FINAL REPORT

Wellington Rail to Bus Costing

Greater Wellington

Wellington

August 2003

Booz | Allen | Hamilton

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1 Findings

1.1 Net Cost Estimate

Booz Allen Hamilton was engaged by Greater Welllington to

> *"determine fhe (net) cost of replacing the current Wellington rail service (excluding the Johnsonville line) with a 'rail quality' bus service",*

Our estimate of the net cost (range), including both operating and capital costs, of providing a bus service to replace the current Wellington rail service (excluding the Johnsonville rail line) is $14.2M - $26.0M per annum.

This net cost is made up as follows :

	Annual Amount ($000)[4]	
	Low Estimate	High Estimate
Bus Operational Cost[1]	20,600	24,800
Bus Operational Infastructure[2]	470	700
On-Road Bus Priority[3]	8,570	12,860
Total Costs	29,640	38,360
Revenue	15,430	12,340
Net Cost	14,210	26,020

Notes: (1) Includes both bus operating costs and bus capital costs
(2) Annualised cost of bus depots and bus shelters
(3) Annualised cost of on-road bus priority measures
(4) Accuracy of +/- 20% assumed on capital costs, +20% on bus operational costs, and -20% on revenue

1.2 Capital Works Programme

Replacing the rail service with a bus service would require capital expenditure in three areas :

- Purchase of new vehicles
- Construction of new bus operational infrastructure
- Construction of on-road bus priority measures.

1.2.1 New Vehicles

We estimate that 145 new 40 seater buses would be required. At an estimated cost of $275,000 per bus this equates to a capital cost of around $4 million.

The estimated new bus requirement does not allow for operational resource efficiencies that could result from a full review of the regions' bus services (incorporate the 'rail bus services' into the existing bus service network).

1.2.2 New Bus Operational Infrastructure

(i) New bus depots will be required as follows :

- Upper Hutt 20 buses
- Taita/Pomare 25 buses
- Paraparaumu 30 buses

In addition, the Porirua East depot will need space for an additional 10 buses.

The above is an estimate only and assumes that around half of the additional buses (70 buses) will be able to be stabled at existing bus depots. The main need for additional bus stabling is likely to be at Upper Hutt, Taita/Pomare and Paraparaumu.

It has been assumed that no additional layover space would be available in Wellington, and peak buses not in service during the interpeak period would be run back to their depots.

(ii) Bus Passenger Protection

Bus shelters will be required at most rail stations to provide weather protection for passengers (the exceptions are the major rail stations, eg Upper Hutt, Waterloo, Porirua). Stations have been sorted, based on their rail patronage, into three groups in terms of extent of passenger protection required : low, medium and high (low = 1 bus shelter required, medium = 3 bus shelters, high = 5 shelters).

1.2.3 Bus Priority Measures

The programme of Am Peak Bus Priority measures required is shown in Table 1.

Three corridors were found to have sufficiently high bus flows to warrant bus priority measures: SH1 from Whitford Brown Drive south; SH2 from the SH58 junction; and the Eastern Hutt route following the present Hutt rail line. The total capital costs of the measures identified from site inspection of these routes was found to be approximately $51 million for the schemes required for the morning peak period only. No costing has been done of any evening peak schemes but, on the basis of the costs of the morning schemes and the nature of evening congestion in Wellington, this has been estimated at a further $20 million.

The measures can be divided into three types: traffic management on arterial and other roads; use of motorway hard shoulders as a bus lane; and motorway widening to accommodate a bus-only lane. Of these, the third are extremely

expensive and the two schemes identified (SH1 Johnsonville to Ngauranga and SH2 Korokoro to Petone) between them account for around 2/3 of the total capital costs.

The remaining less costly schemes between them have a capital cost around $17m and it is to be expected that these would be higher priority. This is because: firstly they represent better value for money; secondly they are unlikely to require resource consent; and thirdly the major widening schemes may be hard to justify for buses only (rather than general traffic).

