Value of CityRail to the Community of New South Wales

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1 Foreword

This analysis has been developed to estimate the value of CityRail to the NSW community. It has been developed as a discussion paper to show the real value of CityRail from an economic framework, which takes into account costs and benefits that may not be reflected in monetary transactions. It accounts for rail user benefits, which are not reflected in the fares paid by CityRail passengers, as well as the value to road users from having less crowded roads and reduced road related costs in addition to environmental externalities associated with the metropolitan rail network.

This document is a work in progress subject to continuous refinement as more information becomes available. Its primary purpose is to facilitate comparison and discussion concerning the wider community/economic and the narrower/accounting value of CityRail. The analysis reflects the views of the authors and does not reflect the views of Rail Corporation NSW.

2 Introduction

The aim of this study is to estimate the value of CityRail to the community of NSW. The main reasons why it is important to provide monetary valuations of the benefits and costs of CityRail are to:

- provide an indication of the scale or magnitude of the value of CityRail to the community;
- assist in the formulation of policies to address the level of expenditure by the community; and
- facilitate project evaluation/investment decisions.

CityRail provides a substantial part of Sydney's transport task and the benefits from its services accrue to rail users, non-rail users and the wider community. It is important to note that CityRail's activities have direct and indirect impacts on the level of environmental, social and economic benefits and costs of transport. Directly, CityRail generates benefits and costs through the provision of rail services to the people of Sydney and regional areas serviced by the metropolitan network. Indirectly, it influences the benefits and costs associated with the metropolitan transport system through its operation as a substitute for private transport. CityRail thus beneficially impacts on the levels of:

- road congestion;
- air pollution;
- traffic noise;
- traffic accidents; and
- road damage costs

by the extent to which the demand for private road transport is reduced by the supply of and demand for the services of CityRail. Deprival[1] of CityRail services would remove all of these benefits and impose a cost on existing and potential transport users.
This would force them to use less preferred modes of transport. The availability of CityRail services provides a substantial private benefit to individual rail users, road users and to the community at large.[2]

The study is based on the methodology developed by the Centre for International Economics [CIE] (2000) to estimate *the economic benefits and costs of CityRail to the community*.[3] In addition, the methodology has been updated to the approach applied by Hensher. D et al (1993) and London Underground Limited (1994).[4]

3 Major assumptions

The general assumptions that underlie the study are as follows:

- estimates of costs and revenues are for CityRail only. CountryLink capital spending, operations costs and revenues are not included;
- all estimates relating to costs and revenues are on a cash basis only. No accrued values are included;
- CityRail's 'Income and Expenditure Statement 2006-07' generated by RailCorp Corporate Finance Group is used to estimate the operating recurrent costs and revenue of CityRail;
- rail users receive "consumer surplus" benefit as they enjoy extra economic benefits over and above the fare that they pay for CityRail's trips, such as ambience benefits;
- road congestion and road externalities increase if CityRail services are not available to the community; and
- avoided costs to operate other transport modes without CityRail services are not included in the study;

3.1 Unit of account

Costs and benefits are expressed in 2006-07 constant prices, thereby adjusting for the relative movement in prices (inflation) over the analysis period.

4 Estimating the value of CityRail

4.1 Methodology

The approach used to measure the benefits that CityRail confers on the community is to value the transport task without a rail network, which is the approach undertaken by Hensher. D et al (1994), LUL (1994) and CIE (2000). CityRail provides an on-going stream of social benefits to both CityRail customers and non-users of CityRail services [see LUL (1994) p.2, and CIE (2000)]. The benefits are notably:

1 Deprival value can be defined as: the loss, which results to an individual (private) or the community (social) from being deprived of a service or an asset. It is the minimum cost of replacing the service rendered by the asset, which measures the loss by deprivation.

2 Centre for International Economics, 2000.

3 Centre for International Economics, 2000.

4 London Underground Limited, 1994.

- the generalised cost savings that accrue to passengers relative to the next best alternative form of transport and/or the "consumer surplus" that would be foregone in the case of a journey that would be totally suppressed in the absence of CityRail;
- road user benefits that is the avoided additional road congestion costs associated with having a rail network;
- externality costs related to road transport including air and noise pollution, greenhouse gas emissions, road accident and road damage costs;
- CityRail's farebox revenue; and
- CityRail's net income and expenditure before government subsidy (producer surplus/shortfall).

The economic benefits generated by the provision of CityRail services can be quantified by investigating the costs and benefits associated with the hypothetical cessation of CityRail services.

The benefits and costs associated with the cessation of CityRail services are as follows:

4.1.1 Benefits

- CityRail cost savings; and
- CityRail capital investment savings.

4.1.2 Costs

- foregone CityRail customer consumer surplus;
- increase in road congestion; and
- increase in road externalities[5].

The benefits of the cessation of CityRail services is the savings in the net operating expenditure of CityRail i.e. "producer surplus".

The cost of cessation of CityRail services is foregone consumer surplus plus the increase in road congestion and associated externalities. Therefore, the estimated value of CityRail to the community can be expressed as follows:

$$VCR = PS + CS + EXT \quad \text{.....(1)}$$

where:

VCR = value of CityRail;
PS = producer surplus/shortfall — CityRail's net income and expenditure;
CS = consumer surplus; and
EXT = road externalities

Each of the three variables is used to measure the value of CityRail to the community.

4.2 CityRail's producer surplus — net income and expenditure

The CityRail 'Income and Expenditure Statement 2006-07' generated by the RailCorp Corporate Finance Group was used in this analysis to estimate CityRail's cost to provide rail passenger services to the community in 2006-07 (table 1).

5 The analysis considered the avoided costs to road users only. If the analysis considered the additional road capacity required to accommodate transferred rail users then we would be double counting.

Farebox revenue, the Government's contribution for concession fares and other operating income were combined to estimate CityRail revenue before general subsidy (table 1). Recurrent and non recurrent operating expenses were combined to give total costs which were then deducted from CityRail revenue to derive the operating shortfall before NSW Government funding.

In addition, 10 year averages of net income and expenditure were produced, using actual figures for the period 1997-98 to 2006-06 and latest estimates for 2006-07, to adjust for annual fluctuations in demand and costs. All costs were done in 2006-07 constant prices to eliminate the effects of inflation.

4.3 CityRail income and expenditure statement 2006-07

4.3.1 Income

CityRail revenue before general subsidy in 2006-07 of $760.6 million is defined as the value of income used in the study to estimate producer surplus/shortfall. This is presented in table 1.

