

# Technical note

**Project:** St Leonards South Strategy**Note:** Masterplan Scale**Author:** Simon Kinnear / Tim Clark**Date:** 8 June 2015**Ref:** STLeon\_TN001r1

## 1 Introduction

Transport Modellers Alliance (TMA) was commissioned by Lane Cove Council (LCC) to undertake investigations of various masterplan configurations within the St Leonards South Strategy Area. This technical note outlines the results of increasing the master plan development scenario from the originally proposed 2000 dwellings to up to 5000 dwellings (as proposed by the Woods Bagot development proposal). The modelling assessments were undertaken for both the AM and PM peak periods for the development scenarios detailed in Table 1.

**TABLE 1 MODEL SCENARIO TESTS**

| St Leonards South Development Scenario                        | Description                                                                                                                                                           |
|---------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Future Base (FB): East of rail</b>                         | Includes LCC approved developments East of railway line (ie, 2009 LEP land use plus planning proposals + 520 Pacific Hwy + 500 Pacific Hwy + Winton).                 |
| <b>Council Masterplan (MP): To Berry Rd East</b>              | As Future Base with original proposed masterplan development growth (2000 dwellings) on the Western side of Railway Line between Duntroon Avenue and Berry Rd East.   |
| <b>Woods Bagot (WB): to Greenwich Rd</b>                      | As Future Base with Woods Bagot proposed masterplan development growth (5000 dwellings) on the Western side of Railway Line between Duntroon Avenue and Greenwich Rd. |
| <b>3200 dwellings (3200): Public proposal to Park Rd East</b> | As Future Base with 3200 dwellings masterplan development growth on the Western side of Railway Line between Duntroon Av and Park Rd East.                            |
| <b>3000 dwellings proposed masterplan (3000)</b>              | As Future Base with 3000 dwellings masterplan development growth on the Western side of Railway Line between Duntroon Av and Park Rd East.                            |
| <b>Public proposal to Park Rd East</b>                        |                                                                                                                                                                       |
| <b>2800 dwellings proposed masterplan (2800)</b>              | As Future Base with 2800 dwellings masterplan development growth on the Western side of Railway Line between Duntroon Av and Park Rd East.                            |
| <b>Public proposal to Park Rd East</b>                        |                                                                                                                                                                       |

Table 1 includes the details of the masterplan area coverage and net dwelling number increases associated with each scenario.

### 1.1 DEVELOPMENT SCENARIOS

Since August 2014, a total of four masterplan development scenarios have been proposed that outline different residential dwelling numbers and access points to the St Leonards South Strategy Area. In

order to assess their likely impacts they have been compared to the Future Base<sup>1</sup> scenario that represents a do minimum scenario that includes already committed developments within the Lane Cove LGA and adjacent council areas affecting St Leonards. The masterplan scenarios include:

- Original Masterplan (Sept 2014): Duntroon Av to Greenwich Rd - 2200 new dwellings: Not proceeded with.
- Council Masterplan: Duntroon Av to Berry Rd - 2000 dwellings
- Woods Bagot - this largely retains the existing road network west of the railway line and increases the Council masterplan proposal from 2000 to 5000 dwellings
- Public proposal - extends the Council masterplan site to western side of original masterplan site (ie, to Park Road instead of Berry from Duntroon Avenue) and incrementally increases dwelling numbers from 2800-3200.

## 1.2 FUTURE ROAD NETWORK ASSUMPTIONS

A future assessment year of 2021 has been assumed for traffic growth purposes<sup>1</sup> and while road networks have generally been kept consistent between development scenarios tests a number of network assumptions changes have been assumed and are detailed in Table 2.

The differences in network assumptions between scenarios is a result of different approaches being taken to managing the access points to the new masterplan area and different internal configurations of road networks within the masterplan area. Note, that as the Original Master scenario has now not been progressed, the road network changes associated with it have also not been implemented in the other scenario assessments.

| TABLE 2 ROAD NETWORK ASSUMPTIONS  |                                                                                                 |                                                                                        |
|-----------------------------------|-------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|
| Location                          | Description of Change                                                                           | Scenarios                                                                              |
| Oxley Street                      | Removal of parking and revised signal times at Pacific Highway                                  | All                                                                                    |
| West of Nicholson Street          | 2-way link between Lithgow and Christie St                                                      | All                                                                                    |
| Pacific Highway at Lithgow Street | Bus stop relocation - subject to North Sydney Council approval                                  | All                                                                                    |
| River Road at Lithgow Street      | New connection between Lithgow/River, subject to North Sydney Council approval                  | All                                                                                    |
| Pacific Highway                   | Signal optimisation along Pacific Highway                                                       | All                                                                                    |
| Greenwich Road                    | Access to western half of masterplan site                                                       | Original Masterplan                                                                    |
| River Road/ Canberra Avenue       | Introduction of through movement from Russell St to Canberra Ave - this is not feasible anymore | Original Masterplan                                                                    |
| West of Marshall Avenue           | Western extension of Marshall Av between Berry and Park                                         | proposed masterplan (2800)<br>proposed masterplan (3000)<br>proposed masterplan (3200) |

<sup>1</sup> Refer to "St Leonards South Strategy, 2021 LEP Development - Model Development Report", Appendix B, TMA (June 2014) for detailed assumptions around Future Base background growth and assumed levels of development.

### 1.3 DISTRIBUTION OF DEVELOPMENT

The distribution of development varies across the masterplan proposals as a result of varying dwelling densities across the site. This together with the different internal road network within the masterplan area results in a different traffic assignment across the study network under the various proposals.

Figure 1 shows the upgraded access at Greenwich Road and Canberra Avenue under the Original masterplan proposal with these intersections together with Berry Street forming the three main accesses to the site. This has been superseded by the exhibited plan covering only Duntroon Av to Berry Rd (east side). The Public Proposal masterplan indicates accesses as existing with the addition of Park Rd (east side) and a westbound extension of Marshall Avenue that connects Park Road, Berry Lane and Berry Road with the latter forming the main access to Pacific Highway.

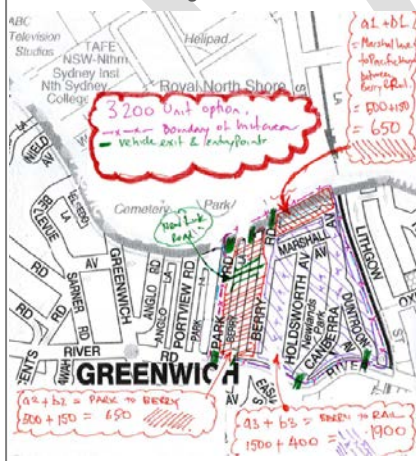
The Woods Bagot masterplan assumes no road network changes over the “do minimum changes” network previously described in Table 2.



Source: TMA masterplan road network, option 1



Source: Woods Bagot Allotment Plan



Source: LCC email for Council Preferred 29/5/15

**FIGURE 1 DWELLING & ACCESS DISTRIBUTION**

## 2 Demand Development

### 2.1 MASTERPLAN AREAS FOR DEVELOPMENT

A simple method of demand growth was applied across all development scenarios that resulted in net increases of dwellings with their associated traffic generations being applied to the Council Masterplan distribution.

The growth factor increases were applied across the entire St Leonards South study area (shown by red and blue shaded areas in Figure 2) for the Woods Bagot masterplan proposal and only the red shaded area for the Council Preferred masterplan proposal.



FIGURE 2 ST LEONARDS SOUTH STRATEGY AREAS

### 2.2 DISTRIBUTION OF NEW TRIPS

The distribution of new trips associated with the proposed masterplan areas was based on the previously calculated distribution from the Council masterplan proposal and this was calculated simply by subtracting the Future Base demands matrix from the Council masterplan demand matrix. This resulted in a new matrix that represents the Council masterplan trips that were then growthed according to the factors described in section 2.3. In calculating the distribution matrices for each of the proposed masterplan developments only the appropriate zones within each of the St Leonards South Strategy Areas (illustrated in Figure 2) were utilised. For the Public Proposal - masterplan this involved the identification all the zones west of Park Road and moving the development distribution associated with these zones to the zones east of Park Road. The St Leonards South Strategy Area (east) was further divided into three regions as illustrated in Figure 1 for the Council Preferred masterplan.

### 2.3 APPLIED GROWTH

The increase / decrease in traffic volumes in the model zones that corresponded to trips beginning or ending in the development area were then multiplied by a factor representing the proportional increase in residential dwellings over and above that considered in the Council masterplan proposal. The growth factors applied were:

- Original Masterplan to Greenwich (2200) = not assessed
- Council exhibited Masterplan to Berry (east) (2000) growth factor = 1.0
- Woods Bagot growth factor = 2.5

- Public proposal (2800) growth factor = 1.4
- Public proposal (3000) growth factor = 1.5
- Public proposal (3200) growth factor = 1.6

These growth factors were then applied to the distribution matrices described in section 2.2 to arrive at new development matrices for assessment purposes.

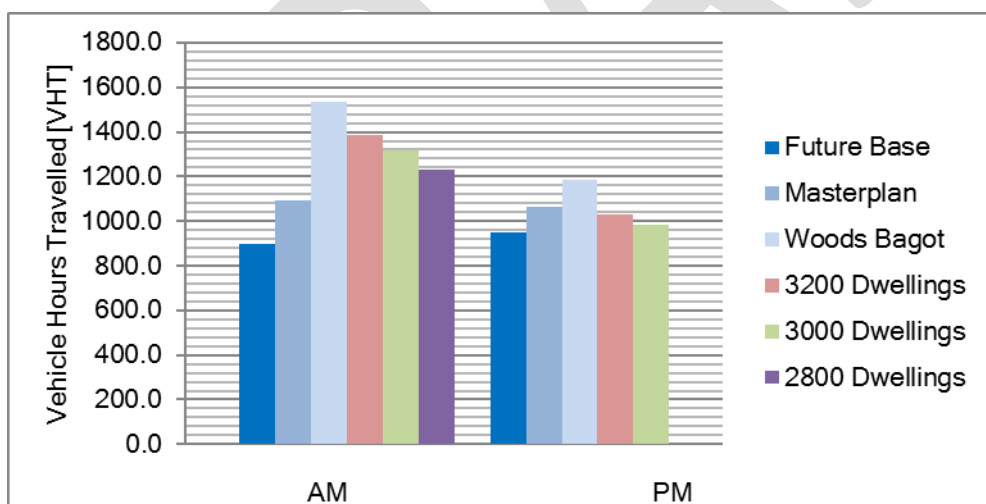
### 3 Model Assessment Results

After initial observation and preliminary investigation of the results it was apparent that the AM peak represents the critical period on the network as well as for residential vehicle trips leaving the masterplan area. For this reason, only the AM peak has been assessed under all development scenarios previously described in Table 1. The PM peak has also been assessed for all scenarios except for the Public Proposal - masterplan 2800 dwellings scenario as it was felt that these results would not be required given Council's preference for further examination of road network improvements to improve operation of the 3200 dwelling scenario.

#### 3.1 NETWORK STATISTICS

A good way of comparing scenarios and assessing the future road network's ability to cater for these increased demands is to consider the total vehicle hours travelled across the network as this most succinctly captures effects of local congestion as well as any widespread issues that result.

Figure 3 illustrates how each of the scenarios compare against the Future Base model (that represents no masterplan development but broader background growth to 2021 and committed developments east of the railway line).



**FIGURE 3 VEHICLE HOURS TRAVELLED COMPARISON**

It is apparent from Figure 3 that the introduction of the Woods Bagot masterplan would see substantial increases in network wide vehicle travel time over both the Future Base and Council Masterplan. This is to be expected as the Future Base Model indicates that the network is approaching capacity by 2021 and therefore any additional traffic over and above these levels will have significant impacts on broader network operation.

The future network has more capacity to deal with increased residential development as is illustrated by the lower overall vehicle hours on the network as well as the significant increases in vehicle hours associated with the incremental increases in development.

Table 3 provides more detail of the vehicle hours on the network and shows that Woods Bagot proposal represents a 71% increase in vehicle hours travelled over the Future Base in the AM peak and 25% in the PM peak. In addition some 360 vehicles will not be able to enter the network during the AM peak due to downstream congestion.

| TABLE 3 NETWORK STATISTICS - SCENARIOS |                |                  |         |        |                     |
|----------------------------------------|----------------|------------------|---------|--------|---------------------|
|                                        | Description    | Mean Speed (kph) | VKT     | VHT    | Unreleased Vehicles |
| <b>AM</b>                              | Future Base    | 21.4             | 19117.0 | 896.7  | 57                  |
|                                        | Masterplan     | 17.8             | 19463.2 | 1094.6 | 132                 |
|                                        | Woods Bagot    | 12.8             | 19661.4 | 1536.3 | 360                 |
|                                        | 3200 Dwellings | 13.9             | 19007.2 | 1384.5 | 180                 |
|                                        | 3000 Dwellings | 14.8             | 19401.1 | 1316.4 | 159                 |
|                                        | 2800 Dwellings | 15.8             | 19335.4 | 1233.4 | 142                 |
| <b>PM</b>                              | Future Base    | 20.3             | 19219.8 | 950.4  | 63                  |
|                                        | Masterplan     | 18.6             | 19719.7 | 1066.4 | 45                  |
|                                        | Woods Bagot    | 16.6             | 19655.0 | 1185.0 | 194                 |
|                                        | 3200 Dwellings | 18.9             | 19439.4 | 1030.4 | 100                 |
|                                        | 3000 Dwellings | 19.8             | 19416.1 | 983.3  | 76                  |
|                                        | 2800 dwellings | 19.8             | 19434.3 | 980.7  | 90                  |

These statistics improve when only 3200 dwellings are considered with a 54% increase in vehicle hours travelled over the Future Base in the AM peak and 8% in the PM peak.