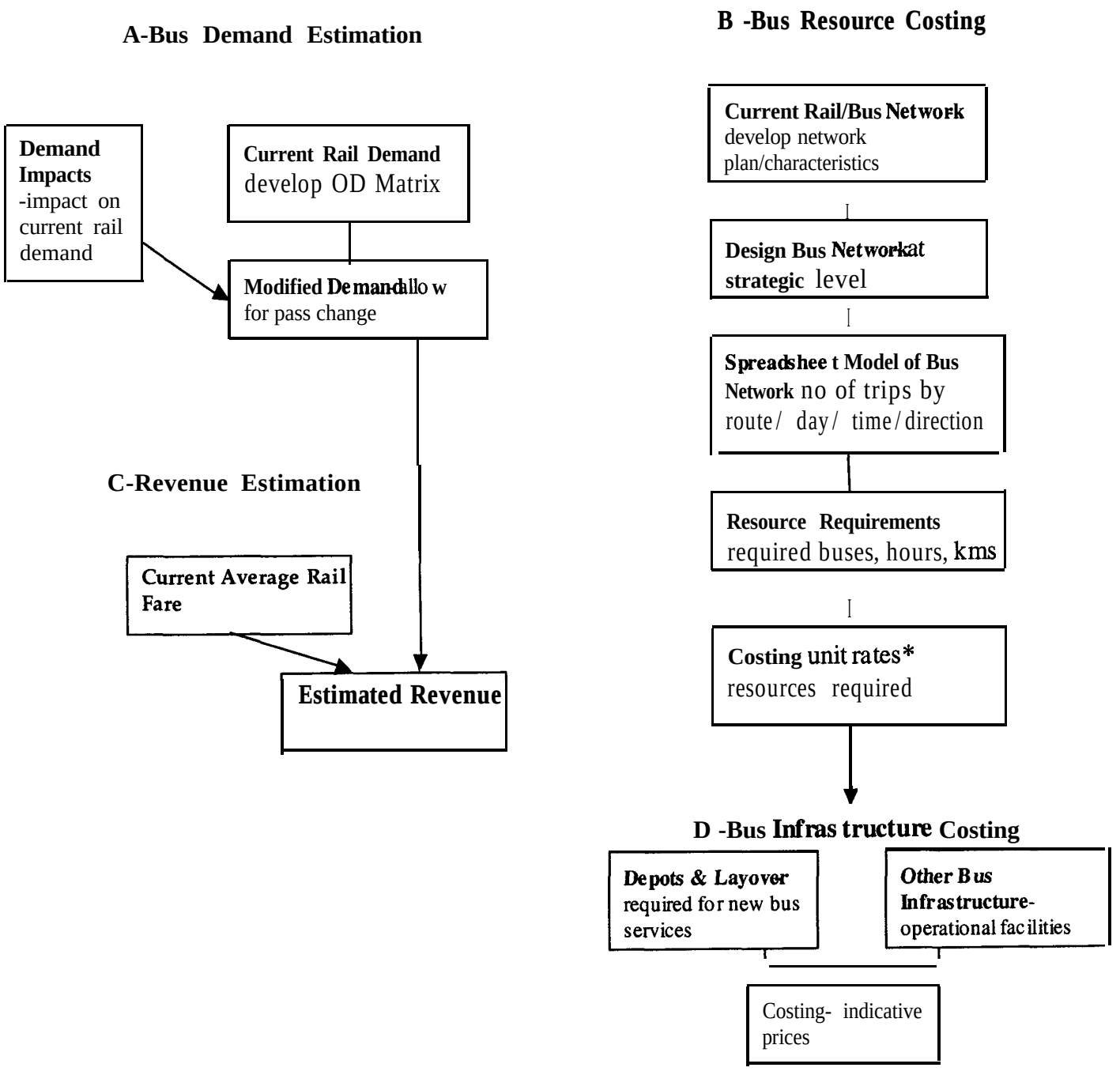
Table 1 Bus Priority Programme - Am Peak			
Site	**Initiative**	**Description**	**Estimate 6,000)**
State Highway *1* Corridor			
Whitford Brown to Takapu Road	Bus lane, New phase	New phase at Whitford Brown traffic lights	200
Takapu Road to Helston Road	Bus lane	Widen existing shoulder by lm average	500
Helston Road to SH2	Bus lane	Widen road including reconstruct Helston Road overbridge, widening of pedestrian underpass and Newlands underpass	18200
Subtotal			18.900
State Highway 2 Corridor			
SH58 to Hebden Crescent	Bus lane	Convert existing sealed shoulder	30
Hebden Crescent to Wairere Road	Bus lane	Widen pavement by 3m on river side including bridge, relocation of islands and moving traffic signal poles	4,000
Wairere Road to Block Road	Bus lane	Widen pavement by a full lane	1,000
Block Road to Melling Link	Bus lane	Widen pavement by a full lane	1,600
Melling Link to Dowse Drive	Bus lane	On current rail reserve, may require relocation of pier on the Normandale Road overbridge	1,700
Dowse Drive to Korokoro Road	Bus lane	Widen existing road by one lane including a bridge, culvert open drain	2,500
Korokoro Road to Esplanade Merge	Bus lane	Widen by one lane on western side, extend pedestrian overbridge	16,400
Esplanade Merge to Ngauranga	Bus lane	Use hard shoulder, construct busway on rail reserve	3,400
Ngauranga to CBD	Bus lane	Kerbside priority lane including removal of parking spaces	40
Subtotal			**30,670**
Cambridge Terrace Route			
Taita College pedestrian crossing	Bus pre-emption	Signalise existing crossing including bus pre-emption	100
Cambridge Terrace / Eastern Hutt Road / Percy Cameron Street Intersection	Road layout change	Change to a signalised seagull intersection	400
Cambridge Terrace / Whites Line East Intersection	Bus pre-emption	Incorporate bus-preemtion at existing signals	100
Whites Line East / Randwick Road / Ludlam Crescent Intersection	Bus lane	Construct bus only free left turn lane	400
Randwick Road	Bus pre-emption	Signalise two pedestrian crossings and incorporate bus pre-emption	200
Hutt Park Roundabout - Option 1	Bus lane	Off side bus lane, make Croft Grove left in, left out only	40
Petone Esplanade	Bus lane	Create bus lane to replace existing peak-hour only bus lane, minor pavement widening, ban southbound approach, reroute cycle lane	***550***
Subtotal			***1,790***
		Total	**51,360**