Table 1
CityRail income and expenditure statement 2006-07 and the average of the ten year period from 1997-98 to 2006-07
In 2006-07 prices

Description of incomes and expenditures	2006-07[(b)] ($million)	Ave. 1997-98 to 2006-07 ($ million)
Operating revenue		
Farebox revenue	498.5	520.0
Revenue from other rail organisations	-	68.4
Other income[(a)]	102.1	103.0
Total revenue before Govt subsidy	600.6	691.5
Non operating income		
Free & concessional contract revenue	160.0	183.5
Revenue before general subsidy	760.6	874.9
Operating expenses		
Recurrent Operating		
Labour costs	1 210.8	857.2
Oncosts - non Comm	-	45.5
Security contract services	24.1	32.0
Electricity	36.6	31.3
Other Operating	673.6	430.0
Transfer Charge/allocation to CountryLink	-	-31.6
Above rail recurrent operating	1 945.1	1 364.3
Access fees	5.3	271.9
Recurrent operating	1 950.4	1 636.3
Non-recurrent operating expenses		-
Severance	-	7.3
Non-cash		-
Depreciation	437.0	262.1
Non operating expenses		
Finance charges	19.7	16.3
Fixed assets written off /sold	4.0	41.5
Capital grants made to RAC	-	50.4
Total non recurrent operating expenses	460.7	377.6
Total costs to CityRail	2 411.1	2 013.9
Surplus/(shortfall) before Govt funding	-1 650.5	-1 139.0

Source: Budgeting and Reporting, RailCorp Finance

Note(a): other operating income comprises of penalty notices, property rental, interest income, asset disposal and sundry income.

(b) forecast.

This comprises $498.5 million farebox revenue (66 per cent), $102.1 million of other operating income (13 per cent) and $160.0 million of concession revenue (21 per cent). CityRail is financed by the NSW Treasury through Community Service Obligation (CSO) payments to compensate CityRail for providing non commercial services to certain sections of the community and therefore this payment is not a subsidy by Government to CityRail to operate the metropolitan rail network.

4.3.2 Expenditure

In 2006-07, CityRail estimates that it will require $2 411.1 million to operate and maintain its current passenger services. The total recurrent operating expenditure is estimated at $1 950.4 million in 2006-07, comprising $1 210.8 million labour costs and $739.6 million non labour costs (table 1). Labour costs include CityRail's staff salaries, wages and on-costs. Non-Labour costs encompass all other recurrent expenses such as contracts and professional services including the Transport Infrastructure Development Corporation, NSW (TIDC), materials, spares and equipment hire and other business and utility costs (table 1). Non recurrent operating expenses for 2006-07 are estimated at $460.7 million, comprising $437.0 million depreciation, $19.7 million finance charges and $4.0 million in fixed asset sales and write offs (table 1).

4.4 CityRail 10 year average income and expenditure for period 1997-98 to 2006-07

4.4.1 Income

The 10 year average for CityRail revenue before general subsidy from 1997-98 to 2006-07 of $874.9 million comprises farebox revenue of $520.0 million (59 per cent), revenue from other rail organisations of $68.4 million (8 per cent), $103.0 million of other operating income (12 per cent) and $183.5 million of concession revenue (21 per cent), as set out in table 1.

4.4.2 Expenditure

The 10 year average cost for CityRail to operate and maintain its passenger services is $2 013.9 million. The average total recurrent operating expenditure is $1 636.3 million, comprising $902.7 million labour and oncosts and $733.6 million non labour costs (table 1). Average non recurrent operating expenses are $377.6 million, comprising $262.1 million depreciation, $16.3 million finance charges, $41.5 million in fixed asset sales and write offs and $50.4 million capital grants (table 1).

4.5 Rail user benefits – consumer surplus

Rail user benefits are quantified by the measure of 'consumer surplus' which is a measure of perceived consumer benefits from rail travel over and above the fare that they pay[6].

6 Motorists do not meet the true cost of road travel including externality costs. Thus there is a possibility that demand for CityRail services could be higher then current levels. In addition, the fares that CityRail passengers pay do not reflect the true resource cost of their travel. If the real resource cost for travel was charged, the average price would be higher than what is actually charged. These factors could lead to a higher value for CityRail services. The estimated value of CityRail to the community may therefore be underestimated.

The consumer surplus is the difference between a consumer's marginal value or utility of a unit of a good or service and its price.

The willingness of rail users to pay for rail services at different price levels is represented by the demand schedule in figure 1. The blue triangle in figure 1 estimates consumer surplus. This measures the difference between what price rail users are willing to pay and the price (fare) that they do pay.

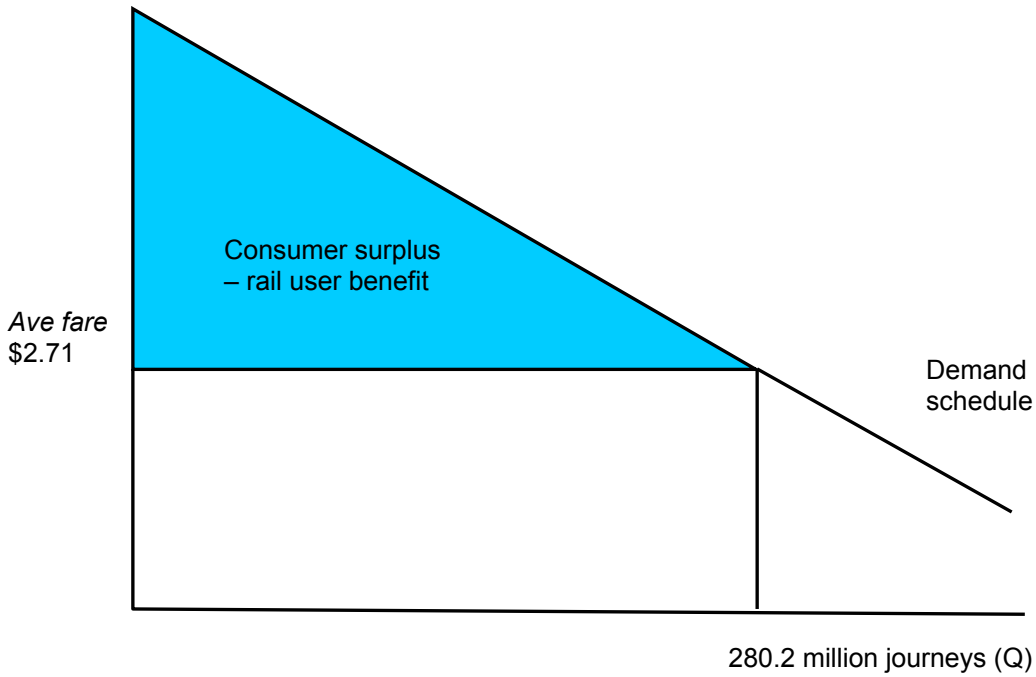


Figure 1
Demand for CityRail services

Or simply expressed as:

$$CS = \left(\frac{f * Q}{\varepsilon} \right) \qquad (2)$$

where:

CS = consumer surplus;
f = average fare;
Q = passenger journeys, and
ε = fare (price) elasticity.