Clearly given the substantial increase in vehicle hours in the AM peak even with the 3200 dwelling masterplan proposal there would be a need to undertake additional road network improvements to further reduce the increases in travel time across the network.

## 3.2 TRAVEL TIMES

### 3.2.1 AM Peak

Another useful metric for assessing congested networks is the travel times required to traverse the main routes within study area however some care is required in interpreting these results as it does not include the time taken for vehicles waiting to get onto the study network (from unreleased queues described in section 3.1).

Figure 4 shows the peak direction cumulative travel times of vehicles on Pacific Highway during the AM peak. It is apparent from this figure that any development of the masterplan area will impact this section of Pacific Highway eastbound travel times by around 25-30%.

The small difference between the various masterplan scenarios is due to the Berry Road egress operating with similar phase times and this figure not accounting for additional time required to enter the study network from the external queues described previously.

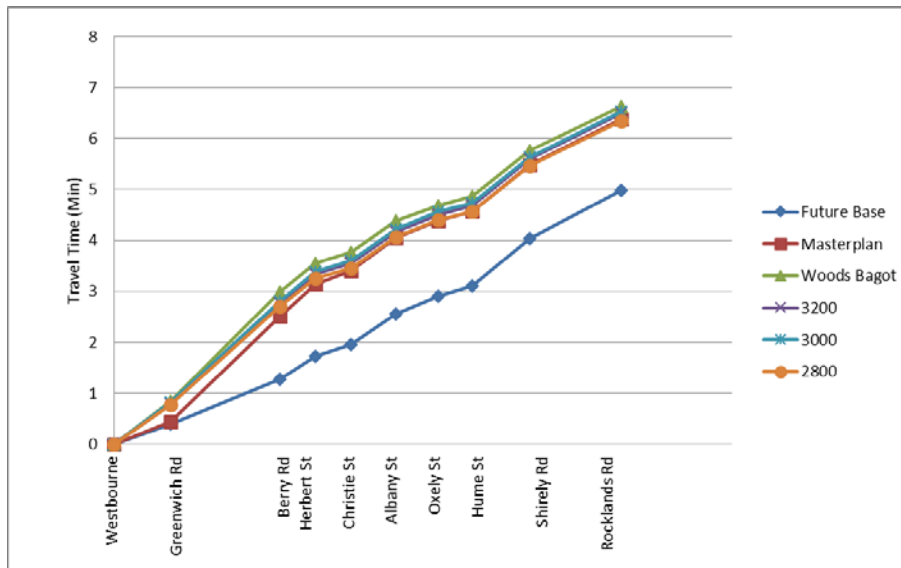


FIGURE 4 PACIFIC HIGHWAY EASTBOUND (AM PEAK)

The counter-peak direction on Pacific Highway during the AM peak shows little difference between scenarios as illustrated in Figure 5. Woods Bagot proposal experiences westbound travel time increases of around 10% over both the Future Base and other masterplan scenarios.

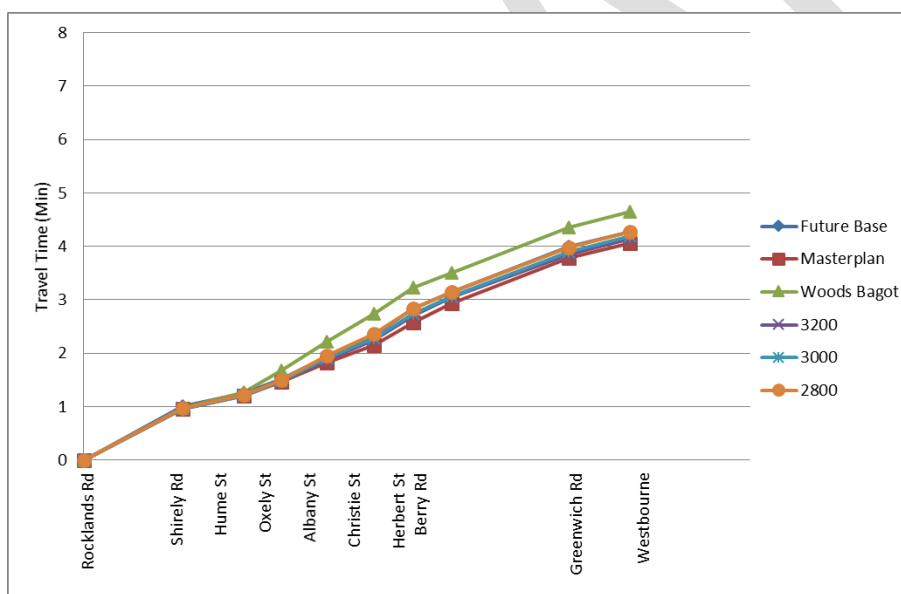


FIGURE 5 PACIFIC HIGHWAY WESTBOUND (AM PEAK)

The other alternate east-west route for masterplan traffic is River Road and this travel time traversal route is shown in Figure 6 for the AM peak direction. It is apparent from this figure that the most significant delays occur at the Pacific Highway intersection under the Woods Bagot proposal as this is the steepest part of the line (the other masterplan scenarios also experience their highest delays here).

It is apparent from Figure 6 that the level of development on the masterplan site has a step-change effect on travel times on this route as it shows that the Council Masterplan can be accommodated since the travel times match the Future Base and when the masterplan scenario proposals increase

dwelling numbers to 2800-3200 then travel times increase by approximately 15%. Another step-change occurs when the dwelling numbers increase to 5000 with a corresponding 33% increase over the Future Base/Council masterplan results.

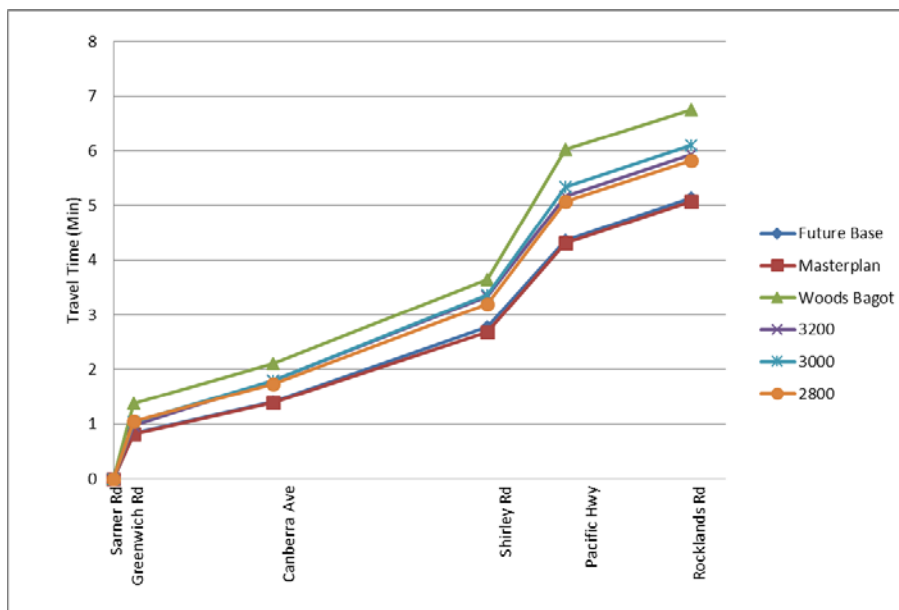


FIGURE 6 RIVER ROAD EASTBOUND (AM PEAK)

Figure 7 shows westbound traversal times on River Road during the AM peak are broadly similar under each scenario with increases in development generally increasing travel times. The 3200 dwelling proposed masterplan experiences queue-spill back from the right hand turn provided at Duntroon Avenue explaining why this line is significantly above the other scenarios.

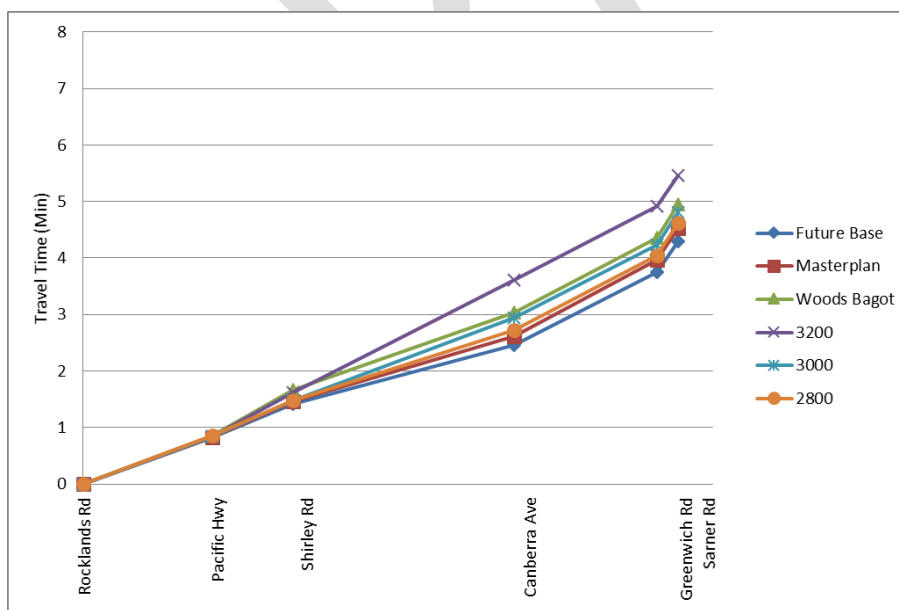


FIGURE 7 RIVER ROAD WESTBOUND (AM PEAK)

### 3.2.2 PM Peak

Figure 8 shows the peak direction cumulative travel times of vehicles on Pacific Highway during the PM peak. It is apparent from this figure that any development of the masterplan area will impact this section of Pacific Highway westbound travel times by up to 10% under the Woods Bagot proposal.

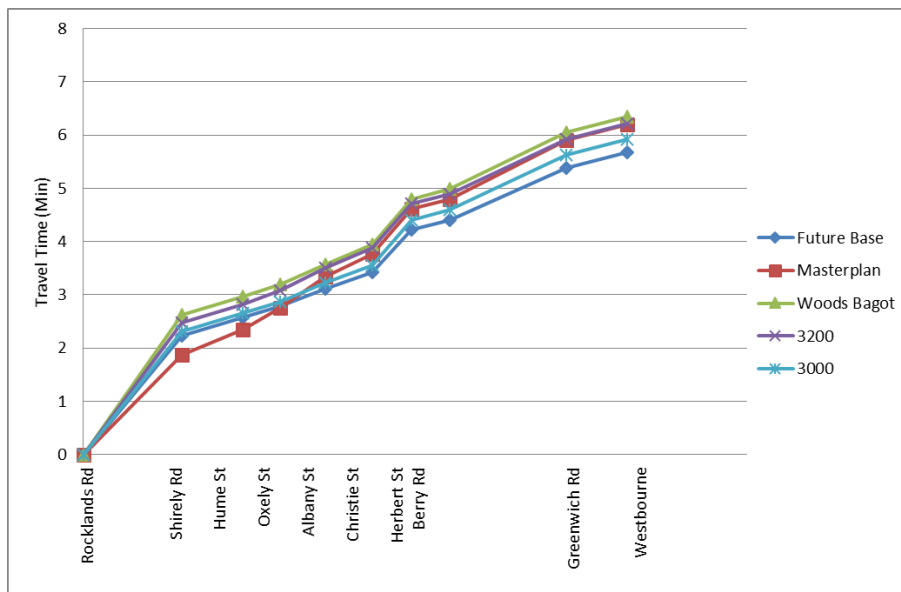


FIGURE 8 PACIFIC HIGHWAY WESTBOUND (PM PEAK)

The counter-peak direction on Pacific Highway during the PM peak (shown in Figure 9) indicates no clear pattern of how eastbound travel times are impacted by the scale of the masterplan development scenario. This suggests that this direction of travel is not critical to scenario assessment.

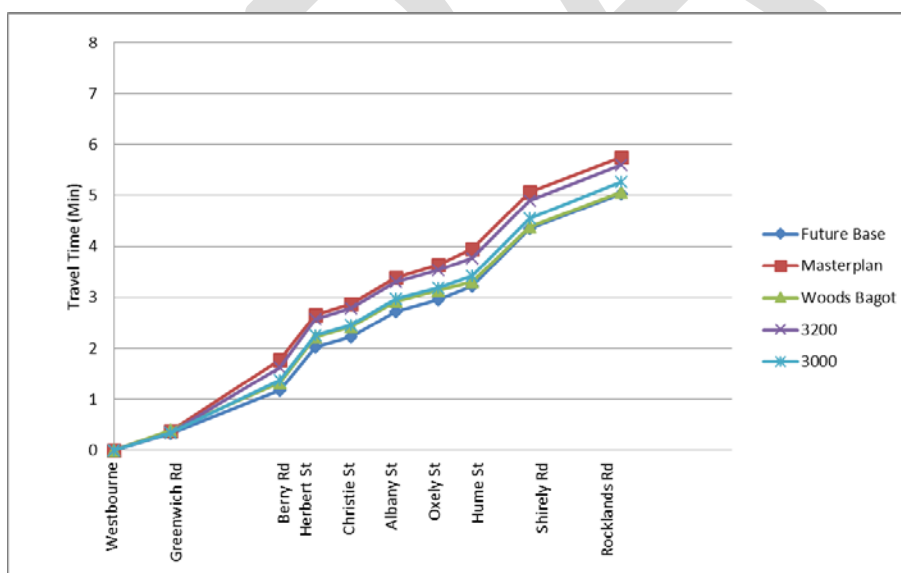


FIGURE 9 PACIFIC HIGHWAY EASTBOUND (PM PEAK)

The alternative east-west traversal route through the study area on River Road shows that the westbound direction during the PM peak shows a consistent degradation in travel times (by up to 17%) as masterplan development increases. The two locations that cause the most delay to traffic on this route is shown in the graph by the steepest line gradients at Pacific Highway and Greenwich Road.

