashworth Drive** roundabout operates well with no congestion apparent.

Screenshots of queuing from the PM 2035 Paramics model for Option 1 are shown as follows.

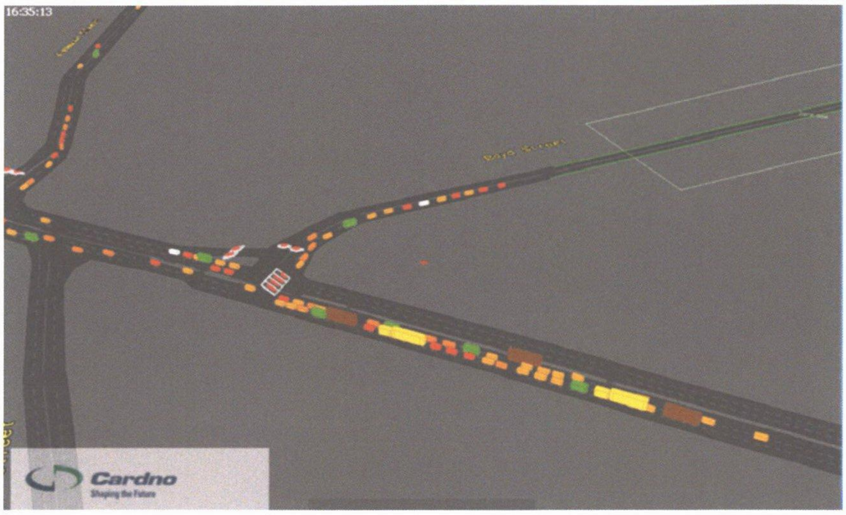
- Option 1: Stockland Avenue @ 4.40pm 2035



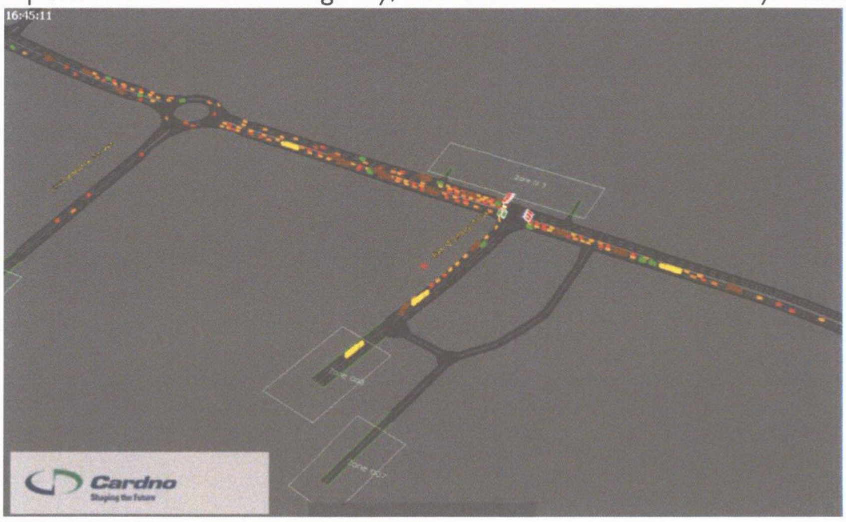
- Option 1: Gilmour Street @ 4.30pm 20 35



- Option 1: Boyd Street @ 4.30pm 2035



- Option 1: Great Western Highway, Littlebourne Street & Pat O'Leary Street @ 4.45pm 2035



Option 2 (proposal 'C2') - 2035 PM peak Paramics visual analysis

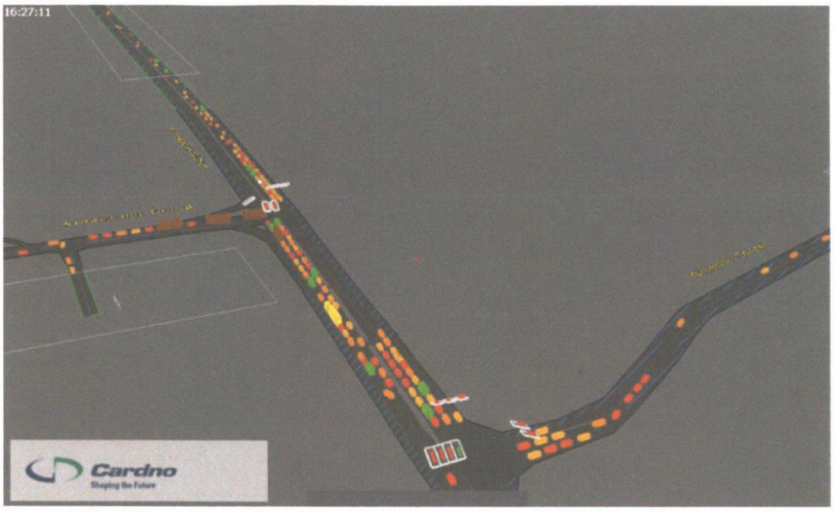
In the PM peak hour for Option 2, Great Western Highway operates reasonably well with all vehicles getting released into the road network. The Great Western Highway to the western end of the model area does experience some blockages for vehicles entering the network however; this is due to the additional green time required for Stockland Drive to cater for the u-turners coming from the eastern end of the model, with a destination at View Street. Following are the most notable points for Option 2:

- As with Option 1, signalisation of **Stockland Drive generally** facilitates reasonable timings for all turning movements, including Great Western Highway in both directions. The queuing is however longer on the western leg of Great Western Highway and also Stockland Drive due to the additional u-turners mentioned previously.
- Similar to Option 1, the **linked signalisation of Gilmore and Boyd Streets** also facilitates Great Western Highway to operate well. The queuing on the western leg of Great Western Highway extends approximately an additional 100-150 metres beyond Option 1, largely due to the additional u-turners.
- **Littlebourne Street** signalised intersection operates reasonable well, despite the LoS dropping from LoS B in Option 1 to a LoS D in Option 2. The queuing does clear in both options however; it's just the delays which are more extensive in Option 2.
- **Littlebourne Street and Pat O'Leary Drive** also operate well with minor queuing - clearing easily.

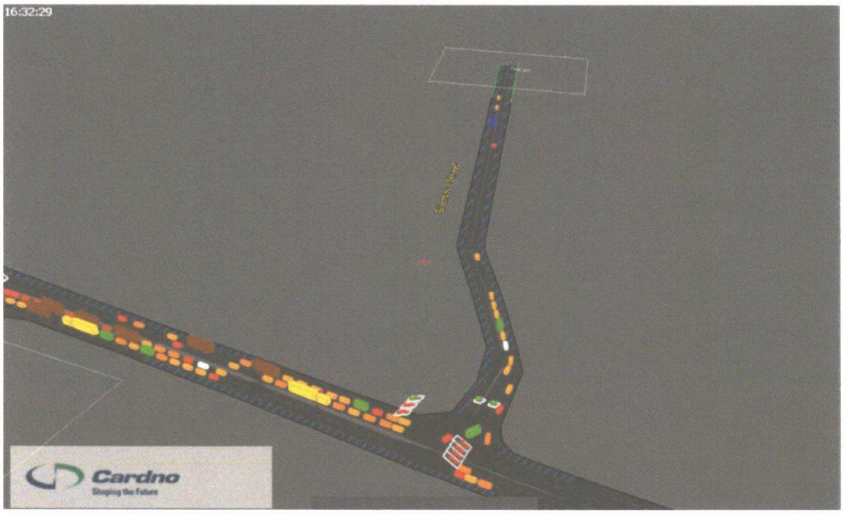
- The **Ashworth Drive** roundabout operates well.

Screenshots of queuing from the PM 2035 Paramics model for Option 2 are shown as follows:

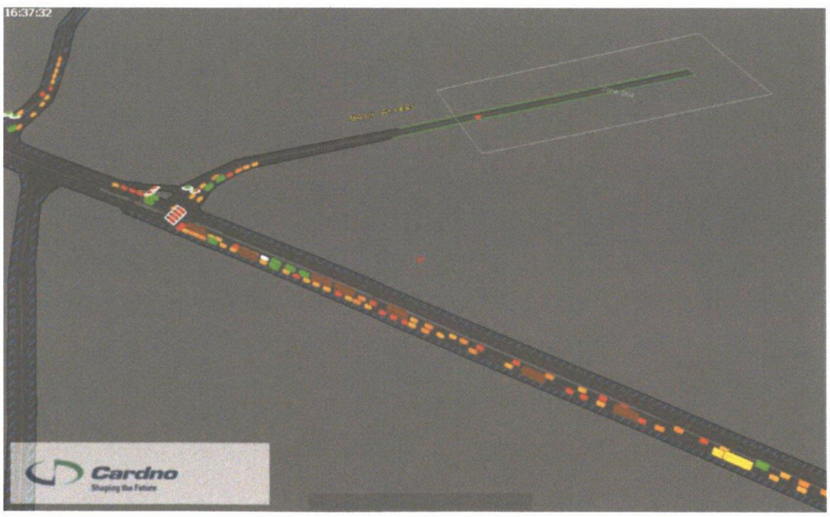
- Option 2: Stockland Avenue @ 4.40pm 2035



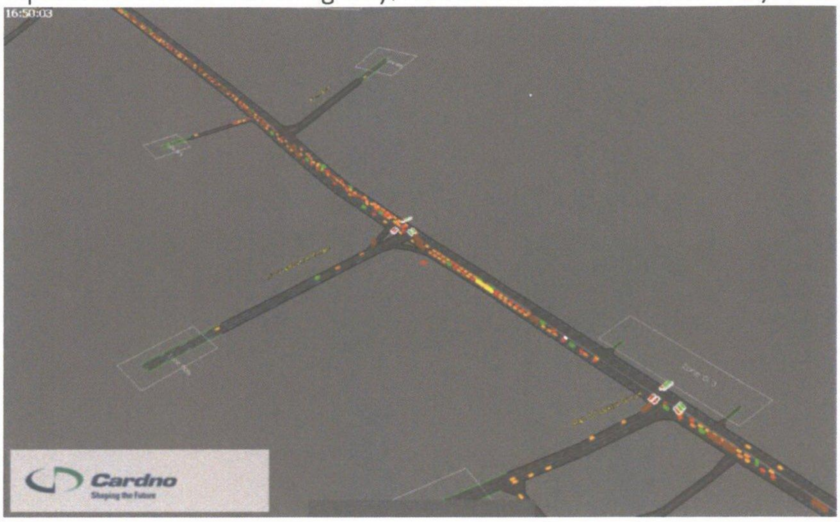
- Option 2: Gilmour Street @ 4.30pm 2035



- Option 2: Boyd Street @ 4.30pm 2035



- Option 2: Great Western Highway, Littlebourne Street & Pat O'Leary Street @ 4.45pm 2035



Overall the entire model area, including Great Western Highway itself operates reasonably well in 2035 with significantly increased volumes, with mostly operational queuing occurring at signalised junctions and the Littlebourne Street roundabout (and signals in Option 2). Mid-block delays are apparent in the PM peak in both options, and much more pronounced in Option 2.

The overall visual assessment reveals increased queuing in Option 2 largely due to increased volumes through the network because of u-turners form the east using Stockland Drive to get to View Street and also because of the signal timing changes required to accommodate these additional trips.

In addition, the introduction of signals at Littlebourne Street in Option 2 increased delay in that area of the network as there is less free flow and an additional 'all-stop' phase to cater for crossing pedestrians.

Proposal 'C' - 2011 and 2035 AM and PM Paramics travel times outputs

Network travel times were estimated from the Paramics models. The travel times were measured for:

- Vehicles travelling eastbound on Great Western Highway from Stockland Drive to Ashworth Drive.
- Vehicles travelling westbound on Great Western Highway from Ashworth Drive to Stockland Drive.

The travel times results are provided in Table 5.9 for the 2011 Base model as well as the 2035 Option 1 and Option 2 models.

Table 5.9 Comparison of modelled travel times (mm:ss)

Direction of travel on Great Western Highway	Travel time (mm:ss)					
	AM peak			PM peak		
	2011 Base	2035 Option 1	2035 Option 2	2011 Base	2035 Option 1	2035 Option 2
Eastbound - Stockland Dr to Ashworth Dr	02:43	03:20	03:10	03:01	03:30	03:30
Westbound - Ashworth Dr to Stockland Dr	02:54	05:20	06:20	03:38	04:40	05:10

The table shows that the 2035 comparisons between Options 1 and 2 are reasonably close eastbound, with no significant differences. Option 1 however has significantly better travel times, in the westbound direction, being between half a minute to a minute quicker. It is noted overall, that travel times through the network in 2035 are greater than in 2011 in both directions, though less pronounced eastbound

The analysis shows that the increased number of vehicles needing to travel westbound, u-turn and double back eastbound to access View Street partially contributes to the travel time increases in Option 2. Signalisation of Littlebourne Street also causes greater delays due to pedestrian crossing times being added that weren't previously available in Option 1 (with the roundabout in place).

Proposal 'C' - 2011 and 2035 AM and PM Paramics model flows

Figure 5.6 to Figure 5.12 shows the model output flows from Paramics in vehicles per hour during the AM peak periods, for 2011 and 2035 Options 1 and 2. Figure 5.13 to Figure 5.19 provides the PM peak model flows. Each graphic shows 3 comparable volumes, one each for the 2011 base model, 2035 Option 1 model and 2035 Option 2 model:

888	2011 Calibrated base model flows (vehicles/hour)
888	2035 Option 1 model flows (vehicles/hour)
888	2035 Option 2 model flows (vehicles/hour)

There is generally little difference between the Option 1 and 2 flows in 2035, as the models have been optimised in favour of the Great Western Highway movements eastbound and westbound. Bearing in mind all that was mentioned previously with regard to the additional numbers u-turning due to the Option 2 configurations, it is actually Option 1 that operates slightly better in 2035, with less queuing and delay, even though Option 2 appears to push through more vehicles.

Important to Note for Option 2

Where there are increased flows in Option 2, it is generally because there is also a higher flow volume needing to make the relevant movement, rather than it being a case of latent demand that wasn't getting through in Option 1.

For example, in both the AM and PM for Option 2 with signals at Littlebourne Street and no right turn into View Street, there is a demand of over 120 vehicles (including heavies) from east of View Street, which have their destination at the View Street zone. As a result of the right-turn ban into View Street in Option 2 these vehicles have to travel to from east of View Street to undertake a u-turn manoeuvre and then approach View Street from the west. A formal u-turn facility was modelled in Stockland Drive and hence in the model these u-turn are performed on Stockland Drive. However, in reality drivers may choose to turn into Boyd Street to undertake a u-turn.

If the right turners into View Street were rerouted to Boyd Street this would then increase the Boyd Street right turn by approximately 120 vehicles, and given that Boyd Street is signal controlled there would be additional delays for other legs of this intersection unless the 120 right turners were stored and delayed on Great Western Highway. This option that was not tested in the 2035 Option 2 models.

It is therefore expected in the modelling that all the associated flows along Great Western Highway and at Stockland should be higher by at that amount (approximately 120 vehicles) in Option 2 because of the increased number of vehicles needing to make those movements, and not because Option 1 configurations were a constraint as might be the temptation to initially think.

Therefore all junctions west of View Street should have a through movement of approximately 120 vehicles higher in Option 2 (westbound) and similarly those 120 vehicles should also be getting through in the eastbound direction as they travel back towards View Street. The exceptions of course are that an additional 120 vehicles should also be turning left into Stockland Drive (and subsequently right out of Stockland Drive), and those same vehicles should be then turning left into View Street in Option 2. Cognisance needs to be maintained of this when checking the 2035 Option 1 and Option 2 flows.

Anywhere that there is not an additional 120 vehicles getting through the model network, at the relevant intersections in Option 2, it is an indication that there is actually additional congestion and not less.

Figure 5.6 AM Paramics model flows Great Western Highway/Stockland Drive (vehicles/hour)

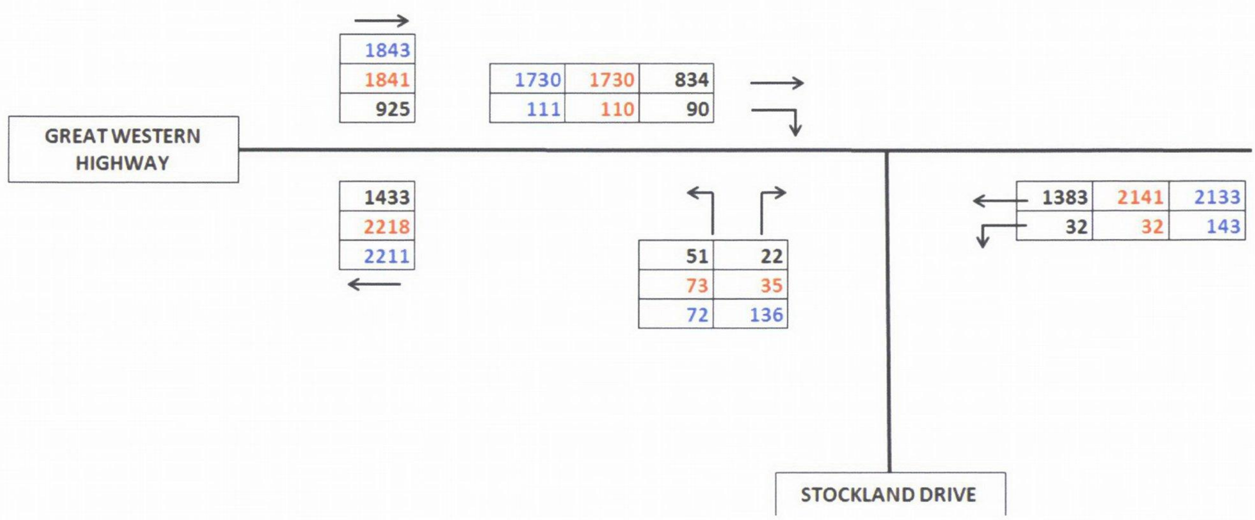


Figure 5.7 AM Paramics model flows Great Western Highway/Gilmour Street (vehicles/peak hour)

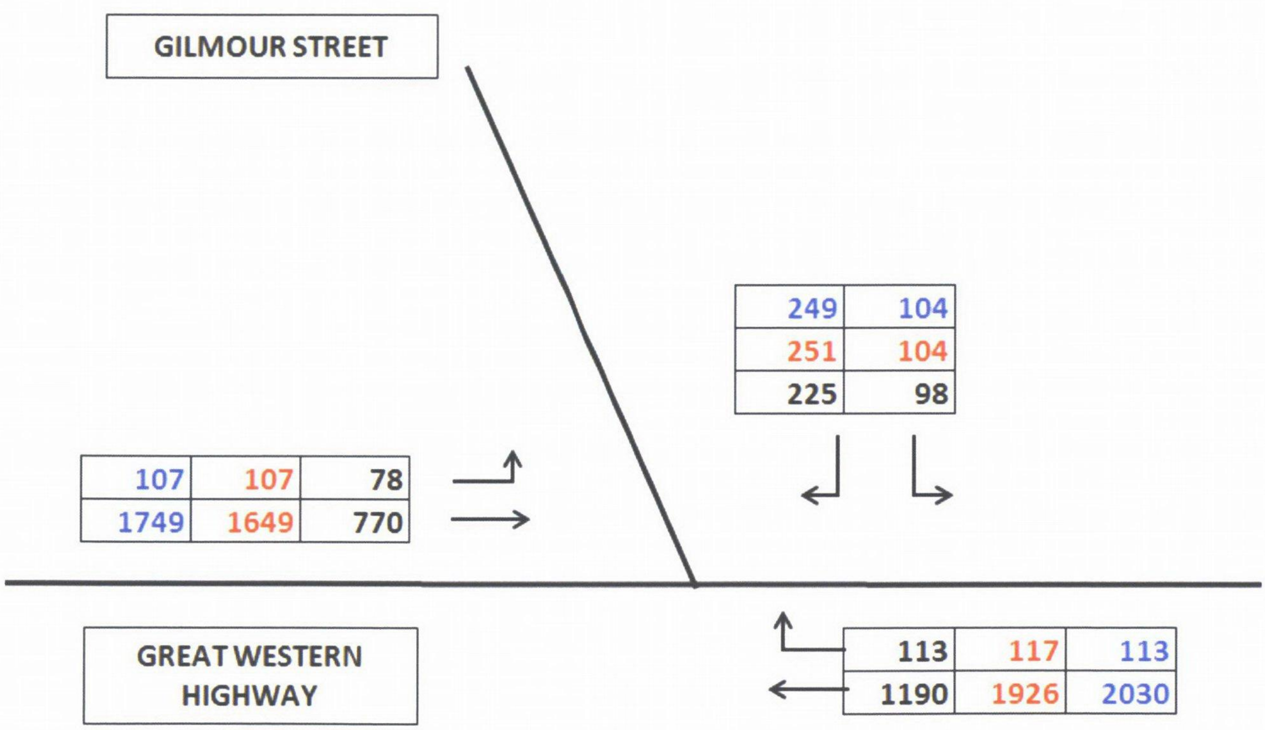


Figure 5.8 AM Paramics model flows Great Western Highway/Boyd Street (vehicles/peak hour)

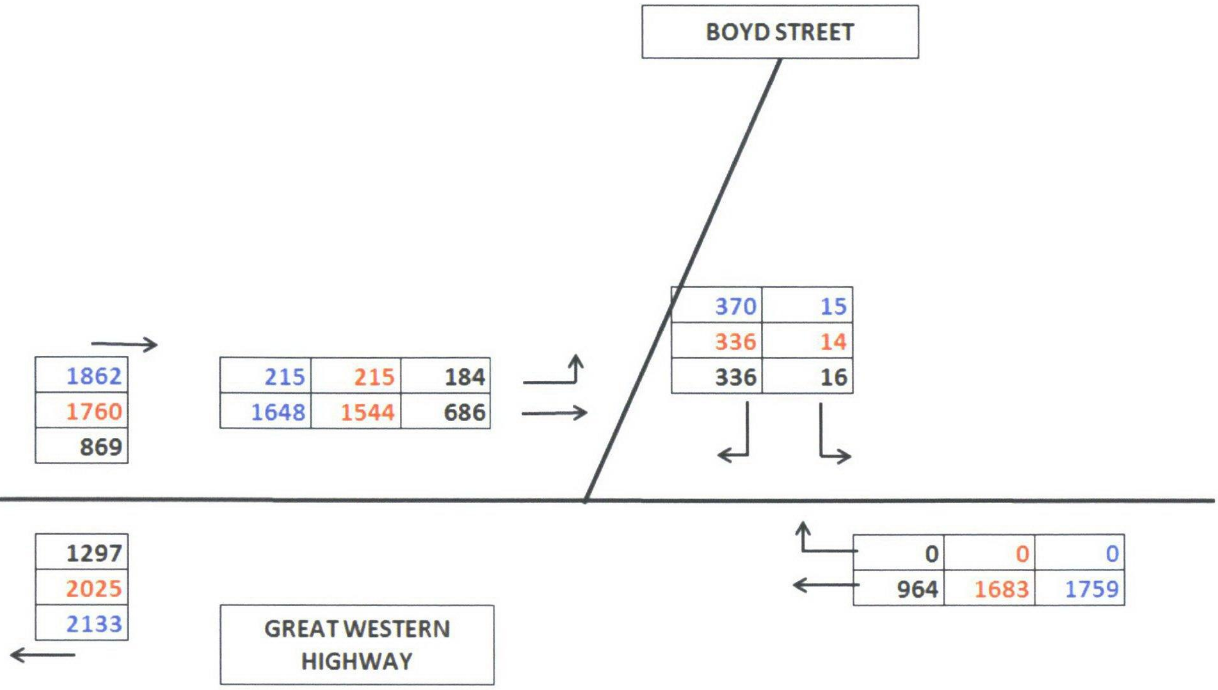


Figure 5.9 AM Paramics model flows Great Western Highway/View Street (vehicles/peak hour)

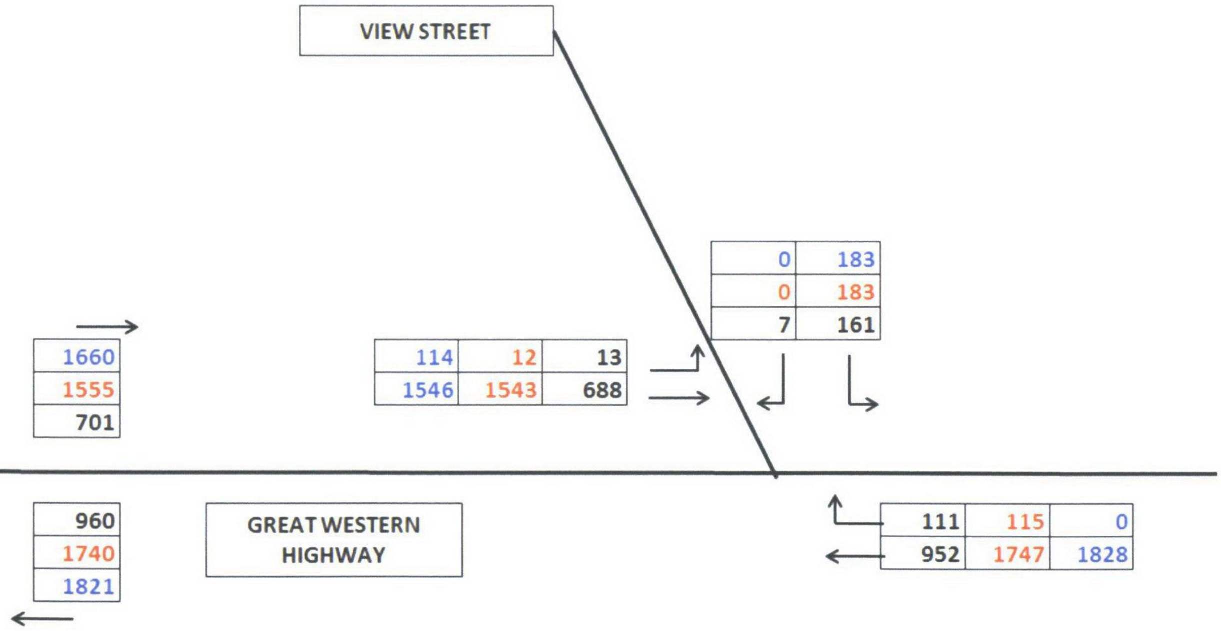


Figure 5.10 AM Paramics model flows Great Western Highway/Littlebourne Street (vehicles/peak hour)

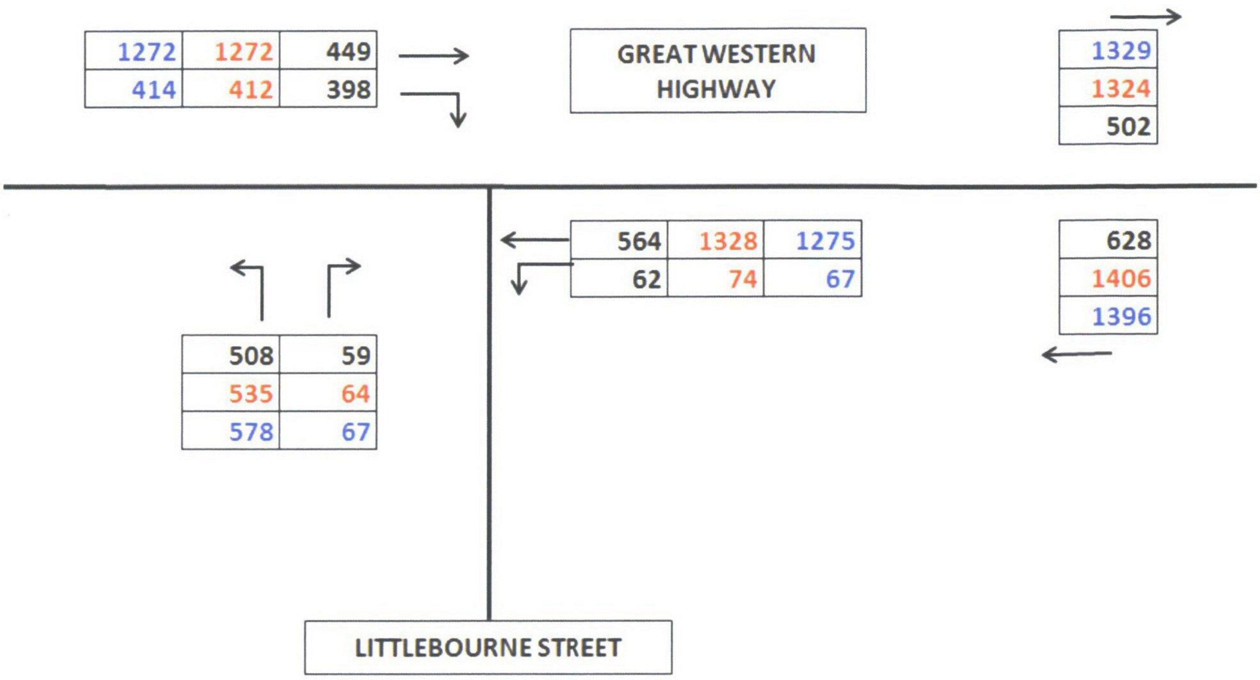


Figure 5.11 AM Paramics model flows Great Western Highway/Pat O'Leary Drive (vehicles/peak hour)