A more mathematical way of measuring consumer surplus was developed by LUL and it is presented in Appendix B

The variables and parameters used to estimate the consumer surplus are presented in table 2.

In 2006-07, CityRail's annual revenue from farebox and concession revenue was $760.6 million and the number of passenger journeys was 280.2 million. This generates an average fare of $2.71 per trip. As shown in table 2, with an average fare of $2.71 (*f*), passenger

journeys of 280.2 million (Q) and an average fare elasticity ε) of –0.37, the value of CityRail to its passengers as measured by rail user benefits (consumer surplus) is $2 055.7 million.[7]

For the 10 years between 1997-98 and 2006-07 CityRail's average annual revenue from farebox and concession revenue was $874.9 million and the average annual number of passenger journeys was 274.9 million. This generated an average fare of $3.18 per trip. As shown in table 6, with an annual average fare of $3.18 (*f*), annual average passenger journeys of 274.9 million (Q) and an average fare elasticity ε) of –0.37, the annual average value of CityRail to its passengers as measured by rail user benefits (consumer surplus) is $2 364.9 million.

Table 2
Rail user benefits – consumer surplus 2006-07
In 2006-07 prices

Variables	Unit	Parameters 2006-07	Average 1997-98 to 2006-07
CityRail revenue	($million)	760.6	874.9
Passenger journeys	(million)	280.2	274.9
Average revenue fare	($/trip)	2.71	3.18
Fare elasticity – ε	ε	-0.37	-0.37
Rail user benefits	$million	2 055.7	2 364.9

4.6 Non-user benefits – external effects

It is assumed that with the cessation of all CityRail services the current trips undertaken by CityRail passengers will be diverted to road transport - private cars and buses. The diversion of traffic from rail to road is expected to increase road congestion, accidents, air and noise pollution, greenhouse gas emissions and road damage. In addition, the elimination of all CityRail services will avoid externality costs associated with operating the CityRail fleet.

4.6.1 Alternative mode of transport

In 2006-07, the people of Sydney and the regions bounded by the CityRail metropolitan network used the rail network to undertake an estimated 280.2 million passenger journeys.

Over the past ten year period 1997-98 to 2006-07, the people of Sydney and the regions bounded by the CityRail metropolitan network used the rail network to undertake an annual average 274.9 million passenger journeys.

Removing CityRail and thus depriving these passengers of CityRail services would decrease the level of travel and change the nature of the supply of travel. This is because passengers may not have an alternative mode of transport, for example, they may live in an area such as Leppington in the Outer Western Suburbs, where public transport is not available or they may be a single car owner.

Considering how the supply of travel will change provides the basis for estimating the public cost of removing CityRail services or alternatively the benefit of retaining them CIE (2000). The second best alternative mode of transport of rail users was used[8] to estimate the cost of the removal of CityRail services. Rail users' second best alternative mode of transport and the number of rail users affected are shown in table 3.

7 The figure may not calculate exactly due to rounding.

8 CityRail, 2006.

Based on the 10 year average for the period 1997-98 to 2006-07, the second best alternative mode of transport for rail users to and from the CBD is car at 76.5 million (51.5 per cent), followed by bus at 65.8 million (44.3 per cent) and then walk at 6.2 million (4.2 per cent). For non CBD rail users the second best alternative mode of transport is car at 68.5 million (54.2 per cent), followed by bus at 51.3 million (40.6 per cent) and then walk at 6.6 million (5.3 per cent).

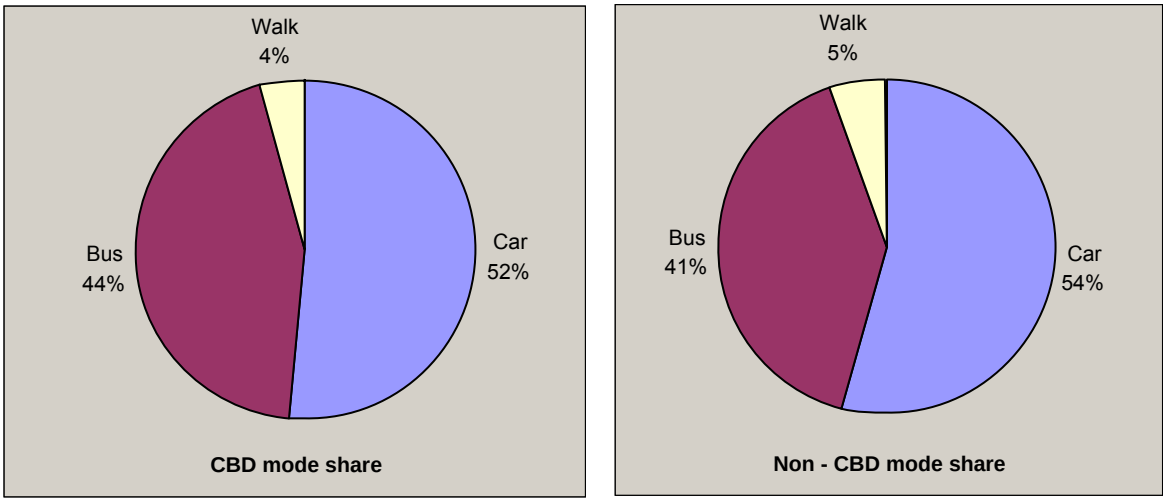
Table 3
Rail users' second best alternatives by length of journey

Passengers diverted	2006-07 (million)	Average 1997-98 to 2006-07 (million)
CBD		
Car	77.9	76.5
Bus	67.1	65.8
Walk	6.3	6.2
Total – CBD	151.3	148.4[(a)]
Non CBD		
Car	69.9	68.5
Bus	52.3	51.3
Walk	6.8	6.6
Total - Non CBD	128.9	126.4
Total passengers diverted	280.2	274.9

Note(a): the figure may not add due to rounding.

Based on the 10 year average, overall annual average passenger journeys diverted to car would increase by 145.0 million, to bus by 117.1 million and by foot by 12.8 million.

In 2006-07, 151.3 million passenger journeys to and from the CBD would be diverted from rail to other modes of traffic. Of these 77.9 million (51.5 per cent) would divert to road, followed by bus at 67.1 million (44.3 per cent) and then walk at 6.3 million (4.2 per cent).



Figures 2 & 3
Mode share – best alternatives to rail – CBD and Non CBD share

For non CBD rail users in 2006-07 with 128.9 million journeys, the second best alternative mode of transport is car at 69.9 million (54.2 per cent), followed by bus at 52.3 million (40.6 per cent) and then walk at 6.8 million (5.3 per cent).