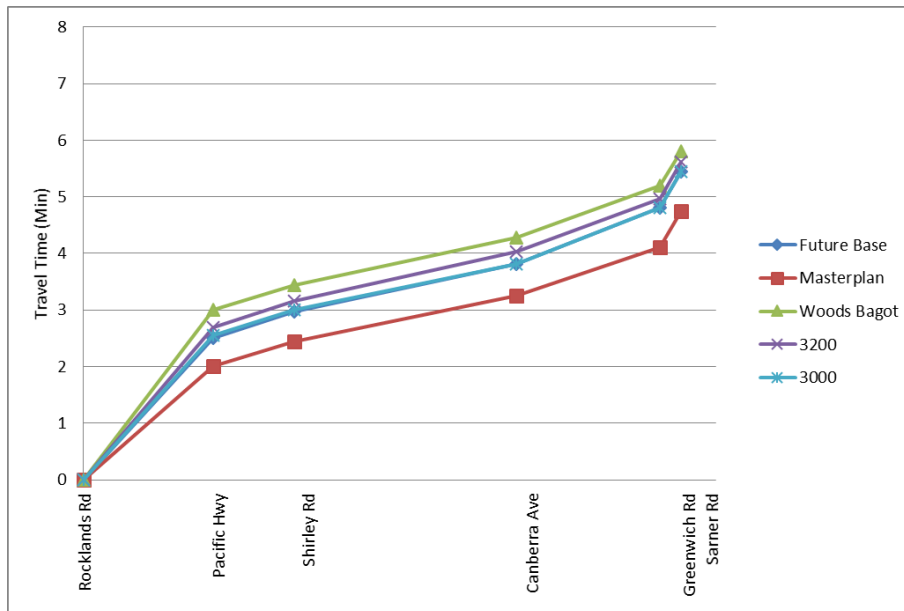


FIGURE 10 RIVER ROAD WESTBOUND (PM PEAK)

There is no discernible difference in eastbound travel times on River Road during the PM peak except for the Woods Bagot proposal that experiences a 12% increase over the other scenarios as can be seen in Figure 11.

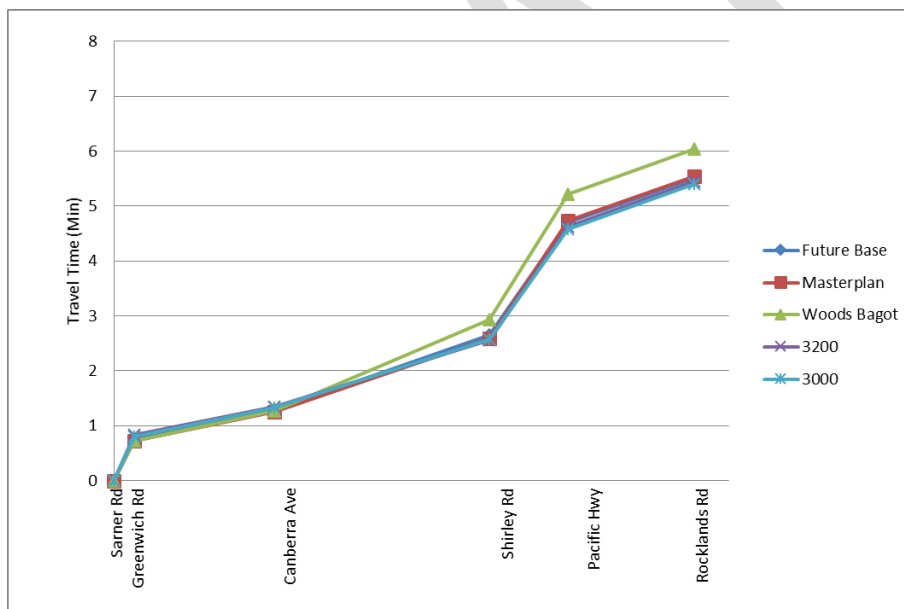


FIGURE 11 RIVER ROAD EASTBOUND (PM PEAK)

### 3.3 LEVEL OF SERVICE

Intersection Level of Service (LoS) is a broadly recognised method of assessing intersection operation against defined performance criteria from A (little or no delay) to F (oversaturated, congested conditions). At signalised intersections the LoS criteria relate to the average intersection delay (expressed as seconds per vehicle) while at priority intersections and roundabouts, the LoS is based on the delay for the worst movement. Table 4 provides a summary of the LoS criteria applied.

**TABLE 4 RMS LEVELS OF SERVICE (LOS)**

| Level of service | Average delay<br>(seconds per<br>vehicle) | Traffic signals, Roundabout                                                                            | Priority Intersection ('Stop' and<br>'Give Way')                   |
|------------------|-------------------------------------------|--------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------|
| <b>A</b>         | Less than 14                              | Good operation                                                                                         | Good operation                                                     |
| <b>B</b>         | 15 to 28                                  | Good with acceptable delays and spare capacity                                                         | Acceptable delays and spare capacity                               |
| <b>C</b>         | 29 to 42                                  | Satisfactory                                                                                           | Satisfactory, but accident study required                          |
| <b>D</b>         | 43 to 56                                  | Operating near capacity                                                                                | Near capacity and accident study required                          |
| <b>E</b>         | 57 to 70                                  | At capacity. At signals, incidents will cause excessive delays. Roundabouts require other control mode | At capacity, requires other control mode                           |
| <b>F</b>         | Greater than 71                           | Unsatisfactory with excessive queuing                                                                  | Unsatisfactory with excessive queuing; requires other control mode |

Source: RTA Guide to Traffic Generating Developments (2002)

It can be seen from Table 5 that both the Pacific Highway/Reserve Road/Berry Road and River Road/Lithgow Street intersections experience a consistent operation of LoS F across all scenarios. The Pacific Highway/Falcon Street/Shirley Street intersection also operates at LoS F except under the Council Masterplan scenario where it is anticipated to operate at LoS E.

In addition to these identified intersections that operate at or beyond their capacity, due to the way Paramics software (used to undertake the modelling assessments) collects delay statistics the peak direction delays (ie eastbound during the AM peak) at Christie Street and Herbert Street intersections with Pacific Highway are likely to be under-represented and can also be considered as operating at LoS F.

The Woods Bagot proposal can also be shown to cause the River Road/ Shirley Road intersection to exceed capacity.

TABLE 5 INTERSECTION LEVEL OF SERVICE (AM PEAK)

| Intersection                     | Approach        | Delay (s) |       |       |       |       |       | Vehicles |      |      |      |      |      | Level of Service |    |    |      |      |      |
|----------------------------------|-----------------|-----------|-------|-------|-------|-------|-------|----------|------|------|------|------|------|------------------|----|----|------|------|------|
|                                  |                 | FB        | MP    | WB    | 3200  | 3000  | 2800  | FB       | MP   | WB   | 3200 | 3000 | 2800 | FB               | MP | WB | 3200 | 3000 | 2800 |
| Pacific Hwy/Reserve Rd/Berry Rd  | Reserve Rd      | 56.2      | 55.78 | 79.0  | 70.4  | 79.3  | 76.4  | 82       | 89   | 78   | 87   | 87   | 96   | D                | D  | F  | F    | F    | F    |
|                                  | Pacific Hwy [E] | 98.1      | 95.82 | 99.7  | 111.2 | 102.6 | 108.7 | 1689     | 1597 | 1663 | 1704 | 1673 | 1616 | F                | F  | F  | F    | F    | F    |
|                                  | Berry Rd        | 55.0      | 68.13 | 124.4 | 165.7 | 144.3 | 106.2 | 125      | 193  | 279  | 217  | 234  | 243  | D                | E  | F  | F    | F    | F    |
|                                  | Pacific Hwy [W] | 112.5     | 162.9 | 183.8 | 173.4 | 192.0 | 165.6 | 1965     | 1859 | 1730 | 1734 | 1714 | 1749 | F                | F  | F  | F    | F    | F    |
|                                  | Intersection    | 103.1     | 126.8 | 139.9 | 142.2 | 146.0 | 134.6 | 3861     | 3738 | 3750 | 3742 | 3708 | 3704 | F                | F  | F  | F    | F    | F    |
| Pacific Hwy/Herbert St           | Herbert St      | 139.3     | 110.4 | 153.9 | 144.8 | 132.4 | 150.0 | 618      | 673  | 602  | 692  | 681  | 617  | F                | F  | F  | F    | F    | F    |
|                                  | Pacific Hwy [E] | 62.8      | 59.98 | 66.7  | 59.3  | 58.6  | 65.1  | 2112     | 2031 | 2135 | 2118 | 2098 | 2062 | E                | E  | E  | E    | E    | E    |
|                                  | Pacific Hwy [W] | 31.9      | 38.68 | 41.1  | 42.2  | 42.2  | 37.9  | 1940     | 1910 | 1888 | 1867 | 1863 | 1913 | C                | C  | C  | C    | C    | C    |
|                                  | Intersection    | 60.1      | 58.52 | 67.6  | 65.2  | 62.8  | 65.1  | 4670     | 4614 | 4625 | 4677 | 4642 | 4592 | E                | E  | E  | E    | E    | E    |
|                                  | Intersection    | 60.1      | 58.52 | 67.6  | 65.2  | 62.8  | 65.1  | 4670     | 4614 | 4625 | 4677 | 4642 | 4592 | E                | E  | E  | E    | E    | E    |
| Pacific Hwy/Christie St          | Christie St [N] | 80.5      | 106   | 106.5 | 115.4 | 88.1  | 110.0 | 499      | 493  | 559  | 527  | 543  | 499  | F                | F  | F  | F    | F    | F    |
|                                  | Pacific Hwy [E] | 15.8      | 14.11 | 22.2  | 13.8  | 13.1  | 17.1  | 1995     | 1949 | 1966 | 1994 | 1956 | 1938 | B                | B  | B  | A    | A    | B    |
|                                  | Pacific Hwy [W] | 15.8      | 17.71 | 16.3  | 17.1  | 15.9  | 16.1  | 2249     | 2249 | 2128 | 2180 | 2167 | 2154 | B                | B  | B  | B    | B    | B    |
|                                  | Intersection    | 22.6      | 25.49 | 29.6  | 26.7  | 23.1  | 26.7  | 4743     | 4691 | 4653 | 4701 | 4666 | 4591 | B                | B  | C  | B    | B    | B    |
|                                  | Intersection    | 22.6      | 25.49 | 29.6  | 26.7  | 23.1  | 26.7  | 4743     | 4691 | 4653 | 4701 | 4666 | 4591 | B                | B  | C  | B    | B    | B    |
| Pacific Hwy/Albany St            | Pacific Hwy [N] | 35.3      | 35.61 | 33.6  | 34.0  | 32.7  | 33.5  | 1759     | 1750 | 1581 | 1660 | 1651 | 1674 | C                | C  | C  | C    | C    | C    |
|                                  | Albany St       | 68.7      | 69.6  | 90.7  | 65.4  | 65.0  | 74.8  | 610      | 622  | 620  | 605  | 607  | 587  | E                | E  | F  | E    | E    | F    |
|                                  | Pacific Hwy [S] | 28.3      | 24.84 | 41.5  | 26.9  | 25.9  | 28.1  | 1593     | 1557 | 1568 | 1596 | 1562 | 1536 | B                | B  | C  | B    | B    | B    |
|                                  | Intersection    | 37.6      | 36.72 | 46.3  | 36.0  | 35.0  | 37.7  | 3962     | 3929 | 3769 | 3861 | 3820 | 3797 | C                | C  | D  | C    | C    | C    |
|                                  | Intersection    | 37.6      | 36.72 | 46.3  | 36.0  | 35.0  | 37.7  | 3962     | 3929 | 3769 | 3861 | 3820 | 3797 | C                | C  | D  | C    | C    | C    |
| Pacific Hwy/Oxley St             | Pacific Hwy [N] | 18.6      | 18.25 | 16.8  | 17.8  | 17.5  | 17.6  | 1387     | 1420 | 1302 | 1379 | 1371 | 1349 | B                | B  | B  | B    | B    | B    |
|                                  | Oxley St [E]    | 44.2      | 40.09 | 43.4  | 43.1  | 42.9  | 41.3  | 114      | 126  | 124  | 107  | 106  | 128  | D                | C  | D  | D    | C    | C    |
|                                  | Pacific Hwy [S] | 21.5      | 21.51 | 33.1  | 21.6  | 21.6  | 20.9  | 1373     | 1334 | 1378 | 1374 | 1335 | 1310 | B                | B  | C  | B    | B    | B    |
|                                  | Oxley St [W]    | 67.8      | 71.07 | 69.7  | 65.4  | 65.3  | 67.6  | 430      | 463  | 445  | 428  | 434  | 427  | E                | F  | E  | E    | E    | E    |
|                                  | Intersection    | 27.1      | 27.69 | 32.0  | 26.4  | 26.4  | 26.5  | 3304     | 3343 | 3249 | 3288 | 3246 | 3214 | B                | B  | C  | B    | B    | B    |
| Pacific Hwy/Hume St              | Pacific Hwy [N] | 13.4      | 14.2  | 13.3  | 13.2  | 13.0  | 13.1  | 1446     | 1511 | 1403 | 1457 | 1451 | 1426 | A                | B  | A  | A    | A    | A    |
|                                  | Hume St [E]     | 54.0      | 56.71 | 62.8  | 57.8  | 63.1  | 54.9  | 188      | 203  | 221  | 253  | 251  | 219  | D                | D  | E  | E    | E    | D    |
|                                  | Pacific Hwy [S] | 18.6      | 19.1  | 23.1  | 19.9  | 19.5  | 19.0  | 1257     | 1194 | 1283 | 1229 | 1182 | 1179 | B                | B  | B  | B    | B    | B    |
|                                  | Hume St [W]     | 56.4      | 58.74 | 53.8  | 51.3  | 52.4  | 49.0  | 142      | 156  | 130  | 132  | 136  | 165  | D                | E  | D  | D    | D    | D    |
|                                  | Intersection    | 20.1      | 21.2  | 22.8  | 21.2  | 21.5  | 20.5  | 3033     | 3064 | 3037 | 3071 | 3020 | 2989 | B                | B  | B  | B    | B    | B    |
| Pacific Hwy/Falcon St/Shirley Rd | Pacific Hwy [N] | 49.2      | 54.21 | 46.9  | 52.7  | 52.3  | 50.2  | 1413     | 1469 | 1374 | 1441 | 1428 | 1379 | D                | D  | D  | D    | D    | D    |
|                                  | Falcon St       | 171.2     | 95.34 | 183.2 | 142.4 | 174.9 | 140.2 | 879      | 845  | 897  | 905  | 898  | 849  | F                | F  | F  | F    | F    | F    |
|                                  | Pacific Hwy [S] | 29.3      | 30.3  | 30.9  | 30.7  | 30.0  | 29.3  | 876      | 827  | 828  | 806  | 809  | 834  | C                | C  | C  | C    | C    | C    |
|                                  | Shirley Rd      | 92.9      | 93.35 | 150.1 | 102.5 | 115.8 | 106.0 | 457      | 501  | 545  | 525  | 513  | 495  | F                | F  | F  | F    | F    | F    |
|                                  | Intersection    | 79.5      | 63.71 | 92.3  | 77.1  | 86.4  | 74.5  | 3625     | 3642 | 3644 | 3677 | 3648 | 3557 | F                | E  | F  | F    | F    | F    |
| Pacific Hwy/Alexander St         | Pacific Hwy [N] | 26.7      | 27.93 | 22.6  | 25.2  | 25.4  | 23.1  | 1253     | 1336 | 1283 | 1295 | 1283 | 1246 | B                | B  | B  | B    | B    | B    |
|                                  | Alexander St    | 46.6      | 46.03 | 44.4  | 45.3  | 44.4  | 46.9  | 356      | 364  | 345  | 365  | 360  | 344  | D                | D  | D  | D    | D    | D    |
|                                  | Pacific Hwy [S] | 33.0      | 31.89 | 34.9  | 31.9  | 31.8  | 32.3  | 1124     | 1057 | 1097 | 1024 | 1025 | 1043 | C                | C  | C  | C    | C    | C    |
|                                  | Intersection    | 31.9      | 31.84 | 30.3  | 30.5  | 30.4  | 29.8  | 2733     | 2757 | 2725 | 2684 | 2668 | 2633 | C                | C  | C  | C    | C    | C    |
|                                  | Intersection    | 31.9      | 31.84 | 30.3  | 30.5  | 30.4  | 29.8  | 2733     | 2757 | 2725 | 2684 | 2668 | 2633 | C                | C  | C  | C    | C    | C    |
| River Rd/Shirley Rd              | Shirley Rd [N]  | 59.4      | 58.85 | 84.5  | 78.6  | 60.0  | 59.1  | 455      | 447  | 407  | 439  | 477  | 463  | E                | E  | F  | F    | E    | E    |
|                                  | Shirley Rd [S]  | 47.4      | 44.15 | 89.5  | 57.9  | 53.6  | 45.1  | 202      | 190  | 208  | 218  | 219  | 203  | D                | D  | F  | E    | D    | D    |
|                                  | River Rd        | 54.8      | 55.49 | 64.5  | 58.2  | 56.0  | 52.5  | 894      | 944  | 968  | 966  | 942  | 953  | D                | D  | E  | E    | D    | D    |
|                                  | Intersection    | 55.2      | 55.08 | 73.0  | 63.7  | 56.9  | 53.4  | 1551     | 1581 | 1583 | 1623 | 1638 | 1619 | D                | D  | F  | E    | D    | D    |
|                                  | Intersection    | 55.2      | 55.08 | 73.0  | 63.7  | 56.9  | 53.4  | 1551     | 1581 | 1583 | 1623 | 1638 | 1619 | D                | D  | F  | E    | D    | D    |
| River Rd/Lithgow St              | Lithgow St      | 107.8     | 218.7 | 631.3 | 384.0 | 134.1 | 74.9  | 17       | 15   | 15   | 17   | 18   | 16   | F                | F  | F  | F    | F    | F    |
|                                  | River Rd [E]    | 10.3      | 9.255 | 21.6  | 25.7  | 15.3  | 13.0  | 560      | 552  | 524  | 514  | 565  | 547  | A                | A  | B  | B    | B    | A    |
|                                  | River Rd [W]    | 13.8      | 15.32 | 19.6  | 19.0  | 16.3  | 14.8  | 1066     | 1097 | 1152 | 1084 | 1073 | 1090 | A                | B  | B  | B    | B    | B    |
|                                  | Intersection    | 107.8     | 218.7 | 631.3 | 384.0 | 134.1 | 74.9  | 1643     | 1664 | 1691 | 1615 | 1656 | 1653 | F                | F  | F  | F    | F    | F    |
|                                  | Intersection    | 107.8     | 218.7 | 631.3 | 384.0 | 134.1 | 74.9  | 1643     | 1664 | 1691 | 1615 | 1656 | 1653 | F                | F  | F  | F    | F    | F    |