2 Methodology

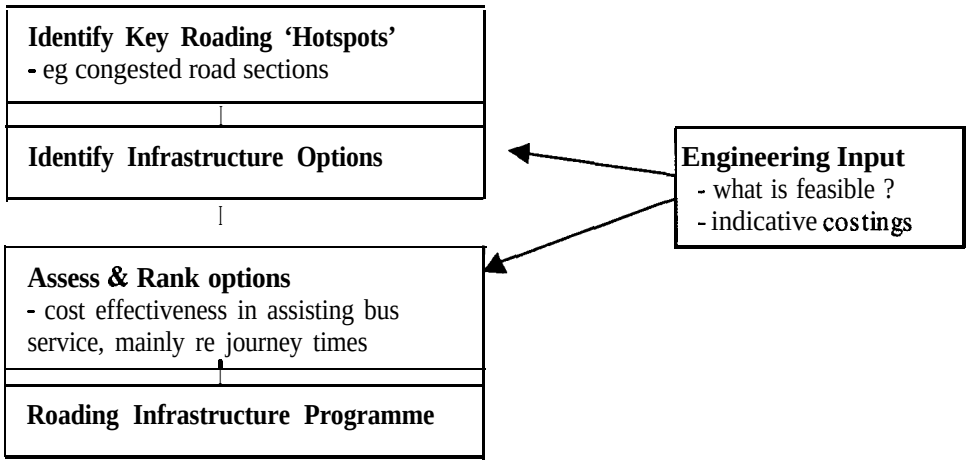
2.1 Methodology

Figure 1 provides an overview of the methodology used to determine the resources required to replace the existing rails service with a bus service, and to estimate the net costs of these resources. Key points in regard to each part of the analysis are made below.