In 2006-07, overall annual average rail passenger journeys diverted to car are estimated to be 147.8 million, to bus is estimated at 119.3 million and to foot is estimated at 13.1 million. The mode-shares between rail, bus, car and walk in the Sydney CBD and non-CBD areas are shown in Figures 2 and 3 below.

4.6.2 Congestion

By diverting rail passenger journeys from rail to road, there is a net disbenefit (disutility) to all road users by slowing down traffic. The disutility from increased road congestion has been based on traffic analysis by Masson, Wilson and Twiney[9] as part of the Parramatta Rail Link Environmental Impact Statement and the North West Rail Transport Link Economic Appraisal by Douglas Economics (2005)[10]. The disutility for road congestion values were also adjusted with other contemporary studies undertaken by AUSTROADS (2003)[11]; the NSW Road and Transport Authority (2003)[12]; Sinclair Knight Merz (2000)[13] and BTRE (2006).

Table 4
Road congestion cost parameters

Description	Unit	Car	Bus
Occupancy rate	Number	1.2	60.0
Ave. distance travelled	Kilometre	18.7	18.7
Decongestion benefit	Cents/km	30.5	104.0

The estimated road congestion cost of 30.5 cents in 2006-07 prices per diverted car kilometre and 104.0 cents per diverted bus kilometre has been combined with forecasts of the increase in car and bus kilometres to produce a congestion cost to road users.

Table 5
Road congestion costs, 2006-07
In 2006-07 prices

	Unit	Parameters	Average 1997-98 to 2006-07
Cars			
Passengers diverted	Millions	147.8	145.0
Extra car trips	Millions	123.2	120.8
Extra road kilometres	Millions	2 303.2	2 259.4
Congestion costs	$million	701.8	688.5
Buses			
Passengers diverted	Millions	119.3	117.1
Extra bus trips	Millions	2.0	2.0
Extra road kilometres	Millions	37.2	36.5
Congestion costs	$million	38.7	37.9
Total congestion costs	$million	740.5	726.4

In 2006-07, with 267.1 million passenger journeys diverted from rail to road travel (for both car and bus combined), an average car occupancy rate of 1.2, an average bus occupancy rate of 60, an average motor vehicle trip distance to the CBD of 18.7 km[14] and the estimated

9 Masson, Wilson and Twiney, 1999.

10 Douglas Economics, 2005.

11 AUSTROADS, 2003.

12 The Roads and Traffic Authority , NSW, 2003.

13 Sinclair Knight Merz ,2000.

14 Transport Data Centre of the Department of Transport.

road decongestion benefit of 30.5 cents per car kilometre and 104.0 cents per bus kilometre, the estimated total cost of increasing congestion is $740.5 million (table 4).

Over the ten years from 1997-98 to 2006-07, with an annual average of 262.0 million passenger journeys diverted from rail to road travel (for both car and bus combined), an average car occupancy rate of 1.2, an average bus occupancy rate of 60, an average motor vehicle trip distance to the CBD of 18.7 km[15] and the estimated road decongestion benefit of 30.5 cents per car kilometre and 104.0 cents per bus kilometre, the estimated total cost of increasing congestion is $726.4 million (table 5).

By comparison, direct estimates of total urban road congestion cost in Sydney have produced figures of about $2 billion annually. The Commeignes (1993) study of road congestion in Sydney found that congestion causes (in 1993 prices):

- average road speeds to drop from 45 to 40kph;
- average increased delays for commuters of at least 3 minutes;
- 116 million person hours per year to be wasted on delays to private trips, at a cost of about $826 million;
- 23 million vehicle hours per year to be wasted on commercial trips, incurring a cost of about $690 million;
- vehicle operating costs to increase by about $300 million; and
- professional drivers to waste 12 per cent of their driving time.

NIEIR (1995) estimated road congestion costs at $2 billion per annum and Meyrick (1994) estimated an annual congestion cost for Sydney of $1.8 billion. BTCE (1996) estimated a congestion cost of $1.7 million per hour during the morning peak. When this hourly rate is translated to annual congestion costs the estimated cost is similar to Commeignes, NIEIR and Meyrick's estimates of annual congestion.

4.6.3 Road externality costs

The transfer of passengers from rail to road is expected to increase accidents, air and noise pollution, greenhouse gas emissions and road damage. Car externality costs are estimated at 10.4 cents per car kilometre and 58.8 cents per bus kilometre (table 6). The values have been based on the review of various studies which include: Parramatta Rail Link NetworkTraffic Modelling with NETANA by Masson, Wilson and Twiney (1999); Valuing Environmental and Other Externalities by AUSTROADS (2003); the Economic Analysis Manual by the NSW Road and Transport Authority (2003); the North West Transport Link Economic Appraisal by Douglas Economics (2005); the Liverpool-Parramatta Rapid Bus Economic evaluation by Sinclair Knight Merz (2000)[16] and correspondence (e-mail) of Dr. D. Cosgrove of BTRE (2006) . All values have been updated to 2006-07 prices using the non-farm GDP implicit price deflator.

The equation used to measure the road externalities due to change in demand for road trips without CityRail services is as follows:

$$\Delta Ext = ((\Delta Q_{car}/OCR_{car} * pkm_{car} * ExtVal_{car}) + (\Delta Q_{bus}/OCR_{bus} * pkm_{bus} * ExtVal_{bus})) - ExtVal_{Rail} \quad (3)$$

where:

ΔExt = change in road externalities due to transfer of passenger trips from rail to road - car and bus;

ΔQ_{car} = *change in demand for car trips without CityRail service;*

OCR_{car} = *passenger occupancy rate for car;*

15 Transport Data Centre of the Department of Transport.

16 Sinclair Knight Merz, 2000.

pkm_{car} = *passenger distance travelled in car kilometre;*
$ExtVal_{car}$ = *value of car externalities;*
ΔQ_{bus} = *change in demand for bus trips without CityRail service;*
OCR_{bus} = *passenger occupancy rate for bus;*
pkm_{bus} = *passenger distance travelled in bus kilometre;*
$ExtVal_{bus}$ = *value of bus externalities; and*
$ExtVal_{Rail}$ = *value of rail externalities;*

The equation used to measure the value of rail externalities is defined as:

$$\text{Ext}Val_{Rail} = (Rail * \text{vkm}_{Rail} * \text{Ext}Val_{\text{Rail}}) \quad (4)$$

where:
Rail = *number of rail cars used to provide CityRail services;*
vkm_{Rail} = *number of kilometres distance travelled per rail car/vehicle; and*
$ExtVal_{Rail}$ = *value of rail externalities per rail car km.*

The estimated costs of road externalities are shown in table 6. The values are in 2006-07 prices.