The PM Peak like the AM peak has both the Pacific Highway/Reserve Road/Berry Road and River Road/Lithgow Street intersections experiencing excessive delays with LoS F operation across all scenarios.

In addition to these identified intersections that operate at or beyond their capacity, due to the way Paramics software (used to undertake the modelling assessments) collects delay statistics the peak direction delays (ie westbound in the PM peak) at Christie Street and Herbert Street intersections with Pacific Highway are likely to be under-represented and can also be considered as operating at LoS F.

TABLE 6 INTERSECTION LEVEL OF SERVICE (PM PEAK)

| Intersection                     | Approach        | Delay (s) |       |       |       |       | Vehicles |      |      |      |      | Level of Service |    |    |      |      |
|----------------------------------|-----------------|-----------|-------|-------|-------|-------|----------|------|------|------|------|------------------|----|----|------|------|
|                                  |                 | FB        | MP    | WB    | 3200  | 3000  | FB       | MP   | WB   | 3200 | 3000 | FB               | MP | WB | 3200 | 3000 |
| Pacific Hwy/Reserve Rd/Berry Rd  | Reserve Rd      | 75.4      | 96.85 | 73.9  | 69.8  | 69.8  | 224      | 198  | 209  | 205  | 207  | F                | F  | F  | E    | E    |
|                                  | Pacific Hwy [E] | 94.7      | 99.25 | 103.5 | 97.2  | 97.2  | 1718     | 1807 | 1970 | 1883 | 1886 | F                | F  | F  | F    | F    |
|                                  | Berry Rd        | 95.0      | 83.2  | 118.4 | 145.3 | 145.3 | 154      | 144  | 175  | 152  | 150  | F                | F  | F  | F    | F    |
|                                  | Pacific Hwy [W] | 125.2     | 146.1 | 127.1 | 131.1 | 131.1 | 1412     | 1439 | 1402 | 1376 | 1415 | F                | F  | F  | F    | F    |
|                                  | Intersection    | 105.8     | 117.3 | 111.4 | 110.5 | 110.7 | 3508     | 3588 | 3756 | 3616 | 3658 | F                | F  | F  | F    | F    |
| Pacific Hwy/Herbert St           | Herbert St      | 40.2      | 59.75 | 90.6  | 54.5  | 54.5  | 887      | 963  | 978  | 947  | 958  | C                | E  | F  | D    | D    |
|                                  | Pacific Hwy [E] | 58.8      | 60.23 | 64.1  | 58.6  | 58.6  | 1925     | 1946 | 2035 | 1996 | 2015 | E                | E  | E  | E    | E    |
|                                  | Pacific Hwy [W] | 51.9      | 53.37 | 53.3  | 59.5  | 59.5  | 1513     | 1470 | 1491 | 1524 | 1555 | D                | D  | D  | E    | E    |
|                                  | Intersection    | 52.6      | 57.82 | 66.3  | 58.1  | 58.1  | 4325     | 4379 | 4504 | 4467 | 4528 | D                | E  | E  | E    | E    |
| Pacific Hwy/Christie St          | Christie St [N] | 58.0      | 61.43 | 105.4 | 61.9  | 61.9  | 411      | 474  | 493  | 486  | 485  | E                | E  | F  | E    | E    |
|                                  | Pacific Hwy [E] | 16.8      | 17.92 | 20.7  | 16.4  | 16.4  | 1904     | 1888 | 1911 | 1937 | 1941 | B                | B  | B  | B    | B    |
|                                  | Pacific Hwy [W] | 15.5      | 15.62 | 15.8  | 16.5  | 16.5  | 2019     | 1981 | 1922 | 2000 | 2039 | B                | B  | B  | B    | B    |
|                                  | Intersection    | 20.1      | 21.62 | 28.1  | 21.4  | 21.4  | 4334     | 4343 | 4326 | 4423 | 4465 | B                | B  | B  | B    | B    |
| Pacific Hwy/Albany St            | Pacific Hwy [N] | 30.5      | 27.19 | 26.5  | 27.7  | 27.7  | 1548     | 1426 | 1426 | 1438 | 1487 | C                | B  | B  | B    | B    |
|                                  | Albany St       | 67.3      | 72.73 | 61.3  | 57.6  | 57.6  | 603      | 589  | 532  | 535  | 544  | E                | F  | E  | E    | E    |
|                                  | Pacific Hwy [S] | 19.5      | 23.07 | 31.9  | 21.7  | 21.7  | 1511     | 1547 | 1540 | 1579 | 1579 | B                | B  | C  | B    | B    |
|                                  | Intersection    | 32.0      | 32.93 | 34.2  | 29.5  | 29.6  | 3662     | 3562 | 3498 | 3552 | 3610 | C                | C  | C  | C    | C    |
| Pacific Hwy/Oxley St             | Pacific Hwy [N] | 14.6      | 14.09 | 13.1  | 13.7  | 13.7  | 1244     | 1163 | 1198 | 1178 | 1221 | B                | B  | A  | A    | A    |
|                                  | Oxley St [E]    | 43.7      | 39.61 | 40.6  | 45.1  | 45.1  | 142      | 144  | 138  | 142  | 144  | D                | C  | C  | D    | D    |
|                                  | Pacific Hwy [S] | 14.2      | 16.5  | 15.8  | 14.0  | 14.0  | 1381     | 1476 | 1455 | 1425 | 1441 | B                | B  | B  | B    | B    |
|                                  | Oxley St [W]    | 119.7     | 76.52 | 80.2  | 81.9  | 81.9  | 513      | 458  | 505  | 517  | 515  | F                | F  | F  | F    | F    |
|                                  | Intersection    | 32.2      | 25.14 | 25.8  | 26.0  | 25.8  | 3280     | 3241 | 3296 | 3262 | 3321 | C                | B  | B  | B    | B    |
| Pacific Hwy/Hume St              | Pacific Hwy [N] | 17.5      | 12.62 | 13.6  | 12.9  | 12.9  | 1320     | 1208 | 1251 | 1250 | 1297 | B                | A  | A  | A    | A    |
|                                  | Hume St [E]     | 78.6      | 68.67 | 80.9  | 69.6  | 69.6  | 275      | 291  | 282  | 285  | 267  | F                | E  | F  | E    | E    |
|                                  | Pacific Hwy [S] | 18.8      | 19.75 | 19.8  | 18.9  | 18.9  | 1170     | 1278 | 1259 | 1213 | 1245 | B                | B  | B  | B    | B    |
|                                  | Hume St [W]     | 52.2      | 54.9  | 55.2  | 52.7  | 52.7  | 164      | 166  | 205  | 161  | 176  | D                | D  | D  | D    | D    |
|                                  | Intersection    | 25.7      | 23.64 | 25.4  | 23.2  | 22.8  | 2929     | 2943 | 2997 | 2909 | 2985 | B                | B  | B  | B    | B    |
| Pacific Hwy/Falcon St/Shirley Rd | Pacific Hwy [N] | 63.4      | 56.51 | 62.3  | 55.6  | 55.6  | 1269     | 1164 | 1236 | 1241 | 1297 | E                | D  | E  | D    | D    |
|                                  | Falcon St       | 85.0      | 103.5 | 116.0 | 100.1 | 100.1 | 892      | 910  | 948  | 967  | 958  | F                | F  | F  | F    | F    |
|                                  | Pacific Hwy [S] | 68.9      | 67.63 | 74.3  | 72.4  | 72.4  | 1003     | 1112 | 1062 | 1052 | 1096 | E                | E  | F  | F    | F    |
|                                  | Shirley Rd      | 116.8     | 110   | 141.5 | 135.8 | 135.8 | 672      | 708  | 657  | 716  | 677  | F                | F  | F  | F    | F    |
|                                  | Intersection    | 79.2      | 80.39 | 91.9  | 85.3  | 84.2  | 3836     | 3894 | 3903 | 3976 | 4028 | F                | F  | F  | F    | F    |
| Pacific Hwy/Alexander St         | Pacific Hwy [N] | 15.6      | 15.71 | 18.3  | 15.4  | 15.4  | 1102     | 1054 | 1026 | 1074 | 1076 | B                | B  | B  | B    | B    |
|                                  | Alexander St    | 87.1      | 126.5 | 127.5 | 72.4  | 72.4  | 239      | 246  | 251  | 249  | 254  | F                | F  | F  | F    | F    |
|                                  | Pacific Hwy [S] | 83.3      | 66.74 | 87.6  | 106.0 | 106.0 | 1256     | 1384 | 1305 | 1317 | 1379 | F                | E  | F  | F    | F    |
|                                  | Intersection    | 54.9      | 52.18 | 64.0  | 66.0  | 66.8  | 2597     | 2684 | 2582 | 2640 | 2709 | D                | D  | E  | E    | E    |
| River Rd/Shirley Rd              | Shirley Rd [N]  | 27.5      | 27.48 | 28.3  | 27.7  | 27.7  | 756      | 782  | 817  | 835  | 829  | B                | B  | B  | B    | B    |
|                                  | Shirley Rd [S]  | 59.7      | 53.46 | 102.4 | 60.8  | 60.8  | 419      | 421  | 440  | 437  | 427  | E                | D  | F  | E    | E    |
|                                  | River Rd        | 32.4      | 34.42 | 57.7  | 46.7  | 46.7  | 684      | 740  | 632  | 726  | 688  | C                | C  | E  | D    | D    |
|                                  | Intersection    | 36.6      | 35.75 | 55.4  | 41.8  | 41.7  | 1859     | 1943 | 1889 | 1998 | 1944 | C                | C  | D  | C    | C    |
| River Rd/Lithgow St              | Lithgow St      | 26.7      | 26.61 | 81.3  | 36.5  | 36.5  | 112      | 169  | 126  | 112  | 105  | B                | B  | F  | C    | C    |
|                                  | River Rd [E]    | 5.7       | 5.552 | 6.7   | 6.4   | 6.4   | 918      | 950  | 974  | 1010 | 999  | A                | A  | A  | A    | A    |
|                                  | River Rd [W]    | 9.6       | 9.632 | 18.5  | 10.3  | 10.3  | 659      | 697  | 629  | 724  | 694  | A                | A  | B  | A    | A    |
|                                  | Intersection    | 26.7      | 26.61 | 81.3  | 36.5  | 36.5  | 1689     | 1816 | 1729 | 1846 | 1798 | B                | B  | F  | C    | C    |