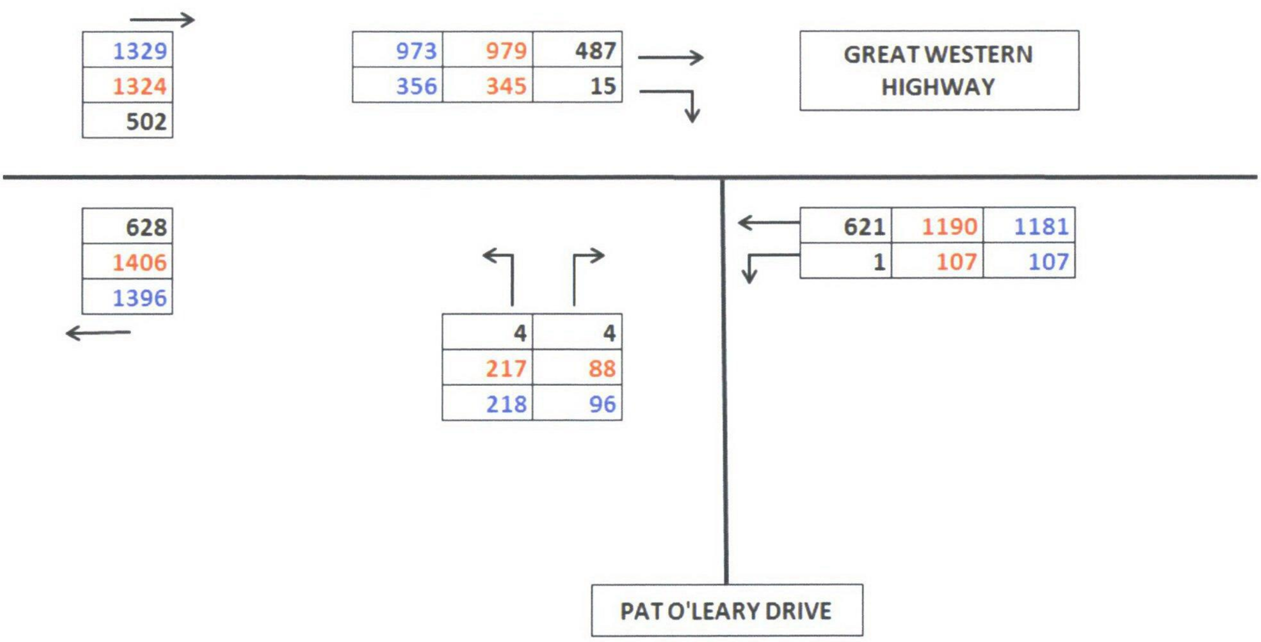


Figure 5.12 AM Paramics model flows Great Western Highway/Ashworth Drive (vehicles/peak hour)

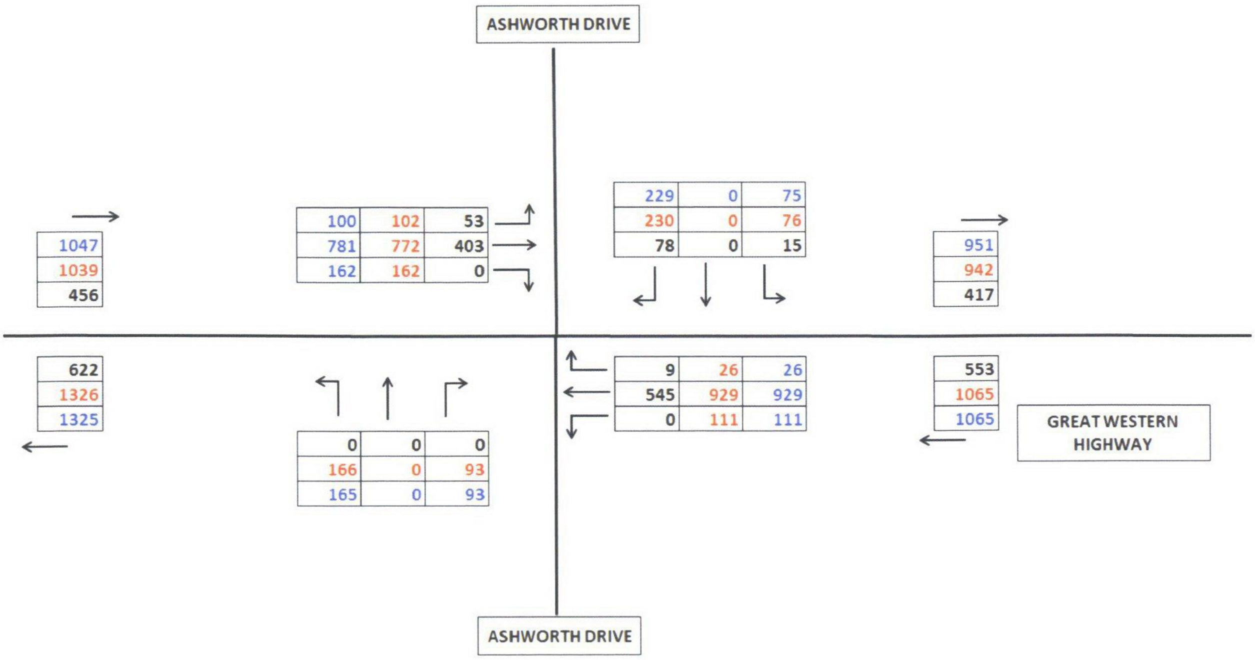


Figure 5.13 PM Paramics model flows Great Western Highway/Stockland Drive (vehicles/peak hour)

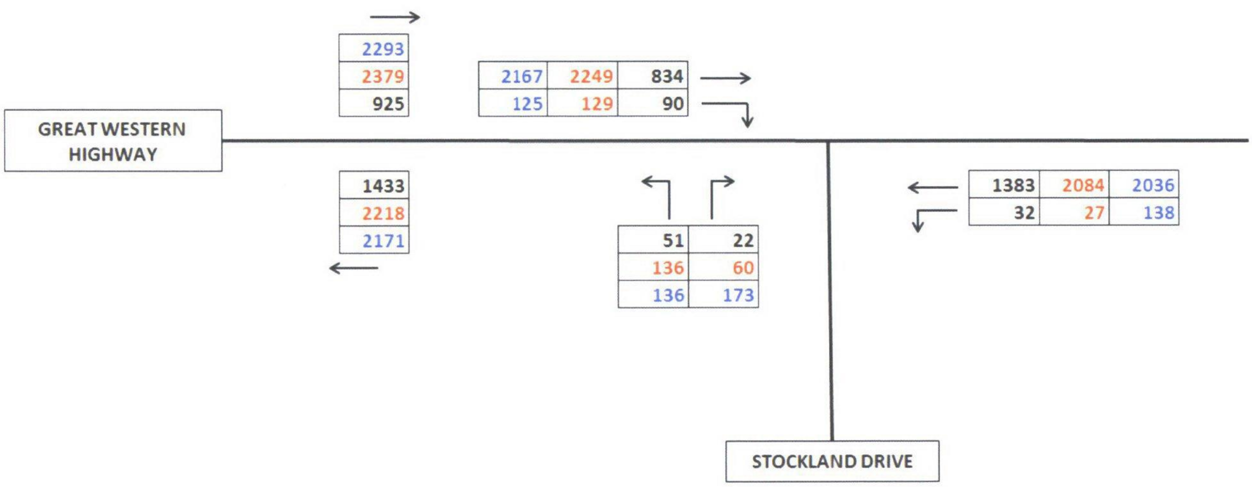


Figure 5.14 PM Paramics model flows Great Western Highway/Gilmour Street (vehicles/peak hour)

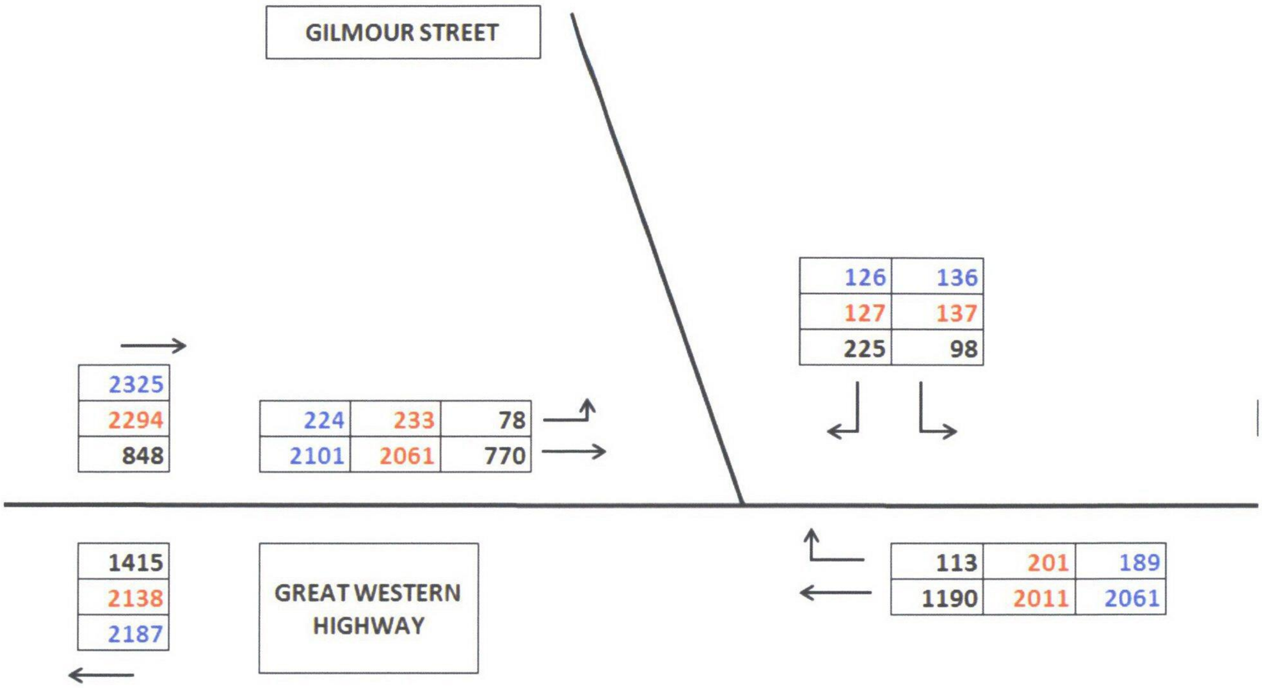


Figure 5.15 PM Paramics model flows Great Western Highway/Boyd Street (vehicles/peak hour)

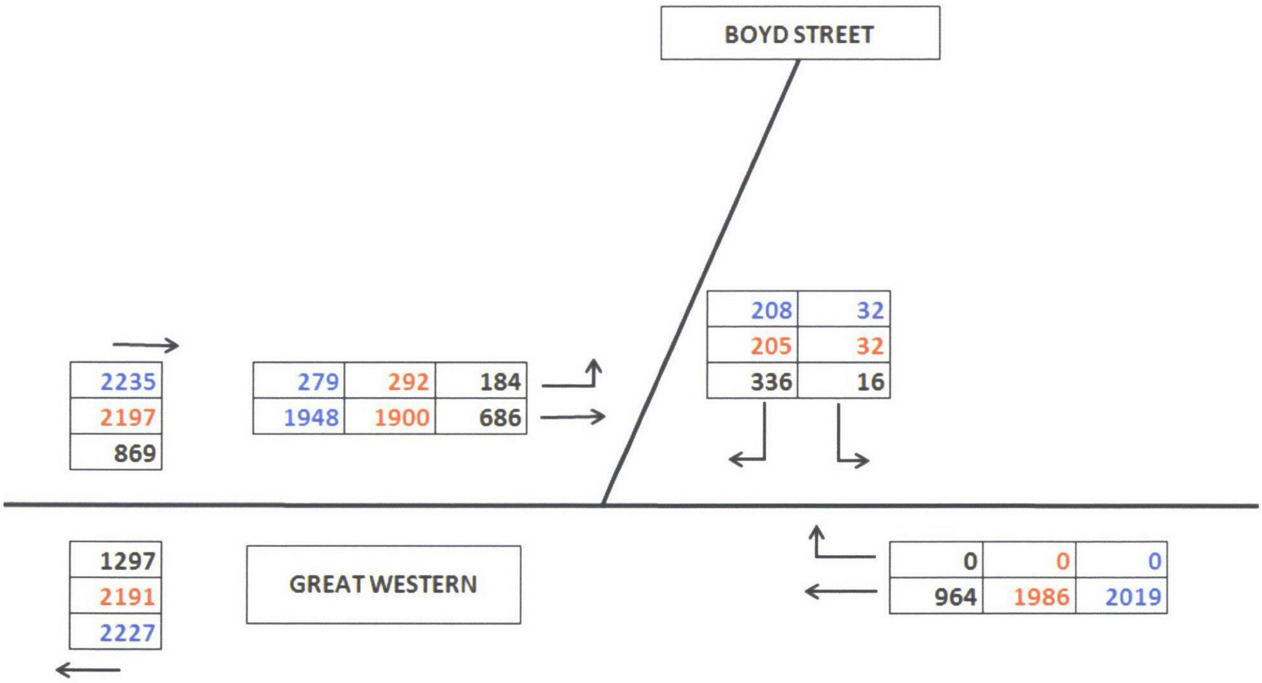


Figure 5.16 PM Paramics model flows Great Western Highway/View Street (vehicles/peak hour)

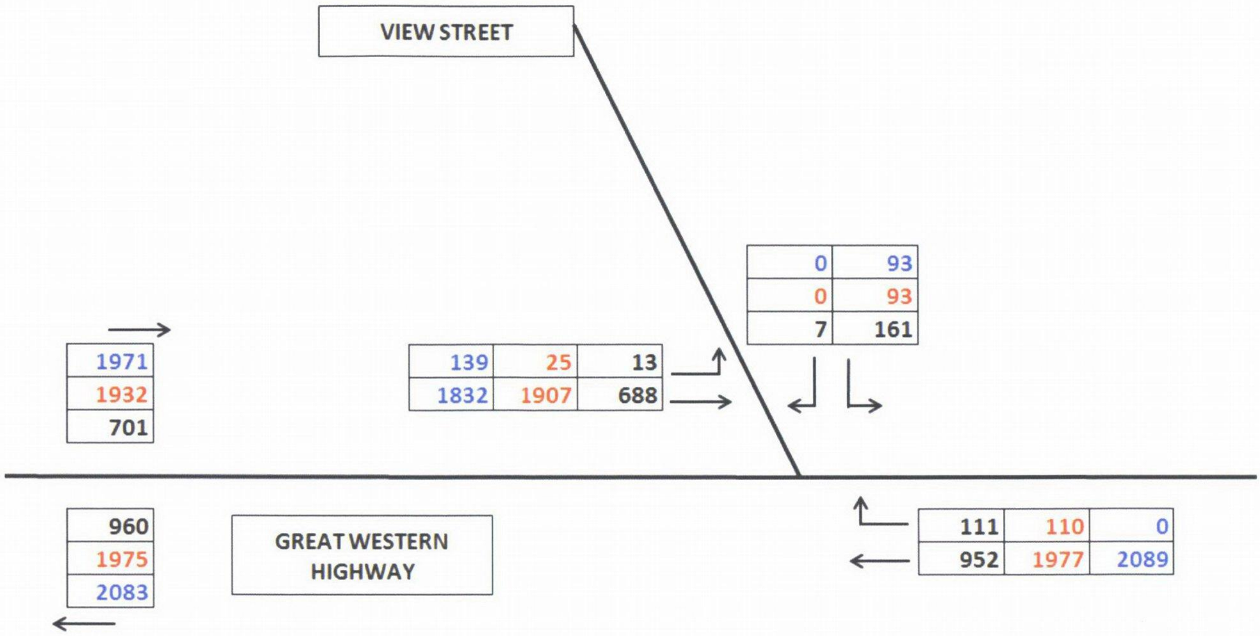


Figure 5.17 PM Paramics model flows Great Western Highway/Littlebourne Street (vehicles/peak hour)

Figure 5.18 PM Paramics model flows Great Western Highway/Pat O'Leary Drive (vehicles/peak hour)

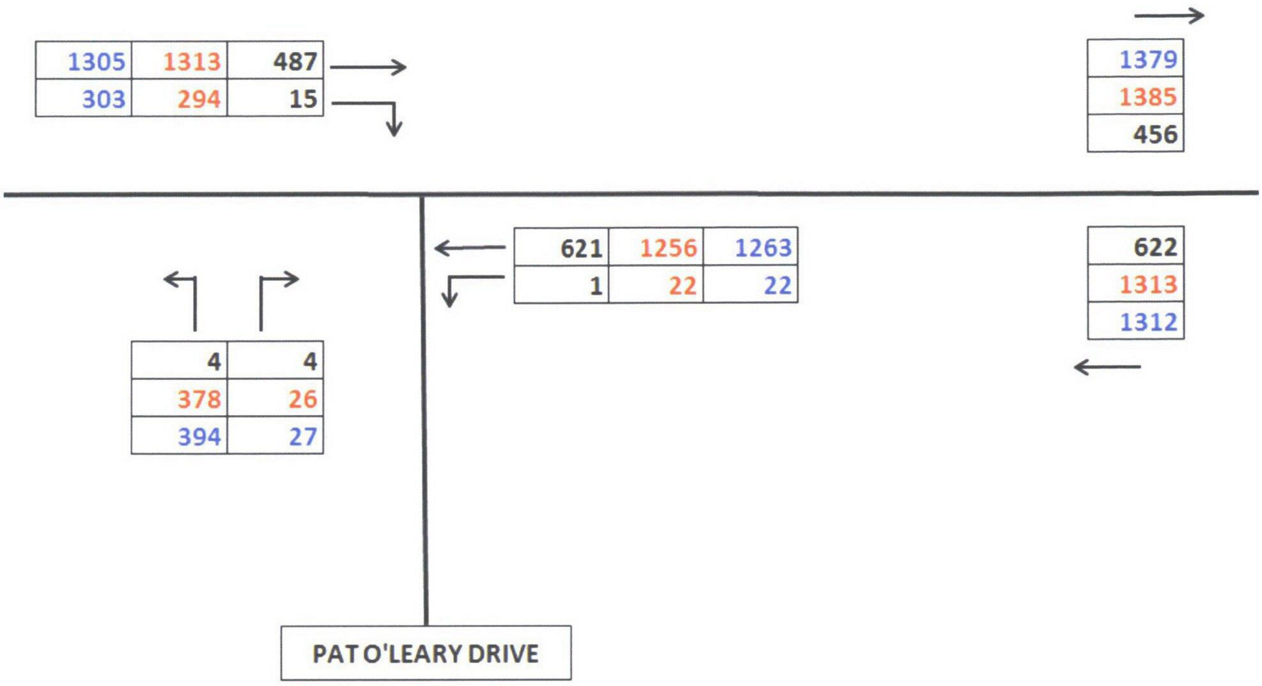
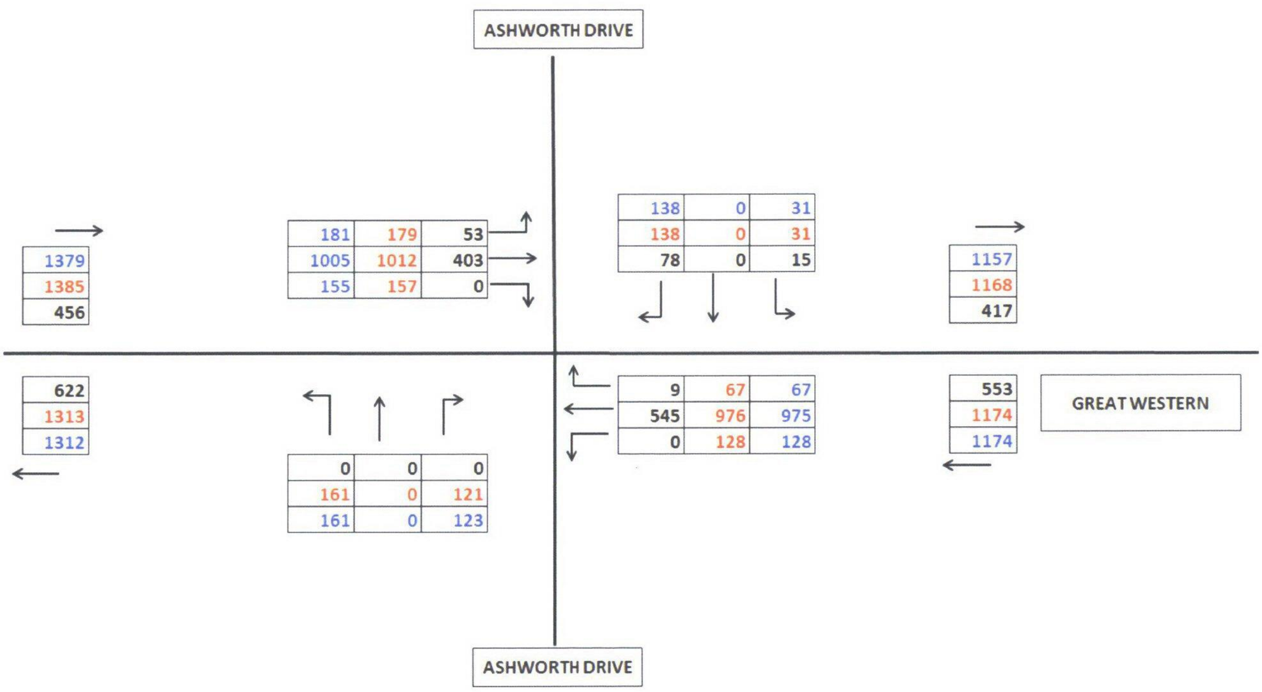


Figure 5.19 PM Paramics model flows Great Western Highway/Ashworth Drive (vehicles/peak hour)



Option 1 (Proposal 'C1') - 2035 SIDRA assessment results

Table 5.10 and Table 5.11 presents the results of the SIDRA assessment undertaken for the 2035 AM and PM peak period respectively under Proposal 'C1' intersection controls. Full SIDRA movement summaries are attached in Appendix K and Appendix L. It should be noted that each of these intersections was tested in isolation and the Paramics outputs supplement this data.

Table 5.10 Summary of 2035 AM peak hour SIDRA analysis – Proposal 'C1'

Intersection of GWH with	Control*		Degree of saturation	LoS	Average delay (sec/veh)	Max queue (m)	Comment
Stockland Dr	Traffic signals; U-turn facility provided	Average	0.975	C	37.5	>500	The critical movements are GWH westbound through and GWH right turn into Stockland Dr (both Los E), delays are 59 and 70 secs/veh respectively.
Gilmour St	Traffic signals	Average	0.817	B	21.7	311	The critical movement is GWH right turn into Gilmour St (LoS E with delays over 60 secs/veh). Queues on the GWH extend to around 300m in each direction.
Lee St	Stop sign; Left-out only; No right turn	Average	1.000	A	2.4	29	High LOS due to side road delay. No delays or queues on GWH.
		Worst	1.000	F	>90	29	
Boyd St	Traffic signals	Average	0.809	B	21.8	291	Boyd St approach experiences LoS E with delays of 57 secs/veh for the right turn out. Queues on the GWH extend to almost 300m in each direction.
View St	Give-way; Left-out only	Average	0.809	A	2.9	39	High LOS due to side road delay. No delays or queues on GWH.
		Worst	0.809	D	45.1	39	
Littlebourne St	Round about	Average	0.845	A	11.0	99	Acceptable performance as a roundabout.
		Worst	0.845	B	24.6	99	
Pat O'Leary Dr	Traffic signals	Average	0.853	C	29.1	264	Good operation - worst delays occur on right turns (LoS D). Longest queues occur on GWH westbound (264m).
Ashworth Dr	Round about	Average	0.611	A	8.2	39	Acceptable performance as a roundabout.
		Worst	0.611	A	8.2	39	

* For priority controlled and roundabout junctions the overall LoS is based on the LoS of the worst movement

Give-way or yield priority controlled side road; Stop sign on side road; Round about; Traffic signals

Left-out only from side road; No right turn into side road; U-turn facility provided

Table 5.11 Summary of 2035 PM peak hour SIDRA analysis – Proposal 'C1'

Intersection of GWH with	Control*		Degree of saturation	LoS	Average delay (sec/veh)	Max queue (m)	Comment
Stockland Dr	Traffic signals; U-turn facility provided	Average	0.926	B	27.1	>500	The critical movement is GWH right turn into Stockland Dr (Los F), delays are 74secs/veh.
Gilmour St	Traffic signals	Average	1.188	D	50.2	>500	The critical movements are GWH eastbound through and GWH right turn into Gilmour St (LoS F). Queues on the GWH extend beyond 300m in both directions.
Lee St	Stop sign; Left-out only; No right turn	Average	1.000	A	2.1	29	High LOS due to side road delay. No delays or queues on GWH.
		Worst	1.000	F	>90	29	
Boyd St	Traffic signals	Average	0.866	B	18.7	374	Boyd St approach experiences LoS E with delays of 59 secs/veh for the right turn out. Queues on GWH eastbound extend to almost 400m and westbound to almost 300m.
View St	Give-way; Left-out only	Average	0.616	A	1.7	19	Acceptable performance - LOS D due to side road delay. No delays or queues on GWH.
		Worst	0.616	D	45.5	19	
Littlebourne St	Round about	Average	0.871	A	11.5	112	Acceptable performance – LOS C as a roundabout.
		Worst	0.871	C	30.0	45	
Pat O'Leary Dr	Traffic signals	Average	0.734	B	23.3	227	Good operation - worst delays occur on right turns: out of Pat O'Leary Dr (50secs/veh); into Pat O'Leary Dr (53secs/veh). Longest queues occur on GWH westbound (227m).
Ashworth Dr	Round about	Average	0.647	A	7.8	39	Acceptable performance as a roundabout.
		Worst	0.647	B	157.8	36	

* For priority controlled and roundabout junctions the overall LoS is based on the LoS of the worst movement

Give-way or yield priority controlled side road; Stop sign on side road; Round about; Traffic signals

Left-out only from side road; No right turn into side road; U-turn facility provided

Option 2 (proposal 'C2') - 2035 SIDRA assessment results

Table 5.12 and Table 5.13 presents the results of the SIDRA assessment undertaken for the 2035 AM and PM peak period respectively under Proposal 'C2' intersection controls. Full SIDRA movement summaries are attached in Appendix M and Appendix N.

Table 5.12 Summary of 2035 AM peak hour SIDRA analysis – Proposal 'C2'

Intersection of GWH with	Control*		Degree of saturation	LoS	Average delay (sec/veh)	Max queue (m)	Comment
Stockland Dr	Traffic signals, U-turn facility provided	Average	0.971	C	36.1	>500	The critical movements are GWH westbound through and GWH right turn into Stockland Dr (LoS A). Queues on the GWH extend beyond 500m westbound and beyond 200m eastbound.
Gilmour St	Traffic signals	Average	0.866	B	24.5	371	Right turn into Gilmour St experiences LoS E with delays of 64secs/veh. Queues on the GWH extend to > 300m in each direction.
Lee St	Stop sign, left-out only, no right turn	Average	1.000	A	2.2	28	High LOS due to side road delay. No delays or queues on GWH through movements.
		Worst	1.000	F	>90	28	
Boyd St	Traffic signals	Average	0.876	B	26.8	373	Boyd St approach experiences LoS E with delays >60 secs/veh for the right turn out. Queues on GWH extend to around 300m in each direction.
View St	Give-way, left-out only, no right turn	Average	1.825	C	40.6	443	High LOS due to side road delay. No delays or queues on GWH through movements.
		Worst	1.825	F	>90	443	
Littlebourne St	Traffic signals	Average	1.000	D	48.9	422	Acceptable performance as signals, some individual movements experience significant delays: GWH westbound (81secs/veh); GWH right turn into Littlebourne St (90secs/veh). Queues on the GWH extend to over 400m westbound.
Pat O'Leary Dr	Traffic signals	Average	0.879	C	31.0	279	Good operation - worst delays occur for right turn into and out of Pat O'Leary Dr (around 50secs/veh). Longest queues occur on GWH westbound (279m).
Ashworth Dr	Round about	Average	0.610	A	8.2	38	Acceptable performance as a roundabout.
		Worst	0.610	B	15.4	7	

* For priority controlled and roundabout junctions the overall LoS is based on the LoS of the worst movement

Give-way or yield priority controlled side road — Stop sign on side road — Round about — Traffic signals

Left-out only from side road — No right turn into side road — U-turn facility provided

Table 5.13 Summary of 2035 PM peak hour SIDRA analysis – Proposal 'C2'

Intersection of GWH with	Control*		Degree of saturation	LoS	Average delay (sec/veh)	Max queue (m)	Comment
Stockland Dr		Average	0.904	B	23.7	455	Acceptable performance – delays are notable on GWH for right turn into Stockland Dr (70secs/veh). Queues on GWH westbound extend beyond 400m and eastbound beyond 300m.
Gilmour St		Average	1.187	D	55.8	>500	The critical movements are GWH eastbound through and GWH right turn into Gilmour St (LoS F). Queues on the GWH extend beyond 300m westbound and beyond 500m eastbound.
Lee St		Average	1.000	A	2.0	29	High LOS due to side road delay. No delays or queues on GWH through movements.
		Worst	1.000	F	>90	29	
Boyd St		Average	0.888	B	20.6	414	Boyd St right turn out experiences LoS E (delays 60secs/veh). Queues on GWH eastbound extend to >400m and westbound around 300m.
View St		Average	1.513	A	13.2	188	High LOS due to side road delay. No delays or queues on GWH through movements.
		Worst	1.513	F	>90	188	
Littlebourne St		Average	1.000	D	47.1	504	Acceptable performance as signals, some individual movements experience significant delays: GWH westbound (77secs/veh); GWH right turn into Littlebourne St (>90secs/veh). Queues on the GWH extend to over 500m westbound.
Pat O'Leary Dr		Average	0.751	B	23.8	233	Good operation - worst delays occur on right turns: out of Pat O'Leary Dr (50secs/veh); into Pat O'Leary Dr (53secs/veh). Longest queues occur on GWH westbound (230m).
Ashworth Dr		Average	0.645	A	7.8	39	Acceptable performance as a roundabout.
		Worst	0.645	B	15.7	12	

* For priority controlled and roundabout junctions the overall LoS is based on the LoS of the worst movement

Give-way or yield priority controlled side road; Stop sign on side road; Round about; Traffic signals

Left-out only from side road; No right turn into side road; U-turn facility provided

6 SUMMARY & CONCLUSIONS

Growth assumptions

The assessment of the 2035 traffic volumes under the various scenarios assumes that there will be around 2,700 – 2,800 additional vehicle trips during the peak hours. To realise this level of growth the following will need to occur:

- Regional traffic (through traffic along the Highway and from Littlebourne Street) grows at 1.5 per cent per annum (compound) resulting in 460 – 510 additional through trips in the peak hours (17 – 18 per cent of the total growth).
- Around 1,200 lots will be developed in the Kelso area by 2035 resulting in over 1,100 additional residential vehicle trips in the peak hours (35 – 37 per cent of the total growth).
- Employment traffic growth will account for the largest proportion of additional trips (46 – 47 per cent), with around 1,230 – 1,355 additional trips in the peak hours. Over half (53 – 58 per cent) of these additional trips are from the approved developments off Pat O'Leary Drive, with a further 21 – 26 per cent from the proposed Intermodal Terminal.

These growth assumptions have been developed through investigations of Council approved developments and plans, discussions with the RTA and assessment of historic growth patterns. The assumptions are considered to be relatively conservative and there is a good level of confidence that these predicted volumes will not be exceed before 2035.

Hence, the analysis of the performance of the road network improvement proposals under these growth assumptions is reasonable and there can be a high level of confidence in the results.