Table 6
Estimated 2006-07 car and bus externality costs
In 2006-07 prices

	Car cents per vehicle kilometre (*c/vkm)*	Bus cents per vehicle kilometre (*c/vkm)*
Air pollution	2.6	32.8
Greenhouse gas emission	2.1	12.1
Noise pollution	0.9	2.1
Accidents	4.8	9.5
Road damage	0.1	2.2
Total	10.4	58.8

Note: (a) Figures may not add due to rounding.

In 2006-07 the total externality cost is estimated at $261.7 million, comprising $239.9 million for cars and $21.9 million for buses (table 7).

With 147.8 million passenger journeys diverted from rail to cars, a car occupancy rate of 1.2, an average car trip to the CBD of 18.7 km (Transport Data Centre, Department of Transport) and the estimated road externality costs of 10.4 cents per car kilometre, the estimated total costs of increasing environmental pollution, road accident and road damage are $239.9 million for cars (table 7).

With 119.3 million passenger journeys diverted from rail to bus, a bus occupancy rate of 60, an average bus trip of 18.7 km (Transport Data Centre, Department of Transport) and the estimated road externality benefit of 58.8 cents per vehicle kilometre, the estimated total costs of increasing environmental pollution, road accident and road damage are $21.9 million for buses (table 7).

For the ten years from 1997-98 to 2006-07 the total annual average externality cost is estimated at $256.7 million, comprising $235.3 million for cars and $21.5 million for buses (table 7).

With an annual average of 145.0 million passenger journeys diverted from rail to cars, a car occupancy rate of 1.2, an average car trip to the CBD of 18.7 km and the estimated road

externality costs of 10.4 cents per car kilometre, the estimated total costs of increasing environmental pollution, road accident and road damage are $235.3 million for cars (table 7).

With an annual average of 117.1 million passenger journeys diverted from rail to bus, a bus occupancy rate of 60, an average bus trip of 18.7 km and the estimated road externality benefit of 58.8 cents per vehicle kilometre, the estimated total costs of increasing environmental pollution, road accident and road damage are $21.5 million for buses (table 7).

Table 7
Value of externalities 2006-07
In 2006-07 prices

Item	Unit	Value	Average 1997-98
Cars			
Passengers diverted	Million	147.8	145.0
Occupancy rate	Number	1.2	1.2
Extra trips per year	Million	123.2	120.8
Average distance travelled per trip	Kilometre	18.7	18.7
Total car kilometre in 2006-07	Million	2 303.2	2 259.4
Air pollution	$million	58.8	57.6
Greenhouse gas emission	$million	47.6	46.7
Noise pollution	$million	19.6	19.2
Accidents	$million	111.1	108.9
Road damage	$million	2.9	2.8
Total	$million	239.9	235.3
Bus			
Passengers diverted	Million	119.3	117.1
Occupancy rate	Number	60.0	60.0
Extra trips per yr	Million	2.0	2.0
Ave distance travelled	Kilometre	18.7	18.7
Total car km per year	Million	37.2	36.5
Air pollution	$million	12.2	12.0
Greenhouse gas emission	$million	4.5	4.4
Noise pollution	$million	0.8	0.8
Accidents	$million	3.5	3.5
Road damage	$million	0.8	0.8
Total	$million	21.9	21.5
Total externalities			
Air pollution	$million	71.0	69.6
Greenhouse gas emission	$million	52.1	51.1
Noise pollution	$million	20.4	20.0
Accidents	$million	114.6	112.4
Road damage	$million	3.7	3.6
Total	$million	261.7	256.7

4.6.4 Rail externality costs

Operating rolling stock generates externalities, which includes air pollution, greenhouse gas emissions, noise pollution and accident costs. Externality costs were estimated at 5.8 cents per car kilometre — 0.9 cents for air pollution; 1.2 cents for greenhouse gases; 3.7 cents for noise pollution; and 0.02 cents for accidents — as referenced in *Douglas Economics, 2005*.

Table 8
Value CityRail fleet externalities 2006-07
In 2006-07 prices

	Unit	Parameter
Cars in rail fleet	Number	1 584
Distance travelled per car each year	km/year	196 776

Distance travelled fleet each year	km/year	311 693 184
Externality Cost per car	$/km	0.06
Value of CityRail fleet – externality	$million	18 0

These values have been adjusted in line with RailCorp's own review as stated above in this section. The externality cost of operating 1 584 rail cars in 2006-07 is estimated at $18.0 million (table 8).

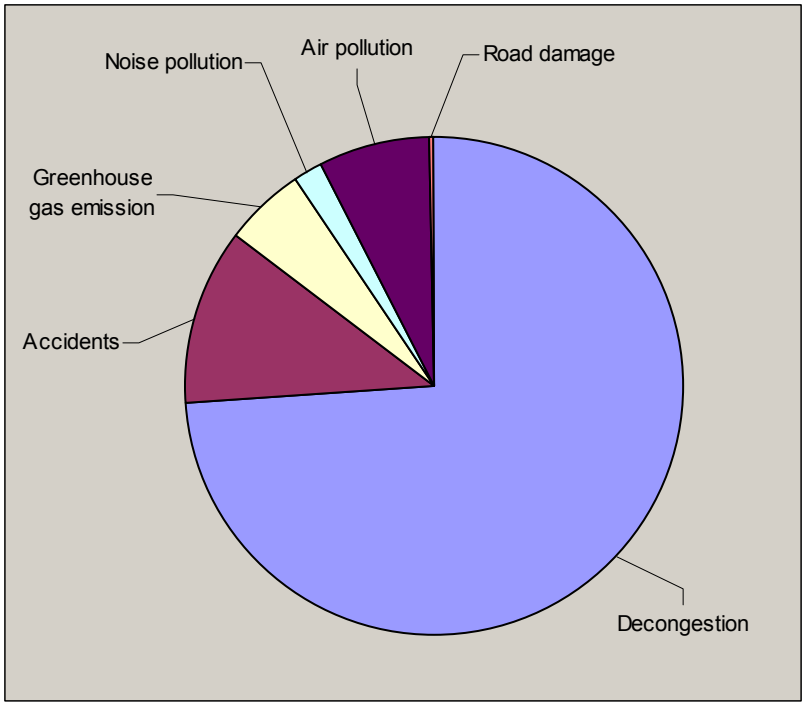


Figure 4
The sources of externality benefits

5 Estimated value of CityRail to the community

The value of CityRail to the community is the sum of producer surplus, rail user benefits (i.e. consumer surplus), and avoided congestion and externality costs.

For the purposes of this study, the 2006-07 income and expenditure statement and the ten year average are used to illustrate the methodology and analysis used to estimate the value of CityRail to the NSW community. The income and expenditure statements and the overall rail user and non-rail user benefits are presented as appendix tables.