Figure 1 Methodology



E –Roading Infrastructure Prioritisation and Costing



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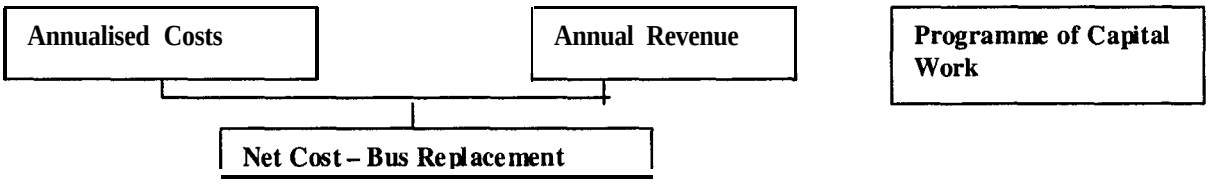

2.2 Bus Demand Estimation

2.2.1 Current Rail Demand

The current rail demand by origin area was determined based on rail am peak and interpeak origin-destination matrices from the Wellington Transport Strategic Model (WTSM). The model am peak period is only 2 hours (7-9am) whereas the rail service am peak is 3 hours, 6-9am. Loadings on the 6-7am trips were assumed to be 60% of the 7-9 am services. Pm peak patronage was assumed to be equal to am peak patronage. Evening patronage was taken as 1.5 times the 2 hour interpeak patronage (ie WTSM model output of average 2 hours within interpeak period), and weekend patronage as 6 times the interpeak (2 hour).

2.2.2 *Modified Demand*

The current rail demand was then adjusted to allow for the fact that replacing the rail service with buses can be expected to result in decreased patronage as a result of two factors:

1) longer journey times as a result of buses being caught to some extent in traffic (even with bus priority measures); and,

2) public transport users generally prefer rail over bus due to its better ride quality and other aesthetic factors.

An attempt to estimate the extent of this loss in patronage was made. The approach adopted is outlined below.

In the conventional transport modelling framework (for example that being used currently in the development of WTSM), the choice between modes (eg between car and passenger transport (PT) or between bus and rail) is addressed frequently. In mode choice modelling all aspects of a trip are combined in the "generalised cost (GC)", which includes in-vehicle time, walk and wait time, fare and also a "mode-specific constant (MSC)" representing modal preferences which cannot otherwise be quantified. In this way the two factors described above can be represented as an increase in the GC of a PT trip if rail is replaced by bus.

Based on results from elsewhere, an increase in GC of between 10 and 20 minutes can be expected if bus replaces rail. This is a combination of the extra in-vehicle time and a higher MSC for bus than rail when in competition with car.

Mode choice modelling has been an integral part of the development of WTSM. In general however bus and rail were not in competition at the time the model data was collected so no parameters are available for a bus versus rail choice model. In view of this an alternative approach was adopted.

WTSM models the choice between two modes, car and PT. In the corridors presently served by rail, the replacement of bus by rail will increase the GC of PT and hence cause a shift to car. The only exceptions to this are those who are "captive" to PT, i.e. they do not have access to a car.

For the purposes of this exercise a spreadsheet model was developed to forecast the expected change in mode split resulting from the replacement of rail by bus. This used:

- Mode split parameters from WTSM
- An increase in the PT GC of between 10 and 20 minutes
- A range of current PT mode shares on the rail corridors between 10 and 20%
- The proportion of captive users from WTSM.

This indicated that, depending on the base assumptions, the proportion of current rail users who would switch to bus would be in the range 70% to 85%. In the light of this a value of 75% was used; that is, for every 4 rail users now there will be 3 bus users if rail is replaced.

This demand adjustment factor of 0.75 was applied to the current rail demand to produce a (rail) bus demand by origin area. Each area's patronage was then applied to an existing rail station.

2.3 Bus Resource Costing

The approach taken in regard to bus network design was to assume that the bus service would simply replace the rail service, ie it would run between the existing

rail stations. No attempt was made to integrate the current feeder buses into the rail bus service. This approach taken was considered the simplest one and the approach which would be taken in the short-term if the rail actually was replaced with buses. In a medium term situation with no rail the whole bus network would be reviewed to provide an integrated bus service.

A key assumption of the analysis was that the replacement bus service would be of an equivalent standard to the current rail service. This was taken to principally mean equivalent service frequencies, and, as far as possible, similar journey times. As indicated above, this latter feature was generally not achievable, even with bus priority measures (without the priority measures the bus journey times would have been substantially longer). Bus service frequencies will, however, be higher than the current rail service frequencies.