Results

A summary of the SIDRA analysis results for all options is provided in Table 6.1.

The results show that both the 2035 Proposal 'C' options generally operates reasonably well from a Level of Service (LoS) perspective, especially given the significantly high increases in volumes over the current Base year 2011.

The results of SIDRA and Paramics show that both options are likely work in 2035, but with some caveats in the case of Option 2. In order for Option 2 to cater for the additional u-turning vehicles in 2035, there are repercussions in terms of increased delay at View Street and Littlebourne Street and also increased queues on side streets.

The major upgraded intersections of Stockland Drive, Littlebourne Street and Ashworth Drive produced the following results in 2035 for Option 1:

- Option 1 – Stockland Drive AM LoS C / PM LoS B.
- Option 1 – Littlebourne Street (Roundabout) AM and PM LoS B.
- Option 1 – Ashworth Drive AM LoS A / PM LoS B.

For the same three intersections the Option 2 results are similar except for Littlebourne Street (with signals) which results in LoS D during the AM and PM peaks.

Table 6.1 Summary of 2035 SIDRA results – Desktop Model vs. Paramics Model

Intersection of GWH with	Peak	Desktop model						Paramics model					
		Proposal A			Proposal B			Proposal 'C1'			Proposal 'C2'		
		DoS	Delay* / (LoS)	Max. queue (m)	DoS	Delay* / (LoS)	Max queue (m)	DoS	Delay* / (LoS)	Max queue (m)	DoS	Delay* / (LoS)	Max queue (m)
Stockland Dr	AM	1.087	91.2 (F)	>500	1.034	59.0 (E)	>500	0.975	37.5 (C)	>500	0.971	36.1 (C)	>500
	PM	1.024	38.3 (C)	>500	1.000	35.8 (C)	>500	0.926	27.1 (B)	>500	0.904	23.7 (B)	455
Gilmour St	AM	0.809	21.1 (B)	313	0.857	25.9 (B)	372	0.817	21.7 (B)	310	0.866	24.5 (B)	371
	PM	1.043	32.0 (C)	>500	1.188	57.5 (E)	>500	1.188	50.2 (D)	>500	1.187	55.8 (D)	>500
Lee St	AM	0.729	>120 (F)	21	1.015	>120 (F)	45	1.000	>120 (F)	4	1.000	>120 (F)	28
	PM	0.837	>120 (F)	28	0.996	>120 (F)	52	1.000	>120 (F)	29	1.000	>120 (F)	29
Boyd St	AM	0.894	31.5 (C)	384	0.864	32.9 (C)	384	0.809	21.8 (B)	290	0.876	26.8 (B)	373
	PM	0.946	30.3 (C)	>500	0.920	26.4 (B)	488	0.866	18.7 (B)	374	0.888	20.6 (B)	414
View St	AM	0.924	67 (E)	73	>1.00	>120 (F)	489	0.809	45.1 (D)	5	>1.000	>120 (F)	443
	PM	0.677	54.9 (D)	26	1.579	>120 (F)	210	0.616	22.1 (B)	19	1.513	>120 (F)	188
Littlebourne St	AM	0.977	50.2 (D)	220	1.00	49.6 (D)	362	0.845	24.6 (B)	99	1.00	48.9 (D)	422
	PM	1.007	48.4 (D)	293	1.041	68.1 (E)	>500	0.871	30.0 (C)	112	1.00	47.1 (D)	>500
Pat O'Leary Dr	AM	0.759	24.3 (B)	215	0.753	25.6 (B)	214	0.853	29.1(C)	264	0.879	31.0 (C)	279
	PM	0.862	27.3 (B)	271	0.859	26.6 (B)	268	0.734	23.3 (B)	227	0.751	23.8 (B)	233
Ashworth Dr	AM	0.530	14.6 (B)	34	0.883	45.6 (D)	218	0.611	15.4 (B)	39	0.610	15.4 (B)	38
	PM	0.665	15.6 (B)	49	0.786	36.4 (C)	213	0.647	15.8 (B)	39	0.645	15.7 (B)	39

* - Delay reported is as follows for each intersection type: Signals – average intersection delay Roundabout – worst movement delay Priority – worst movement delay

Give-way or yield priority controlled side road — Stop sign on side road — Round about — Traffic signals

Left-out only from side road — No right turn into side road — U-turn facility provided

The main differences between Option 1 and Option 2 are evident at View Street and Littlebourne Street with the following results:

- LoS drops at View Street intersection from LoS D on Option 1 to LoS F in Option 2 in both the AM and PM (with significant increases in delay and queue lengths).
- LoS drops at Littlebourne Street intersection from LoS B in Option 1 to LoS D in Option 2 again in the AM and PM (also with significant increases in delay and queue lengths).
- Option 1 has significantly better travel times than Option 2

Delays which are common to both options are: Lee Street intersection with LoS F in AM and PM for both Options 1 and 2. This however is misleading to some degree as the average delay is no more than 3.8 seconds at this intersection in any option in any peak and the average queues are also low at a maximum of 29 metres. Lee Street leg experiences low traffic volumes but has the longest delay and so skews the overall LoS result for the intersection.

It should also be noted that the Gilmour and Boyd Street junctions experience long queues on the side street legs which are also more evident and will be discussed further in the Paramics outputs section, next.

In addition, there is potential that pedestrian safety may be compromised at signalised crossing locations in Option 2 due to the additional signal optimisation across the corridor for the increased volumes and resultant problems. This led to pedestrians getting the minimum times to cross the highway and in the context of such a busy environment, it is not a scenario which we would endorse on either safety grounds or operational grounds, while Option 1 is available and also working better operationally.

Conclusion

A comparative summary of the performance of the road network under each option is provided in Table 6.2.

Table 6.2 Comparison of option 'C1' and option 'C2'

Best Performer / Preferred Option	AM 2035		PM 2035		Overall 2035	
	Option 'C1'	Option 'C2'	Option 'C1'	Option 'C2'	Option 'C1'	Option 'C2'
Level of service (LoS) and delays	✓		✓		✓	
Flows	✓	✓	✓	✓	✓	✓
Queuing / congestion	✓		✓		✓	
Travel times	✓		✓		✓	
Paramics visual assessment - operations	✓		✓		✓	
Overall preferred option	✓		✓		✓	

The preferred option (1) operates better in terms of intersection LoS, travel times and delay. Although this is a modelling exercise and not a safety analysis, it is nevertheless important to flag the concern for safety of pedestrians in an environment with such high traffic volumes and minimum crossing times allocated to pedestrians.

This being said, it is also recommended that Option 1 with a roundabout at Littlebourne Street be designed with pedestrian safety as a priority and tested further as a potential option using Paramics, if at-grade crossings are to be installed on any of the roundabout legs. Grade separated crossings would negate the need for additional modelling at Littlebourne Street for pedestrians.

Appendix F

Construction and operational noise and vibration assessment (SLR Consulting 2011)

global environmental solutions

Great Western Highway Upgrade at Kelso

Ashworth Drive to Stockland Drive, Kelso

Noise and Vibration Assessment

Report Number 640.10004-R1

4 November 2011

NGH Environmental
18/21 Mary Street
SURRY HILLS NSW 2010

Version: Revision 0

Great Western Highway Upgrade at Kelso

Ashworth Drive to Stockland Drive, Kelso

Noise and Vibration Assessment

PREPARED BY:

SLR Consulting Australia Pty Ltd
ABN 29 001 584 612
2 Lincoln Street Lane Cove NSW 2066 Australia

(PO Box 176 Lane Cove NSW 1595 Australia)
T: 61 2 9427 8100 F: 61 2 9427 8200
E: sydney@slrconsulting.com www.slrconsulting.com

DOCUMENT CONTROL

Reference	Status	Date	Prepared	Checked	Authorised
640.10004-R1	Revision 0	4 November 2011	Robert Hall / Robert Trieu	Conrad Weber	Conrad Weber

TABLE OF CONTENTS

TABLE OF CONTENTS

TABLES

FIGURES

APPENDICES

1 INTRODUCTION

The NSW Roads and Traffic Authority (RTA) has developed a concept design for the upgrade of the Great Western Highway between Ashworth Drive and Stockland Drive in Kelso.

The existing 2.4 km section of the Great Western Highway would be upgraded to four lanes with a raised median, plus modifications to the existing eight intersections and various other works.

SLR Consulting Australia Pty Ltd (SLR) has been commissioned by NGH Environmental, on behalf of the RTA, to assess the potential noise and vibration impacts associated with the proposal.

This report has been prepared to support the Review of Environmental Factors (REF) for the proposal and provides a preliminary assessment of the potential construction and operational noise and vibration impacts and likely mitigation measures.

The report has been prepared in accordance with the relevant construction and operational noise and vibration guidelines including the *"Environmental Criteria for Road Traffic Noise"* (EPA 1999), the *"Environmental Noise Management Manual"* (RTA 2001), the *"Interim Construction Noise Guideline"* (DECCW 2009) and *"Assessing Vibration: a technical guideline"* (DEC 2006).

This report uses specific terms which may have specific technical meanings, reference should be made to **Appendix A** (Acoustic Terminology).

2 PROPOSAL DESCRIPTION

The RTA propose to widen the Great Western Highway (GWH) at Kelso to four lanes, improve intersections and separate opposing directions of traffic. The proposal covers a length of approximately 2.4 km, commencing just west of the Stockland Drive intersection near Raglan Creek, and extending approximately 250 m east of Ashworth Drive, near the Gold Panner Motor Inn. The existing 2.4 km length of the GWH is generally a two lane highway with eight signalised and un-signalised intersections.

General intersection arrangements include:

- Stockland Drive - Install Roundabout.
- Gilmour Street - Retain Signals.
- Lee Street - Retain Left in/left out.
- Boyd Street - Realign Signals and add a protected right turn bay west bound.
- View Street - Left in/left out and add a protected right in, but no right turn out.
- Littlebourne Street - Signals to be replaced with Roundabout.
- Pat O'Leary Drive - Install Signals.
- Ashworth Drive - Install Roundabout.

Key features of the proposal would include:

- Providing two travel lanes in each direction.
- Raised medians - narrow and wide.
- Kerb and guttering.
- Paved pedestrian pathway(s).
- Provision for cyclists.
- Replacement of the existing bridge and widening of various drainage culverts.
- A shoulder/parking lane in each direction.

A plan view of the proposed works is provided on the following page.

SLR has been commissioned to assess the potential noise and vibration impacts associated with the proposed upgrade during construction and once the road is open to traffic.

In terms of the **construction** phase of the proposal, this report is limited to:

- Identifying the catchment areas where further consideration of noise and vibration mitigation measures is likely.
- Identifying the potential mitigation and management measures that are likely to be required to reduce the potential noise and vibration impacts.

In terms of the **operational** phase of the proposal, this report is limited to:

- Identifying the catchment areas where further consideration of noise mitigation is warranted.
- Identifying the form of potential noise mitigation measures that are likely to be required to reduce the potential noise impacts.

The assessment embodied within this report is based upon the RTA's current Concept Design. This represents one example of how the proposal could be constructed. During the detailed design stage of the proposal, details of the proposal may change and alter the final form of the proposed mitigation and management measures.

Should circumstances arise that result in minor changes to the proposal's design or construction, the noise and vibration impacts would not be expected to be significantly greater than those described and assessed within this report. If the detailed design phase does result in significant changes, these would need to be assessed and approved on a case by case basis.

Figure 1 Plan View of Proposed Upgrade

3 SITE DESCRIPTION AND NOISE CATCHMENT AREAS

Figure 2 presents an overview of the proposal area which has been broken up into ten Noise Catchment Areas labelled A to J. These are also described in **Table 1**.

Figure 2 Noise Catchment Areas

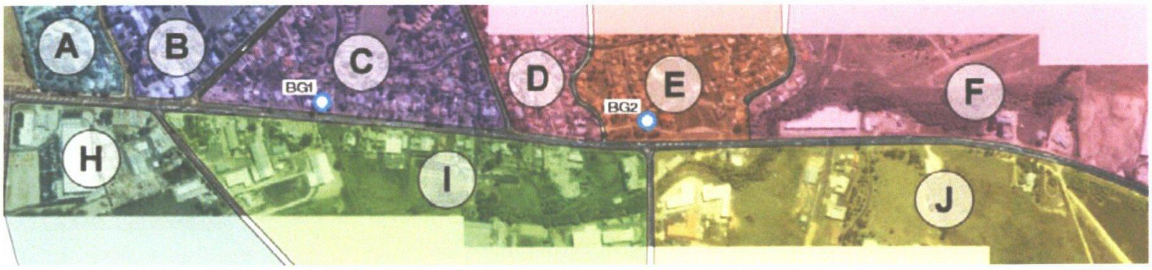


Table 1 Noise Catchment Areas

Catchment Area	Description
A	West of Gilmour Street on northern side, land usage is residential
B	Between Gilmour Street and Boyd Street on northern side, nearest receivers are commercial with residential behind on side streets
C	Between Boyd Street and View Street on northern side, land use is predominantly residential with a car dealership located near Boyd Street
D	Between View Street and Oxley Place on northern side, land use is residential
E	Between Oxley Place and Patterson Place on northern side, land use is residential
F	Between Patterson Place and Ashworth Drive on northern side, land use is residential
G	East of Ashworth Drive on the northern side is the Gold Panner Motor Inn
H	Between Stockland Drive and Lee Street on southern side, land use is commercial
I	Between Lee Street and Littlebourne Street on southern side, land use is mixed use commercial and residential
J	East of Littlebourne Street on the southern side, land use is commercial

At the majority of residential locations, vehicular access to the properties is provided directly via the GWH (eg west of Littlebourne Street). On the northern side of the GWH east of 138 GWH and Oxley Place (Catchment Area E), property access is provided via an unsealed access road off GWH, and via the local road network off Boyd Street. At the Motel on the corner of GWH and Littlebourne Street, access is provided off Littlebourne Street.

4 CONSTRUCTION ASSESSMENT CRITERIA

4.1 Construction Noise Metrics

The three primary noise metrics used to describe construction noise emissions:

$L_{A1(1minute)}$ the "typical maximum noise level" for an event, used in the assessment of potential sleep disturbance during night-time periods. Alternatively, assessment may be conducted using the L_{Amax} or maximum noise level.

$L_{Aeq(15minute)}$ the "energy average noise level" evaluated over a 15-minute period. This parameter is used to assess the potential construction noise impacts.

L_{A90} the "background noise level" in the absence of construction activities. This parameter represents the average minimum noise level during the daytime, evening and night-time periods respectively. The $L_{Aeq(15\ minute)}$ construction Noise Management Levels are based on the L_{A90} background noise levels.

The subscript "A" indicates that the noise levels are filtered to match normal human hearing characteristics (ie A-weighted).

4.2 NSW Interim Construction Noise Guideline

SLR Consulting has conducted a review of guidelines and current practices for the assessment and subsequent mitigation of construction noise, and, for this proposal, has adopted the approach laid down in the NSW Department of Environmental, Climate Change and Water (DECCW, currently Office of Environment and Heritage (OEH)) *"Interim Construction Noise Guideline"* (ICNG 2009).

The ICNG was developed with an emphasis on minimising construction noise impacts by implementing various work practices rather than focussing only on achieving numerical noise levels. A recurring feature of the guideline is the use of the term "feasible and reasonable" in relation to the control of construction noise impacts. The guideline recognises that construction activities are often inherently noisy but are generally of a temporary nature.

On the basis of the guideline, SLR Consulting has adopted the following approach for this and other recent road upgrade projects:

- Determine project specific **Noise Management Levels** (NMLs) for noise affected receivers consistent with current practices to deal with construction noise in a transparent and consistent way.
- Where the construction noise levels are predicted to exceed the NMLs, all **feasible** and **reasonable** work practices would be investigated to minimise noise emissions.

Consistent with this approach, the following $L_{Aeq(15minute)}$ NMLs have been adopted for sensitive receivers:

- Daytime (7.00 am to 6.00 pm) RBL (or L_{A90} Background) +10 dBA
- Evening (6.00 pm to 10.00 pm) RBL (or L_{A90} Background) +5 dBA
- Night-time (10.00 pm to 7.00 am) RBL (or L_{A90} Background) +5 dBA

The DECCW's Guideline also presents NMLs for areas of other sensitive land uses. These are detailed in **Table 2** below. Kelso High School is the only non-residential sensitive land use that has been identified within the proposal area. This receiver is situated on Boyd Street approximately 900 m to the north of the GWH.

Table 2 Interim Construction Noise Guideline - Other Sensitive Land Uses

Land Use	Noise Management Level (NML) $L_{Aeq(15minute)}$ (applies when properties are being used)
Classrooms at schools and other educational facilities	45 dBA (internal)
Hospital wards and operating theatres	45 dBA (internal)
Places of worship	45 dBA (internal)
Active recreation areas[1]	65 dBA (external)

Note 1: Characterised by sporting activities and activities which generate their own noise or focus for participants, making them less sensitive to external noise intrusion

Where internal NMLs are presented in the above table, the corresponding external noise level (which the assessments are based upon) has been determined on the assumption that a 10 dBA reduction from outside to inside noise is applicable for an openable window, with a 20 dBA reduction where mechanical ventilation has been provided.

Sleep Disturbance

The most recent guidance in relation to sleep disturbance is contained in the DECCW's *"Application Notes - NSW Industrial Noise Policy"*. The pertinent section of the DECCW's Application Notes states the following:

> *"DECC[W] reviewed research on sleep disturbance in the NSW Environmental Criteria for Road Traffic Noise (ECRTN) (EPA, 1999). This review concluded that the range of results is sufficiently diverse that it was not reasonable to issue new noise criteria for sleep disturbance.*
>
> *From the research, DECC[W] recognised that current sleep disturbance criterion of an L_{A1}, (1 minute) not exceeding the L_{A90}, (15 minute) by more than 15 dBA is not ideal. Nevertheless, as there is insufficient evidence to determine what should replace it, DECC[W] will continue to use it as a guide to identify the likelihood of sleep disturbance. This means that where the criterion is met, sleep disturbance is not likely, but where it is not met, a more detailed analysis is required.*
>
> *The detailed analysis should cover the maximum noise level or L_{A1}, (1 minute), that is, the extent to which the maximum noise level exceeds the background level and the number of times this happens during the night-time period. Some guidance on possible impact is contained in the review of research results in the appendices to the ECRTN. Other factors that may be important in assessing the extent of impacts on sleep include:*
>
> - *How often high noise events will occur.*
> - *Time of day (normally between 10pm and 7am).*
> - *Whether there are times of day when there is a clear change in the noise environment (such as during early morning shoulder periods).*
> - *The LA1, (1 minute) descriptor is meant to represent a maximum noise level measured under "fast" time response. DECC[W] will accept analysis based on either LA1, (1 minute) or LAmax"*

Scope for Exceedances

Where predicted or measured levels exceed the NMLs the ICNG recommends that the proponent apply all "feasible and reasonable" work practices in order to minimise noise.

Where $L_{Aeq(15minute)}$ construction noise levels are predicted to be "highly noise affected" (ie above 75 dBA) the relevant authority (consent, determining or regulatory) may require respite periods to be observed. This may include restricting the hours that the very noisy activities can occur, taking into account:

- Times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences).
- If the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.

The implementation of an effective community consultation and liaison programme is emphasised as being a critical tool in successfully handling adverse noise impacts from construction works.

The ICNG provides comprehensive guidance for work practices which aim to achieve *"desired environmental outcomes - there are no prescribed noise controls for construction works."*

4.3 Construction Vibration Assessment Criteria

Vibration targets vary primarily according to whether the particular activities of interest are continuous in nature or intermittent, and whether they occur during the day or night-time. The effects of vibration in buildings can be divided into three main categories:

- Those in which the occupants or users of the building are inconvenienced or possibly disturbed, ie human disturbance.
- Those in which the integrity of the building or the structure itself may be prejudiced.
- Those where the building contents may be affected.

Criteria which are relevant to the response of building occupants to vibration are more stringent than those relevant to building damage. This is because people are able to "feel" vibration at levels lower than those required to cause even superficial damage to the most susceptible classes of building.

This ability of people to sense vibration at relatively low magnitudes has created a widespread and strong public misconception which can cause considerable overestimation of the risk of damage associated with vibration in buildings. This is particularly the case when the source of that vibration is outside the building, visible and audible, but generally not within the occupant's control.

Many people, for example, believe that even barely perceptible levels of building vibration from say, traffic, excavation or construction works, can damage dwellings, or may affect delicate objects or other items of personal value within their homes. This largely subjective response is particularly the case when these low levels of vibration are accompanied by high noise levels, or if there are other adverse connotations or effects associated with the source of the vibration. These might include startlement, loss of privacy or perceived loss of property value, fear, inconvenience, odour, etc.

On the other hand, sources of much higher levels of vibration (eg domestic appliances, people walking on floors, slamming of doors, etc) are readily accepted due to their day-to-day familiarity or because they are "within the control" of the occupant.

It is primarily these day-to-day effects which cause the gradual, long-term fatigue-induced deterioration of most structures - considered to be normal ageing. Provided that the levels of vibration-induced structural stress from an additional source are well below those of these "normal" stress-inducing events, then the additional source of vibration is unlikely to accelerate the normal ageing process.

4.3.1 General

Humans are far more sensitive to vibration than is commonly realised. They can detect vibration levels which are well below those causing any risk of damage to a building or its contents.

The actual perception of motion or vibration may not, in itself, be disturbing or annoying. An individual's response to that perception, and whether the vibration is "normal" or "abnormal", depends very strongly on previous experience and expectations, and on other connotations associated with the perceived source of the vibration. For example, the vibration that a person responds to as "normal" in a car, bus or train is considerably higher than what is perceived as "normal" in a shop, office or dwelling.

Human tactile perception of random motion, as distinct from human comfort considerations, was investigated by Diekmann and subsequently updated in German Standard DIN 4150 Part 2-1975. On this basis, the resulting degrees of perception for humans are suggested by the vibration level categories given in **Table 3**.

Table 3 Peak Vibration Levels and Human Perception of Motion

Approximate Vibration Level		Degree of Perception
Peak Vibration Level	**RMS Vibration Level**	
0.10 mm/s	0.07 mm/s	Not felt
0.15 mm/s	0.1 mm/s	Threshold of perception
0.35 mm/s	0.25 mm/s	Barely noticeable
1 mm/s	0.7 mm/s	Noticeable
2 mm/s	1.4 mm/s	Easily noticeable
6 mm/s	4.2 mm/s	Strongly noticeable
14 mm/s	10 mm/s	Very strongly noticeable

Note: These approximate vibration levels (in floors of building) are for vibration having a frequency content in the range of 8 Hz to 80 Hz. The RMS vibration levels assume a crest factor of 1.4 for sinusoidal vibration.

Table 3 suggests that people will just be able to feel floor vibration at levels of about 0.1 mm/s (RMS) and that the motion becomes "noticeable" at a level of approximately 0.7 mm/s (RMS).

The DECCW's "*Assessing Vibration: a technical guideline"* notes that *"vibration in buildings can be caused by many different external sources, including industrial, construction and transportation activities. The vibration may be continuous (with magnitudes varying or remaining constant with time), impulsive (such as in shocks) or intermittent (with the magnitude of each event being either constant or varying with time)."*

Construction activities typically generate building vibrations that are intermittent or impulsive in nature, however vibration levels may sometimes be constant from sources such as generators or ventilation fans.

Examples of intermittent vibration events include the vibration generated by rockbreakers, vibratory rollers, drilling/piling and excavators. Examples of impulsive vibration events include the vibration generated by demolition activities, blasting or the dropping of heavy equipment.

Where vibration is intermittent or impulsive in character, the DECCW vibration guideline (and other similar guidelines) recognise that higher vibration levels are tolerable to building occupants than for continuous vibration. As such, higher vibration goals are usually applicable for short term, intermittent and impulsive vibration activities than for continuous vibration sources.

The following sections describe the applicable continuous and intermittent vibration goals for construction activities.

4.3.2 Human Comfort Goals for Continuous and Impulsive Vibration

The DECCW's "*Assessing Vibration: a technical guideline*" is applicable for this proposal and is based on the guidelines contained in British Standard BS 6472-1992 "*Evaluation of Human Exposure to Vibration in Buildings (1 Hz to 80 Hz)*". The DECCW guideline refers only to human comfort considerations and nominates preferred and maximum vibration goals for critical areas, residences and other sensitive receivers.

The criteria in the DECCW guideline are non-mandatory, "*they are goals that should be sought to be achieved through the application of all feasible and reasonable mitigation measures. Where all feasible and reasonable measures have been applied and vibration values are still beyond the maximum value, the operator would need to negotiate directly with the affected community*".

Construction vibration can be continuous, intermittent or impulsive and the DECCW's vibration guideline provides different goals for each category. The continuous vibration goals are most stringent and higher vibration levels are acceptable for intermittent and impulsive vibration on the basis of the shorter exposure times. Examples of typical vibration sources are provided in **Table 4**.

Table 4 Examples of Vibration (DECCW Vibration Guideline)

Continuous Vibration	Impulsive Vibration	Intermittent Vibration
Machinery, steady road traffic, continuous construction activity (such as tunnel boring machinery).	Infrequent: Activities that create up to 3 distinct vibration events in an assessment period, e.g. occasional dropping of heavy equipment, occasional loading and unloading. Blasting is assessed using ANZECC (1990).	Trains, nearby intermittent construction activity, passing heavy vehicles, forging machines, impact pile driving, jack hammers. Where the number of vibration events in an assessment period is three or fewer this would be assessed against impulsive vibration criteria.

The applicable human comfort vibration goals for continuous, intermittent and impulsive vibration sources are provided in **Table 5**, **Table 6** and **Table 7** respectively. In all cases, the vibration goals are expressed in terms of the RMS vibration velocity level in mm/s, measured in the most sensitive direction (z-axis).

The DECCW vibration guideline notes the following in relation to the preferred and maximum vibration levels:

> *"There is a low probability of adverse comment or disturbance to building occupants at vibration values below the preferred values. Activities should be designed to meet the preferred values where an area is not already exposed to vibration. Where all feasible and reasonable measures have been applied, values up to the maximum value may be used if they can be justified. For values beyond the maximum value, the operator should negotiate directly with the affected community. Situations exist where vibration above the preferred values can be acceptable, particularly for temporary disturbances and infrequent events of short term duration. An example is a construction or excavation project.*
>
> *In circumstances where work is short term, feasible and reasonable mitigation measures have been applied, and the project has a demonstrated high level of social worth and broad community benefits, then higher vibration values (above the maximum) may apply. In such cases, best management practices should be used to reduce values as far as practicable, and a comprehensive community consultation programme should be instituted."*

Table 5 Preferred and Maximum Vibration Levels for Continuous Vibration

Building Type	Preferred Vibration Level RMS Velocity (mm/s)	Maximum Vibration Level RMS Velocity (mm/s)
Critical Working Areas (eg hospital operating theatres, precision laboratories)	0.10	0.20
Residential Daytime	0.20	0.40
Residential Night-time	0.14	0.28
Offices, schools, educational institutions and places of worship	0.40	0.80
Workshops	0.80	1.60

Note: Daytime is 7.00 am to 10.00 pm and night-time is 10.00 pm to 7.00 am.

Table 6 Preferred and Maximum Vibration Levels for Intermittent Vibration (Vibration Dose Values)

Building Type	Preferred Vibration Dose Value ($m/s^{1.75}$)	Maximum Vibration Dose Value ($m/s^{1.75}$)
Critical Working Areas (eg hospital operating theatres, precision laboratories)	0.10	0.20
Residential Daytime	0.20	0.40
Residential Night-time	0.13	0.26
Offices, schools, educational institutions and places of worship	0.40	0.80
Workshops	0.80	1.60

Note: For the definition of the Vibration Dose Value refer to the discussion in the following section. Daytime is 7.00 am to 10.00 pm and night-time is 10.00 pm to 7.00 am.

Table 7 Preferred and Maximum Vibration Levels for Impulsive Vibration

Building Type	Preferred Vibration Level RMS Velocity (mm/s)	Maximum Vibration Level RMS Velocity (mm/s)
Critical Working Areas (eg hospital operating theatres, precision laboratories)	0.1	0.2
Residential Daytime	6.0	12.0
Residential Night-time	2.0	4.0
Offices, schools, educational institutions and places of worship	13.0	26.0
Workshops	13.0	26.0

Note: Daytime is 7.00 am to 10.00 pm and night-time is 10.00 pm to 7.00 am.

4.3.3 Vibration Criteria - Surface Structures

Most commonly specified "safe" structural vibration limits are designed to minimise the risk of threshold or cosmetic surface cracks, and are set well below the levels that have potential to cause damage to the main structure.

British Standard 7385: Part 2 - 1993 Guidelines

In terms of the most recent relevant vibration damage goals, Australian Standard AS 2187: Part 2-2006 *"Explosives - Storage and Use - Part 2: Use of Explosives"* recommends the frequency dependent guideline values and assessment methods given in BS 7385 Part 2-1993 *"Evaluation and measurement for vibration in buildings Part 2"* as they "are applicable to Australian conditions".

The Standard sets guide values for building vibration based on the lowest vibration levels above which damage has been credibly demonstrated. These levels are judged to give a minimum risk of vibration-induced damage, where minimal risk for a named effect is usually taken as a 95% probability of no effect.

Sources of vibration that are considered in the standard include demolition, blasting (carried out during mineral extraction or construction excavation), piling, ground treatments (eg compaction), construction equipment, tunnelling, road and rail traffic and industrial machinery.

The recommended limits (guide values) for transient vibration to ensure minimal risk of cosmetic damage to residential and industrial buildings are presented numerically in **Table 8** and graphically in **Figure 3**.