In 2006-07 the annual NSW Government subsidy to CityRail to operate the metropolitan rail network was $1 650.5 million. The total annual benefit of CityRail to the community in 2006-07 was estimated at $3 039.9 million. The benefit to the community for 2006-07 comprised $2 055.7 million of rail user benefits, $740.5 million of road user benefits and $261.7 million of road related externalities minus $18.0 million of rail associated externalities. The detailed externality benefits are shown in Figure 4.

The average value over the ten year period is as follows:

- average annual NSW Government subsidy to CityRail to operate the metropolitan rail network is $1 139 million;
- total average benefit of CityRail to the community is estimated at $3 329.8 million;

- average annual benefit to the community of $3 329.8 million comprised $2 364.6 million of rail user benefits, $726.4 million of road user benefits and $256.7 million of road related externalities minus $18.0 million of rail associated externalities.

Table 9
Estimated CityRail benefits and costs to the community of NSW in 2006-07 and the 10 year average from 1997-98 to 2006-07
In 2006-07 prices

Description	2006-07	Average 1997-98 to 2006-07
Revenue [(a)]	760.6	874.9
Total costs	-2 411.1	-2 013.9
Shortfall [(b)]	-1 650.5	-1 139.0
Rail user benefits [©]	2 055.7	2 364.6
Road user benefits [(d)]	740.5	726.4
Air pollution	71.0	69.6
Greenhouse gas emission	52.1	51.1
Noise pollution	20.4	20.0
Accidents	114.6	112.4
Road damage	3.7	3.6
Fleet externality cost	-18.0	-18.0
Total rail benefit	3 039.9	3 329.8
Net benefit to community	1 389.4	2 190.8
Benefit to subsidy ratio	1.8	3.1

Note(a): Revenue is equal to farebox, revenue from other rail entities, other income and concession revenue from government.
(b) Surplus/shortfall before government funding — total costs minus revenue (producer surplus).
(c) Rail user benefits are equal to rail user consumer surplus.
(d) Road user benefits are equal to road decongestion benefits associated with having a rail network.

The value of CityRail to the community is the sum of producer surplus, rail user benefits, avoided congestion and avoided externality costs and is estimated at $1 389.4 million for 2006-07. The average annual value of CityRail to the community over the ten year period 1997-98 to 2006-07 is estimated at $2 190.8 million.

For every one dollar of Government subsidy to CityRail in 2006-07 to operate the metropolitan network, the community of NSW generated a return of $1.80. That is a benefit to subsidy ratio of 1.8. The benefit subsidy ratio has reduced from the 10 year average in 2006-07 because RailCorp's capital expenditure has increased considerably as part of the NSW Government's program to improve and upgrade the rail network.

The average subsidy ratio over the past 10 years (1997-98 to 2006-07) is 3.1. That is, for every one dollar of NSW Government subsidy to CityRail over the 10 year period to operate the metropolitan network, the community of NSW generated an average return of $3.10.

5.1 Conclusion

CityRail provides a substantial part of Sydney's transport task and the benefits from its services accrue to:

- rail users;
- non-rail users; and
- the wider NSW community.

CityRail generates benefits and costs through the provision of rail services. In addition, it affects the benefits and costs associated with the metropolitan transport system through its operation as a substitute for other modes of transport.

The approach used to measure the benefits that CityRail confers on the community is to value the transport task without a rail network.

In 2006-07, the annual benefit of CityRail to the community is estimated at $3 039.9 million. The cost of operating CityRail before the NSW Government subsidy is $1 650.5 million. This generates an average annual net benefit to the community of $1 389.4 million with a total benefit to subsidy ratio of 1.8.

The average subsidy ratio over the past 10 years (1997-98 to 2006-07) is 3.1. That is, for every one dollar of government subsidy to CityRail over the 10 year period to operate the metropolitan network, the community of NSW generates a return of $3.10.

The benefit subsidy ratio has reduced in 2006-07 because RailCorp's capital expenditure increased substantially as part of the NSW Government's program to improve and upgrade the rail network.

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Appendix A

A.1 CityRail operations

A.1.1 CityRail patronage 1997-98 to 2006-07

In 2006-07, CityRail's total patronage is forecast at 280.2 million passenger journeys, an increase of 34.8 per cent from the 207.9 million passengers carried in 1980-81 and up by 5.1 per cent from the 266.5 million passengers carried in 1997-98. Comparisons between CityRail patronage for the years between 1997-98 and 2006-07 are set out in table A1 and figure A1 below. On an average weekday approximately 940,000 rail trips are currently made on CityRail services. About 550,000 individuals use these services each day.

Table A1
CityRail patronage, 1997-98 to 2006-07

Financial year	Passenger journeys (millions)	Passenger journeys Annual change (%)
1997-98	266.5	0.9
1998-99	270.5	1.2
1999-2000	278.7	3.0
2000-01	285.7	2.5
2001-02	276.4	-3.3
2002-03	273.4	-1.1
2003-04	273.3	-
2004-05	270.3	-1.1
2005-06	273.7	1.3
2006-07	280.2	2.4
10 year average	274.9	

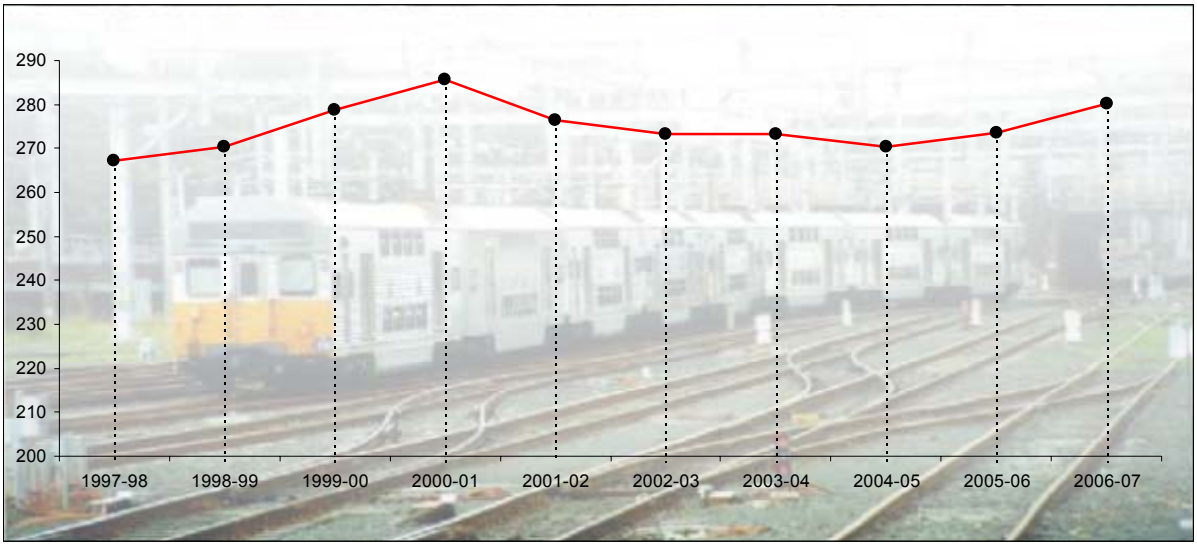

Figure A1
CityRail annual patronage, 1997-98 to 2006-07— passenger journeys (in millions)