### 3.4 EGRESS TIMES FROM THE MASTERPLAN SITE

Another method of understanding the relative performance of each scenario is to consider the amount of time it takes to egress the site in the morning as this is what masterplan area residents will experience as a consequence of network congestion.

Table 7 provides an overview of the key egress routes from the masterplan site (under each scenario expressed in both minutes of travel time to progress) onto Pacific Highway as well as the number of signal cycles drivers will be forced to wait before finding their way onto Pacific Highway.

It is apparent from the table that both the Greenwich Road (northbound) movement onto Pacific Highway and the Berry Road (northbound) movement onto Pacific Highway experience similar levels of delay with the exception of the Future Base and Public Proposal (3000) masterplan proposal with Berry Street egress having considerably less delay than Greenwich Road.

TABLE 7 PACIFIC HIGHWAY ACCESS TIMES

|                                 | Future Base | Masterplan | Woods Bagot | Council Preferred 3200 | Council Preferred 3000 |
|---------------------------------|-------------|------------|-------------|------------------------|------------------------|
| Time to Exit (minutes)          |             |            |             |                        |                        |
| Greenwich Rd to Pacific Highway | 2.35        | 2.46       | 5.18        | 3.95                   | 3.53                   |
| Berry Rd to Pacific Highway     | 1.11        | 2.32       | 5.66        | 6.6                    | 3.43                   |
| Oxley St to Pacific Highway     | 0.98        | 0.95       | 1.4         | 1.1                    | 0.9                    |
| Shirley Rd to Pacific Highway   | 1.69        | 1.79       | 2.47        | 2.09                   | 1.93                   |
| No of Signal Cycles to Exit     |             |            |             |                        |                        |
| Greenwich Rd to Pacific Highway | 2           | 2          | 3           | 2                      | 2                      |
| Berry Rd to Pacific Highway     | 1           | 2          | 3           | 3                      | 2                      |
| Oxley St to Pacific Highway     | 1           | 1          | 1           | 1                      | 1                      |
| Shirley Rd to Pacific Highway   | 1           | 1          | 2           | 1                      | 1                      |

Table 7 shows that under the Woods Bagot proposal the traffic would experience up to three signal cycles before being able to egress from either Greenwich Road or Berry Road onto Pacific Highway. Due to the additional traffic utilising the Berry Road egress as a result of the proposed Marshall Street extension west to Park Road, the Council Preferred (3200) scenario also requires up to three signal cycles to egress.

### 3.5 CONCLUSIONS FOR MINIMUM ROAD UPGRADES

It is apparent from the review of the model results that the do minimum future road network may require further enhancements if anything more than the Council exhibited Masterplan or Future Base scenarios are to be accommodated in St Leonards.

As the key intersections that dictate the study area network capacity lie outside the Lane Cove Council area the authority to approve intersection upgrades and signal operations lies with both North Sydney Council and Roads and Maritime Services.

## 4 Road Network Upgrades

In addition to those future (do minimum) road network assumptions in Table 2, a number of additional upgrades could be implemented to further enhance network operations and return network performance back towards that which may be experienced under the Council Masterplan.

Given the general levels of congestion and the ability of traffic in the modelling software to re-route to find the most efficient travel paths through the network (much like the real-world), localised improvements do not always have the expected benefits with knock-on secondary impacts also revealed by this form of modelling assessment.

The Council Preferred (3200) masterplan scenario has been used to assess these network upgrades and assessments have been undertaken during the AM and PM peak periods. Two packages of works have been identified that further enhance network operations, these are summarised in Table 8 and illustrated in Figure 12.

| TABLE 8 ROAD NETWORK UPGRADE PACKAGES |                                                                                                                                             |                          |                          |
|---------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|--------------------------|
| #                                     | Description                                                                                                                                 | Network Upgrades 1 (NU1) | Network Upgrades 2 (NU2) |
| 1                                     | Signal timing changes at Shirley/Falcon/Pacific Hwy intersection.                                                                           | ✓                        |                          |
| 2                                     | Removal of parking eastbound on River Rd between Christie and Lamont.                                                                       | ✓                        | ✓                        |
| 3                                     | Signal phasing changes and introduction of double-right turn from Berry Street at the Berry/Reserve/ Pacific Hwy intersection.              | ✓                        | ✓                        |
| 4                                     | Additional lane added (by re-allocating one of the two exit lanes) on Falcon Street approach at Shirley/Falcon/Pacific Hwy intersection.    |                          | ✓                        |
| 5                                     | Lane re-allocation on Shirley Rd approach to the Shirley/Falcon/Pacific Hwy intersection from shared through/right to dedicated right turn. |                          | ✓                        |

The location of these individual network upgrades is illustrated in Figure 12.

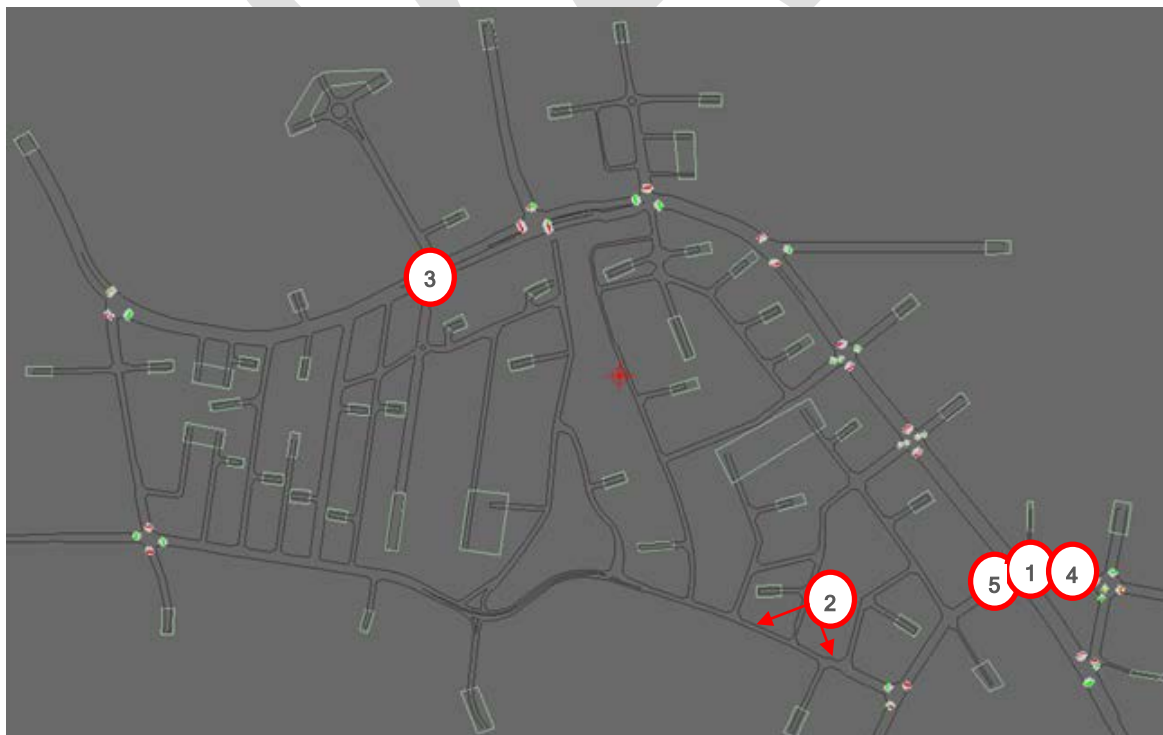


FIGURE 12 LOCATION OF ROAD NETWORK UPGRADES

The results from each of these proposed network upgrade packages as applied to the Council Preferred (3200) masterplan scenario, are compared to the Future Base, Council masterplan and 3200 Do Minimum road network upgrade scenarios and are presented in the following sections.

#### 4.1 NETWORK STATISTICS

Figure 13 shows the effects of both network upgrades packages (NU1 and NU2) against the do minimum network upgrades previously assessed for the Council Masterplan (3200) scenario. During the AM peak it is possible to reduce network-wide travel times by 10% and 12% under either the network upgrade 1 or 2 packages respectively.

During the PM network wide travel times are anticipated to improve by 6.5% and 5% under implementation of either network upgrade package 1 or 2 respectively.

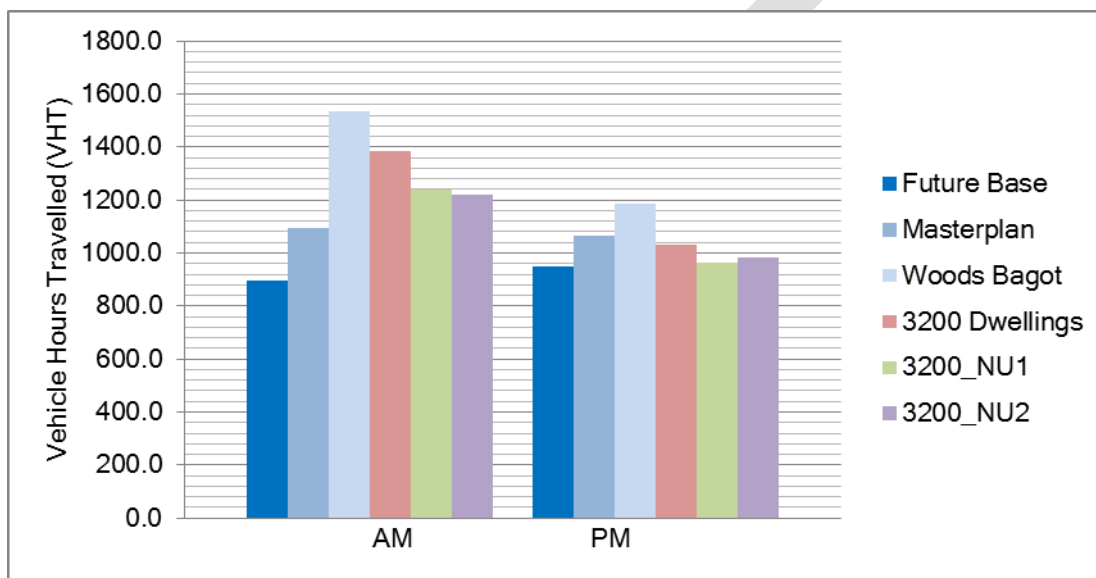


FIGURE 13 COUNCIL PREFERRED WITH NETWORK UPGRADES

Table 9 shows the network statistics with network upgrades package 1 (NU1) and package 2 (NU2) implemented.

| TABLE 9 NETWORK STATISTICS - UPGRADES |                |                  |         |        |                     |
|---------------------------------------|----------------|------------------|---------|--------|---------------------|
|                                       | Description    | Mean Speed (kph) | VKT     | VHT    | Unreleased Vehicles |
| <b>AM</b>                             | Future Base    | 21.4             | 19117.0 | 896.7  | 57                  |
|                                       | Masterplan     | 17.8             | 19463.2 | 1094.6 | 132                 |
|                                       | Woods Bagot    | 12.8             | 19661.4 | 1536.3 | 360                 |
|                                       | 3200 Dwellings | 13.9             | 19007.2 | 1384.5 | 180                 |
|                                       | 3200_NU1       | 15.8             | 19600.5 | 1241.5 | 181                 |
|                                       | 3200_NU2       | 15.8             | 19595.7 | 1218.0 | 179                 |
| <b>PM</b>                             | Future Base    | 20.3             | 19219.8 | 950.4  | 63                  |
|                                       | Masterplan     | 18.6             | 19719.7 | 1066.4 | 45                  |
|                                       | Woods Bagot    | 16.6             | 19655.0 | 1185.0 | 194                 |
|                                       | 3200 Dwellings | 18.9             | 19439.4 | 1030.4 | 100                 |
|                                       | 3200_NU1       | 20.1             | 19548.7 | 964.3  | 45                  |
|                                       | 3200_NU2       | 21.1             | 19530.5 | 982.0  | 54                  |

The table above shows mean speeds can be improved by 14% in the AM peak and 6-12% in the PM peak. When compared to Table 3, the vehicle hours travelled and mean speeds experienced across the network under the network upgrades with 3200 Dwellings are comparable to the do minimum network with 2800 Dwellings. Even with network upgrade packages implemented there will remain around 180 vehicles unable to enter the study network due to downstream congestion in the AM peak.