Table 8 Transient Vibration Guide Values - Minimal Risk of Cosmetic Damage

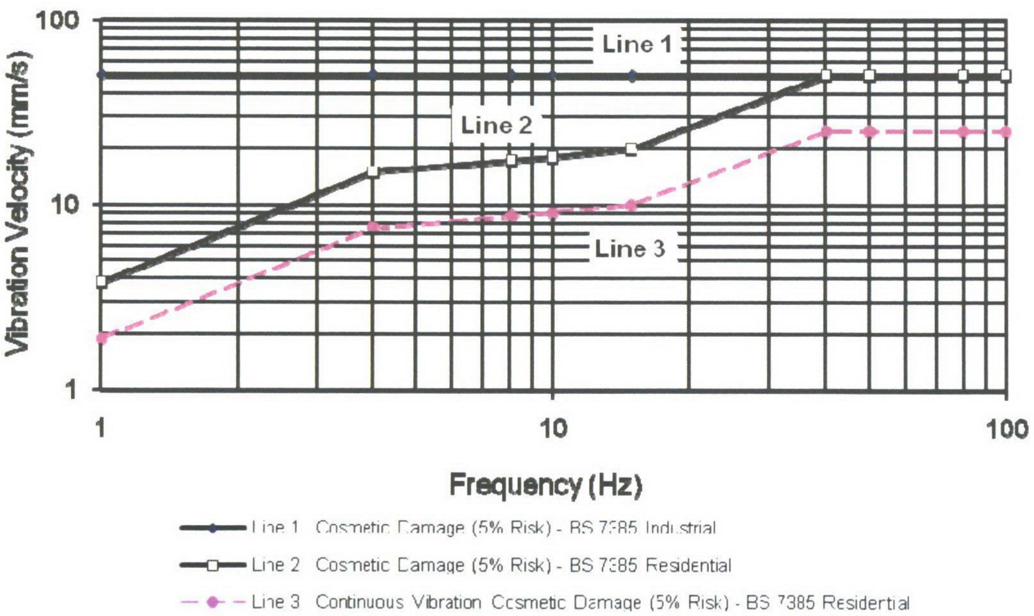
Line	Type of Building	Peak Component Particle Velocity on Frequency Range of Predominant Pulse	
		4 Hz to 15 Hz	**15 Hz and Above**
1	Reinforced or framed structures Industrial and heavy commercial buildings	50 mm/s at 4 Hz and above	
2	Unreinforced or light framed structures Residential or light commercial type buildings	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above

The Standard states that the guide values in **Table 8** relate predominantly to transient vibration which does not give rise to resonant responses in structures and low-rise buildings.

Where the dynamic loading caused by continuous vibration may give rise to dynamic magnification due to resonance, especially at the lower frequencies where lower guide values apply, then the guide values in **Table 8** may need to be reduced by up to 50%.

Note: rockbreaking/hammering activities are considered to have the potential to cause dynamic loading in some structures (eg residences) and it may therefore be appropriate to reduce the transient values by 50%.

Figure 3 Graph of Transient Vibration Guide Values for Cosmetic Damage



In the lower frequency region where strains associated with a given vibration velocity magnitude are higher, the guide values for building types corresponding to "Line 2" are reduced. Below a frequency of 4 Hz where a high displacement is associated with the relatively low peak component particle velocity value, a maximum displacement of 0.6 mm (zero to peak) is recommended. This displacement is equivalent to a vibration velocity of 3.7 mm/s at 1 Hz.

The Standard goes on to state that minor damage is possible at vibration magnitudes which are greater than twice those given in **Table 8**, and major damage to a building structure may occur at values greater than four times the tabulated values.

Fatigue considerations are also addressed in the Standard and it is concluded that unless calculation indicates that the magnitude and number of load reversals is significant (in respect of the fatigue life of building materials) then the guide values in **Table 8** should not be reduced for fatigue considerations.

In order to assess the likelihood of cosmetic damage due to vibration, AS 2187 specifies that vibration measured should be undertaken at the base of the building and the highest of the orthogonal vibration components (transverse, longitudinal and vertical directions) should be compared with the guidance curves presented in **Figure 3**.

It is noteworthy that extra to the guide values nominated in **Table 8**, the standard states that:

> *"Some data suggests that the probability of damage tends towards zero at 12.5 mm/s peak component particle velocity. This is not inconsistent with an extensive review of the case history information available in the UK."*

Also that:

> *"A building of historical value should not (unless it is structurally unsound) be assumed to be more sensitive."*

5 OPERATIONAL ROAD TRAFFIC NOISE CRITERIA, GUIDELINES AND OBJECTIVES

There are two documents that are relevant to the assessment of noise from new or upgraded roadways in NSW:

- *Environmental Criteria for Road Traffic Noise* (ECRTN) (EPA, 1999) - which details the relevant criteria.
- *Environmental Noise Management Manual* (ENMM) (RTA, 2000) - which provides guidance on the form and type of noise mitigation considered by reasonable and feasible.

5.1 ECRTN LAeq Noise Goals

For the purposes of establishing acceptable levels of road traffic noise at residences surrounding the proposal, the GWH would be considered an arterial roadway. The corresponding base noise objectives for traffic noise are summarised in **Table 9**.

Table 9 Operational Traffic Noise Criteria

Road Type	Daytime Criteria (7 am to 10 pm)	Night-time Criteria (10 pm to 7 am)	Guidance when the Existing Ambient Noise Already Exceeds the Base Criteria
Redevelopment of existing freeway/arterial road	LAeq(15hour) 60 dBA	LAeq(9hour) 55 dBA	In all cases, the redevelopment should be designed so as not to increase existing noise levels by more than 2 dB. Where feasible and reasonable, noise levels from existing roads should be reduced to meet the noise criteria. In many instances this may be achievable only through long-term strategies, such as improved planning, design and construction of adjoining land use developments; reduced vehicle emission levels through new vehicle standards and regulation of in-service vehicles; greater use of public transport; and alternative methods of freight haulage

It is noted that in situations where the existing ambient noise level already exceeds the above criteria, and where all reasonable and feasible noise mitigation measures have been considered and implemented, an "allowance" criterion is applicable. For a redeveloped road this allowance criterion limits the noise increase from the proposal under consideration to no more than 2 dB.

The road traffic noise criteria apply for the projected traffic flow and road alignment after opening and at a point in time 10 years after the roadway has been completed. The external levels for residential receiver locations apply 1 m from the facade of dwellings.

5.2 Sleep Disturbance

As discussed in the ECRTN, at the current level of understanding, it is not possible to establish absolute noise level criteria that would correlate to an acceptable level of sleep disturbance, however the ECRTN recommends the assessment and reporting of maximum noise levels during each hour of the night-time period to give an indication of the likelihood of awakening reactions.

The NSW Roads and Traffic Authority's ENMM Practice Note 3 (NSW Roads and Traffic Authority 2008) outlines a protocol for assessing and reporting on maximum noise levels and the potential for sleep disturbance and is reproduced in part below:

> *"an evaluation of maximum noise levels may prove beneficial in managing the concerns of surrounding residents if interruptions to traffic flows are proposed (such as would occur with the installation of roundabouts or traffic lights)."*

NSW Roads and Traffic Authority's *Environmental Noise Management Manual* (ENMM) - Practice Note III protocol for assessing the potential for sleep disturbance is determined by performing L_{AFmax} - $L_{Aeq(1hr)}$ calculations for individual vehicle passbys during the night-time period. Recording of the number of night-time passby events where the L_{AFmax} - $L_{Aeq(1hr)}$ difference is greater than 15 dBA is to be noted.

With regard to reaction to potential sleep disturbance events, the ENMM gives the following guidance:

> *"From the research on sleep disturbance to date it can be concluded that:*
>
> - *maximum internal noise levels below 50–55 dB(A) are unlikely to awaken people from sleep*
> - *one or two noise events per night, with maximum internal noise levels of 65–70 dB(A), are not likely to affect health and wellbeing significantly."*

5.3 Procedure for Considering Noise Mitigation

It must be noted that not all properties that exceed the base criteria automatically qualify for consideration of noise mitigation. All properties that exceed the base criteria are examined to see if acoustic benefits can be gained from changes in the proposed road alignment, or other similar measures that could provide acoustic benefit.

The ENMM fully details the procedures for which properties qualify for noise mitigation. This is a multi-step process and initially involves the identification of those properties where there is:

- Exceedance of the base objective, and
- The proposal results in a predicted change in the noise environment of more than 2 dB, when comparing the future Y2023 and the 'future existing' Y2013 (ie the do-nothing scenario).

Table 10 presents a matrix of conditions, indicating which properties are further considered for noise mitigation.

Table 10 Operational Noise Level Matrix

Overall Noise Level (Future 2023)	Change in Noise level		
	Change < 0 dBA (ie decrease in noise)	**0 < change ≤ 2 dBA (ie marginal increase)**	**Increase > 2 dBA (ie noticeable increase)**
< Base Criteria	No further consideration of noise mitigation		
Between 0 dBA to 2 dBA above Base Criteria	No further consideration of noise mitigation		Further consideration is given to the provision of noise mitigation
Between 2 dBA to 5 dBA above Base criteria	No further consideration of noise mitigation		
≥ 5 dBA above Base Criteria (termed "acute")[1]	Further consideration is given to the provision of noise mitigation		

Note 1: The ENMM uses the term "acute". This refers to properties which are exposed to adverse levels of road traffic generated noise (ie at least 65 dBA $L_{Aeq(15hour)}$ or 60 dBA $L_{Aeq(9hour)}$). In operational road traffic noise assessments, consideration for noise mitigation treatment is given to properties that experience acute levels of noise at the proposal design year even when there is no change in noise level due to the proposal.

Where properties qualify for further consideration of noise mitigation, the options available are further assessed in terms of their:

- **Reasonableness** - which includes considerations of cost (ie the relationship between cost and noise reduction provided), equity, visual impacts, the change in noise levels etc), and
- **Feasibility** - ie engineering considerations, including whether it can be readily built, consideration of; stormwater access, safety issues, maintenance requirements, etc.

Additional Notes Relating to Feasible and Reasonable Mitigation Measures

In addition to road design and development controls, the ECRTN document nominates a number of other strategies which may be used to reduce the impact of traffic noise. These include:

- Governing maximum noise levels from individual vehicles.
- Developing programmes to monitor and control noisy vehicles on the road system.
- Controlling noise from heavy vehicle exhaust and engine brakes.
- Implementing traffic management policy at local and regional levels.
- Continuing encouragement of the community to use public transport and to increase the number of passengers travelling in private vehicles.

The ECRTN embodies a non-mandatory performance-based approach. The proposed criteria (or objectives) are to be applied as targets, applicable to the future volumes of traffic projected to 10 years' time, however it is recognised that situations will exist where planning strategies are not feasible.

Solutions that can be reasonably applied in the short-term may not always achieve the targets. In such cases, a longer-term perspective may need to be taken to institute ongoing strategies that will minimise traffic noise impacts over time.

The ECRTN notes that there are generally limited resources to provide noise control on existing roads to meet the target criteria and that the noise minimisation strategies adopted must take into account what is reasonable and feasible. The ECRTN goes on to note that in the urban context, background noise levels are elevated and generally increase incrementally over long periods of time. This affects the level of noise mitigation that is practicably achievable.

It is recommended that the criteria in the ECRTN be referred to in the early stages of planning for new roads or modifications to existing roads. The effects of road traffic noise can then be assessed and controlled throughout the planning process. Where feasible, a new or existing road should be aligned and designed and constructed to meet the criteria. However, if this is not practicable, other initiatives such as the control of road use behaviour (including speed control), managing the use of exhaust brakes, land use planning and building design would need to be instituted to assist in minimising the impacts.

6 AMBIENT NOISE ENVIRONMENT

6.1 Noise Monitoring Locations

In order to characterise the existing noise environment adjacent to the proposal area (in relation to both the construction and operational noise assessments) and to establish the noise levels upon which to base the noise emission objectives, environmental noise monitoring was performed at two representative locations.

These locations were selected based on the basis of an inspection of the potentially affected areas, giving consideration to other noise sources which may adversely influence the measurements, security issues for the noise monitoring devices and gaining permission for access from the resident or landowner. The monitoring was completed over a one week period between 4 and 9 November 2010 at the following locations:

- Location BG1 - 15 Greville Place.
- Location BG2 - 86 Sydney Road (Great Western Highway).

Unattended noise loggers were deployed adjacent to residential dwellings in order to measure the prevailing levels of road traffic noise. The measurements were conducted at a height of 1.5 m above ground floor level and at a distance of 1 m from the facade of the subject building, in accordance with the ECRTN. The noise logging locations, BG1 and BG2 are shown in **Figure 2**.

All noise measurement instrumentation used in the surveys was designed to comply with the requirements of AS 1259.2-1990 *"Acoustics - Sound Level Meters. Part 2: Integrating - Averaging"* and carried appropriate and current NATA calibration certificates.

The equipment utilised for the continuous unattended noise surveys comprised of an Acoustic Research Laboratories Type EL316 noise logger and a Svantak Type 957 noise logger, each fitted with microphone wind shields.

The calibration of the loggers was checked prior to, and following, the measurement survey and the variation in calibration was found to not exceed 0.5 dBA.

The noise loggers were set to record statistical noise descriptors in continuous 15-minute sampling periods for the duration of their deployment.

Weather data recorded during the noise monitoring survey periods by the Sydney Bureau of Meteorology was used to assist in identifying potentially adverse weather conditions that could have a detrimental impact on the measured noise levels such as rainy periods, etc.

6.2 Ambient Noise Monitoring Results

The results of the ambient noise surveys are presented in tabular form in **Table 11** and **Table 12** and are also illustrated graphically in **Appendix B** (in the form of plots which show the 24 hour noise levels at each monitoring location for the duration each logging period).

Representative Rating Background Levels (RBL) during the DECCW's standard daytime construction, evening and night-time periods, as required by the NSW "*Industrial Noise Policy*" (INP) and "*Interim Construction Noise Guideline*", are provided in **Table 11**. These noise levels are used to set noise objectives in relation to the construction phase of the proposal.

To represent overall day to day variations in road traffic noise emissions for freeways, use is made of the $L_{Aeq(15hour)}$ and $L_{Aeq(9hour)}$ noise indices. These indices represent the energy-averaged noise level that prevails during the daytime (7.00 am to 10.00 pm) and night-time (10.00 pm to 7.00 am) periods. These indices, which are used for the operational assessment, are provided in **Table 12**.

Observations of the acoustical environment at the noise monitoring locations indicate that, during some periods, the noise environment would be influenced by short-term high noise level events such as sirens, horns, etc, as well as the prevailing road traffic. As these former noise sources are relatively short-term in nature, they would have the effect of increasing the higher order L_{Amax} and L_{Aeq} indices rather than the L_{A10} and L_{A90} levels.

The ECRTN requires that, when conducting ambient noise surveys, it is only the noise level contributions from road traffic noise that are relevant, therefore in order for the measured data to reflect the prevailing levels of road traffic noise, the data was processed taking into account the following:

- Prevailing weather conditions.
- Uncharacteristic changes in the noise indices.
- Uncharacteristic variations of the L_{Aeq} compared to the L_{A10} index.

Table 11 Summary of Unattended Noise Logging - Construction Noise Indices

Receiver ID	Address	Construction Noise Indices (RBL) (dBA)		
		Daytime Period[1]	Evening Period[2]	Night-time Period[3]
BG1	15 Greville Place	57	47	40
BG2	86 Sydney Road	56	44	37

Note 1: DECCW's standard construction hours: 7.00 am to 6.00 pm Monday to Friday, 8.00 am to 1.00 pm on Saturdays and no work on Sundays or Public Holidays.

Note 2: Evening hours: 6.00 pm to 10.00 pm.

Note 3: Night-time hours: 10.00 pm to 7.00 am Sunday to Friday, 10.00 pm Saturday to 8.00 am Sunday.

Table 12 Summary of Unattended Noise Logging - Road Traffic Noise Indices

Receiver ID	Address	Road Traffic Noise Indices (dBA)			
		Weekdays Only		Including Weekends	
		LAeq(15hour)[1]	LAeq(9hour)[2]	LAeq(15hour)[1]	LAeq(9hour)[2]
BG1	15 Greville Place	64	59	63	58
BG2	86 Sydney Road	68	63	67	62

Note 1: $L_{Aeq(15hour)}$ refers to the 7.00 am to 10.00 pm daytime period.

Note 2: $L_{Aeq(9hour)}$ refers to the 10.00 pm to 7.00 am night-time period.

Reference to the background noise logging data contained in **Table 12** indicates that the existing levels of road traffic noise are already above the ECRTN base criteria of 60 dBA $L_{Aeq(15hour)}$ and 55 dBA $L_{Aeq(9hour)}$ at the two unattended noise logging locations. Noise levels during the 15-hour daytime period were approximately 5 dBA higher than during the 9-hour night-time period.

7 TRAFFIC NOISE MODELLING OF THE STUDY AREA

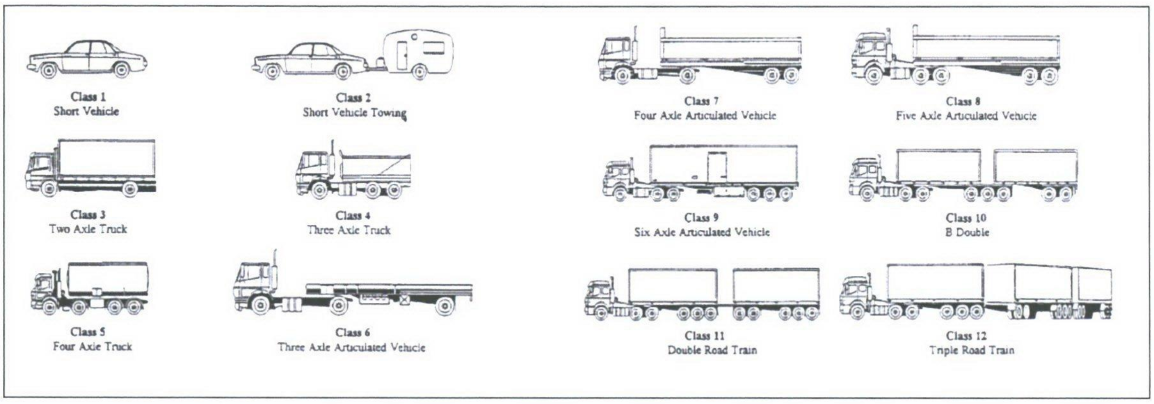
The noise modelling has been carried out using the SoundPLAN V7.0 suite of acoustics software using the Calculation of Road Traffic Noise (CORTN) prediction model for all calculations.

Road traffic noise levels were predicted using RTA and DECCW recommended procedures, as detailed in the CORTN methodology. The input data required for each section of road for these calculations includes the total traffic count, the percentage of heavy vehicles within total traffic flow and vehicle speed.

7.1 Vehicle Classification

Traffic has been split between cars and trucks based on Austroads vehicle classification system, as shown in **Figure 4**. For the purposes of the noise model, cars are considered Class 1 & 2 vehicles, and trucks are considered to be Class 3 and above.

Figure 4 Austroads Vehicle Classification System



7.2 Choice of Scenarios to be Modelled

The criteria used for evaluating the operational noise impact of the proposal require a prediction of noise levels for the following scenarios:

- **Base Scenario** (Year 2011) representing the existing noise levels without the proposed road upgrade. This model is used in conjunction with the unattended noise monitoring results to validate the computer noise model.
- **Future Existing Scenario** (Year 2015) representing noise levels which would exist in the Year 2015 without the proposed road upgrade.
- **Proposal Opening Scenario** (Year 2015), representing noise levels at proposal opening.
- **Future Scenario** (Year 2025), representing noise levels at a point in time 10 years after proposal opening.

The Year 2015 after opening and Year 2025 after opening scenarios represent the total change in noise levels resulting from the proposal, compared with the Future Existing (do nothing) scenario.

7.3 Traffic Volumes and Speeds

The projected traffic flows for the Year 2015 and Year 2025 noise modelling scenarios were provided by the RTA and are summarised in **Table 13** to **Table 16**. The traffic volumes are based on road traffic counting undertaken by the Cardno within the proposal area in 2011 and refer to individual vehicles. The traffic numbers are determined from the existing (2011) traffic numbers projected to the future dates (2015 (at opening) and 2025 (10 year future)) based on future (2035) traffic numbers provided by Cardno at a constant percentage growth rate. The existing and proposed speed limit within the proposal area is 60 km/h.

Table 13 Traffic Volume Details for Noise Modelling Scenarios (Goldpanner, East of Ashworth Drive)

Noise Modelling Scenario	Weekday Traffic Volumes and Heavy Vehicle (HV) Percentages			
	Westbound	HV	Eastbound	HV
Year 2011 Existing (without upgrade)				
Daytime (7am to 10pm)	6,399	8%	6,971	9%
Night-time (10pm to 7am)	664	18%	829	19%
Year 2015Future Existing (without upgrade)				
Daytime (7am to 10pm)	7,075	8%	7,812	9%
Night-time (10pm to 7am)	734	18%	932	19%
Year 2015 After Opening (with upgrade)				
Daytime (7am to 10pm)	7,075	8%	7,812	9%
Night-time (10pm to 7am)	734	18%	932	19%
Year 2025 10 Years After Opening (with upgrade)				
Daytime (7am to 10pm)	8,764	8%	9,913	10%
Night-time (10pm to 7am)	910	18%	1188	20%

Note 1: Future noise modelling scenarios assume a constant road traffic growth based on difference between existing (2011) and Future (2035) projected road traffic numbers provided by Cardno.

Note 2: Traffic volumes would be the same with or without the proposed upgrade.

Table 14 Traffic Volume Details for Noise Modelling Scenarios (Boyd Creek, West of Pat O'Leary Drive)

Noise Modelling Scenario	Weekday Traffic Volumes and Heavy Vehicle (HV) Percentages			
	Westbound	HV	Eastbound	HV
Year 2011 Existing (without upgrade)				
Daytime (7am to 10pm)	7,126	7%	7,751	8%
Night-time (10pm to 7am)	731	17%	915	17%
Year 2015 Future Existing (without upgrade)				
Daytime (7am to 10pm)	8,383	7%	9,334	9%
Night-time (10pm to 7am)	855	17%	1105	18%
Year 2015 After Opening (with upgrade)				
Daytime (7am to 10pm)	8,383	7%	9,334	9%
Night-time (10pm to 7am)	855	17%	1105	18%
Year 2025 10 Years After Opening (with upgrade)				
Daytime (7am to 10pm)	11,524	7%	13,293	9%
Night-time (10pm to 7am)	1164	17%	1579	19%

Note 1: Future noise modelling scenarios assume a constant road traffic growth based on difference between existing (2011) and Future (2035) projected road traffic numbers provided by Cardno.

Note 2: Traffic volumes would be the same with or without the proposed upgrade.

Table 15 Traffic Volume Details for Noise Modelling Scenarios (BP, West of View Street)

Noise Modelling Scenario	Weekday Traffic Volumes and Heavy Vehicle (HV) Percentages			
	Westbound	HV	Eastbound	HV
Year 2011 Existing (without upgrade)				
Daytime (7am to 10pm)	10,073	8%	10,630	9%
Night-time (10pm to 7am)	864	21%	1,297	14%
Year 2015 Future Existing (without upgrade)				
Daytime (7am to 10pm)	11,483	8%	12,358	10%
Night-time (10pm to 7am)	985	21%	1,509	14%
Year 2015 After Opening (with upgrade)				
Daytime (7am to 10pm)	11,483	8%	12,358	10%
Night-time (10pm to 7am)	985	21%	1,509	14%
Year 2025 10 Years After Opening (with upgrade)				
Daytime (7am to 10pm)	15,007	8%	16,678	10%
Night-time (10pm to 7am)	1,288	21%	2,039	14%

Note 1: Future noise modelling scenarios assume a constant road traffic growth based on difference between existing (2011) and Future (2035) projected road traffic numbers provided by Cardno.

Note 2: Traffic volumes would be the same with or without the proposed upgrade.

Table 16 Traffic Volume Details for Noise Modelling Scenarios (Raglan Creek, West of Stockland Drive)

Noise Modelling Scenario	Weekday Traffic Volumes and Heavy Vehicle (HV) Percentages			
	Westbound	HV	Eastbound	HV
Year 2011 Existing (without upgrade)				
Daytime (7am to 10pm)	14,217	5%	13,427	7%
Night-time (10pm to 7am)	1029	12%	1242	10%
Year 2015 Future Existing (without upgrade)				
Daytime (7am to 10pm)	15,779	5%	15,178	7%
Night-time (10pm to 7am)	1,142	12%	1,405	10%
Year 2015 After Opening (with upgrade)				
Daytime (7am to 10pm)	15,779	5%	15,178	7%
Night-time (10pm to 7am)	1,142	12%	1,405	10%
Year 2025 10 Years After Opening (with upgrade)				
Daytime (7am to 10pm)	19,685	5%	19,556	7%
Night-time (10pm to 7am)	1,424	12%	1,811	10%

Note 1: Future noise modelling scenarios assume a constant road traffic growth based on difference between existing (2011) and Future (2035) projected road traffic numbers provided by Cardno.

Note 2: Traffic volumes would be the same with or without the proposed upgrade.

7.4 Study Area: Terrain, Roadways and Single Point Receivers

Receiver (house) locations, ground topography, current and future road alignment and other cadastral data (eg property boundaries) were derived from aerial photographs and information supplied electronically. The noise modelling was based on 3D design strings provided by the RTA for the current and future road design.

The noise levels at nearby receiver locations have been evaluated through so-called "single point receiver" (SPR) calculations at the unattended noise logging locations and in the form of noise contour plots at other locations throughout the proposal area. Noise level calculations are undertaken at a height of 2.0 m above local ground level, representing a height of approximately 1.5 m above ground floor level at the majority of residential receivers.

7.5 L_{A10} to L_{Aeq} Conversions

A conversion of -3.0 dBA has been used to convert the (CORTN) $L_{A10(18hour)}$ level to the $L_{Aeq(15hour)}$ and the $L_{A10(1hour)}$ level to the $L_{Aeq(1hour)}$.

This figure was derived from the median difference (before rounding) between the L_{A10} and L_{Aeq} indices of measured noise data, as presented in **Section 6.2**.

7.6 Other Model Parameters

Within SoundPLAN, roadways are sub-divided firstly into small segments, where each segment has a constant gradient. In this way, the additional noise contributions due to road gradient can be adequately modelled.

Table 17 summarises the various key design parameters utilised in the noise modelling.

Table 17 Summary of Modelling Parameters

Parameter	Value used in Model
Vehicle Speed	60 km/hr for existing and future road alignment
Traffic Volumes	As per **Table 13** to **Table 16**
Road Surface	Standard Dense Graded Asphalt as described in Subgrade Evaluation and Pavement Design Report (RTA - April 2007)
Receiver height	Ground floor: 1.5 m above ground floor level
Receiver location	Building facade: 2.0 m above local RL level
Receiver facade reflection	+2.5 dBA

For the purpose of the assessment, groups of residences are grouped into Noise Catchment Areas corresponding to areas that experience a similar level of noise exposure, common geographic features and the like. For this proposal, the study area is divided into ten Noise Catchment Areas, as discussed in **Section 3**.

7.7 Validation of Computer Noise Model

The validation of the noise model was performed by comparing the unattended noise monitoring results with the Base Scenario noise level predictions for the $L_{Aeq(15hour)}$ and $L_{Aeq(9hour)}$ noise level descriptors. The results of this comparison are provided in **Table 18**.

Small variations between measured and predicted values are to be expected within any noise model. This is due to the dependence of measured noise levels on road surface characteristics near the specific measurement sites, the accuracy of the traffic volumes and percentage heavy vehicles, the incidence of vehicles changing gears near the site, the use of brakes in downhill sections, the bias in use of multiple lanes during different periods of the day, the effects of local screening (eg fences, sheds), etc.

Comparison of measured and predicted levels has been performed by undertaking single point receiver calculations at the two locations coinciding with the ambient monitoring. The noise logging locations, BG1 and BG2 are shown in **Figure 2**.

Table 18 Comparison of Measured and Predicted Noise Data (Base 2010)

No.	Address	Measured		Predicted		Predicted MINUS Measured	
		LAeq(15hour)	LAeq(9hour)	LAeq(15hour)	LAeq(9hour)	LAeq(15hour)	LAeq(9hour)
BG1	86 Sydney Road (GWH)	64	59	64	60	0	+1
BG2	15 Greville Place	68	63	69	64	+1	+1
	Average { PREDICTED – MEASURED } Difference =					**0.5 dBA**	**1.0 dBA**

Table 18 shows that the predicted noise levels provide a consistent, and slightly conservative, estimate of measured levels. On the basis of the comparison of the model predictions with baseline measurement results, it is concluded that the noise model provides results which enable a reliable assessment of the proposed upgrade works and associated noise mitigation treatments.

8 ROAD TRAFFIC NOISE ASSESSMENT AND MITIGATION

8.1 Noise Modelling Results without Mitigation Measures

Year 2015 Future Existing Predictions

A summary of the predicted $L_{Aeq(15hour)}$ daytime and $L_{Aeq(9hour)}$ night-time noise levels for the Year 2015 Future Existing scenario are presented in graphical form in **Appendix C**. This scenario represents the existing road alignment prior to the road upgrade.

Year 2015 After Opening Predictions

A summary of the predicted $L_{Aeq(15hour)}$ daytime and $L_{Aeq(9hour)}$ night-time noise levels for the Year 2015 after opening scenario are presented in graphical form in **Appendix C**. This scenario represents the change in noise levels associated with the road upgrade proposal. As the speed limit and number of vehicles does not change for this scenario, the change in noise level compared with the Future Existing scenario is associated with minor changes in the road alignment and the proximity of the road traffic to the nearest receivers.

For this scenario, the change in noise levels is greatest at the nearest residential receivers near the new roundabout proposed at Littlebourne Street. The change in noise levels at this locality, however, is predicted to be less than 2 dB and would not be noticeable.

Year 2025 10 Years After Opening Predictions

A summary of the predicted $L_{Aeq(15hour)}$ daytime and $L_{Aeq(9hour)}$ night-time noise levels for the Year 2025 future (10 years after opening) scenario are presented in graphical form in **Appendix C**. This scenario represents the change in noise levels associated with the road upgrade proposal as well as the change in traffic numbers over a 10 year period after opening.

The predicted noise level change as a result of the proposal remains less than the 2 dB allowance at all residential receivers.

Summary of Noise Levels Without Mitigation Measures

Table 19 provides a summary of the predicted noise levels at the nearest residences in each Noise Catchment Area for the 10 Years After Opening scenario.

Table 19 Summary of Operational Noise Levels Without Mitigation Measures

Catchment Area	Noise Goal (dBA)		Acute Noise Level Threshold (dBA)		Predicted Noise Levels (10 Years After Opening) - dBA	
	LAeq(15hour)	LAeq(9hour)	LAeq(15hour)	LAeq(9hour)	LAeq(15hour)	LAeq(9hour)
A	60	55	65	60	68*	63*
B	60	55	65	60	63	58
C	60	55	65	60	64 to 71*	59 to 66*
D	60	55	65	60	66*	61*
E	60	55	65	60	64 to 66*	58 to 60*
G	60	55	65	60	<60	<55
I	60	55	65	60	68* to 72*	63* to 67*

Note *: Represents locations where the Future Noise Levels 10 Years After Opening are above the "acute" noise level thresholds

Consideration of Noise Mitigation Measures

In accordance with the noise criteria and guidelines discussed in **Section 5** and **Table 10**, further consideration of noise mitigation measures is required for the following situations:

- Where the predicted noise levels 10 years after opening are above the Base Criteria (noise goals) and the noise level increase as a result of the proposal is greater than 2 dB; or
- Where the predicted noise levels 10 years after opening are 5 dB or more above the Base Criteria (termed "acute").