A.1.2 CityRail network and stations

CityRail operates 304 suburban and interurban stations. The CityRail network comprises:

- suburban train services within the area bounded by Waterfall to the south, Macarthur to the south-west, Emu Plains to the west and Berowra to the north;
- InterCity services within the wider electrified network are bounded by Kiama to the south, Lithgow to the west and Newcastle to the north; and
- diesel train services bounded within the area from Bomaderry to Kiama in the south (South Coast), Dungog/Scone to Newcastle in the north (Hunter Valley) and Macarthur to Goulburn (Southern Highlands).

A.1.3 CityRail fleet

CityRail operates a fleet of 1 584 carriages (table A2). It has a suburban fleet of 1 223 double deck suburban carriages comprising 714 Double Deck Suburban carriages (C, K, R and S sets), 368 suburban Tangara (T set) cars and 141 Millennium (M set) cars.

The InterCity fleet of 361 cars comprises 321 electric multiple units (EMUs) made up of 76 Tangara (G set) cars, 225 V set cars and 20 OSCARs. The remaining 40 cars are diesel multiple units (DMUs) of which 28 are Endeavour cars and 12 are the 620/720 class.

Table A2
CityRail rolling stock 2006-07

Type of carriage	Cars (no.)	Year of procurement (year)	Age of cars (year)
CityRail Suburban			
Double Deck Suburban			
S and R Set	498	1972-79	30
K Set	160	1982	25
C set	56	1987	20
Total DD Suburban	*714*		
T set (Tangara Suburban)	368	1988-94	19
M set (Millennium)	141	2001-02	6
Total suburban fleet	*1 223*		
CityRail InterCity			
G set (Tangara)	76	1994-96	13
V set (Double Deck InterCity)	225	1977-89	20
DMU 620/720	12	1966	41
DMU Endeavour	28	1994-96	12
OSCAR	20	2007	-
Total InterCity fleet	*361*		
Total CityRail fleet	1 584		

A.1.4 Demand for rail services

In 2005-06, CityRail provided 273 million passenger journeys, carrying 0.9 million passengers on a typical weekday. More than 90 per cent of all rail journeys occurred in the Sydney suburban area and CityRail provided 53 per cent of all journey to work trips into the Sydney CBD.

Demand for CityRail services continues to increase and CityRail estimates that total passenger journeys for 2006-07 will be approximately 7 million more than for 2005-06. Based on Property Council of Australia data released in February 2007, an additional 8 200 office workers gained jobs in the Sydney CBD during 2006. It is estimated that 4 100 of these workers have become CityRail customers.

Analysis of CityRail ticket sales in 2006 showed more than a 6 per cent increase in commuter based ticket sales from 2005 to 2006, indicating that increases in rail patronage are being driven by employment growth. Approximately 75 per cent of the additional passenger journeys made in 2006 were to the CBD.

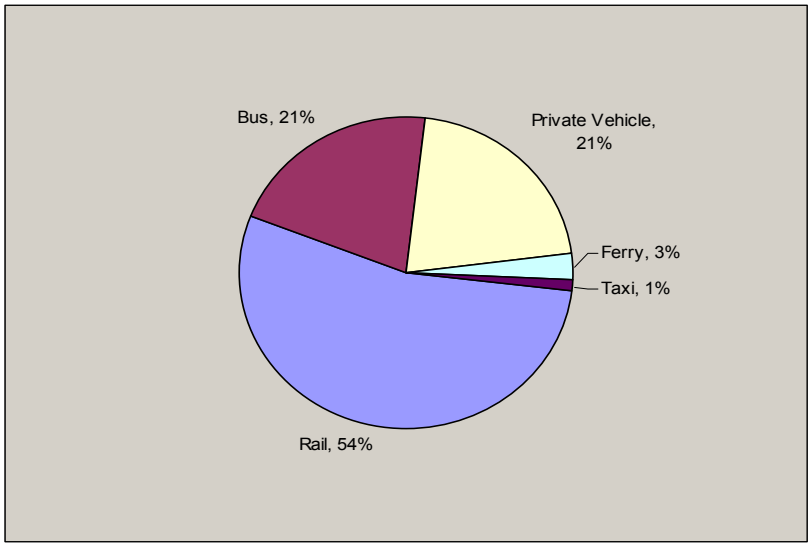

Figure A2
Rail's share of transport modes for AM peak travel to Sydney's CBD

As shown in Figure A2, according to the 2001 Census "Journey to Work" data, CityRail's mode share for peak travel to the CBD was a substantial 54 per cent. This was followed by private car with a share of 21 per cent and then by bus with 21 per cent, ferry with 3 per cent and taxi with 1 per cent.

Table A3
Destination of CityRail passengers during the weekday morning peak (6am to 9:30am) in 2006

	Morning Peak (06:00 - 09:30)	
Line	CityRail Station Exits	%
Bankstown	8 190	2.9
Blue Mountains	960	0.3
CBD/Redfern	145 080	50.5
Central Coast	1 940	0.7
East Hills/Airport	6 470	2.3
ESR (Eastern Suburbs Railway)	7 880	2.7
Illawarra	11 860	4.1
Inner West/Olympic Park	11 110	3.9
Main North	11 070	3.9
Newcastle/Hunter	2 540	0.9
North Shore	37 110	12.9
South	14 530	5.1
South Coast	2 610	0.9
Southern Highlands	140	0.0
West	25 570	8.9
TOTAL	287 060	100.0

Demand for rail services is stronger for travel to major employment centres reflecting the importance of rail to commuter travel. On a typical weekday morning in 2006, travel to the CBD/Redfern was the preferred destination of 50.5 per cent or 145 080 of rail users (table A3 and figure A3).

The second most popular journey to work destination of CityRail rail users was the North Shore with 37 110 or 12.9 per cent of all passengers.