## 4.2 TRAVEL TIMES

The proposed network upgrades when implemented are likely to improve the River Road peak direction of travel in the AM peak as illustrated in Figure 14.

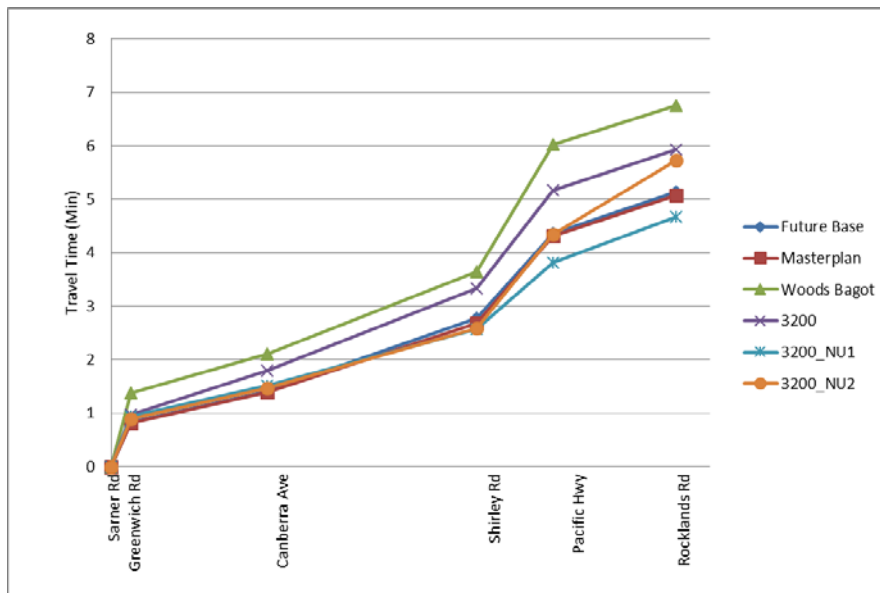


FIGURE 14 RIVER ROAD EASTBOUND (AM PEAK)

It can be seen that the 3200\_NU2 (package 2) are not anticipated to offer as much benefit as the package 1 upgrades as increased delays extend back from Rocklands Road. The situation is different for the Pacific Highway eastbound travel times during the AM peak as can be seen in Figure 15.

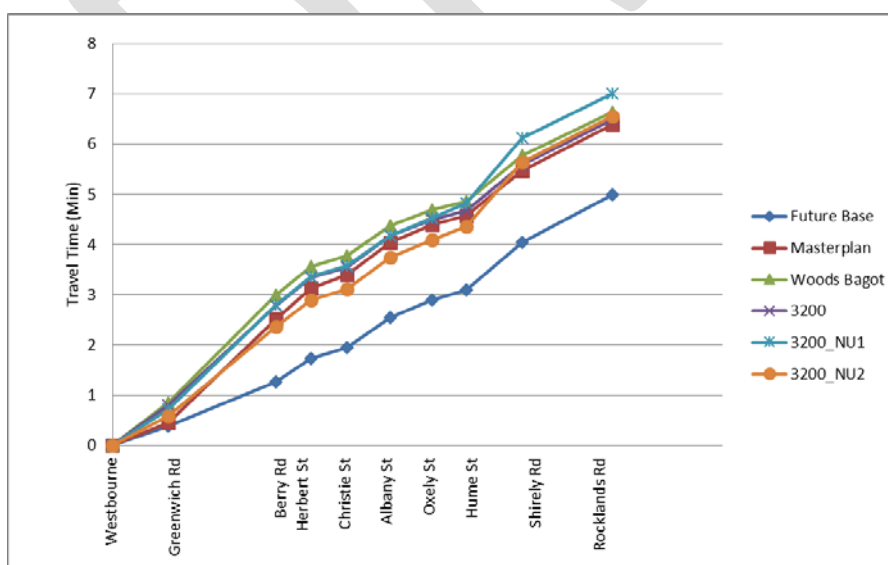


FIGURE 15 PACIFIC HIGHWAY EASTBOUND (AM PEAK)

During the PM peak the westbound direction of travel (which is the peak direction of travel) is likely to be improved significantly with the introduction of either network upgrades package 1 or 2, as demonstrated by Figure 16.

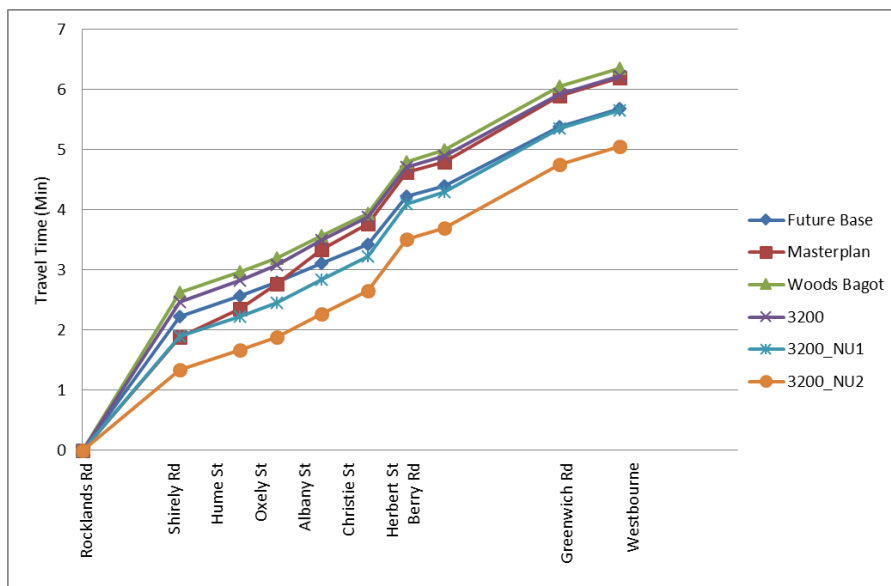


FIGURE 16 PACIFIC HIGHWAY WESTBOUND (PM PEAK)

The westbound travel times on the River Road traversal route are improved by the introduction of either of the network upgrade packages as shown in Figure 17.

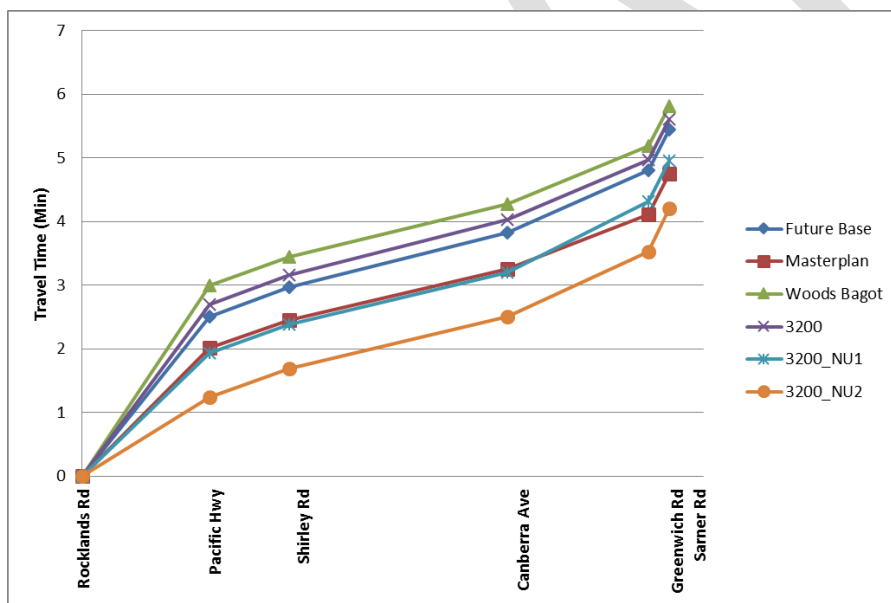


FIGURE 17 RIVER ROAD WESTBOUND (PM PEAK)

#### 4.3 LEVEL OF SERVICE

The Level of Services (LoS) improvements that can be realised from each of the network upgrade packages are detailed in Table 10 for 'NU1' and 'NU2' representing package 1 and package 2 upgrades respectively.

TABLE 10 LEVEL OF SERVICE WITH UPGRADES (AM PEAK)