On the basis of the predicted noise levels in **Table 19**, the operational noise level criteria discussed in **Section 5**, the following provides a brief summary of the Noise Catchment Areas where consideration of noise mitigation measures is required:

- On the basis that the change in noise levels as a result of the proposed upgrade is predicted to be less than the 2 dB threshold at all residential receivers, no further consideration of mitigation measures is required in Noise Catchment Areas F, G, H and J, and at residences in Noise Catchment Areas C and E where the 10 Years After Opening noise levels are less than LAeq(15hour) 65 dBA and LAeq(9hour) 60 dBA (ie not acute).
- In Noise Catchment Areas A, C, D and I, consideration of noise mitigation measures is required at all residences where the 10 Years After Opening noise levels are greater than or equal to LAeq(15hour) 65 dBA or LAeq(9hour) 60 dBA. Residential receivers in this noise level range are termed "acute" on the basis of the terminology in the RTA's ENMM. In operational road traffic noise assessments, consideration for noise mitigation treatment is given to properties that experience acute levels of noise at the proposal design year even when there is no change in noise level due to the proposal.

8.2 Potential Sleep Disturbance

In accordance with the NSW Roads and Traffic Authority's *Environmental Noise Management Manual* (ENMM) - Practice Note III, an evaluation of the number of night-time passby events where the LAFmax - LAeq(1hr) difference is greater than 15 dBA has been undertaken. Results of this assessment are provided in **Table 20** and include predicted maximum internal noise levels. The internal LAmax noise levels are based on the maximum measured LAmax, at noise logging location BG1 (refer to **Figure 2**) and include a conservative 10 dBA outside to inside noise reduction assuming open windows (for ventilation).

Table 20 Night-time Vehicle Passby (L_{Amax} - L_{Aeq}) Noise Assessment - Logger BG1

Monitoring Date	Number of Maximum Noise Events per hr / Estimated Maximum Internal L_{AFmax} (dBA)									
	22:00-23:00	23:00-00:00	00:00-01:00	01:00-02:00	02:00-03:00	03:00-04:00	04:00-05:00	05:00-06:00	06:00-07:00	Total/ (Range)
04/11/10	- / -	- / -	- / -	- / -	- / -	- / -	- / -	- / -	- / -	-/-
05/11/10	1 / 71	- / -	1 / 67	- / -	-/-	-/-	1 /70	- / -	- / -	3/(67 to 70)
06/11/10	2 / 68	3 / 75	- / -	- / -	- / -	1 / 67	- / -	- / -	- / -	6/(67 to 75)
07/11/10	- / -	2 / 68	- / -	1 / 65	1 / 63	2 / 61	2 / 61	2 / 65	- / -	10/(61 to 68)
08/11/10	2 / 71	- / -	- / -	1 / 66	- / -	1 / 67	- / -	- / -	- / -	4/(66 to 71)
09/11/10	- / -	- / -	1 / 68	- / -	- / -	- / -	1 / 69	- / -	- / -	2/(68 to 69)

From **Table 20**, it is seen that, on average, approximately five maximum noise level events may be expected during the night-time period, with typical estimated internal L_{Amax} levels of 60 dBA to 70 dBA, and a small number of events up to 75 dBA.

The ENMM notes the following in relation to sleep disturbance:

- maximum internal noise levels below 50 dBA to 55 dBA are unlikely to awaken people from sleep
- one or two noise events per night, with maximum internal noise levels of 65–70 dBA, are not likely to affect health and wellbeing significantly.

The above assessment shows that existing maximum noise level events within the proposal area for receivers immediately adjacent to the GWH may marginally exceed the guideline levels. As the extent of these exceedances is relatively small, it is reasonable to expect that receivers which are not immediately adjacent to the GWH would be unlikely to exceed these guideline values.

From SLR Consulting's experience on road upgrade proposals involving similar traffic numbers and receiver offset distances, it is expected that the proposed road would result in an increased number of maximum noise events, commensurate with the percentage growth in road traffic numbers (refer to **Section 7.3**). This may result in an additional 1 to 2 maximum noise events per night at the nearest residences 10 years after opening compared with the existing situation.

On the basis of this evaluation and consistent with the recommendations in the RTA's ENMM, it is recommended that the prioritisation, selection and design of noise control measures should take account of maximum noise levels.

Notwithstanding the marginal increase in the number of maximum noise level events at the nearest residences, it should be noted that strategies are currently being implemented to reduce road traffic noise across the state's road network which may reduce the number of maximum noise levels events. These include local council requirements to include noise mitigation in new dwellings, metropolitan plans to increase the use of public transport, statewide plans for upgrades of major transport routes, and national initiatives to reduce heavy vehicle engine brake noise and road freight haulage. The *NSW Freight Strategy* being developed by Transport NSW is expected to result in reduced noise from heavy vehicle freight on roads in many areas and a corresponding reduction in high noise level events from road traffic.

8.3 Operational Road Traffic Noise - Available Mitigation Options

The computer model predictions suggest that in several catchment areas, the current and future noise levels at the potentially most affected residences immediately adjacent to the study area exceed the ECRTN noise goals. Furthermore, at a number of locations, residential receivers would experience road noise levels at or above 65 dBA during the daytime and 60 dBA during the night-time, placing them in the "acute" noise exposure category as described in the RTA's "*Environmental Noise Management Manual*". At these locations, further consideration of noise mitigation is warranted.

In broad terms, noise mitigation options available for consideration include the following:

- **Operational treatments**

  These would include an improved quieter road surface, limits on vehicle speed, etc.

  In this particular case, a reduction in the speed limit from 60 km/h to 50 km/h would result in minimal noise reduction and would counteract one of the proposal objectives of improved traffic flow through the study area.

  The use of quiet road surfaces can provide a noise reduction of approximately 2 dB in comparison to Dense Grade Asphalt (DGA). The use of a quiet road surface at this location is not likely to be feasible. According to the RTA's ENMM quieter pavements are not considered to be a cost-effective noise treatment option where posted speeds are less than 80 km/h. This is because experience has shown that below this speed, noise reduction of the whole traffic stream is compromised as the overall vehicle noise tends to mask any reductions in noise generated at the tyre-pavement interface.

- **Noise walls**

  Substantial noise reductions are possible for noise walls devoid of large gaps. Earth berms can also form adequate noise barriers where aesthetic consideration precludes the use of a solid vertical noise wall. Earth berms however require a relatively large footprint which is directly related to the batter and height of the berm.

  As discussed previously in **Section 3**, vehicular access to the nearest residences is provided directly via the GWH at the majority of locations and hence the construction of noise barriers or earth berms at such locations is not feasible. On the northern side of the GWH east of 138 GWH and Oxley Place (Noise Catchment Area E), property access is provided via an unsealed access road off GWH, and via the local road network off Boyd Street. At this locality, the construction of a noise barrier or earth berm would be feasible and should be considered as part of the detailed design.

- **Architectural treatments**

  These primarily aim to reduce internal noise levels. Potential architectural treatments generally provided by the RTA are limited to:

  - Fresh air ventilation systems that meet Building Code of Australia requirements with the windows and doors shut.
  - Upgrade windows and glazing and solid core doors on the exposed facades.
  - Upgrading window and door seals.
  - The sealing of wall vents.
  - The installation of external screen walls.

  Likely practical solutions to assist in achieving the proposal noise goals would include the use of noise walls and/or architectural treatment.

8.4 Operational Road Traffic Noise - Recommended Noise Mitigation Measures

Table 19 provides a summary of the Noise Catchment Areas where consideration of noise mitigation measures is required on the basis of the predicted L_{Aeq} noise levels. As discussed in **Section 8.2**, there is existing potential for sleep disturbance to occur at receiver positions in close proximity to the GWH with an expected increase in typical number of maximum noise events from five per night to six or seven per night (10 years after opening).

Within the Noise Catchments Areas identified as requiring noise mitigation, the only location where a noise barrier or earth berm is likely to be feasible and reasonable is Noise Catchment Area E, adjacent to the proposed new roundabout on the northern side. At this locality, the predicted noise levels 10 years after proposal opening are "acute" at three residences (15 and 16 Greville Place and 10 Spofforth Place).

At all other locations where the predicted noise levels 10 years after proposal opening are "acute", architectural treatments are recommended.

8.5 Comments on Architectural Treatments

A number of buildings have been identified as potentially qualifying for consideration of architectural treatments.

The owners of the properties identified in this report should not infer any guarantee by the RTA (or their sub-contractors) that property treatments would be provided, based on the contents of this report. This report is only one part of a larger process, as discussed in the RTA's ENMM.

Table 21 presents the addresses of the properties with Year 2025 noise levels equal to or exceeding the "acute" noise thresholds of $L_{Aeq(15hour)}$ 65 dBA and $L_{Aeq(9hour)}$ 60 dBA (excluding Noise Catchment Area E where a noise barrier or earth berm is recommended). Appendix D presents the modelled noise levels of acute properties with consideration to future existing (2015), proposal opening (2015), and 10 years after opening (2025).

Table 21 Addresses of Acute Properties with the recommended Mitigation Measures

Catchment Area	Residences Where Noise Levels 10 Years After Proposal Opening are Acute
A	36, 38 and 40 GWH
B	Nil, ,
C	74, 76, 78, 82, 84, 86, 88, 90, 92, 94, 98, 100, 102, 104, 106, 108, 110, 112, 114, 116 and 120 GWH
D	126, 130, 132 and 134 GWH
E[1]	Noise Barrier/Earth Berm recommended for consideration at this locality (15 and 16 Greville Place and 10 Spofforth Place)
F	Nil
G	Nil
H	Nil
I	41, 43, 45, 61, 67, 79, 81, 83, 91, 97, 101, 103, 109, 111 and 119 GWH
J	Nil

Note 1: In case where no noise barrier is selected at Noise Catchment Area E, these receivers would qualify for consideration of architectural treatment.

In accordance with Part II Section 8 of the ENMM, **Table 22** presents a range of noise level reductions which can be achieved by various types of architectural treatment.

Table 22 Noise Level Reduction for Architectural Treatments

Building Type	Treatment Type	Noise Level Reduction (dBA)
Light Frame	Fresh air ventilation system	10
	Fresh air ventilation system, upgraded window and door seals	12
Masonry	Fresh air ventilation system	15
	Fresh air ventilation system, upgraded window and door seals and sealed wall vents	20
	Fresh air ventilation system, upgraded window and door seals, upgraded glazing, solid core doors and sealed wall vents	25

Based on the noise level reductions in presented in **Table 22** and the predicted noise levels in **Table 19**, the predicted noise levels 10 years after opening are up to 10 dB above the noise goals at the majority of residences and up to 12 dB at the nearest residences in Noise Catchment Area I. On this basis, the fresh air ventilation system option would be the most suitable type of architectural treatment at most residences to achieve acceptable indoor noise levels. This would also be expected to adequately address the potential for sleep disturbance from maximum noise level events.

9 CONSTRUCTION NOISE AND VIBRATION MODELLING OF THE STUDY AREA

9.1 Noise Modelling

In order to quantify the likely noise emissions from the proposed construction works, calculations have been undertaken to predict the $L_{Aeq(15minute)}$ noise levels at the nearest sensitive receivers using a spreadsheet-based noise model consistent with the methodologies described in Appendix B of Australian Standard AS 2436-2010 *"Guide to noise and vibration control on construction, demolition and maintenance sites"*.

The calculations take into account the source noise levels of the anticipated equipment, the location of the nearest residential receivers and the typical offset distance between the equipment and the nearest receivers.

9.2 Construction Equipment

The following construction equipment (refer **Table 23**) are likely to be utilised during the construction phase of the proposal. This table also includes typical Sound Power Levels associated with each item, taken from SLR's noise source database and other sources.

Also included are the L_{Aeq} noise levels at typical offset distances of 10 m and 20 m from each item of equipment. These distances are representative of the minimum offset distances between the construction works and nearest residences and indicate that for the majority of diesel-powered construction equipment, the maximum L_{Aeq} noise levels are likely to be in the range of 70 dBA to 80 dBA for most activities when equipment is operating directly adjacent to receivers. The maximum L_{Aeq} noise levels adjacent (10 m) to the rockbreaker works may exceed 90 dBA.

Table 23 Construction Scenarios and Equipment

Equipment	Used for	Sound Power Level (dBA) LAeq	LAeq Noise Levels at Typical Receiver Location (dBA)	
			10 m Distance	20 m Distance
20t Excavator	Bulk and trench excavation. Clearing and Grubbing	99	71	65
35t Excavator	Bulk and trench excavation. Clearing and Grubbing	107	79	73
Aggregate spreader truck	For interlayer bitumen work	90	62	56
Air Compressor, and attachments	Minor demolition work and scabbling concrete joints.	93	65	59
Articulated dump truck	Cart materials within site.	100	72	66
Backhoe Trenching.	Move small amounts of materially locally.	103	75	69
Bitumen spray truck	For interlayer bitumen work	103	75	69
Bobcat	Minor detailed excavation and filling.	104	76	70
Broom tractor mounted	Sweep area clean	103	75	69
Bulk cement carrier	Delivery of bulk cement	103	75	69
Cherry Picker	Services relocation work	97	69	63
Cold miller	Profiling existing pavements	111	83	77
Concrete agitator truck	Delivery of small batches of concrete	107	79	73
Crane	Bridge and larger culvert works	106	78	72
Dozer (small)	Stockpile management and ripping	112	84	78
Float	Carting plant to and from site.	101	73	67
Grader Spread material.	Trim sub]base and base.	105	77	71
K & G laying machine	Constructing kerbs and gutters	107	79	73
Lighting Tower	Night work.	77	49	43
Pavement marking machine	Temporary and permanent line marking	104	76	70
Plate compactor	Minor compaction work	108	80	74
Road suction sweeper	Maintain site in clean condition	107	79	73
Rock hammer	Demolition work	121	93	87
Roller multi tyred pneumatic	Bitumen compaction	100	72	66
Roller smooth and pad -foot	Compaction of sub -base and base materials.	100	72	66
Semitrailer	Delivery of materials to site	103	75	69
Site vehicles □ utes, 4WD, etc	Transport men and equipment on site	100	72	66
Slipform paving machine	For laying concrete base	104	76	70
Tandem dump truck	Cart materials within site.	100	72	66
Tandem dump truck and trailer	Cart materials to and from site.	100	72	66
Tray truck with Hiab	General site work vehicle	98	70	64
Trencher	Installation of services and sub -soil drainage.	102	74	68
Vacuum Suction Truck	Potholing	100	72	66
Water pump - diesel	Emergency use.	107	79	73
Water truck	Conditioning of soil and dust control	100	72	66
Wheel Loader	Loading out spoil.	108	80	74

9.3 Construction Noise Management Levels

As discussed in **Section 4.2**, the *NSW "Interim Construction Noise Guideline"* (ICNG) sets out the requirements for assessing the potential noise impacts at sensitive receivers. The process involves the following two steps:

1) Determine project specific **Noise Management Levels** (NMLs) for noise affected receivers.
2) Where the construction noise levels are predicted to exceed the NMLs, all **feasible** and **reasonable** work practices would be investigated to minimise noise emissions.

On the basis of the background noise logging results presented in **Table 11**, a summary of the NMLs during the daytime, evening and night-time periods is provided in **Table 24**.

For preliminary assessment purposes, it has been assumed that the background noise environment is similar across the proposal area and therefore the Rating Background Levels (RBLs) at Location BG2 (86 Sydney Road - GWH) have been used to determining the NMLs at all residential locations. Whilst the measured RBLs were 1 dB higher at the 15 Greville Place locality during the daytime period and 3 dB higher during the evening and night-time periods, this is not significant in terms of the potential construction noise impacts and/or proposed mitigation and noise management measures.

Table 24 Construction Noise Management Levels

Receiver Type	Noise Management Levels - NMLs (dBA)		
	Daytime Period[1]	Evening Period[2]	Night-time Period[3]
Residential (Noise Affected)	66	49	42
Residential (Highly Noise Affected)	75	N/A	N/A
Commercial Premises (When in Use)	70	70	70
Industrial Premises (When in Use)	75	75	75

Note 1: DECCW's standard construction hours: 7.00 am to 6.00 pm Monday to Friday, 8.00 am to 1.00 pm on Saturdays and no work on Sundays or Public Holidays.

Note 2: Evening hours: 6.00 pm to 10.00 pm.

Note 3: Night-time hours: 10.00 pm to 7.00 am Sunday to Friday, 10.00 pm Saturday to 8.00 am Sunday.

9.4 Assessment of Construction Noise Impacts

At any particular location, the potential noise impacts can vary greatly depending on factors such as the relative proximity of sensitive receivers, the overall duration of the construction works, the intensity of the noise, the number of plant items operating simultaneously, the time at which the construction works are undertaken and the character of the noise.

At this stage in the assessment process, detailed construction methodologies for the proposal are not available. As indicated in **Section 9.2**, maximum L_{Aeq} noise levels are likely to be in the range of 70 dBA to 80 dBA for most activities when equipment is operating within distances of 10 m to 20 m from sensitive receivers. Construction activities using rockbreakers may generate noise levels in the range of 87 dBA to 93 dBA when equipment is operating within distances of 10 m to 20 m from sensitive receivers.

During any particular 15-minute assessment period, it is likely that several items of equipment could be operating within a distance of 100 m from any particular sensitive receiver, however it is unlikely that all equipment would be operating at 100% capacity.

On the basis of the construction equipment and source noise levels in **Table 23**, the typical offset distances to the nearest receivers, and our experience on similar road upgrade proposals in terms of the number of plant items operating simultaneously, $L_{Aeq(15minute)}$ noise levels are anticipated to be in the range of 75 dBA to 85 dBA at the nearest receivers during noise intensive construction periods.

In relation to the NMLs of $L_{Aeq(15minute)}$ 66 dBA for residential receivers and the "highly affected" noise level of $L_{Aeq(15minute)}$ 75 dBA, construction noise levels are anticipated to be within the "highly affected" noise range at the nearest residences. The ICNG provides the following commentary when noise levels are within this range:

> *"The highly noise affected level represents the point above which there may be strong community reaction to noise. Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account:*
>
> 1. *times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences*
> 2. *if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times."*

Construction Noise Levels at Kelso High School

Within the proposal area, Kelso High School is the only non-residential sensitive land use. At this location, construction noise levels are anticipated to be up to 50 dBA outdoors and up to 40 dBA indoors within windows open (only during noise intensive construction activities). On the basis that the predicted internal noise level of 40 dBA is lower than the internal NML of 45 dBA for classrooms, it is not anticipated that the noise impact of the construction works would be excessive at this receiver however it may be necessary to schedule noise intensive construction works outside examination periods if noise levels during construction are found to be excessive.

9.5 Construction Noise - Recommended Noise Mitigation Measures

Construction Hours

In order to minimise the potential noise impacts at residential receivers, the proposed construction works should be undertaken during the DECCW's preferred daytime construction hours as follows:

- Monday to Friday 7.00 am to 6.00 pm
- Saturday 8:00 am to 1.00 pm
- No Work on Sundays or Public Holidays

For road upgrade proposals, it is recognised that there would be instances where work outside the DECCW's preferred daytime construction hours would be required. Examples include:

- The delivery of oversized plant or structures that police or other authorities determine require special arrangements to transport along public roads.
- Emergency work to avoid the loss of life or damage to property, or to prevent environmental harm.
- Maintenance and repair of public infrastructure where disruption to essential services and/or considerations of worker safety do not allow work within standard hours.
- Public infrastructure works that shorten the length of the proposal and are supported by the affected community.
- Works where a proponent demonstrates and justifies a need to operate outside the recommended standard hours.

In the last two categories, the proponent should provide the relevant authority with clear justification for reasons other than convenience, such as to sustain operational integrity of road, rail and utility networks. For the GWH upgrade proposal, night-time works are likely to be required for works that would result in unacceptable traffic delays to the public if undertaken during daytime periods.

Architectural Treatments and Noise Barriers

As discussed in **Section 8.5**, a number of properties have been identified where a noise barrier or architectural treatments would be considered to mitigate operational noise. As these measures would also reduce the potential noise impacts at the nearest sensitive receivers during the construction phase, consideration should be given to implementing the architectural treatments prior to construction and constructing the noise barrier as soon as practical during the construction phase.

Community Consultation

Active community consultation and the maintenance of positive relations with local residents and would assist in alleviating concerns and thereby minimising complaint.

Temporary Noise Barriers

On this proposal, it is unlikely that temporary noise barriers are likely to be feasible due to property access requirements and space limitations within the road corridor. Where appropriate, acoustic enclosures could be constructed around fixed plant operating on a continuous basis during the construction phase at a particular site. Such enclosures can provide between 15 dBA to 30 dBA attenuation.

Notwithstanding the above, due to the likely noise impacts adjacent to rockbreaker activities, use of localised acoustic hoarding around this equipment is recommended where practicable. This would be expected to provide between 5 dBA and 10 dBA of additional noise attenuation, if adequately constructed to ensure line-of-sight between sensitive receivers and the construction equipment is broken.

Site Layout

Where feasible, site compounds should be located away from sensitive receiver locations as far as practical in order to minimise the potential noise impacts. Additionally, maintenance work on all construction plant should be carried out away from noise sensitive receivers as far as practical and confined to standard daytime construction hours.

Noise Management Plans

An environmental management plan or, more specifically relating to noise, a construction noise management plan is a site or proposal specific plan developed to ensure that appropriate work practices are implemented during a proposal's construction to minimise noise impact.

Noise management plans can be used to explain in detail how the proponent intends to implement work practices on a proposal to minimise noise.

For large proposals a construction noise management plan may include the following features:

- Identification of all nearby residences and other sensitive land uses and, where relevant, the noise or blasting management levels at the identified assessment locations.
- An assessment of potential noise or blasting impacts from the proposed construction methods and construction vehicle movements.
- Detailed examination of feasible and reasonable noise mitigation measures that would minimise or avoid noise impacts - this would include a commitment to what feasible and reasonable work practices and measures are to be applied to minimise noise impacts.
- Preparation of regular feedback by undertaking noise monitoring and analysis of the results to improve the management plan, so that best practice noise control is continually met for the duration of the proposal.

- Development of reactive and pro-active strategies for dealing promptly with any noise complaints, including documentation and feedback mechanisms.
- Identification of a site contact person to follow up complaints.
- Details of noise or blast monitoring and reporting procedures, including where these have been established as necessary during the noise impact assessment.
- The establishment of monitoring systems at affected residences and other sensitive land uses for noise levels and weather conditions (for example, wind speed and direction, rainfall).
- Regular internal checks of plant and equipment to confirm there has been no degradation in noise levels.
- Regular independent auditing of procedures.

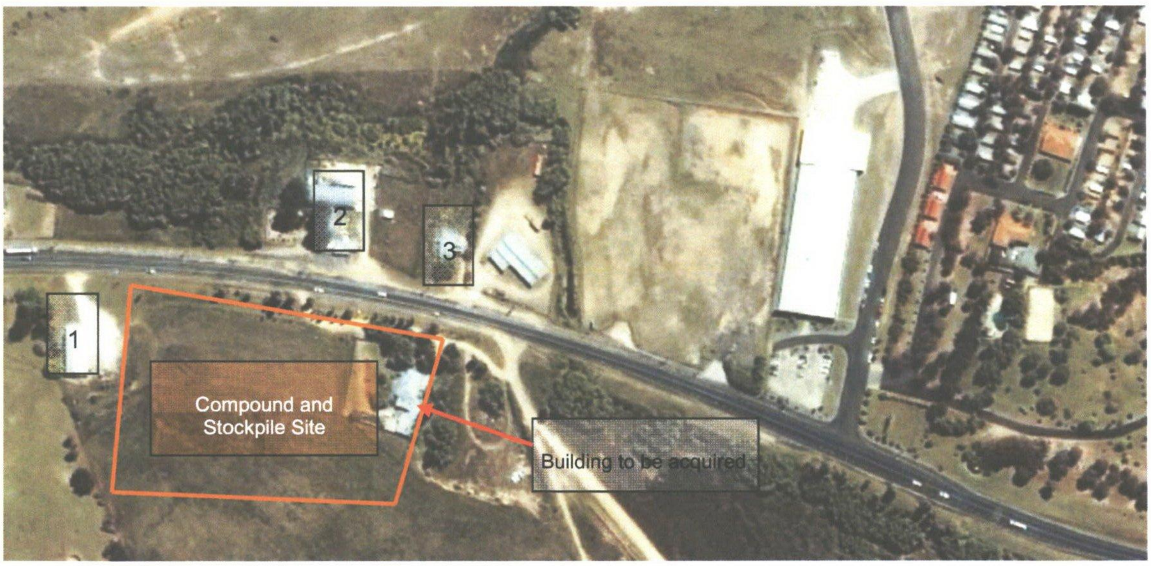
During the detailed design stage, when more specific information is available in relation to the proposed construction works, it is recommended that an environmental noise management plan is prepared, addressing each major stage of the construction works and identifying the appropriate mitigation and management measures.

9.6 Construction Noise Assessment – Site Compound

9.6.1 Location

It is proposed to locate a construction site compound to the east of the proposal area on the south of the GWH as shown in **Figure 5**.

Figure 5 Proposed Construction Site Compound



9.6.2 Identification of Representative Receivers

Representative receivers nearby the proposed construction site are outlined in **Table 25**.

Table 25 Representative Receivers - Site Compound

Receiver Location	Address	Brief Description
1	Lot 1 Sydney Road	Commercial premises
2	216 Sydney Road	Commercial premises
3	222 Sydney Road	Residential premises[1]

Note 1: Appearance of a residential property - this should be confirmed at a later design stage.

9.6.3 Construction Noise Assessment - Site Compound

It is assumed that the proposed construction works would be undertaken using standard plant and equipment frequently used on similar sites. Site/stockpile compounds are usually operational during standard construction hours (Monday to Friday 7.00 am to 6.00 pm, Saturday 8:00 am to 1.00 pm) and therefore these hours of operation have been assumed for this assessment.

In order to assess the potential noise impacts during construction, the $L_{Aeq(15minute)}$ construction noise levels from the site compound (activities assumed adjacent to the closest boundary of the compound) at each of the representative receiver locations has been predicted for typical plant and equipment used in construction site compounds. This is summarised in **Table 26**.

Table 26 Predicted Construction Site Noise Levels at Representative Receiver Locations

Equipment	Used for	Sound Power Level (dBA) LAeq	Estimated LAeq Noise Levels at Representative Receiver Location (dBA)		
			Receiver 1	Receiver 2	Receiver 3
Bobcat	Minor detailed excavation and filling.	104	62	57	60
Broom tractor mounted	Sweep area clean	103	61	56	59
Concrete agitator truck	Delivery of small batches of concrete	107	65	60	63
Crane	Bridge and larger culvert works	106	64	59	62
Dozer (small)	Stockpile management and ripping	112	70	65	68
Float	Carting plant to and from site.	101	59	54	57
Road suction sweeper	Maintain site in clean condition	107	65	60	63
Semitrailer	Delivery of materials to site	103	61	56	59
Site vehicles, utes, 4WD, etc	Transport men and equipment on site	100	58	53	56
Tandem dump truck	Cart materials within site.	100	58	53	56
Tandem dump truck and trailer	Cart materials to and from site.	100	58	53	56
Tray truck with Hiab	General site work vehicle	98	56	51	54
Water truck	Conditioning of soil and dust control	100	58	53	56
Wheel Loader	Loading out spoil.	108	66	61	64

Review of the information contained in **Table 26** indicates the following:

- Estimated $L_{Aeq(15minute)}$ noise levels at Receiver Location 1 (Commercial premises) from the assumed equipment of the site compound working continuously are typically in the range of 60 dBA to 70 dBA.
- Estimated $L_{Aeq(15minute)}$ noise levels at Receiver Location 2 (Commercial premises) from the assumed equipment of the site compound working continuously are typically in the range of 50 dBA to 60 dBA.
- Estimated $L_{Aeq(15minute)}$ noise levels at Receiver Location 3 (Residential premises) from the assumed equipment of the site compound working continuously are typically in the range of 58 dBA to 68 dBA.

Table 27 contains a summary of the corresponding site compound noise impact assessment using the construction noise management levels outlined in **Section 9.3**.

Table 27 Construction Noise Assessment Summary - Site Compound

Representative Receiver Location	Predicted $L_{Aeq(15minute)}$ Construction Noise Level (dBA)	Daytime Noise Management Level - NML (dBA)	Predicted Exceedance (dBA)
Receiver Location 1 (Commercial premises)	60-70	70	nil
Receiver Location 2 (Commercial premises)	50-60	70	nil
Receiver Location 3 (Residential receiver)	58-68	66[1]	up to 2

Note 1: Residential daytime NML.

From the information presented in **Table 27**, it can be seen that operation of typical site plant and equipment as detailed in **Table 26** may result in an exceedance (of up to 2 dBA) of the daytime construction NML at representative receiver location 3 (residential receiver) only. It should be noted that aerial images of this receiver indicate residential use however this should be confirmed at a later design stage. There are no predicted exceedances of the daytime NML for commercial receivers with the proposed site compound location.

The modelling presents a 'worst-case' scenario for each item of equipment which is assumed to be operating continuously and for the full 15 minute assessment period at the typical closest area within the site compound.

The calculated noise levels would inevitably depend on the number of plant items and equipment operating at any one time and their precise location relative to the receiver of interest. From our experience on similar road upgrade proposals where more than one item of plant are operating concurrently this is unlikely to result in increases of overall noise levels of more than 5 dBA above the noisiest item of plant. Corresponding increases in construction noise levels may exceed NML at receiver location 1 by up to around 5 dBA and by up to 7 dBA at location 3. Exceedance of NML at receiver location 2 is not predicted.

In practice, the noise levels would vary due to the fact that plant and equipment would move about the work sites and would not all be operating concurrently. In some cases, reductions in noise levels would occur when plant are located in cuttings or behind embankments, buildings or even other items of equipment.