A spreadsheet based model of the bus replacement services was developed. This model matched the new bus services to the (adjusted) bus demand by station, and determined the total number of bus trips required by station by time period (am peak, interpeak, pm peak, evening, Saturday, Sunday). The bus network model results were then used to produce bus timetables, which were optimised to make maximum use of resources. Initially this was done assuming an even spread of patronage over the peak time period. A further iteration allowed for the very peaked nature of the rail service (around 77% of peak 2 hour passengers in the peak hour) and for the lower average loadings likely to be achieved on a bus service.

The total bus operating and capital resources (ie new buses) were then calculated, and these were multiplied by unit costs to determine the bus operational costs.

2.4 Revenue Estimation

The estimated revenue was determined by multiplying the bus patronage by the current average rail fare (Source GW Rail RFQ). This approach assumes that the current rail fares will be used on the replacement bus service (this would be the case in the short-term at least).

2.5 Bus Infrastructure Costing

2.5.1 Bus Depots

As part of the bus resource costing analysis the number of buses needing to be 'stabled' at key locations was determined. As indicated above, it was assumed that around half of the additional buses required (70 buses) will be able to be stabled at existing bus depots. The bus depot costings assume that a depot consists of :

- a sealed area that allows all buses to be parked within the depot
- a fence surrounding the depot, and
- a small building for drivers, including toilet facilities (not required for Porirua East extension).

The land costs make the following assumptions:

- The sites acquired for the bus depots are already developed (ie have houses on them).
- The average house occupies a 600 square metre section.
- The house has a net zero value (ie its value for removal equals its removal cost).
- House costs are based on an average of recent house sales in the area.

It was not considered that additional bus infrastructure would be required given that the buses would pick up and drop off passengers at the existing rail stations.

25.2 *Bus Passenger Infrastructure*

As indicated above, bus shelters will be required at most rail stations to provide weather protection for passengers (the exceptions are the major rail stations, eg Upper Hutt, Waterloo, Porirua). Stations have been sorted, based on their rail patronage, into three groups in terms of extent of passenger protection required : low, medium and high (low = 1 bus shelter required, medium = 3 bus shelters, high = 5 shelters).

2.6 Roading Infrastructure Prioritisation and Costing

A full description of the process undertaken to identify bus priority measures required, and to cost these measures is provided in Chapter 3 of this report.

In summary, a number of schemes were proposed as a result of a "drive over" of the three main routes where bus flows are sufficient for priority schemes to be justified; these related to morning peak travel only. Some of these are relatively low-cost measures – either traffic management or the use or extension of existing road space - which can be implemented quite quickly. These measures would be introduced as a matter of priority.

Two schemes were identified, one each on SH1 and SH2, each costing in the region of $15-20 million, which would be necessary if buses are to be allowed to by-pass the worst of the morning queues. By their very nature these would take a number of years for resource consent, design and construction.

2.7 Overall Costing

All of the costs were annualised, and then set against the estimated annual revenuei. An annual net cost of replacing the rail service with buses was thereby determined.

[1] Capital costs were annualised using the Funding Gap approach as per Transfund's Alternative to Roading procedures at 10% RRR

3 Bus Priority Measures

3.1 Aim and Scope

The aim of the bus priority investigation was to identify and cost the physical measures that would be required to achieve a bus commute time no longer than the current suburban train commute time in so far as this is possible.

Following a site inspection the scope of work was agreed as:

- to identify locations on the road network where a bus was likely to be delayed during the morning peak
- to identify a suitable means of minimising or eliminating the delay.

The identified physical construction measures were then costed, on a Rough Order of Costs basis, by an experienced civil engineer.

The exercise has looked only at the AM peak; however a similar network of bus priorities would be required in the evening peak to get bus commuters out of Wellington CBD. Outside the peak periods there is unlikely to be sufficient general traffic congestion to warrant priority measures.