| Intersection                     | Approach        | Delay (s) |       |       |       |       |       | Vehicles |      |      |      |      |      | Level of Service |    |    |      |     |     |
|----------------------------------|-----------------|-----------|-------|-------|-------|-------|-------|----------|------|------|------|------|------|------------------|----|----|------|-----|-----|
|                                  |                 | FB        | MP    | WB    | 3200  | NU1   | NU2   | FB       | MP   | WB   | 3200 | NU1  | NU2  | FB               | MP | WB | 3200 | NU1 | NU2 |
| Pacific Hwy/Reserve Rd/Berry Rd  | Reserve Rd      | 56.2      | 55.78 | 79.0  | 70.4  | 101.4 | 87.8  | 82       | 89   | 78   | 87   | 83   | 95   | D                | D  | F  | F    | F   | F   |
|                                  | Pacific Hwy [E] | 98.1      | 95.82 | 99.7  | 111.2 | 105.8 | 116.4 | 1689     | 1597 | 1663 | 1704 | 1736 | 1628 | F                | F  | F  | F    | F   | F   |
|                                  | Berry Rd        | 55.0      | 68.13 | 124.4 | 165.7 | 147.9 | 129.1 | 125      | 193  | 279  | 217  | 245  | 247  | D                | E  | F  | F    | F   | F   |
|                                  | Pacific Hwy [W] | 112.5     | 162.9 | 183.8 | 173.4 | 172.7 | 159.8 | 1965     | 1859 | 1730 | 1734 | 1808 | 1787 | F                | F  | F  | F    | F   | F   |
|                                  | Intersection    | 103.1     | 126.8 | 139.9 | 142.2 | 139.6 | 137.2 | 3861     | 3738 | 3750 | 3742 | 3872 | 3757 | F                | F  | F  | F    | F   | F   |
| Pacific Hwy/Herbert St           | Herbert St      | 139.3     | 110.4 | 153.9 | 144.8 | 136.6 | 148.6 | 618      | 673  | 602  | 692  | 642  | 589  | F                | F  | F  | F    | F   | F   |
|                                  | Pacific Hwy [E] | 62.8      | 59.98 | 66.7  | 59.3  | 63.8  | 63.3  | 2112     | 2031 | 2135 | 2118 | 2184 | 2111 | E                | E  | E  | E    | E   | E   |
|                                  | Pacific Hwy [W] | 31.9      | 38.68 | 41.1  | 42.2  | 41.3  | 41.2  | 1940     | 1910 | 1888 | 1867 | 1930 | 1924 | C                | C  | C  | C    | C   | C   |
|                                  | Intersection    | 60.1      | 58.52 | 67.6  | 65.2  | 64.5  | 65.0  | 4670     | 4614 | 4625 | 4677 | 4756 | 4624 | E                | E  | E  | E    | E   | E   |
|                                  | Intersection    | 80.5      | 106   | 106.5 | 115.4 | 88.1  | 118.1 | 499      | 493  | 559  | 527  | 570  | 508  | F                | F  | F  | F    | F   | F   |
| Pacific Hwy/Christie St          | Christie St [N] | 15.8      | 14.11 | 22.2  | 13.8  | 15.8  | 20.1  | 1995     | 1949 | 1966 | 1994 | 2009 | 1991 | B                | B  | B  | A    | B   | B   |
|                                  | Pacific Hwy [E] | 15.8      | 17.71 | 16.3  | 17.1  | 15.5  | 16.2  | 2249     | 2249 | 2128 | 2180 | 2187 | 2145 | B                | B  | B  | B    | B   | B   |
|                                  | Pacific Hwy [W] | 15.8      | 17.71 | 16.3  | 17.1  | 15.5  | 16.2  | 2249     | 2249 | 2128 | 2180 | 2187 | 2145 | B                | B  | B  | B    | B   | B   |
|                                  | Intersection    | 22.6      | 25.49 | 29.6  | 26.7  | 24.3  | 29.0  | 4743     | 4691 | 4653 | 4701 | 4766 | 4644 | B                | B  | C  | B    | B   | C   |
|                                  | Intersection    | 35.3      | 35.61 | 33.6  | 34.0  | 34.5  | 35.7  | 1759     | 1750 | 1581 | 1660 | 1673 | 1649 | C                | C  | C  | C    | C   | C   |
| Pacific Hwy/Albany St            | Albany St       | 68.7      | 69.6  | 90.7  | 65.4  | 69.0  | 70.9  | 610      | 622  | 620  | 605  | 618  | 608  | E                | E  | F  | E    | E   | F   |
|                                  | Pacific Hwy [S] | 28.3      | 24.84 | 41.5  | 26.9  | 31.7  | 33.7  | 1593     | 1557 | 1568 | 1596 | 1599 | 1591 | B                | B  | C  | B    | C   | C   |
|                                  | Intersection    | 37.6      | 36.72 | 46.3  | 36.0  | 38.8  | 40.5  | 3962     | 3929 | 3769 | 3861 | 3890 | 3848 | C                | C  | D  | C    | C   | C   |
|                                  | Intersection    | 18.6      | 18.25 | 16.8  | 17.8  | 20.3  | 17.5  | 1387     | 1420 | 1302 | 1379 | 1361 | 1325 | B                | B  | B  | B    | B   | B   |
|                                  | Intersection    | 44.2      | 40.09 | 43.4  | 43.1  | 42.8  | 43.4  | 114      | 126  | 124  | 107  | 137  | 105  | D                | C  | D  | D    | C   | D   |
| Pacific Hwy/Oxley St             | Oxley St [E]    | 21.5      | 21.51 | 33.1  | 21.6  | 25.2  | 22.4  | 1373     | 1334 | 1378 | 1374 | 1380 | 1344 | B                | B  | C  | B    | B   | B   |
|                                  | Pacific Hwy [S] | 67.8      | 71.07 | 69.7  | 65.4  | 66.2  | 66.9  | 430      | 463  | 445  | 428  | 446  | 473  | E                | F  | E  | E    | E   | E   |
|                                  | Oxley St [W]    | 27.1      | 27.69 | 32.0  | 26.4  | 29.5  | 27.5  | 3304     | 3343 | 3249 | 3288 | 3324 | 3247 | B                | B  | C  | B    | C   | B   |
|                                  | Intersection    | 13.4      | 14.2  | 13.3  | 13.2  | 23.6  | 13.8  | 1446     | 1511 | 1403 | 1457 | 1427 | 1389 | A                | B  | A  | A    | B   | A   |
|                                  | Intersection    | 54.0      | 56.71 | 62.8  | 57.8  | 79.8  | 52.8  | 188      | 203  | 221  | 253  | 188  | 228  | D                | D  | E  | E    | F   | D   |
| Pacific Hwy/Hume St              | Hume St [E]     | 18.6      | 19.1  | 23.1  | 19.9  | 16.6  | 16.9  | 1257     | 1194 | 1283 | 1229 | 1258 | 1219 | B                | B  | B  | B    | B   | B   |
|                                  | Pacific Hwy [S] | 56.4      | 58.74 | 53.8  | 51.3  | 56.8  | 56.8  | 142      | 156  | 130  | 132  | 169  | 133  | D                | E  | D  | D    | D   | D   |
|                                  | Hume St [W]     | 20.1      | 21.2  | 22.8  | 21.2  | 26.0  | 20.0  | 3033     | 3064 | 3037 | 3071 | 3042 | 2969 | B                | B  | B  | B    | B   | B   |
|                                  | Intersection    | 49.2      | 54.21 | 46.9  | 52.7  | 71.6  | 64.7  | 1413     | 1469 | 1374 | 1441 | 1353 | 1354 | D                | D  | D  | D    | F   | E   |
|                                  | Intersection    | 171.2     | 95.34 | 183.2 | 142.4 | 175.0 | 124.5 | 879      | 845  | 897  | 905  | 893  | 882  | F                | F  | F  | F    | F   | F   |
| Pacific Hwy/Falcon St/Shirley Rd | Falcon St       | 29.3      | 30.3  | 30.9  | 30.7  | 35.7  | 33.8  | 876      | 827  | 828  | 806  | 831  | 880  | C                | C  | C  | C    | C   | C   |
|                                  | Pacific Hwy [S] | 92.9      | 93.35 | 150.1 | 102.5 | 77.0  | 96.4  | 457      | 501  | 545  | 525  | 574  | 545  | F                | F  | F  | F    | F   | F   |
|                                  | Shirley Rd      | 79.5      | 63.71 | 92.3  | 77.1  | 89.6  | 76.4  | 3625     | 3642 | 3644 | 3677 | 3651 | 3661 | F                | E  | F  | F    | F   | F   |
|                                  | Intersection    | 26.7      | 27.93 | 22.6  | 25.2  | 26.5  | 32.0  | 1253     | 1336 | 1283 | 1295 | 1291 | 1254 | B                | B  | B  | B    | B   | C   |
|                                  | Intersection    | 46.6      | 46.03 | 44.4  | 45.3  | 39.3  | 45.5  | 356      | 364  | 345  | 365  | 360  | 370  | D                | D  | D  | D    | C   | D   |
| Pacific Hwy/Alexander St         | Alexander St    | 33.0      | 31.89 | 34.9  | 31.9  | 32.3  | 31.6  | 1124     | 1057 | 1097 | 1024 | 1035 | 1125 | C                | C  | C  | C    | C   | C   |
|                                  | Pacific Hwy [S] | 31.9      | 31.84 | 30.3  | 30.5  | 30.4  | 33.7  | 2733     | 2757 | 2725 | 2684 | 2686 | 2749 | C                | C  | C  | C    | C   | C   |
|                                  | Intersection    | 59.4      | 58.85 | 84.5  | 78.6  | 68.0  | 50.8  | 455      | 447  | 407  | 439  | 430  | 512  | E                | E  | F  | F    | E   | D   |
|                                  | Shirley Rd [N]  | 47.4      | 44.15 | 89.5  | 57.9  | 62.3  | 64.6  | 202      | 190  | 208  | 218  | 207  | 215  | D                | D  | F  | E    | E   | E   |
|                                  | Shirley Rd [S]  | 54.8      | 55.49 | 64.5  | 58.2  | 43.8  | 45.9  | 894      | 944  | 968  | 966  | 1025 | 982  | D                | D  | E  | E    | D   | D   |
| River Rd/Shirley Rd              | River Rd        | 55.2      | 55.08 | 73.0  | 63.7  | 52.4  | 49.7  | 1551     | 1581 | 1583 | 1623 | 1662 | 1709 | D                | D  | F  | E    | D   | D   |
|                                  | Intersection    | 107.8     | 218.7 | 631.3 | 384.0 | 63.1  | 85.1  | 17       | 15   | 15   | 17   | 31   | 21   | F                | F  | F  | F    | E   | F   |
|                                  | Lithgow St      | 10.3      | 9.255 | 21.6  | 25.7  | 7.2   | 11.7  | 560      | 552  | 524  | 514  | 535  | 601  | A                | A  | B  | B    | A   | A   |
|                                  | River Rd [E]    | 13.8      | 15.32 | 19.6  | 19.0  | 10.0  | 10.4  | 1066     | 1097 | 1152 | 1084 | 1151 | 1116 | A                | B  | B  | B    | A   | A   |
|                                  | River Rd [W]    | 107.8     | 218.7 | 631.3 | 384.0 | 63.1  | 85.1  | 1643     | 1664 | 1691 | 1615 | 1717 | 1738 | F                | F  | F  | F    | E   | F   |

It can be seen from Table 10 that substantial delay improvements are possible at the River Road/Lithgow Street intersection and also more moderate improvements at the River Road/Shirley Road intersection. The other intersections show little difference with some slightly better and others slightly worse

In addition to these identified intersections that operate at or beyond their capacity, due to the way Paramics software (used to undertake the modelling assessments) collects delay statistics the peak direction delays (ie eastbound during the AM peak) at Christie Street and Herbert Street intersections with Pacific Highway are likely to be under-represented and can also be considered as operating at LoS F.

During the PM peak the River Road/Shirley Street intersection is adversely impacted by downstream queues extending from the Pacific Highway intersection with Shirley Road as a results of reduced capacity provided under the network package 2 (NU2) at Shirley Street. This is reflected in the LoS statistics provided in Table 11.

In addition to these identified intersections that operate at or beyond their capacity, due to the way Paramics software (used to undertake the modelling assessments) collects delay statistics the peak

direction delays (ie westbound in the PM peak) at Christie Street and Herbert Street intersections with Pacific Highway are likely to be under-represented and can also be considered as operating at LoS F.