9.6.4 Noise Mitigation Recommendations

Operation of equipment within the site compound should be located away from sensitive receiver locations as far as practical in order to minimise the potential noise impacts. Additionally, maintenance work on all construction plant should be carried out away from noise sensitive receivers as far as practical and confined to standard daytime construction hours.

Where practicable, installation of earth bunds and/or hoarding along part of the western boundary of the site compound to block direct line of sight from Receiver Location 1 to the main construction site activity areas should be considered at the detailed design stage. This would be expected to provide between 5 dBA and 10 dBA of additional noise attenuation, if adequately constructed to ensure line-of-sight between all receivers and the construction equipment is broken.

9.7 Construction Vibration Assessment

During construction activities, the major potential sources of vibration include excavation plant (eg excavators, bulldozers and graders), piling equipment and vibratory rollers.

Vibration goals have been provided in **Section 4.3** of this report. As a guide, indicative working distances for typical items of vibration intensive plant are listed in **Table 28**. The indicative working distances are quoted for both "structural" damage and human comfort.

Table 28 Indicative Working Distances for Vibration Intensive Plant

Plant Item	Rating/Description	Indicative Working Distance	
		Structural Damage (DIN 4150)	Human Response (BS 6472)[1]
Vibratory Roller	< 50 kN (Typically 1-2 tonnes)	10 m	15 m
	< 100 kN (Typically 2-4 tonnes)	15 m	20 m
	< 200 kN (Typically 4-6 tonnes)	25 m	40 m
	< 300 kN (Typically 7-13 tonnes)	30 m	60 m
	> 300 kN (Typically 13-18 tonnes)	40 m	90 m
	> 300 kN (> 18 tonnes)	50 m	120 m
Small Hydraulic Hammer	(300 kg - 5 to 12t excavator)	5 m	10 m
Medium Hydraulic Hammer	(900 kg - 12 to 18t excavator)	15 m	25 m
Large Hydraulic Hammer	(1600 kg - 18 to 34t excavator)	40 m	75 m
Vibratory Pile Driver	Sheet piles	8 m	20 m
Pile Boring	≤ 800 mm	4 m	8 m
Jackhammer	Hand held	2 m	Avoid contact with structure

Note 1: The working distances for Human Response assume that the source of the vibration is continuous throughout the 16-hour daytime period. The formulae in **Section 4.3** indicate that higher levels of vibration are acceptable when the vibration levels are intermittent or impulsive. The safe working distance s are therefore considered to be conservative and it is likely that the safe working distances corresponding to a "low probability of adverse comment" would be lower than indicated.

The working distances presented in **Table 28** are indicative only and would vary depending on the particular item of plant and local geotechnical conditions. They apply to cosmetic damage of typical buildings under typical geotechnical conditions. Vibration monitoring trials are recommended to confirm the safe working distances at specific sites and for specific plant items.

In general, vibration produced by earthworks and road forming operations is expected to lie below the cosmetic damage criteria. At locations where the works would be in close proximity to buildings and other sensitive structures (anticipated to be within ten meters at some locations), judicious selection of plant and equipment would be necessary for vibration intensive activities.

Heritage Buildings

There have been 12 listed and unlisted heritage items identified within the proposal area. These items are all adjacent to the GWH and therefore in close vicinity to the proposed construction works. **Table 29** presents a summary of these items.

Table 29 Summary of Identified Listed and Unlisted Heritage Items with the Proposal Area

Item Number	Premises Type	Address
1	Residential - "Kelsoville"	30 Sydney Road
2	Commercial - Shop	48 Sydney Road
3	Commercial - Shop	54 Sydney Road
4	Commercial - Shop	58 Sydney Road
5	Commercial - Police Station (former)	72 Sydney Road
6	Commercial - All Nations Hotel (former)	138 Sydney Road
7	Residential - Convent Building (former)	67 Sydney Road
8	Commercial - Golden Yan Chinese Restaurant	51 Sydney Road
9	Residential	43 Sydney Road
10	Residential	41 Sydney Road
11	Commercial - Kelso Hotel	37 Sydney Road
12	Residential	1 Lee Street (Corner of GWH)

At this stage in the proposal, the construction vibration assessment of these heritage buildings is considered in the same manner as other buildings along the proposal area in close vicinity to the works (ie judicious selection of plant and equipment would be necessary for vibration intensive activities) due to the potential for significant levels of vibration from construction works.

It is recommended that during the later stages of the design process, building surveys of these properties are carried out in order to assess the potential for increased susceptibility to building damage from vibration. Should these buildings be considered more susceptible to vibration, reduced vibration criteria levels may be applicable and subsequently adopted during the selection process for suitable equipment to be used in the vicinity of these buildings.

9.8 Construction Vibration - Recommended Mitigation and Management Measures

The following "baseline" vibration mitigation measures are recommended where reasonably and feasibly practicable:

- Relocate any vibration generating plant and equipment to areas within the site in order to lower the vibration impacts at affected locations.
- All construction works should be carried out Monday to Friday, 7:00 am to 6:00 pm, where possible. Work generating high vibration levels should be scheduled during less sensitive time periods.

- Use lower vibration generating items of excavation plant and equipment eg smaller capacity rockbreaker hammers or ripping time in place of rockbreaker hammers.
- Minimise consecutive works in the same locality (if applicable).
- High vibration generating activities should only be carried out in continuous blocks, not exceeding 4 hours each, with a minimum respite period of 0.5 hours between each block.
- Use only dampened rockbreakers and/or "city" rockbreakers to minimise the impacts associated with rockbreaking works.

It is also recommended that vibration monitoring be initially carried out at nearby structures working within the safe working distances for cosmetic damage as a result of vibration intensive construction activities and where the vibration levels are greater than the maximum recommended values.

It is recommended that supplementary vibration monitoring be carried out in response to complaints, exceedances or for the purpose of refining construction techniques in order to vibration emissions (if required). Monitoring would be attended under these circumstances, in order to provide immediate feedback to the operators.

During the detailed design stage, when more specific information is available in relation to the proposed construction works, it is recommended that an environmental vibration management plan is prepared, addressing each major stage of the construction works and identifying the appropriate mitigation and management measures. This would include building surveys of the heritage buildings to assess the potential for increased susceptibility to building damage from vibration and therefore reduced acceptable vibration levels and corresponding restrictions on plant and equipment working in the immediate vicinity.

10 CONCLUSION

A Noise Impact Assessment has been carried out for the proposed upgrade of the Great Western Highway between Ashworth Drive and Stockland Drive in Kelso.

The existing 2.4 km section of the Great Western Highway would be upgraded to four lanes with a raised median, plus modifications to the existing eight intersections and various other works.

This report provides a preliminary assessment of the potential noise and vibration impacts during construction and once the road is open to traffic. The assessment is based upon the RTA's current Concept Design. This represents one example of how the proposal could be constructed. During the detailed design stage of the proposal, details of the proposal may change and which alter the final form of the proposed mitigation and management measures.

Computer noise modelling has been undertaken to assess the potential noise impacts once the road is open to traffic. In accordance with the DECCW's *Environmental Criteria for Road Traffic Noise*, operational noise levels have been assessed for the future situation 10 years after proposal opening.

The assessment indicates that the increase in noise levels as a result of the road upgrade proposal would be less than the 2 dB allowance level, indicating that the noise level increase is unlikely to be noticeable. Nevertheless, a number of locations have been identified where the future noise levels would be equal to or greater than the RTA's "acute" noise level thresholds of $L_{Aeq(15hour)}$ 65 dBA and $L_{Aeq(9hour)}$ 60 dBA. In operational road traffic noise assessments, consideration for noise mitigation treatment is given to properties that experience acute levels of noise at the proposal design year even when there is no change in noise level due to the proposal. A summary of the properties where noise mitigation measures are recommended, including noise barriers and architectural treatments has been provided.

The predicted noise levels during construction indicate significant exceedances of the DECCW's Noise Management Levels for daytime operations at the nearest receivers. These are a direct result of the relative close proximity of receivers to the construction activities and the absence of any appreciable shielding between sites and receivers.

It is recommended that the proposed noise barrier/earth berm and architectural treatments (to mitigate operational noise) are constructed as soon as practical during the project to minimise the potential noise impacts at these receivers during the construction stage. Construction works should also be undertaken within the DECCW's standard construction periods wherever possible.

Vibration levels from vibratory rollers, excavation equipment and piling equipment is likely to exceed the human comfort guideline levels at the nearest receivers. At the nearest locations, there is also a risk that vibration levels may exceed the safe vibration levels associated with minor cosmetic damage to structures.

The report sets out indicative safe working distances for various items of construction equipment. At locations where the works would be in close proximity to buildings and other sensitive structures (anticipated to be as within ten meters at some locations), judicious selection of plant and equipment would be necessary for vibration intensive activities. If construction works are required at within the indicative safe working distances, it is recommended that vibration monitoring be initially carried out to ensure that vibration levels remain below the maximum recommended values and building condition surveys are undertaken prior to the commencement of construction activities.

During the detailed design stage, when more detailed information is available in relation to the proposed construction works, it is recommended that an environmental noise and vibration management plan is prepared, addressing each major stage of the construction works and identifying the appropriate mitigation and management measures. This would include building surveys of the heritage buildings in the proposal area to assess the potential for increased susceptibility to building damage from vibration and therefore reduced acceptable vibration levels and corresponding restrictions on plant and equipment working in the immediate vicinity.

11 CLOSURE

This report has been prepared by SLR Consulting Australia Pty Ltd with all reasonable skill, care and diligence, and taking account of the manpower and resources devoted to it by agreement with the client. Information reported herein is based on the interpretation of data collected and has been accepted in good faith as being accurate and valid.

This report is for the exclusive use of the RTA. No warranties or guarantees are expressed or should be inferred by any third parties. This report may not be relied upon by other parties without written consent from SLR.

SLR disclaims any responsibility to the client and others in respect of any matters outside the agreed scope of the work.

Acoustic Terminology and Glossary of Terms

1 Sound Level or Noise Level

The terms 'sound' and 'noise' are almost interchangeable, except that in common usage 'noise' is often used to refer to unwanted sound.

Sound (or noise) consists of minute fluctuations in atmospheric pressure capable of evoking the sense of hearing. The human ear responds to changes in sound pressure over a very wide range. The loudest sound pressure to which the human ear responds is ten million times greater than the softest. The decibel (abbreviated as dB) scale reduces this ratio to a more manageable size by the use of logarithms.

The symbols SPL, L or L_P are commonly used to represent Sound Pressure Level. The symbol L_A represents A-weighted Sound Pressure Level. The standard reference unit for Sound Pressure Levels expressed in decibels is 2 x 10^{-5} Pa.

2 'A' Weighted Sound Pressure Level

The overall level of a sound is usually expressed in terms of dBA, which is measured using a sound level meter with an 'A-weighting' filter. This is an electronic filter having a frequency response corresponding approximately to that of human hearing.

People's hearing is most sensitive to sounds at mid frequencies (500 Hz to 4000 Hz), and less sensitive at lower and higher frequencies. Thus, the level of a sound in dBA is a good measure of the loudness of that sound. Different sources having the same dBA level generally sound about equally loud.

A change of 1 dBA or 2 dBA in the level of a sound is difficult for most people to detect, whilst a 3 dBA to 5 dBA change corresponds to a small but noticeable change in loudness. A 10 dBA change corresponds to an approximate doubling or halving in loudness. The table below lists examples of typical noise levels

Sound Pressure Level (dBA)	Typical Source	Subjective Evaluation
130	Threshold of pain	Intolerable
120	Heavy rock concert	Extremely noisy
110	Grinding on steel	
100	Loud car horn at 3 m	Very noisy
90	Construction site with pneumatic hammering	
80	Kerbside of busy street	Loud
70	Loud radio or television	
60	Department store	Moderate to quiet
50	General Office	
40	Inside private office	Quiet to very quiet
30	Inside bedroom	
20	Recording studio	Almost silent

Other weightings (eg B, C and D) are less commonly used than A-weighting. Sound Levels measured without any weighting are referred to as 'linear', and the units are expressed as dB(lin) or dB.

3 Sound Power Level

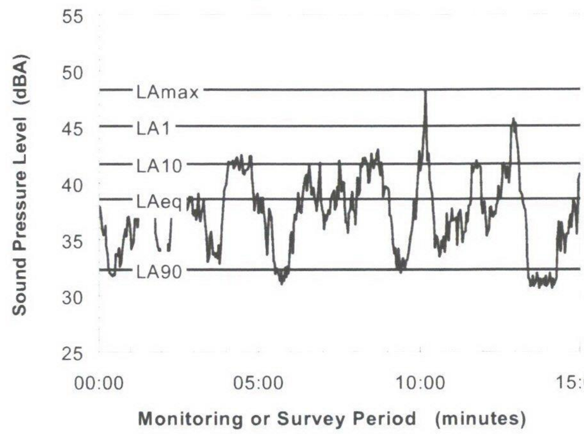
The Sound Power of a source is the rate at which it emits acoustic energy. As with Sound Pressure Levels, Sound Power Levels are expressed in decibel units (dB or dBA), but may be identified by the symbols SWL or L_W, or by the reference unit 10^{-12} W.

The relationship between Sound Power and Sound Pressure may be likened to an electric radiator, which is characterised by a power rating, but has an effect on the surrounding environment that can be measured in terms of a different parameter, temperature.

4 Statistical Noise Levels

Sounds that vary in level over time, such as transportation noise and most community noise, are commonly described in terms of the statistical exceedance levels L_{AN}, where L_{AN} is the A-weighted sound pressure level exceeded for N% of a given measurement period. For example, the L_{A1} is the noise level exceeded for 1% of the time, L_{A10} the noise exceeded for 10% of the time, and so on.

The following figure presents a hypothetical 15 minute noise survey, illustrating various common statistical indices of interest.



Of particular relevance, are:

- L_{A1} The noise level exceeded for 1% of the 15 minute interval.
- L_{A10} The noise level exceed for 10% of the 15 minute interval. This is commonly referred to as the average maximum noise level.
- L_{A90} The noise level exceeded for 90% of the sample period. This noise level is described as the average minimum background sound level (in the absence of the source under consideration), or simply the background level.
- L_{Aeq} The A-weighted equivalent noise level (basically the average noise level). It is defined as the steady sound level that contains the same amount of acoustical energy as the corresponding time-varying sound.

When dealing with numerous days of statistical noise data, it is sometimes necessary to define the typical noise levels at a given monitoring location for a particular time of day. A standardised method is available for determining these representative levels.

This method produces a level representing the 'repeatable minimum' L_{A90} noise level over the daytime and night-time measurement periods, as required by the EPA. In addition the method produces mean or 'average' levels representative of the other descriptors (L_{Aeq}, L_{A10}, etc).

5 Tonality

Tonal noise contains one or more prominent tones (ie distinct frequency components), and is normally regarded as more offensive than 'broad band' noise.

6 Impulsiveness

An impulsive noise is characterised by one or more short sharp peaks in the time domain, such as occurs during hammering.

7 Frequency Analysis

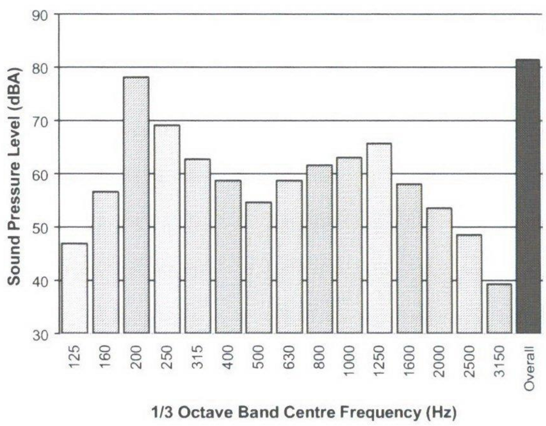
Frequency analysis is the process used to examine the tones (or frequency components) which make up the overall noise or vibration signal. This analysis was traditionally carried out using analogue electronic filters, but is now normally carried out using Fast Fourier Transform (FFT) analysers.

The units for frequency are Hertz (Hz), which represent the number of cycles per second.

Frequency analysis can be in:

- Octave bands (where the centre frequency and width of each band is double the previous band)
- 1/3 octave bands (3 bands in each octave band)
- Narrow band (where the spectrum is divided into 400 or more bands of equal width)

The following figure shows a 1/3 octave band frequency analysis where the noise is dominated by the 200 Hz band. Note that the indicated level of each individual band is less than the overall level, which is the logarithmic sum of the bands.



8 Vibration

Vibration may be defined as cyclic or transient motion. This motion can be measured in terms of its displacement, velocity or acceleration. Most assessments of human response to vibration or the risk of damage to buildings use measurements of vibration velocity. These may be expressed in terms of 'peak' velocity or 'rms' velocity.

The former is the maximum instantaneous velocity, without any averaging, and is sometimes referred to as 'peak particle velocity', or PPV. The latter incorporates 'root mean squared' averaging over some defined time period.

Vibration measurements may be carried out in a single axis or alternatively as triaxial measurements. Where triaxial measurements are used, the axes are commonly designated vertical, longitudinal (aligned toward the source) and transverse.

The common units for velocity are millimetres per second (mm/s). As with noise, decibel units can also be used, in which case the reference level should always be stated. A vibration level V, expressed in mm/s can be converted to decibels by the formula 20 log (V/V_o), where V_o is the reference level (10^{-9} m/s). Care is required in this regard, as other reference levels may be used by some organizations.

9 Human Perception of Vibration

People are able to 'feel' vibration at levels lower than those required to cause even superficial damage to the most susceptible classes of building (even though they may not be disturbed by the motion). An individual's perception of motion or response to vibration depends very strongly on previous experience and expectations, and on other connotations associated with the perceived source of the vibration. For example, the vibration that a person responds to as 'normal' in a car, bus or train is considerably higher than what is perceived as 'normal' in a shop, office or dwelling.

10 Over-Pressure

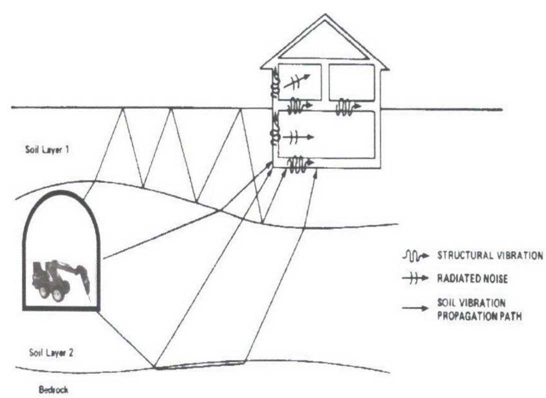
The term 'over-pressure' is used to describe the air pressure pulse emitted during blasting or similar events. The peak level of an event is normally measured using a microphone in the same manner as linear noise (ie unweighted), at frequencies both in and below the audible range.

11 Ground-borne Noise, Structure-borne Noise and Regenerated Noise

Noise that propagates through a structure as vibration and is radiated by vibrating wall and floor surfaces is termed 'structure-borne noise', 'ground-borne noise' or 'regenerated noise'. This noise originates as vibration and propagates between the source and receiver through the ground and/or building structural elements, rather than through the air.

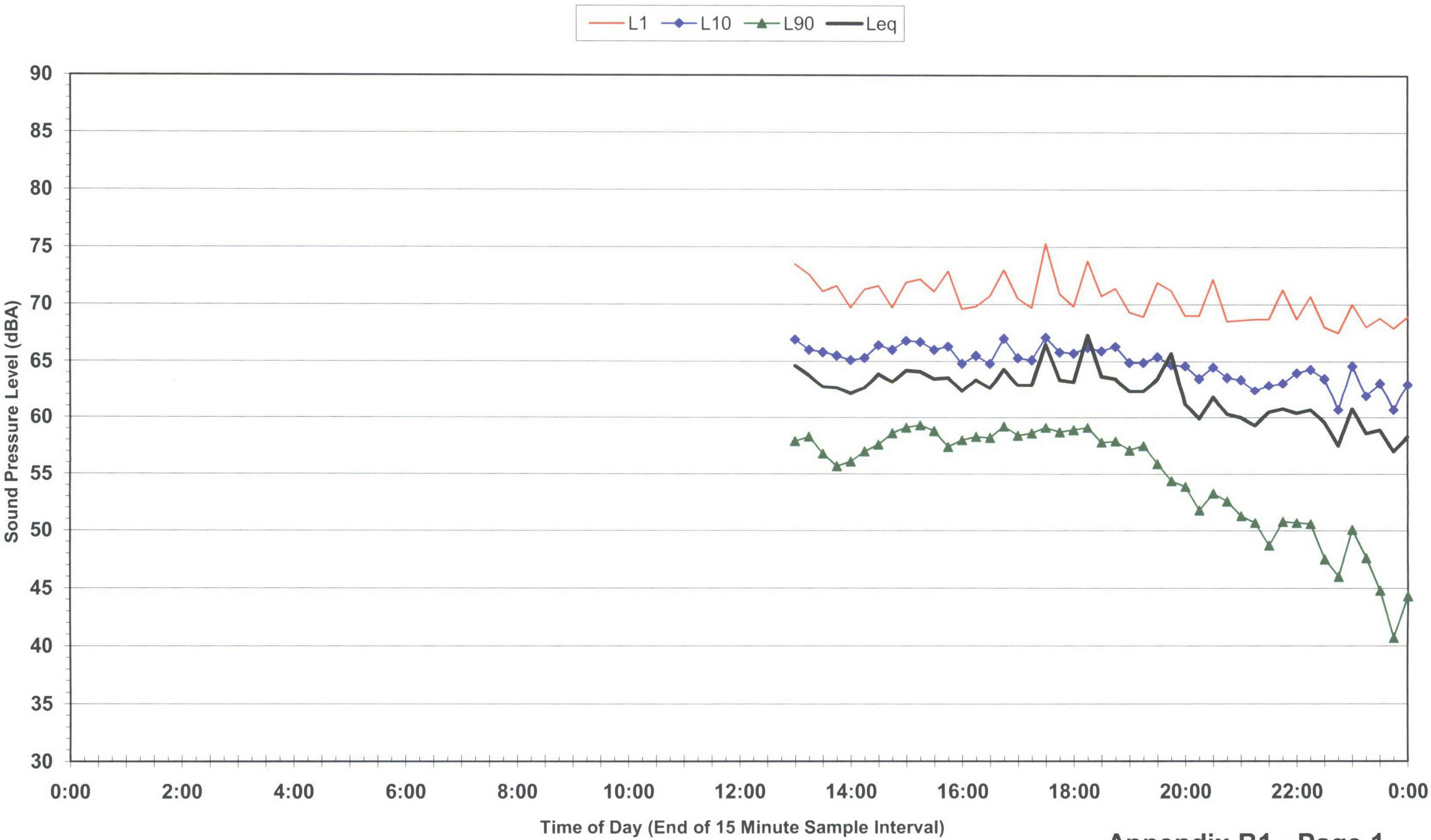
Typical sources of ground-borne or structure-borne noise include tunnelling works, underground railways, excavation plant (eg rockbreakers), and building services plant (eg fans, compressors and generators).

The following figure presents the various paths by which vibration and ground-borne noise may be transmitted between a source and receiver for construction activities occurring within a tunnel.

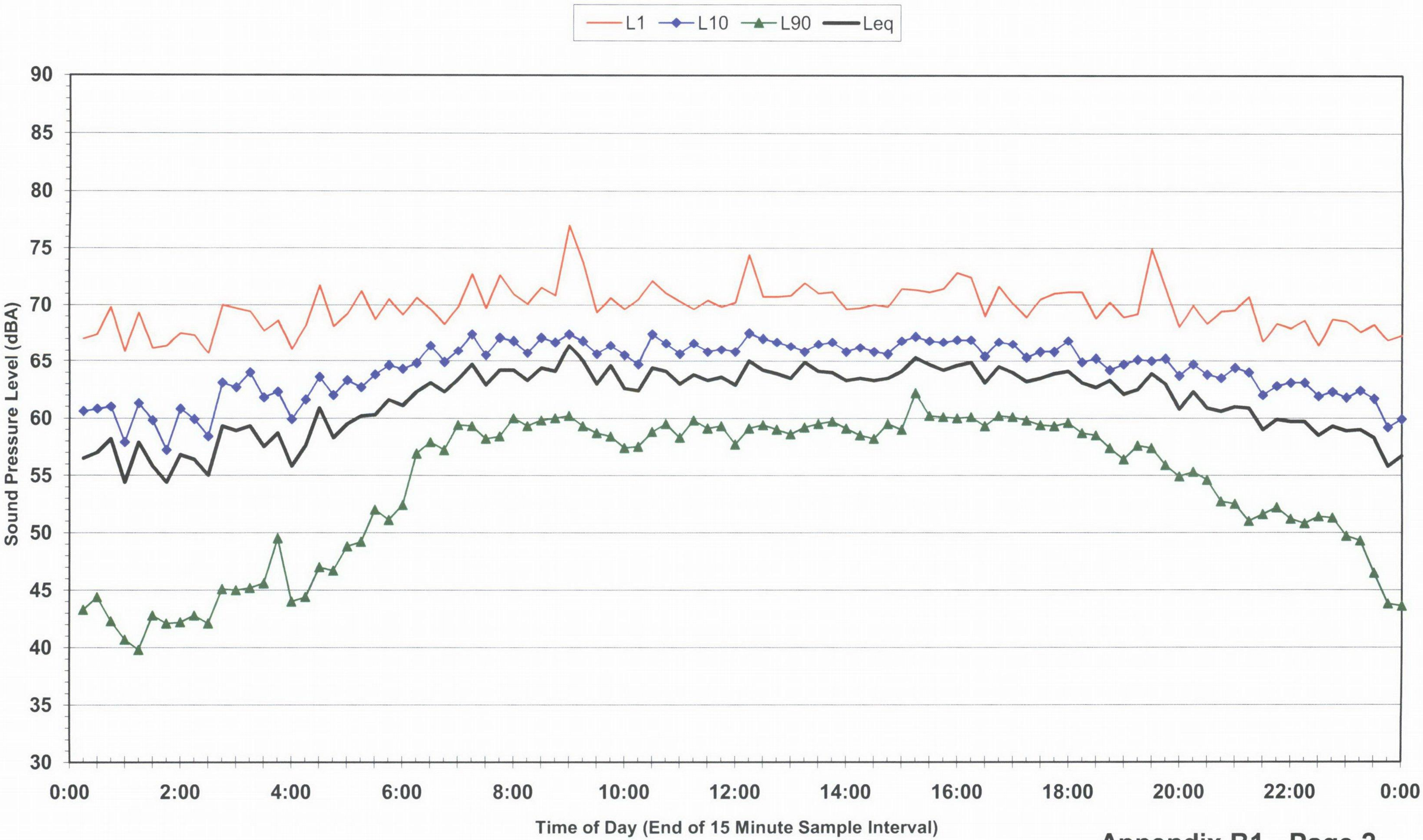


The term 'regenerated noise' is also used in other instances where energy is converted to noise away from the primary source. One example would be a fan blowing air through a discharge grill. The fan is the energy source and primary noise source. Additional noise may be created by the aerodynamic effect of the discharge grill in the airstream. This secondary noise is referred to as regenerated noise

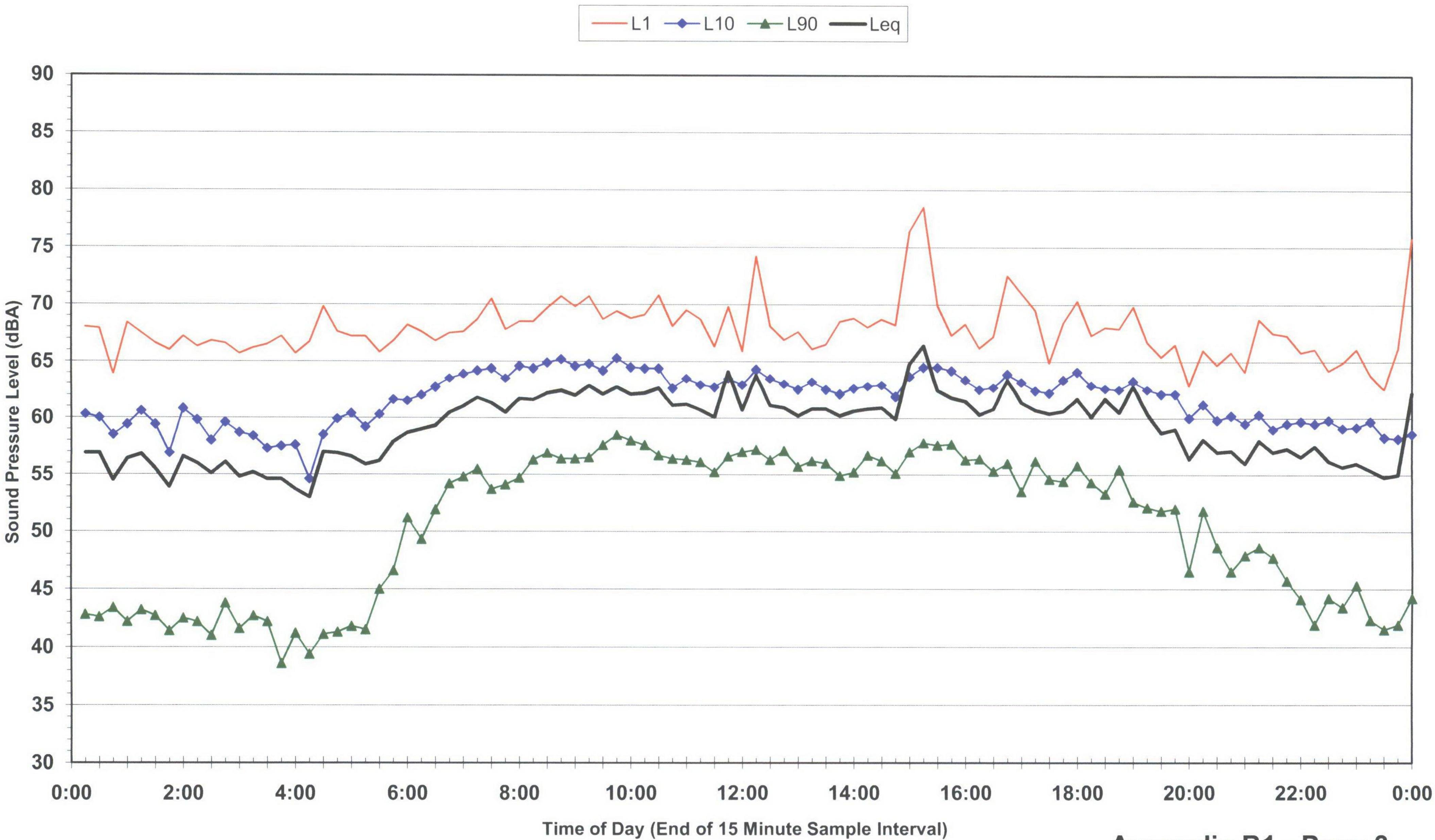
Statistical Ambient Noise Levels
Location BG1 - 15 Greville Place - Thursday 4 November 2010