3.2 Routes

Following the design of a suitable bus route network to replace rail, three routes were found to have sufficiently high bus flows in the AM peak to require priority measures. These were:

- SH1 from the Whitford Brown Avenue intersection to the SH2 intersection,
- SH2 from the SH58 intersection to Wellington CBD
- The Eastern Valley Route (Cambridge Terrace from Ferguson Drive, Whites Line East, Randwick Road, Waione Street, Petone Esplanade) to SH2

Other routes, such as the road through Porirua and Tawa, would have bus services operating but were considered not to have sufficient congestion to justify specific priority measures. Nonetheless buses using these routes will be subject to some congestion, which rail services are not.

3.3 Methodology and Assumptions

An experienced civil engineer and an experienced transportation planner drove the three routes. Locations where buses were likely to be delayed in the morning peak hour traffic were identified from a combination of inspection and consideration of the Congestion Index (CGI) figures collected by Transit NZ for SH1 & SH2.

The methodology incorporates a number of limitations and assumptions.

3.3.1 Limitations

We have generally only identified one bus priority solution for each location. No attempt has been made to identify a range of options and evaluate them to identify a preferred option.

We have not attempted to demonstrate that the identified solution is viable. In each case the identified solution appears viable based on a brief site inspection. No examination of aerial photos, services or other plans, or confirmation of dimensions has been attempted. In practice, even with the measures proposed, there will be locations where bus speeds cannot match rail due to other limitations such as speed limits and delaying factors such as side roads and site access (for example where traffic entering a filling station has to cross a bus lane).

No traffic modelling of the existing and / or proposed situation has been attempted.

3.3.2 Assumptions

We have assumed that:

- land required for the bus priority measures would be made available
- where existing pavement is proposed to be utilised as a bus lane (eg, motorway hard shoulders) we have assumed that the current pavement structure is adequate to support the additional loads that would be imposed on it
- any legislative changes required by the proposed bus priority measures (e.g. a let the bus go first green phase at traffic signals) would be introduced.

3.3.3 Exclusions

- Land acquisition costs
- Resource consent costs

3.4 State Highway 1 Route

3.4.1 Whitford Brown Avenue to Takapu Road

- Utilise the existing shoulder as a priority bus lane on the southbound approach to the signals at Whitford Brown Drive.
- Introduce a new phase at the Whitford Brown traffic lights to let southbound buses on SH1 clear the intersection prior to the commencement of the green phase for other traffic.

3.4.2 Takapu Road to Helston Road

Widen the existing shoulder by 1m (average) so that the widened shoulder can be utilised as a bus lane.

3.4.3 Helston Road to SH2

This section runs from the Helston Road overbridge, along SH1 past the Newlands underpass and the Newlands overbridge, down the Ngauranga Gorge and along the Old Hutt Road off ramp (past L V Martins) to the traffic signals on Old Hutt Road.

- Reconstruct the Helston Road overbridge to accommodate a bus lane on SH1.
- Widen by 3.5m from Helston Road to SH2. Note that significant cuts and fills would be required, a very expensive exercise. Includes widening of the pedestrian underpass and the Newlands underpass. Alterations to the Newlands overbridge will be required as would incorporation of bus pre-emption in the traffic signals at Old Hutt Road.

3.5 State Highway Two Route

3.5.7 SH58 to Hebden Crescent

Convert existing sealed shoulder to a bus lane.

3.5.2 Hebden Crescent to Wairere Road

Widen pavement by 3m on the river side to accommodate the bus lane. Widening will require land take, 2m fill, retaining wall, and noise barrier. Continue widening through Fairway Drive intersection to south side of Belmont school. Requires widening of existing bridge, relocation of islands and lights at intersections.

3.5.3 Wairere Road to Block Road

Widen pavement by a full lane to accommodate the bus lane to Block Road. Allow for 2m fill and batter.

3.5.4 Block Road and Melling Link Intersections

Widen pavement by a full lane to accommodate the bus lane. Allow for relocating traffic islands and moving traffic signal poles.

3.5.5 Melling Link to Dowse Drive

Create a new bus lane on the current rail reserve. This may require relocation of a pier on the Normandale Road overbridge.

3.5.6 Dowse Drive to Korokoro Road

Widen existing road by one lane on the rail side to accommodate the bus lane. Allow for widening of one bridge and to culvert the open drain.