**TABLE 11 LEVEL OF SERVICE WITH UPGRADES (PM PEAK)**

| Intersection                     | Approach        | Delay (s) |       |       |       |       |       | Vehicles |      |      |      |      |      | Level of Service |    |    |      |     |     |
|----------------------------------|-----------------|-----------|-------|-------|-------|-------|-------|----------|------|------|------|------|------|------------------|----|----|------|-----|-----|
|                                  |                 | FB        | MP    | WB    | 3200  | NU1   | NU2   | FB       | MP   | WB   | 3200 | NU1  | NU2  | FB               | MP | WB | 3200 | NU1 | NU2 |
| Pacific Hwy/Reserve Rd/Berry Rd  | Reserve Rd      | 75.4      | 96.85 | 73.9  | 69.8  | 162.1 | 193.1 | 224      | 198  | 209  | 205  | 184  | 172  | F                | F  | F  | E    | F   | F   |
|                                  | Pacific Hwy [E] | 94.7      | 99.25 | 103.5 | 97.2  | 114.4 | 82.2  | 1718     | 1807 | 1970 | 1883 | 1925 | 1928 | F                | F  | F  | F    | F   | F   |
|                                  | Berry Rd        | 95.0      | 83.2  | 118.4 | 145.3 | 79.1  | 75.4  | 154      | 144  | 175  | 152  | 138  | 151  | F                | F  | F  | F    | F   | F   |
|                                  | Pacific Hwy [W] | 125.2     | 146.1 | 127.1 | 131.1 | 116.9 | 130.7 | 1412     | 1439 | 1402 | 1376 | 1434 | 1401 | F                | F  | F  | F    | F   | F   |
|                                  | Intersection    | 105.8     | 117.3 | 111.4 | 110.5 | 116.4 | 105.8 | 3508     | 3588 | 3756 | 3616 | 3681 | 3652 | F                | F  | F  | F    | F   | F   |
| Pacific Hwy/Herbert St           | Herbert St      | 40.2      | 59.75 | 90.6  | 54.5  | 87.7  | 72.0  | 887      | 963  | 978  | 947  | 940  | 976  | C                | E  | F  | D    | F   | F   |
|                                  | Pacific Hwy [E] | 58.8      | 60.23 | 64.1  | 58.6  | 63.1  | 61.8  | 1925     | 1946 | 2035 | 1996 | 2077 | 2029 | E                | E  | E  | E    | E   | E   |
|                                  | Pacific Hwy [W] | 51.9      | 53.37 | 53.3  | 59.5  | 54.1  | 51.8  | 1513     | 1470 | 1491 | 1524 | 1539 | 1512 | D                | D  | D  | E    | D   | D   |
|                                  | Intersection    | 52.6      | 57.82 | 66.3  | 58.1  | 65.1  | 60.6  | 4325     | 4379 | 4504 | 4467 | 4556 | 4517 | D                | E  | E  | E    | E   | E   |
|                                  | Intersection    | 52.6      | 57.82 | 66.3  | 58.1  | 65.1  | 60.6  | 4325     | 4379 | 4504 | 4467 | 4556 | 4517 | D                | E  | E  | E    | E   | E   |
| Pacific Hwy/Christie St          | Christie St [N] | 58.0      | 61.43 | 105.4 | 61.9  | 83.3  | 101.4 | 411      | 474  | 493  | 486  | 530  | 471  | E                | E  | F  | E    | F   | F   |
|                                  | Pacific Hwy [E] | 16.8      | 17.92 | 20.7  | 16.4  | 20.2  | 21.3  | 1904     | 1888 | 1911 | 1937 | 1969 | 1948 | B                | B  | B  | B    | B   | B   |
|                                  | Pacific Hwy [W] | 15.5      | 15.62 | 15.8  | 16.5  | 15.4  | 16.8  | 2019     | 1981 | 1922 | 2000 | 1979 | 2032 | B                | B  | B  | B    | B   | B   |
|                                  | Intersection    | 20.1      | 21.62 | 28.1  | 21.4  | 25.6  | 27.7  | 4334     | 4343 | 4326 | 4423 | 4478 | 4451 | B                | B  | B  | B    | B   | B   |
|                                  | Intersection    | 20.1      | 21.62 | 28.1  | 21.4  | 25.6  | 27.7  | 4334     | 4343 | 4326 | 4423 | 4478 | 4451 | B                | B  | B  | B    | B   | B   |
| Pacific Hwy/Albany St            | Pacific Hwy [N] | 30.5      | 27.19 | 26.5  | 27.7  | 25.9  | 28.6  | 1548     | 1426 | 1426 | 1438 | 1488 | 1501 | C                | B  | B  | B    | B   | B   |
|                                  | Albany St       | 67.3      | 72.73 | 61.3  | 57.6  | 66.7  | 61.3  | 603      | 589  | 532  | 535  | 575  | 573  | E                | F  | E  | E    | E   | E   |
|                                  | Pacific Hwy [S] | 19.5      | 23.07 | 31.9  | 21.7  | 27.4  | 25.4  | 1511     | 1547 | 1540 | 1579 | 1592 | 1551 | B                | B  | C  | B    | B   | B   |
|                                  | Intersection    | 32.0      | 32.93 | 34.2  | 29.5  | 32.9  | 32.4  | 3662     | 3562 | 3498 | 3552 | 3655 | 3625 | C                | C  | C  | C    | C   | C   |
|                                  | Intersection    | 32.0      | 32.93 | 34.2  | 29.5  | 32.9  | 32.4  | 3662     | 3562 | 3498 | 3552 | 3655 | 3625 | C                | C  | C  | C    | C   | C   |
| Pacific Hwy/Oxley St             | Pacific Hwy [N] | 14.6      | 14.09 | 13.1  | 13.7  | 13.3  | 19.0  | 1244     | 1163 | 1198 | 1178 | 1227 | 1256 | B                | B  | A  | A    | A   | B   |
|                                  | Oxley St [E]    | 43.7      | 39.61 | 40.6  | 45.1  | 38.7  | 39.2  | 142      | 144  | 138  | 142  | 135  | 148  | D                | C  | C  | D    | C   | C   |
|                                  | Pacific Hwy [S] | 14.2      | 16.5  | 15.8  | 14.0  | 15.4  | 14.3  | 1381     | 1476 | 1455 | 1425 | 1467 | 1461 | B                | B  | B  | B    | B   | B   |
|                                  | Oxley St [W]    | 119.7     | 76.52 | 80.2  | 81.9  | 82.5  | 136.1 | 513      | 458  | 505  | 517  | 498  | 498  | F                | F  | F  | F    | F   | F   |
|                                  | Intersection    | 32.2      | 25.14 | 25.8  | 26.0  | 25.6  | 35.2  | 3280     | 3241 | 3296 | 3262 | 3327 | 3363 | C                | B  | B  | B    | B   | C   |
| Pacific Hwy/Hume St              | Pacific Hwy [N] | 17.5      | 12.62 | 13.6  | 12.9  | 15.6  | 26.2  | 1320     | 1208 | 1251 | 1250 | 1276 | 1315 | B                | A  | A  | A    | B   | B   |
|                                  | Hume St [E]     | 78.6      | 68.67 | 80.9  | 69.6  | 64.0  | 77.7  | 275      | 291  | 282  | 285  | 273  | 285  | F                | E  | F  | E    | E   | F   |
|                                  | Pacific Hwy [S] | 18.8      | 19.75 | 19.8  | 18.9  | 19.5  | 18.2  | 1170     | 1278 | 1259 | 1213 | 1263 | 1272 | B                | B  | B  | B    | B   | B   |
|                                  | Hume St [W]     | 52.2      | 54.9  | 55.2  | 52.7  | 55.0  | 62.4  | 164      | 166  | 205  | 161  | 170  | 159  | D                | D  | D  | D    | D   | E   |
|                                  | Intersection    | 25.7      | 23.64 | 25.4  | 23.2  | 23.9  | 29.6  | 2929     | 2943 | 2997 | 2909 | 2982 | 3031 | B                | B  | B  | B    | B   | C   |
| Pacific Hwy/Falcon St/Shirley Rd | Pacific Hwy [N] | 63.4      | 56.51 | 62.3  | 55.6  | 65.3  | 68.6  | 1269     | 1164 | 1236 | 1241 | 1239 | 1278 | E                | D  | E  | D    | E   | E   |
|                                  | Falcon St       | 85.0      | 103.5 | 116.0 | 100.1 | 92.6  | 112.7 | 892      | 910  | 948  | 967  | 949  | 899  | F                | F  | F  | F    | F   | F   |
|                                  | Pacific Hwy [S] | 68.9      | 67.63 | 74.3  | 72.4  | 60.3  | 43.9  | 1003     | 1112 | 1062 | 1052 | 1097 | 1163 | E                | E  | F  | F    | E   | D   |
|                                  | Shirley Rd      | 116.8     | 110   | 141.5 | 135.8 | 143.0 | 107.7 | 672      | 708  | 657  | 716  | 662  | 675  | F                | F  | F  | F    | F   | F   |
|                                  | Intersection    | 79.2      | 80.39 | 91.9  | 85.3  | 83.5  | 77.9  | 3836     | 3894 | 3903 | 3976 | 3947 | 4015 | F                | F  | F  | F    | F   | F   |
| Pacific Hwy/Alexander St         | Pacific Hwy [N] | 15.6      | 15.71 | 18.3  | 15.4  | 16.0  | 20.2  | 1102     | 1054 | 1026 | 1074 | 1096 | 1066 | B                | B  | B  | B    | B   | B   |
|                                  | Alexander St    | 87.1      | 126.5 | 127.5 | 72.4  | 87.8  | 84.3  | 239      | 246  | 251  | 249  | 233  | 259  | F                | F  | F  | F    | F   | F   |
|                                  | Pacific Hwy [S] | 83.3      | 66.74 | 87.6  | 106.0 | 70.8  | 31.5  | 1256     | 1384 | 1305 | 1317 | 1334 | 1406 | F                | E  | F  | F    | F   | C   |
|                                  | Intersection    | 54.9      | 52.18 | 64.0  | 66.0  | 49.7  | 32.1  | 2597     | 2684 | 2582 | 2640 | 2663 | 2731 | D                | D  | E  | E    | D   | C   |
|                                  | Intersection    | 54.9      | 52.18 | 64.0  | 66.0  | 49.7  | 32.1  | 2597     | 2684 | 2582 | 2640 | 2663 | 2731 | D                | D  | E  | E    | D   | C   |
| River Rd/Shirley Rd              | Shirley Rd [N]  | 27.5      | 27.48 | 28.3  | 27.7  | 27.5  | 27.9  | 756      | 782  | 817  | 835  | 827  | 850  | B                | B  | B  | B    | B   | B   |
|                                  | Shirley Rd [S]  | 59.7      | 53.46 | 102.4 | 60.8  | 62.4  | 110.3 | 419      | 421  | 440  | 437  | 421  | 437  | E                | D  | F  | E    | E   | F   |
|                                  | River Rd        | 32.4      | 34.42 | 57.7  | 46.7  | 35.7  | 72.7  | 684      | 740  | 632  | 726  | 644  | 675  | C                | C  | E  | D    | C   | F   |
|                                  | Intersection    | 36.6      | 35.75 | 55.4  | 41.8  | 38.1  | 61.7  | 1859     | 1943 | 1889 | 1998 | 1892 | 1962 | C                | C  | D  | C    | C   | E   |
|                                  | Intersection    | 36.6      | 35.75 | 55.4  | 41.8  | 38.1  | 61.7  | 1859     | 1943 | 1889 | 1998 | 1892 | 1962 | C                | C  | D  | C    | C   | E   |
| River Rd/Lithgow St              | Lithgow St      | 26.7      | 26.61 | 81.3  | 36.5  | 17.8  | 76.5  | 112      | 169  | 126  | 112  | 134  | 105  | B                | B  | F  | C    | B   | F   |
|                                  | River Rd [E]    | 5.7       | 5.552 | 6.7   | 6.4   | 5.1   | 5.9   | 918      | 950  | 974  | 1010 | 996  | 1012 | A                | A  | A  | A    | A   | A   |
|                                  | River Rd [W]    | 9.6       | 9.632 | 18.5  | 10.3  | 9.4   | 12.5  | 659      | 697  | 629  | 724  | 637  | 676  | A                | A  | B  | A    | A   | A   |
|                                  | Intersection    | 26.7      | 26.61 | 81.3  | 36.5  | 17.8  | 76.5  | 1689     | 1816 | 1729 | 1846 | 1767 | 1793 | B                | B  | F  | C    | B   | F   |
|                                  | Intersection    | 26.7      | 26.61 | 81.3  | 36.5  | 17.8  | 76.5  | 1689     | 1816 | 1729 | 1846 | 1767 | 1793 | B                | B  | F  | C    | B   | F   |

#### 4.4 EGRESS TIMES FROM THE MASTERPLAN SITE

When considering the ability of traffic to enter Pacific Highway from the masterplan site the number of signal cycles required to wait before accessing the Pacific Highway is of value as this is what drivers will be ware of most when egressing the masterplan site.

Table 12 shows that the introduction of the double right turn movement from Berry Street under both network upgrade packages 1 and 2 has a dramatic effect on pacific highway access times but vehicle may still be required to wait two signal cycles before gaining access to Pacific Highway.

**TABLE 12 PACIFIC HIGHWAY ACCESS TIMES WITH UPGRADES**

|                                    | Future Base | Masterplan | Woods Bagot | Council Preferred 3200 | Council 3200 NU1 | Council 3200 NU2 |
|------------------------------------|-------------|------------|-------------|------------------------|------------------|------------------|
| <b>Time to Exit (minutes)</b>      |             |            |             |                        |                  |                  |
| Greenwich Rd to Pacific Highway    | 2.35        | 2.46       | 5.18        | 3.95                   | 3.51             | 2.75             |
| Berry Rd to Pacific Highway        | 1.11        | 2.32       | 5.66        | 6.6                    | 2.91             | 2.36             |
| Oxley St to Pacific Highway        | 0.98        | 0.95       | 1.4         | 1.1                    | 0.91             | 0.92             |
| Shirley Rd to Pacific Highway      | 1.69        | 1.79       | 2.47        | 2.09                   | 1.28             | 1.61             |
| <b>No of Signal Cycles to Exit</b> |             |            |             |                        |                  |                  |
| Greenwich Rd to Pacific Highway    | 2           | 2          | 3           | 2                      | 2                | 2                |
| Berry Rd to Pacific Highway        | 1           | 2          | 3           | 3                      | 2                | 2                |
| Oxley St to Pacific Highway        | 1           | 1          | 1           | 1                      | 1                | 1                |
| Shirley Rd to Pacific Highway      | 1           | 1          | 2           | 1                      | 1                | 1                |

## 5 Conclusions and Recommendations

### 5.1 CONCLUSIONS

Modelling assessments of the five masterplan scenarios indicate that the Woods Bagot proposal cannot be feasibly implemented without major network upgrades to the adjacent road network.

Delays under the Future Do Minimum road network assumptions with the Woods Bagot level of development will cause drivers to experience network-wide travel time increases (when compared to no development of the masterplan area) of 71% in the AM peak and 25% in the PM peak.

The implementation of the Council Preferred 3200 masterplan scenario will lead to network-wide travel time increases of 54% increase over the Future Base scenario in the AM peak and 8% in the PM peak.

Network upgrades that can be feasibly implemented (through consultation with Roads Maritime Services and North Sydney Council) that will improve masterplan traffic egress and network-wide performance include:

1. Removal of parking eastbound on River Road between Christie Street and Shirley Street to maintain a two lane approach to the Shirley Street/River Road intersection (over 230 metres).
2. Signal timing changes at Shirley Street /Falcon Street /Pacific Hwy intersection to better accommodate future demands.

3. Signal phasing changes and introduction of double-right turn from Berry Street at the Berry/Reserve/ Pacific Hwy intersection to better accommodate masterplan traffic egress demands.

The implementation of the above network upgrades are likely to improve operations such that mean network wide speeds are improved by 14% in the AM peak and 6% in the PM peak. This would make the Public Proposal for 3200 Dwellings perform at a similar level to the Public Proposal for 2800 with no network upgrades. The network upgrades above should be implemented in order given if staged approach to development of masterplan site is taken.

Even with these network upgrade packages implemented there will remain around 180 vehicles unable to enter the study network due to downstream congestion in the AM peak. The distribution of these queued vehicles will predominantly be from Pacific Highway (west), Herbert Street and Christie Street in the morning.

As there will be a gradual degradation in network performance largely as a result of increased traffic volumes on Pacific Highway that result from this development and others in the vicinity. Those intersections providing direct access to these developments have been shown to work adequately (except for Berry Road /Reserve Road/ Pacific Highway) however the key Pacific Highway intersections at Christie and Herbert Streets become congested and propagate queues along Pacific Highway causing some impediment to development and through traffic.

## 5.2 RECOMMENDATIONS

With the package 1 network upgrades implemented network performance (vehicle hours travelled) in the critical AM peak period for the Public Proposal (3200) scenario will still be 13% worse than under the Council masterplan for 2000 dwellings, this equates to a mean network speed drop from 17.8 kph to 15.8 kph it is recommended that:

1. Strict travel demand management policies are applied to those development applications within the 800 metre catchment of the (St Leonards and Wollstonecraft) railway stations that will ensure car trip rates are minimised.
2. A more broad-scale study (that includes adjacent LGAs and more radical network upgrade solutions) is undertaken in consultation with RMS.
3. The Public proposal is initially limited to 2000 dwellings in light of risks surrounding 3<sup>rd</sup> party approvals and sign off processes for recommended network upgrades.

Despite the more extensive network changes under network upgrades package 2, due to the adverse performance of the Shirley Road/Falcon Street/Pacific Highway intersection in the PM peak this proposal is not recommended for implementation.