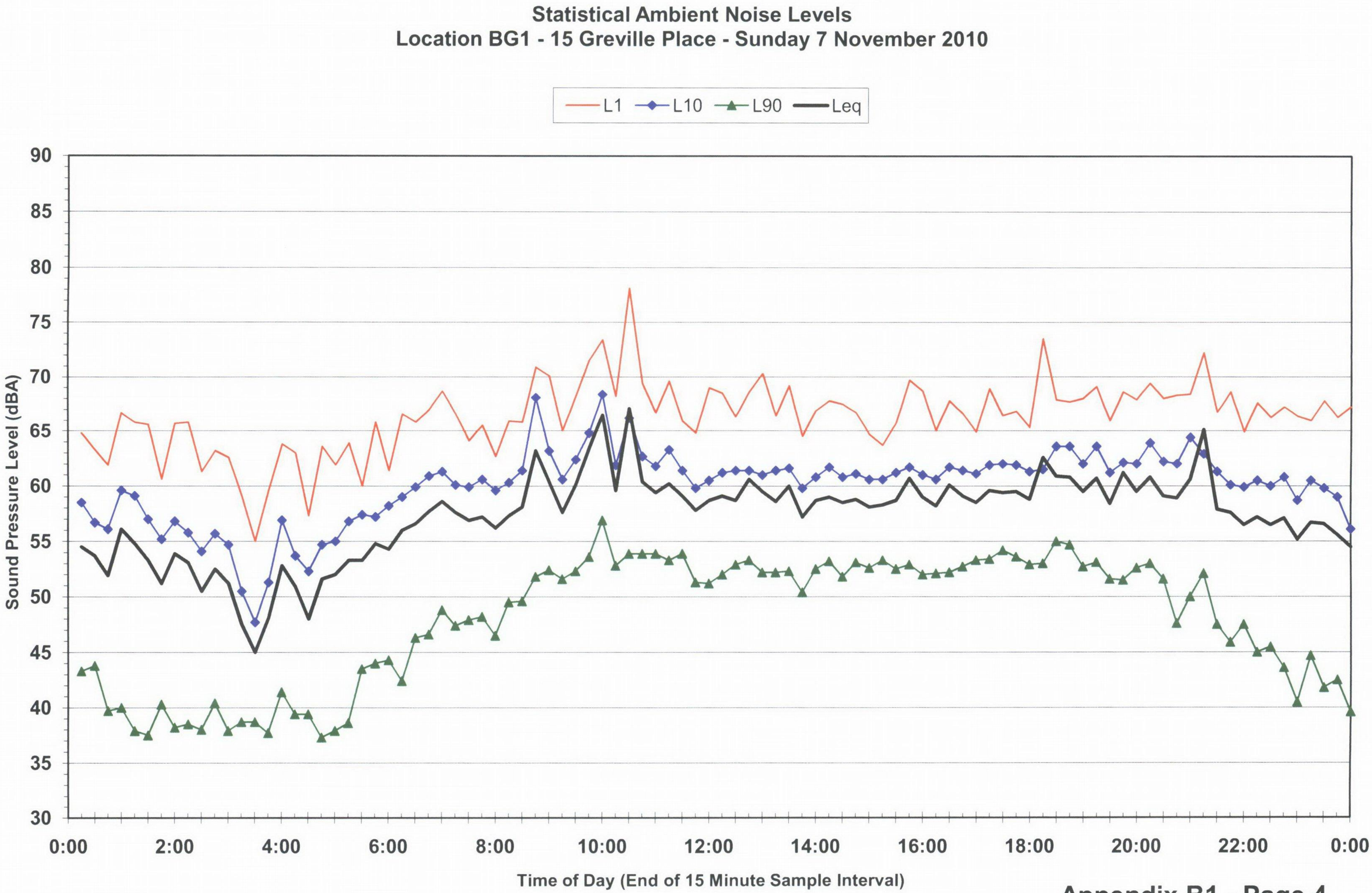


Statistical Ambient Noise Levels
Location BG1 - 15 Greville Place - Friday 5 November 2010

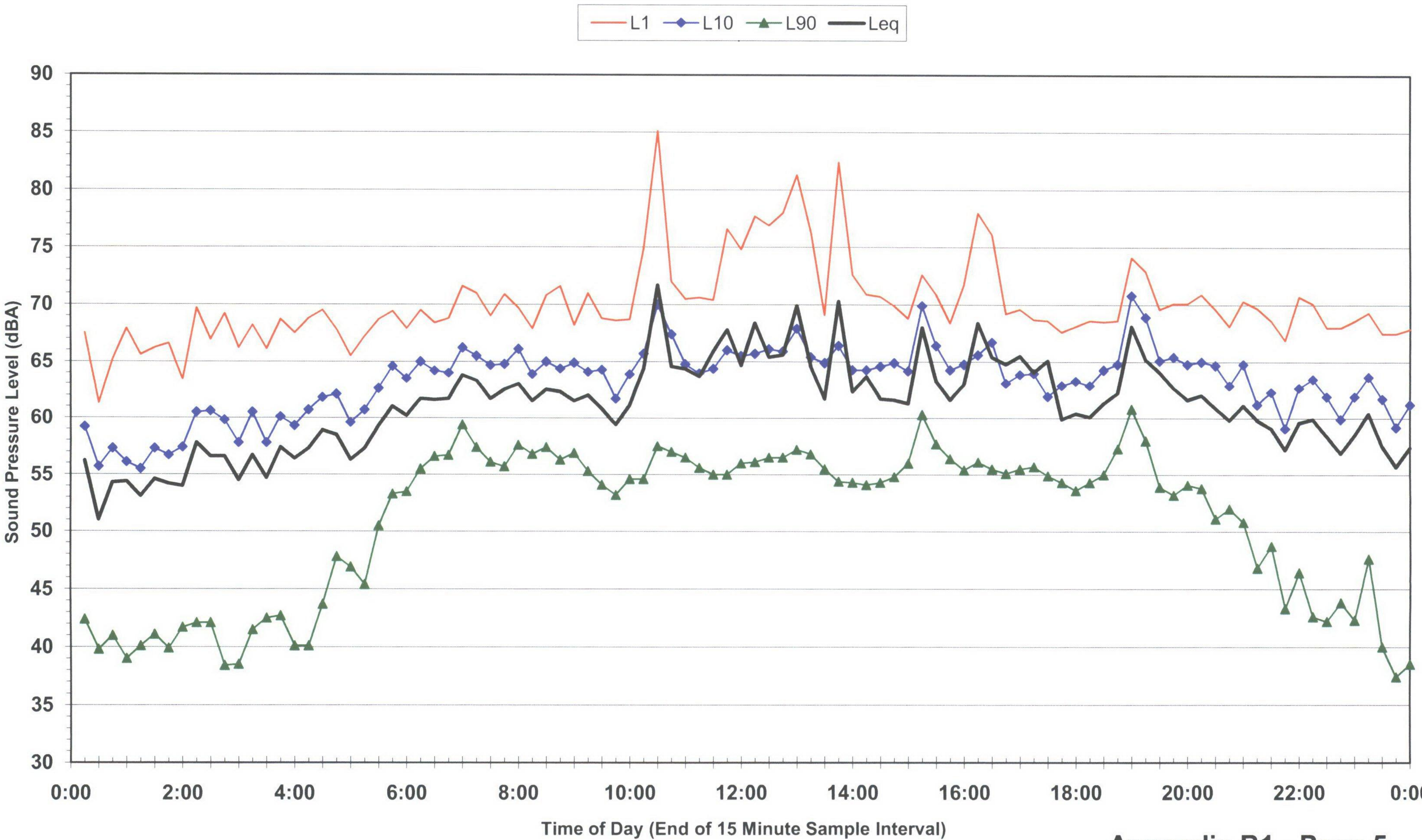


Statistical Ambient Noise Levels
Location BG1 - 15 Greville Place - Saturday 6 November 2010

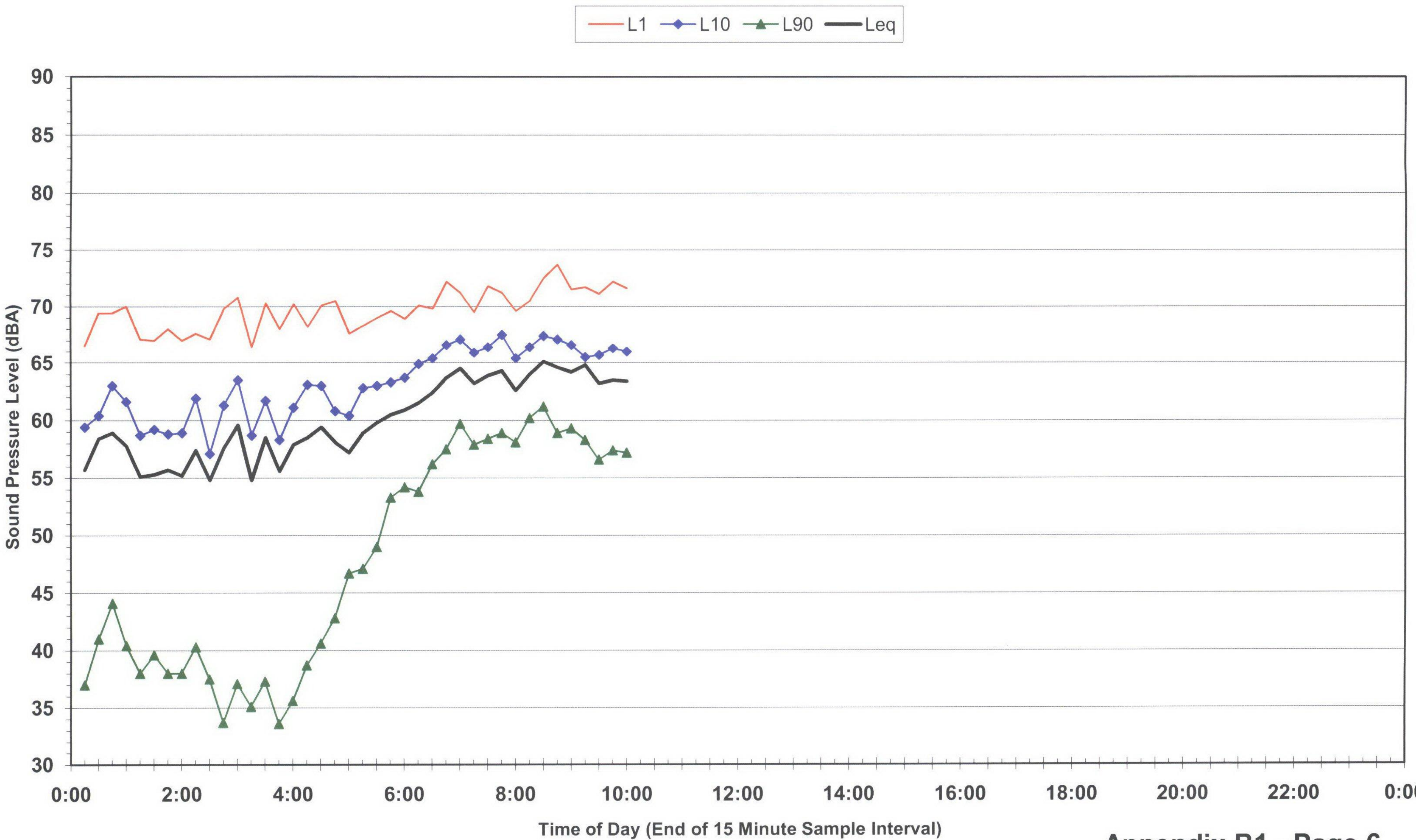



Statistical Ambient Noise Levels
Location BG1 - 15 Greville Place - Sunday 7 November 2010
L1
L10
L90
Leq
Sound Pressure Level (dBA)
90
85
80
75
70
65
60
55
50
45
40
35
30
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
0:00
Time of Day (End of 15 Minute Sample Interval)

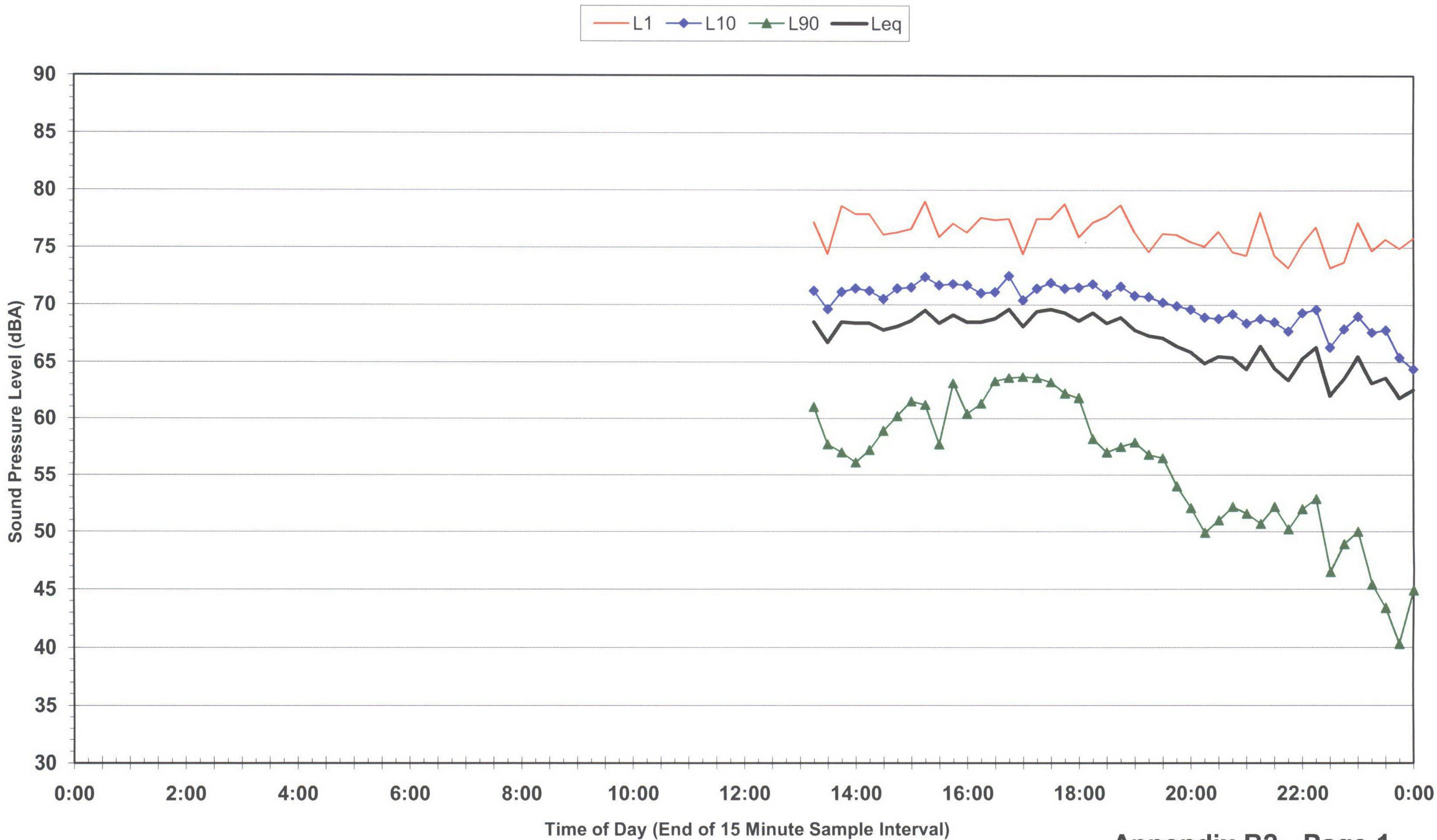
Statistical Ambient Noise Levels
Location BG1 - 15 Greville Place - Monday 8 November 2010



Statistical Ambient Noise Levels
Location BG1 - 15 Greville Place - Tuesday 9 November 2010



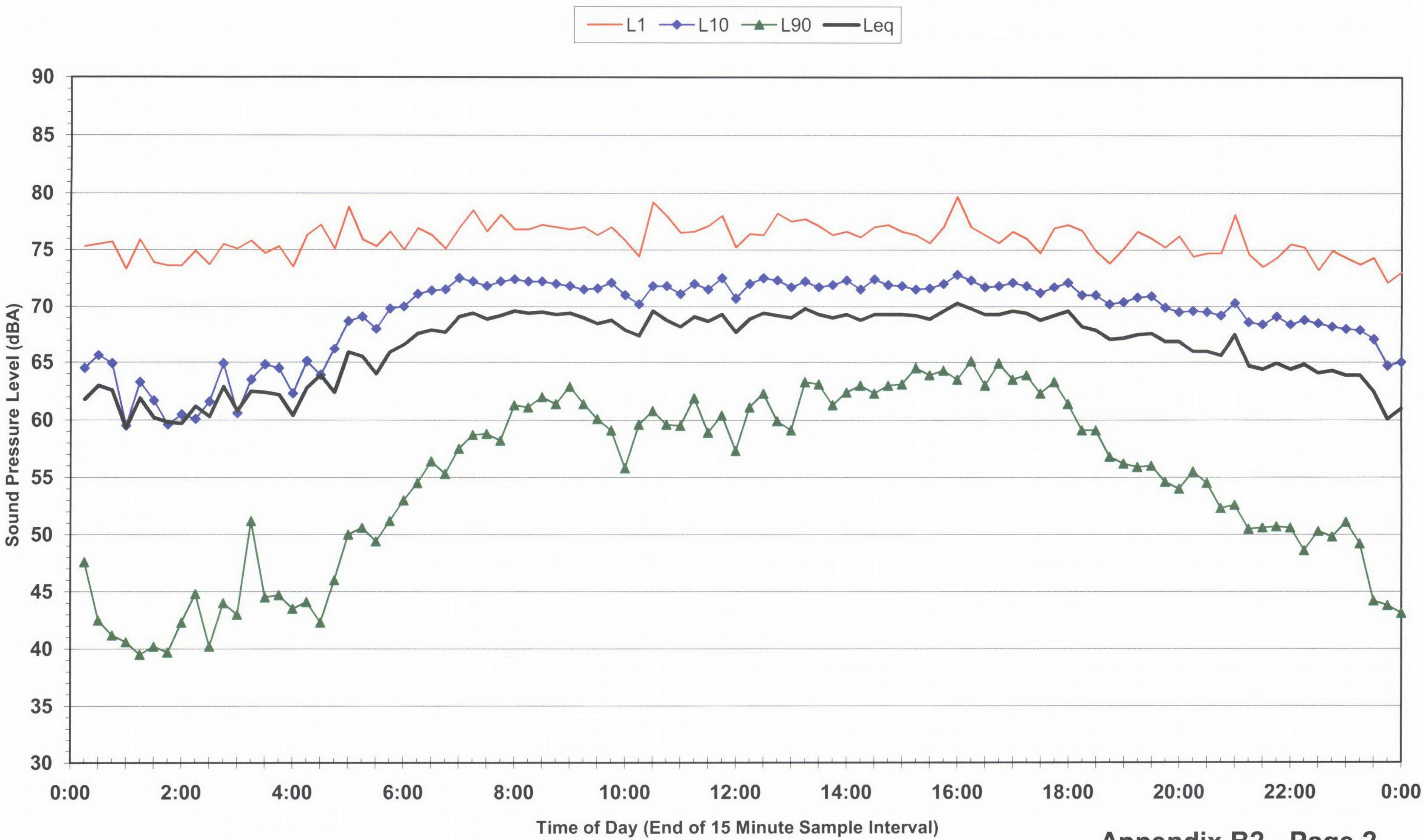
Statistical Ambient Noise Levels
Location BG2 - 86 Sydney Road (Great Western Highway) - Thursday 4 November 2010



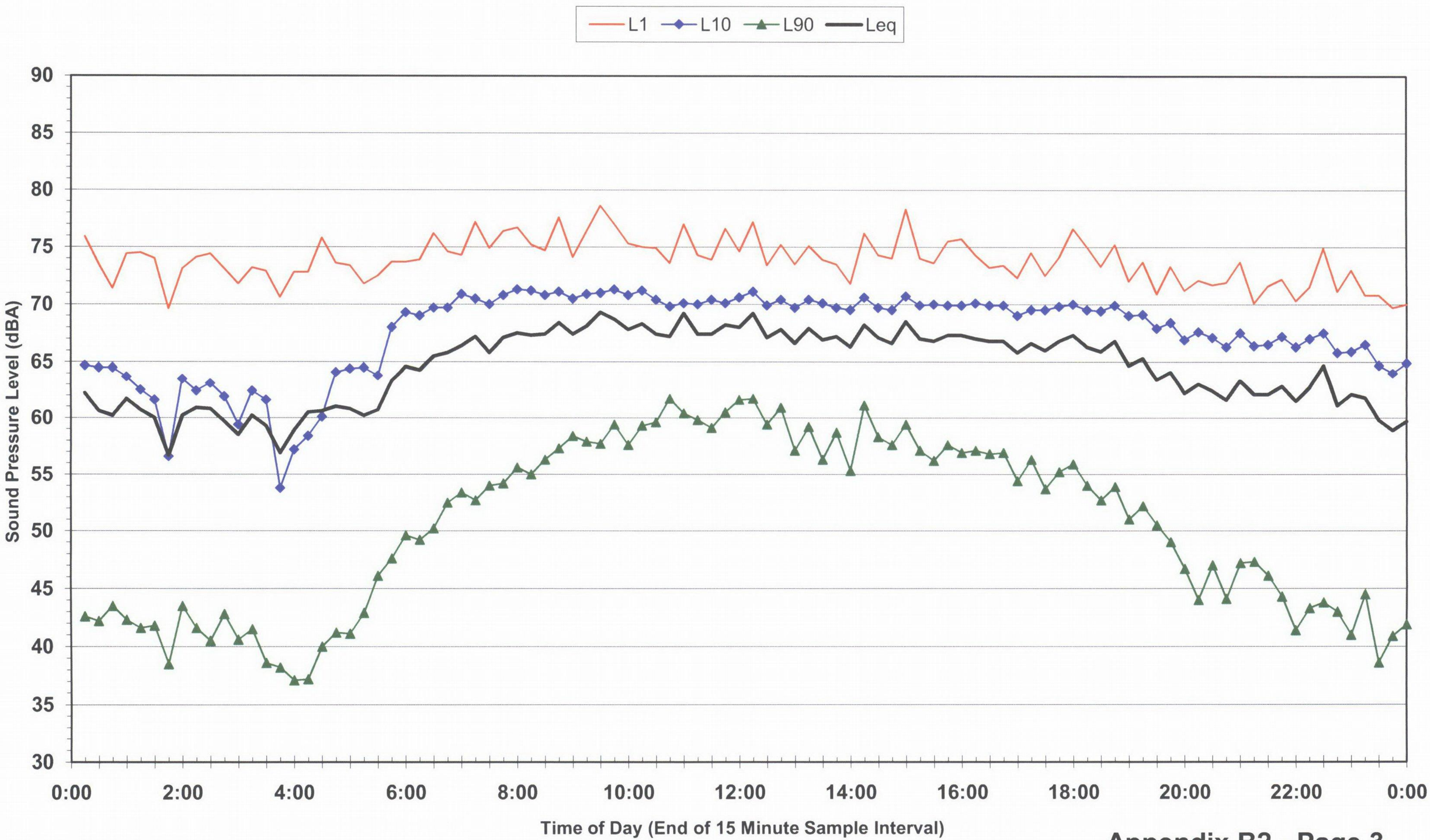
Appendix B2 - Page 1

Statistical Noise Levels

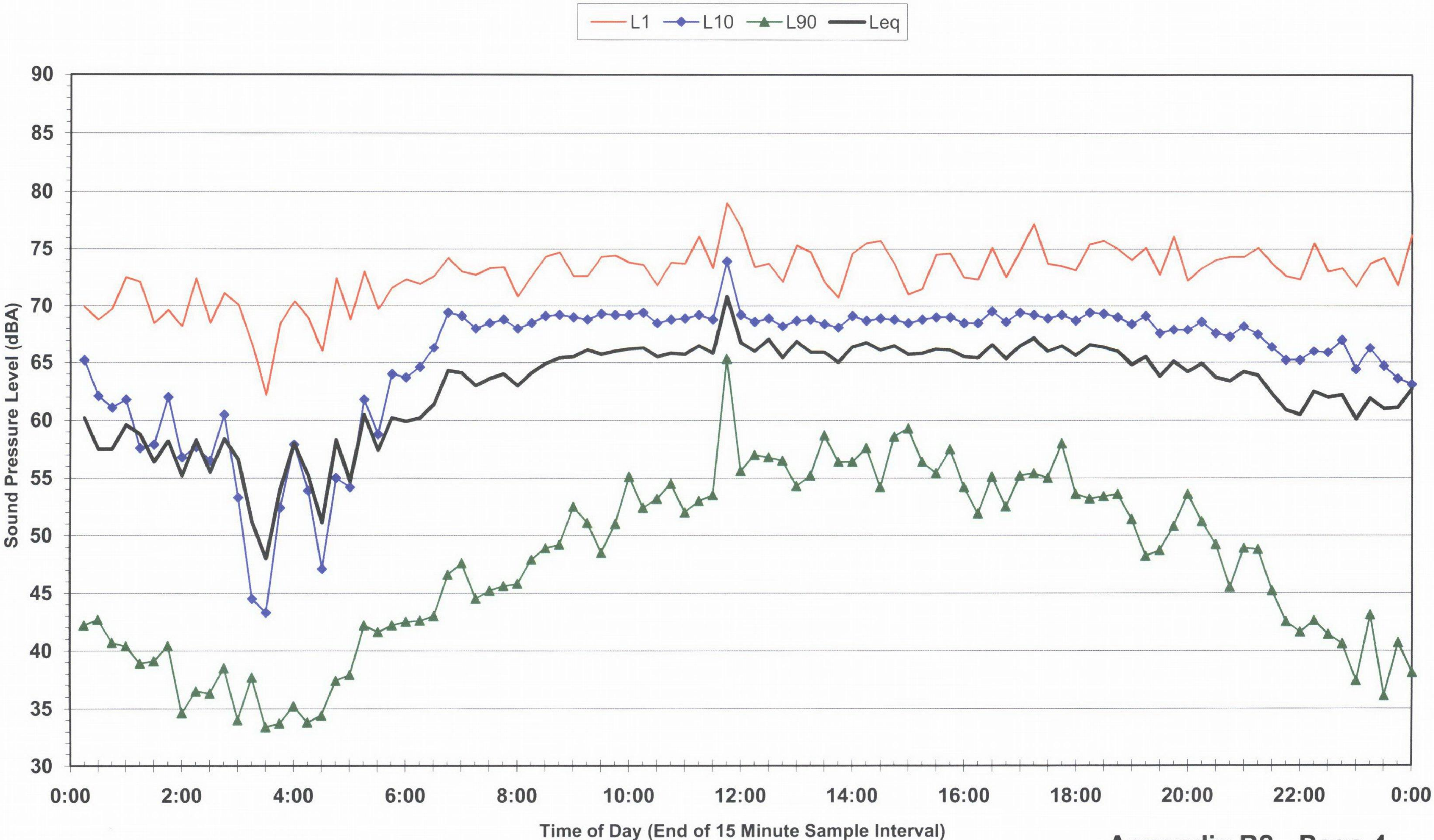
Statistical Ambient Noise Levels
Location BG2 - 86 Sydney Road (Great Western Highway) - Friday 5 November 2010

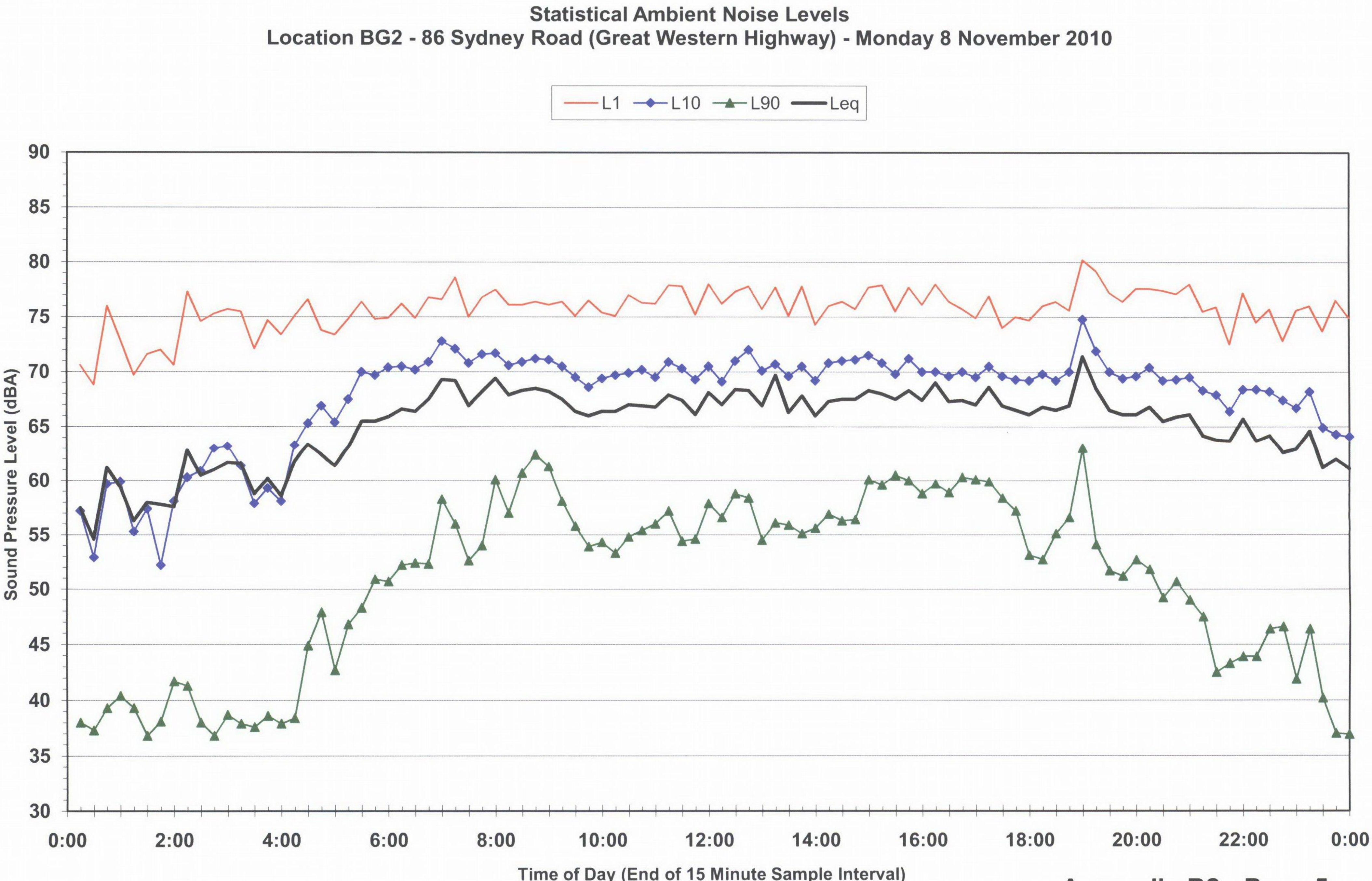


Statistical Ambient Noise Levels
Location BG2 - 86 Sydney Road (Great Western Highway) - Saturday 6 November 2010