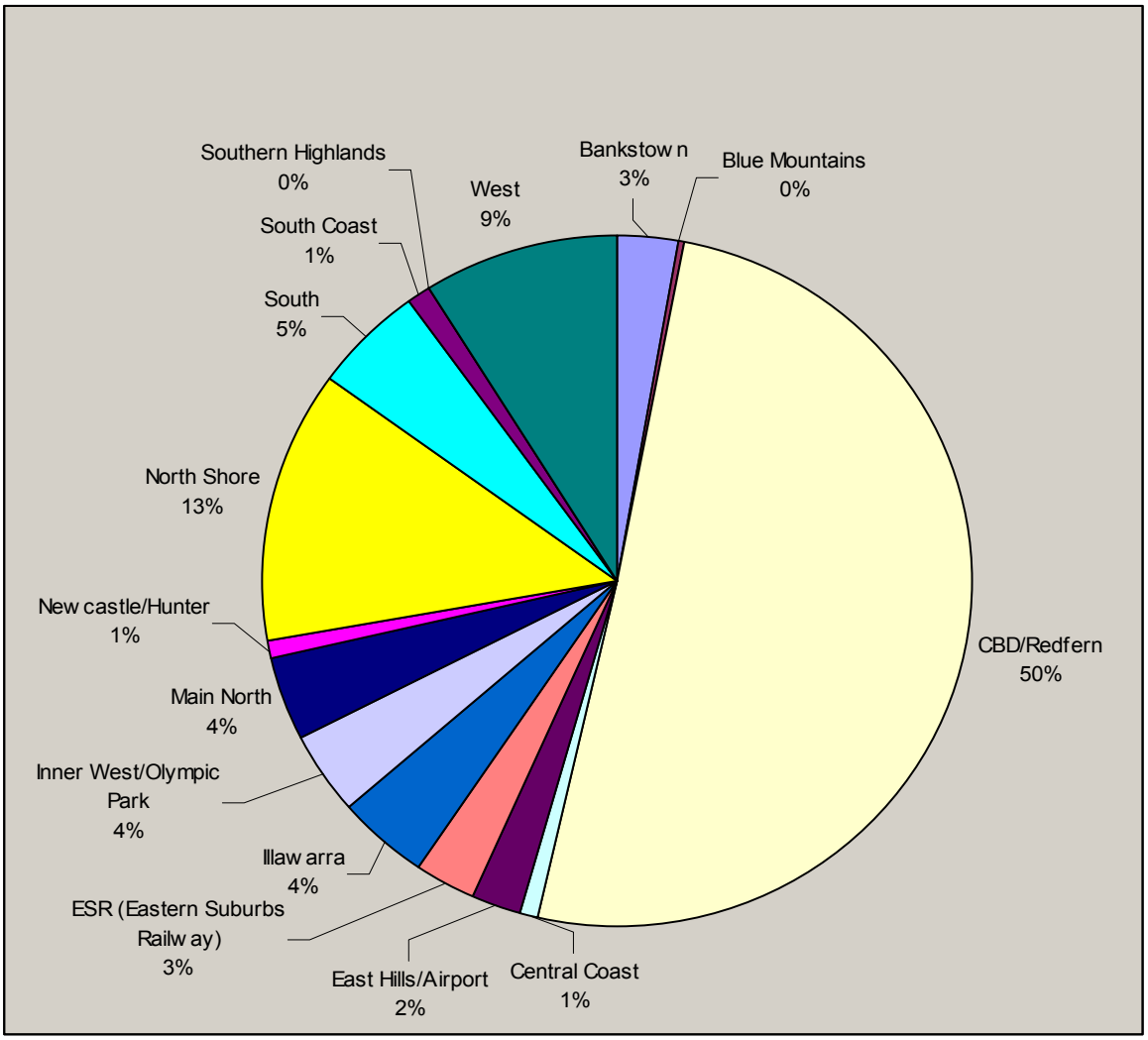

Figure A3
Destination of CityRail passengers – weekday AM peak in 2006

A.1.5 Passenger demand from 1997-98 to 2006-07

Over the ten years 1997-98 to 2006-07, actual passenger journeys across the rail network grew by 5.1 per cent, from 266.5 million passenger journeys to 280.2 million, as set out in table A4.

The greatest growth in passenger journeys on a single line was on the South line where growth was 8.5 per cent over the ten years. In 2006-07, 57.2 million passengers travelled on the South line. Other significant growth occurred on the West line (8.2 per cent growth), East Hills line (7.2 per cent growth) and Main North line (4.3 per cent growth).

Table A4
Passenger demand growth by sector, 1997-98 and 2006-07

Line	1997-98 (millions)	2006-07 (millions)	Change in demand 1997-98 to 2006-07 (%)
Illawarra	58.2	60.2	3.4
East Hills	22.1	23.7	7.2
Bankstown	19.9	18.8	-6.5
North Shore	32.5	33.7	3.4
Main North	32.2	33.6	4.3
West	48.9	52.9	8.2
South	52.7	57.2	8.5
Total	266.5	280.2[(a)]	5.1

Source: Demand Analysis Unit, RailCorp

Note a: Forecast

Appendix B

The methodology adapted by CityRail to estimate consumer surplus was derived from the LUL (1994) study. Consumer surplus can be measured using the following equations:

Given an average CityRail fare of (f), the consumer surplus (CS) associated with the closure of CityRail (without CityRail) is given by:

$$CS = \int_{f}^{\infty} Q(f)df \qquad \text{(B1)}$$

where:

Q(f) = the demand for CityRail services (Q) which is expressed as a function of the CityRail fare (f)

The demand function employed to model CityRail demand is the negative exponential, which has the following form:

$$Q(f) = \alpha e^{-\lambda f}$$

where:

α and λ are constants.

Substituting for Q(f) in equation (B1) and integrating gives

$$CS = 1/\lambda\left[Q(f) - Q(\infty)\right] \qquad \text{(B1.1)}$$

Since $Q(\infty) = 0,$ equation (B1.1) simplifies to

$$CS = 1/\lambda.Q\,(\text{f}) \qquad \text{(B1.2)}$$

This can be simplified further given that the point elasticity for negative exponential (ε_f) is given by

$\varepsilon_f = \lambda$ f or, rearranging, $\lambda = \varepsilon_f / f$ (B2)

Finally, substituting for λ in equation (B2) gives

CS = *f.Q* (*f*) / εf

Or simply expressed as:

$$CS = \left(\frac{f * Q}{\varepsilon} \right) \qquad (B3)$$

where:

CS	=	consumer surplus;
f	=	average fare;
Q	=	passenger journeys, and
ε	=	fare (price) elasticity

The fare or price elasticity (ε) measures the percentage change in rail services demanded for a one per cent change in the fare (f) of the rail service. This reflects how sensitive rail users are to a change in fare. As discussed by LUL (1994) it is important to note that CityRail's own price elasticity is a vital input into the analysis. In particular, the hypothetical closure scenario effectively prices all patronage off the CityRail network. This is a good estimate of CityRail passengers' willingness to pay for rail services. The fare price elasticity used was derived from the work undertaken by Douglas Economics (2006)[17] and CityRail (2006)[18]

17 Douglas Economics, 2006.

18 CityRail, 2006.