3.5.7 Korokoro Road to The Esplanade Merge with SH2

Widen by one lane on the western side to accommodate the bus lane. Land take would be required. Allow to extend the pedestrian overbridge. No solution to getting an extra lane under the esplanade on ramp was identified and it may be necessary to reconstruct the entire on ramp including the bridge – which would be very expensive.

3.5.8 Esplanade Merge to Ngauranga

Use the hard shoulder as bus lane. This may eliminate the cycleway. Take buses off SH2 prior to the Old Hutt Road off ramp and construct a busway on rail reserve to the existing rail tunnel below Homebush Road. This tunnel appears wide enough to accommodate a dedicated busway.

3.5.9 Ngauranga to City

Booz Allen have previously examined a number of possible schemes on this corridor as part of a study of bus priorities for Wellington City Council. One outcome of this study was the median bus lane recently introduced between "Capital Gateway" and Mulgrave St., improving access to the Lambton Interchange.

Two schemes from the earlier study are proposed as part of the bus priority measures which would be required on Old Hutt Road:

- A kerbside priority lane on the approach to the Kaiwharawhara signals
- A kerbside priority lane on the approach to the junction with Tinakori Road.

Downstream from the Tinakori Road junction further measures would be required, again in the form of a kerbside bus lane. As there is adequate road width available here the physical works necessary would be largely "white lining", including the removal of a number of parking spaces. This lane would go as far as "Capital Gateway" and link up with the existing median bus lane.

3.6 Cambridge Terrace (Eastern Hutt) Route

3.6.7 General

It is not clear whether a bus priority lane would be required along this route prior to Petone Esplanade. During the site inspection traffic was flowing freely and there were no obvious pinch points. However there are locations along the route that have clusters of local shopping and businesses. These will create side friction which has the potential to slow traffic movements.

For the purposes of these estimates it has been assumed that a bus priority lane is not required north of Petone Esplanade.

It was noted that the existing pavement appears to be of adequate width to accommodate a bus priority lane. Hence if a decision was made that a bus priority lane is required then the main changes required would be line marking.

3.6.2 Tia ta College Pedestrian Crossing

Signalise the existing crossing, including bus pre-emption.

3.6.3 Cambridge Terrace / Eastern Hutt Road / Percy Cameron Street Intersection

Change to a signalised Seagull Intersection.

3.6.4 Cambridge Terrace / Whites Line East Intersection

Incorporate bus pre-emption at the existing signals.

3.6.5 Whites Line East / Randwick Road / Ludlam Crescent Intersection

Construct a bus only free left turn lane. Allow 200m lineal metres of new pavement, relocation of lights and water main, 2m average fill height and guardrail. Land take will be required.

3.6.6 Randwick Road

Signalise two pedestrian crossings and incorporate bus pre-emption.

3.6.7 Hutt Park Roundabout

3.6.7.1 Option 1

Off side bus lane on the approach to the roundabout to allow buses to by-pass queues and be in the correct position to turn right at the roundabout. Allow 40 lineal metres of new pavement. Make Croft Grove left in left out.

3.6.7.2 Option 2

Grade separated flyover.

3.6.6 Petone Esplanade

Create a bus priority lane along the full length from Hutt Park roundabout to the junction with Hutt Road, replacing the existing peak-hour bus lane. Minor pavement widening required at the Hutt Road roundabout. Ban southbound approach to the roundabout along Hutt Road during the morning peak. Carry bus lane along the on-ramp and on to SH2. Reroute cycle lane to seaward side of rail line. Link up with SH2 measures (see 4.8).

3.7 Conclusions

- Provision of the Am Peak bus priority measures is likely to cost in the vicinity of $50 million.
- Most of the measures are relatively inexpensive to implement, and could be expected to be reasonably effective.
- Most of the cost is incurred for alteration of two existing bridges (Helston Road overbridge on SH1 and Petone esplanade ramps on SH2). If the flyover option is selected at Hutt Park roundabout a further $20 million or so would be added to the cost.
- Implementing the less costly measures without implementing the costly bridge alteration measures may result in the creation of bottlenecks that could significantly delay buses during peak hours.
- The bus journey time after implementation of the bus priority measures are in place is unlikely to match the current commuter rail journey time