Statistical Ambient Noise Levels
Location BG2 - 86 Sydney Road (Great Western Highway) - Sunday 7 November 2010

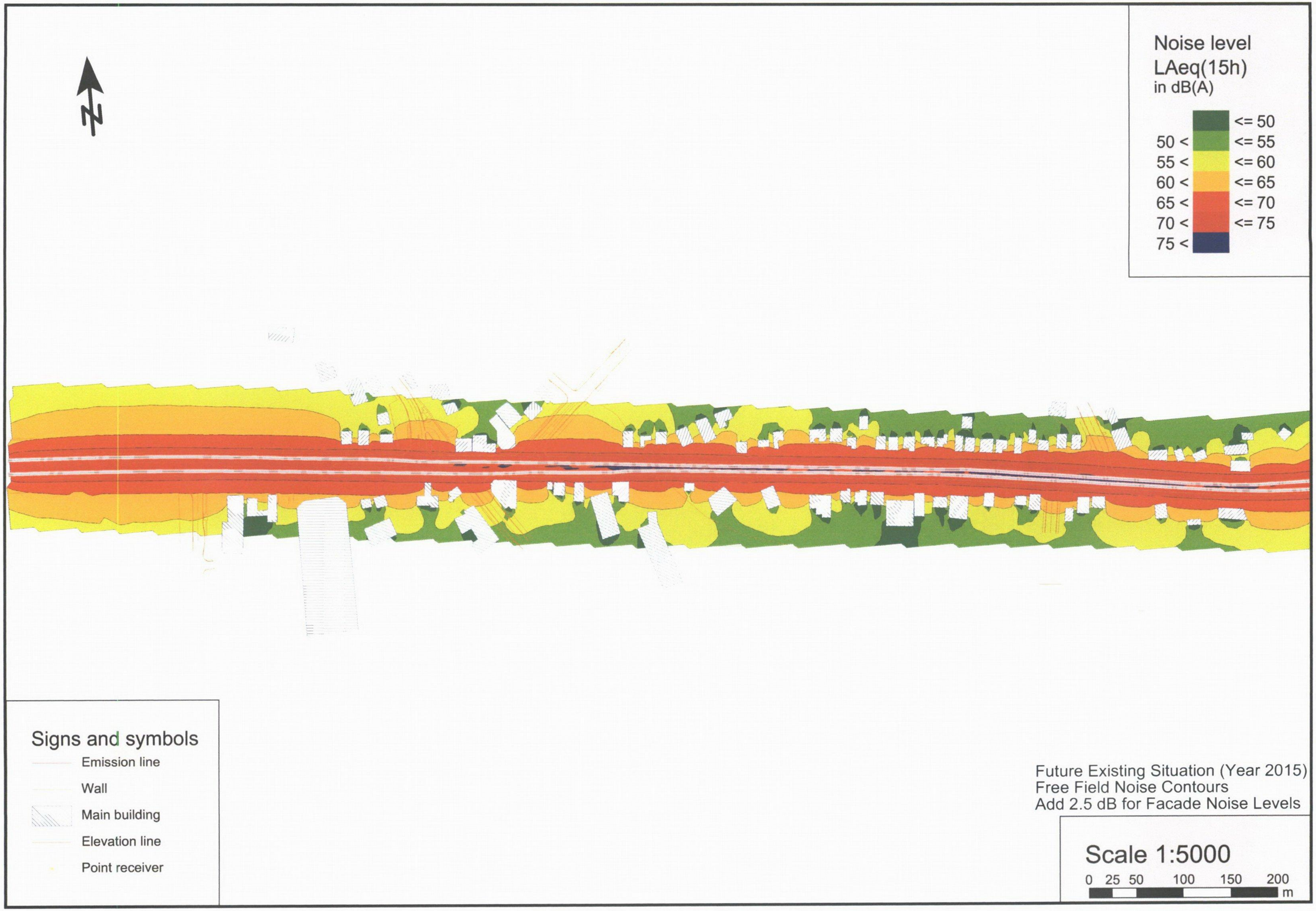




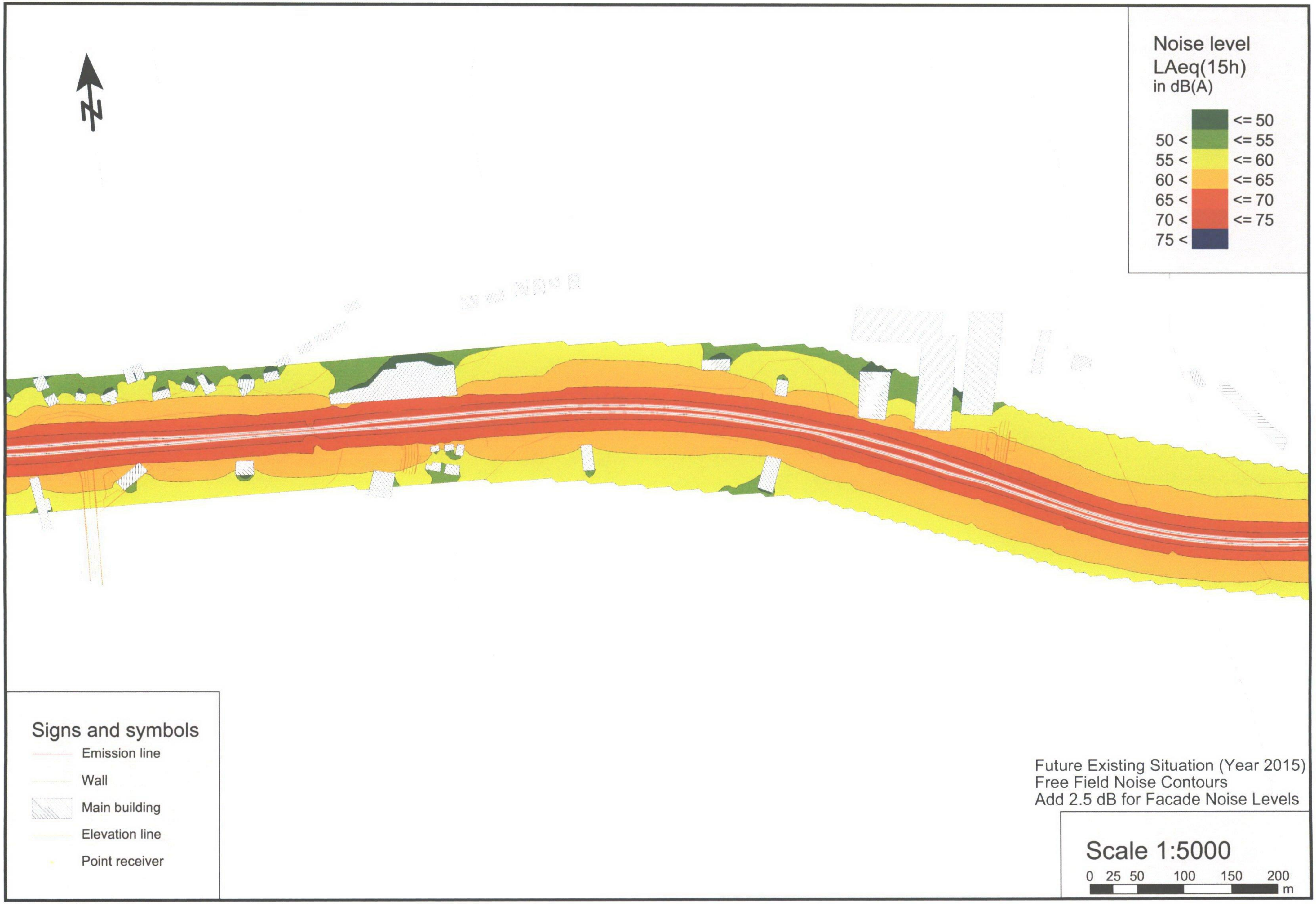
Statistical Ambient Noise Levels
Location BG2 - 86 Sydney Road (Great Western Highway) - Monday 8 November 2010
L1
L10
L90
Leq
Sound Pressure Level (dBA)
90
85
80
75
70
65
60
55
50
45
40
35
30
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
0:00
Time of Day (End of 15 Minute Sample Interval)

Statistical Ambient Noise Levels
Location BG2 - 86 Sydney Road (Great Western Highway) - Tuesday 9 November 2010

FUTURE EXISTING NOISE LEVELS (Y2015) - DAYTIME

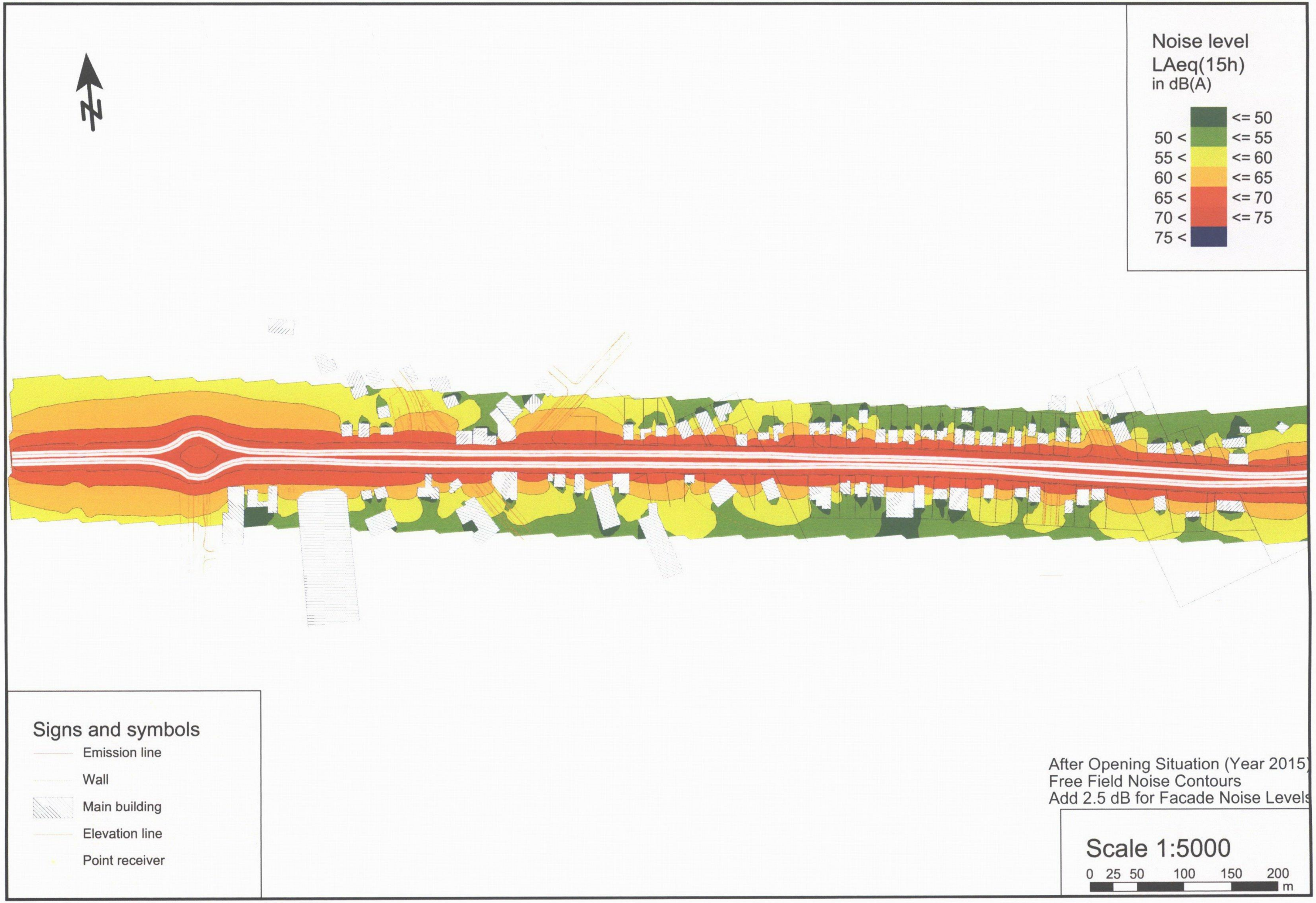


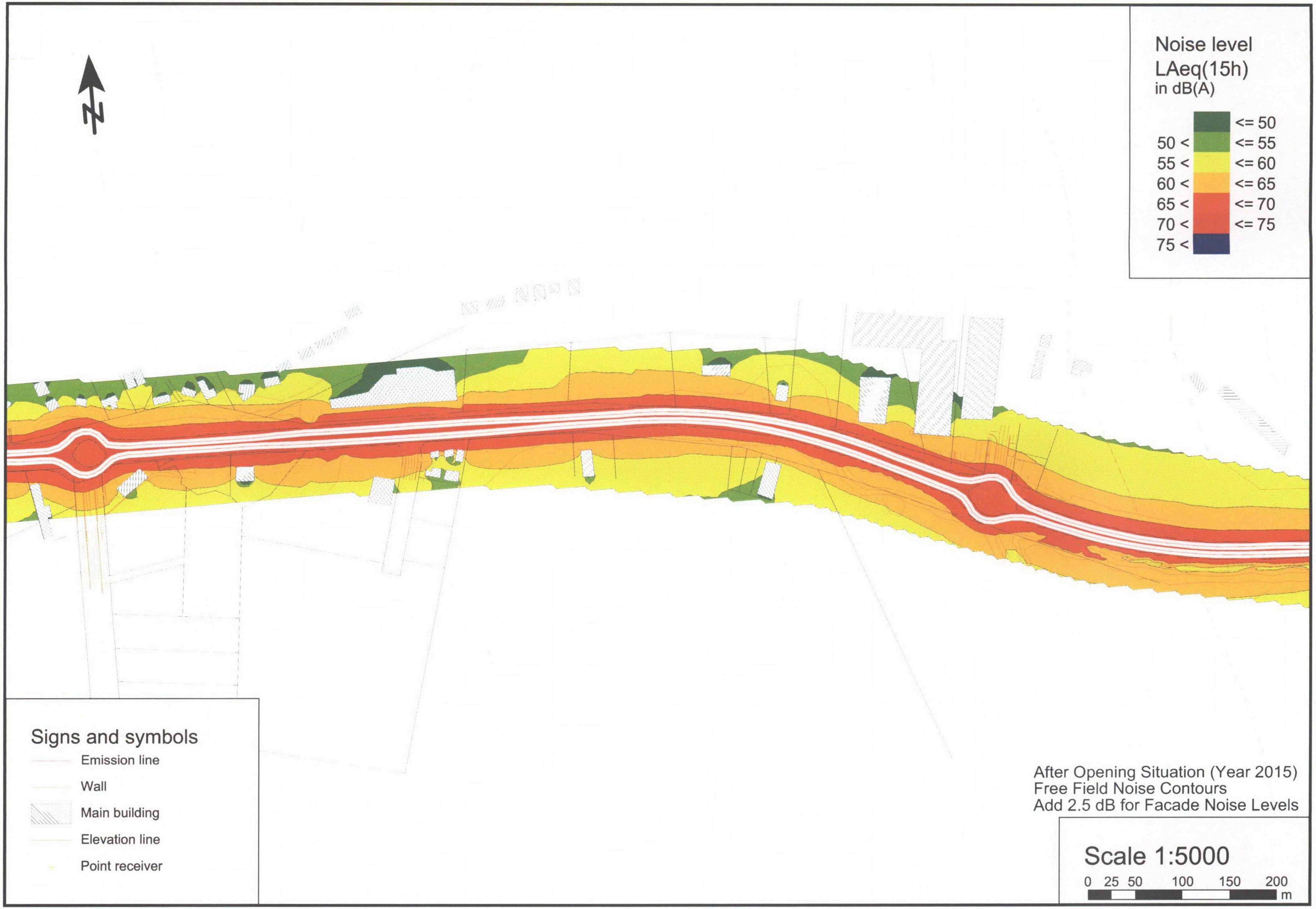
Future Existing Situation (Year 2015)
Free Field Noise Contours
Add 2.5 dB for Facade Noise Levels



Noise level
LAeq(15h)
in dB(A)
<= 50
50 < <= 55
55 < <= 60
60 < <= 65
65 < <= 70
70 < <= 75
75 <
Signs and symbols
Emission line
Wall
Main building
Elevation line
Point receiver
Future Existing Situation (Year 2015)
Free Field Noise Contours
Add 2.5 dB for Facade Noise Levels
Scale 1:5000
0 25 50 100 150 200
m

AFTER OPENING NOISE LEVELS (Y2015) - DAYTIME

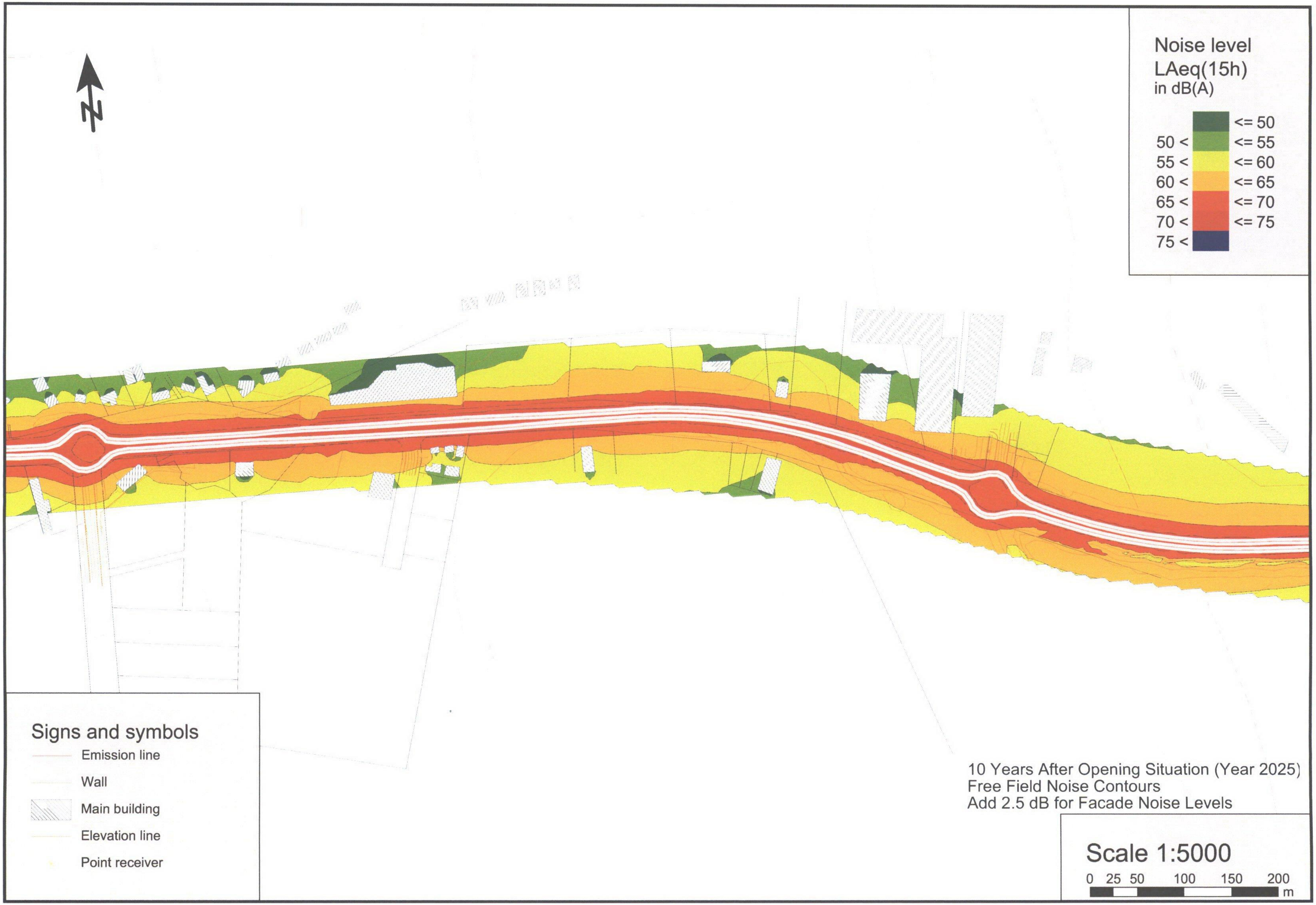

Noise level
LAeq(15h)
in dB(A)
<= 50
50 < <= 55
55 < <= 60
60 < <= 65
65 < <= 70
70 < <= 75
75 <
Signs and symbols
Emission line
Wall
Main building
Elevation line
Point receiver
After Opening Situation (Year 2015)
Free Field Noise Contours
Add 2.5 dB for Facade Noise Levels
Scale 1:5000
0 25 50 100 150 200
m



Noise level
LAeq(15h)
in dB(A)
<= 50
50 < <= 55
55 < <= 60
60 < <= 65
65 < <= 70
70 < <= 75
75 <
Signs and symbols
Emission line
Wall
Main building
Elevation line
Point receiver
After Opening Situation (Year 2015)
Free Field Noise Contours
Add 2.5 dB for Facade Noise Levels
Scale 1:5000
0 25 50 100 150 200
m

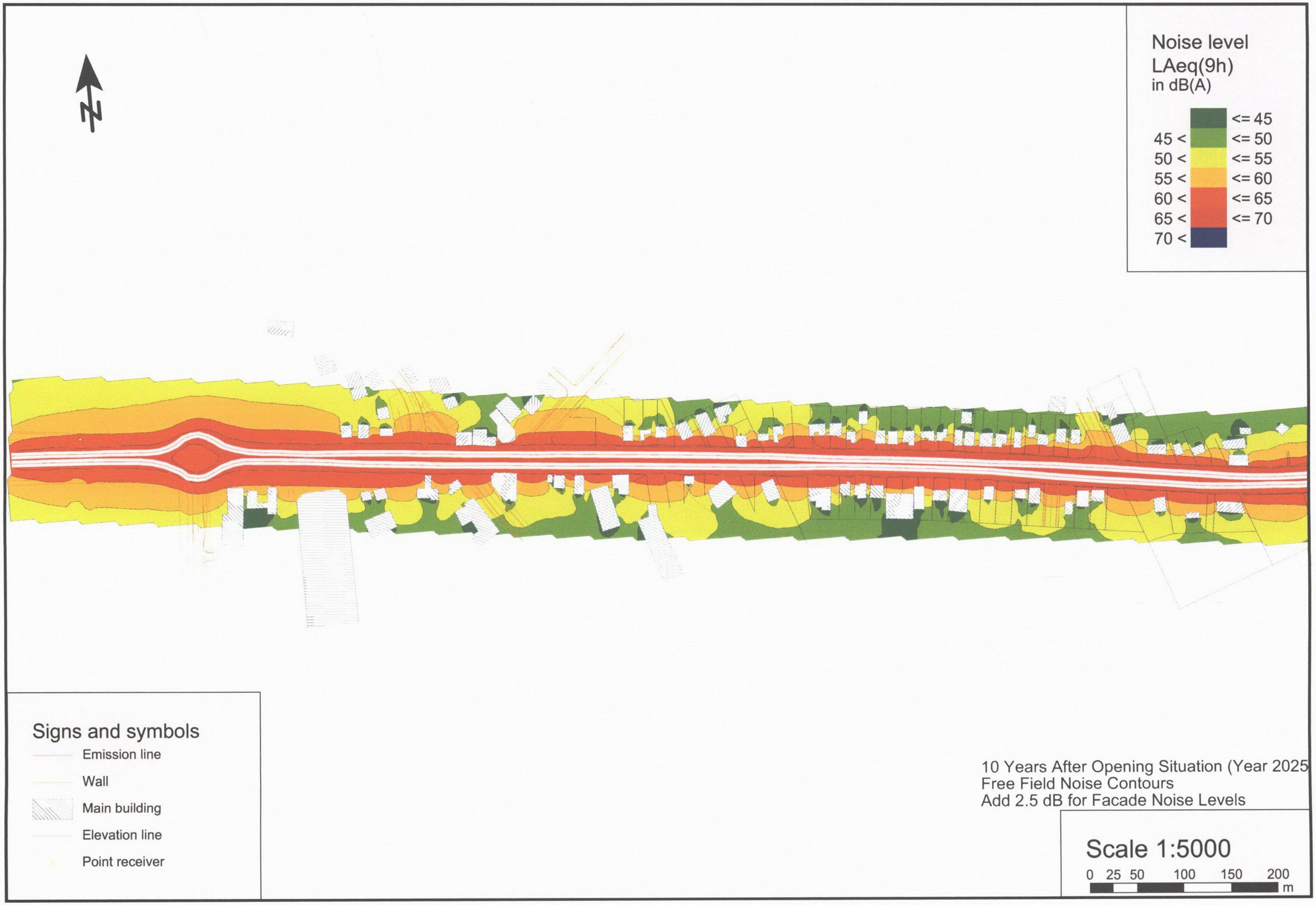
10 YEARS AFTER OPENING NOISE LEVELS (2025) - DAYTIME


Noise level
LAeq(15h)
in dB(A)
<= 50
50 < <= 55
55 < <= 60
60 < <= 65
65 < <= 70
70 < <= 75
75 <
Signs and symbols
Emission line
Wall
Main building
Elevation line
Point receiver
10 Years After Opening Situation (Year 2025
Free Field Noise Contours
Add 2.5 dB for Facade Noise Levels
Scale 1:5000
0 25 50 100 150 200
m



10 Years After Opening Situation (Year 2025)
Free Field Noise Contours
Add 2.5 dB for Facade Noise Levels

10 YEARS AFTER OPENING NOISE LEVELS (2025) - NIGHT-TIME


Noise level
LAeq(9h)
in dB(A)
<= 45
45 < <= 50
50 < <= 55
55 < <= 60
60 < <= 65
65 < <= 70
70 <
Signs and symbols
Emission line
Wall
Main building
Elevation line
Point receiver
10 Years After Opening Situation (Year 2025
Free Field Noise Contours
Add 2.5 dB for Facade Noise Levels
Scale 1:5000
0 25 50 100 150 200
m


Noise level
LAeq(9h)
in dB(A)
<= 45
45 < <= 50
50 < <= 55
55 < <= 60
60 < <= 65
65 < <= 70
70 <
Signs and symbols
Emission line
Wall
Main building
Elevation line
Point receiver
10 Years After Opening Situation (Year 2025)
Free Field Noise Contours
Add 2.5 dB for Facade Noise Levels
Scale 1:5000
0 25 50 100 150 200
m

Table 1 Modelled Noise Levels at Acutely Affected Residential Receivers dBA

Catchment Area	Receiver Address	Future Existing (2015)		Project Opening (2015)		10 Years After Opening (2025)	
		Daytime	Night time	Daytime	Night time	Day time	Night time
A	36 GWH	68	63	68	63	68	63
A	38 GWH	68	63	68	63	68	63
A	40 GWH	67	62	67	62	67	62
C	74 GWH	65	60	65	60	65	60
C	76 GWH	67	62	68	63	68	63
C	78 GWH	66	61	66	61	66	62
C	82 GWH	65	60	65	60	65	60
C	84 GWH	70	64	71	65	71	66
C	86 GWH	66	62	67	63	67	63
C	88 GWH	68	63	69	64	69	64
C	90 GWH	64	59	65	60	65	60
C	92 GWH	64	60	64	60	64	60
C	94 GWH	65	60	65	60	66	61
C	98 GWH	67	62	68	63	68	63
C	100 GWH	67	62	67	62	67	62
C	102 GWH	67	62	68	63	68	63
C	104 GWH	65	60	66	61	66	61
C	106 GWH	65	60	65	61	65	61
C	108 GWH	67	62	68	63	68	63
C	110 GWH	67	62	67	62	67	62
C	112 GWH	67	63	68	63	68	63
C	114 GWH	67	62	68	63	68	63
C	116 GWH	67	62	67	62	67	62
C	120 GWH	64	59	64	59	64	59
D	126 GWH	62	57	62	57	62	58
D	130 GWH	65	60	65	60	66	61
D	132 GWH	65	61	65	61	65	61
D	134 GWH	63	58	63	58	63	58
E	15 Greville Place	64	59	66	60	66	60
E	16 Greville Place	65	59	65	60	65	60
E	10 Spofforth Place	64	59	65	59	65	59
I	41 GWH	71	67	71	67	71	67
I	43 GWH	72	67	72	67	72	67
I	45 GWH	71	67	71	67	71	67
I	61 GWH	71	67	71	67	71	67

Modelled Noise Levels at Acutely Affected Residential Receivers

Catchment Area	Receiver Address	Future Existing (2015)		Project Opening (2015)		10 Years After Opening (2025)	
		Daytime	Night time	Daytime	Night time	Day time	Night time
I	67 GWH	69	64	69	64	69	64
I	79 GWH	68	63	68	63	68	63
I	81 GWH	69	64	69	64	69	64
I	83 GWH	68	63	68	63	68	63
I	91 GWH	68	63	68	63	68	63
I	97 GWH	69	64	69	64	69	64
I	101 GWH	69	64	69	64	69	64
I	103 GWH	70	65	70	65	70	65
I	109 GWH	70	65	70	65	70	65
I	111 GWH	70	66	70	66	70	66
I	119 GWH	68	63	68	63	68	63