WORKING PAPER:

DIRECTOR GENERAL OF TRANSPORT

NORTH EAST AREA PUBLIC TRANSPORT REVIEW

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GROUP NO. 25

ECONOMIC ASSESSMENT

Study Area
SAHT
SALC
1577ha
3785ac

See pp 7+8 re Discount Rate – Also p. 32
Norm Fisher/ Bob Calver/ /Jarrett Terminal
Barnard. Value.

Also p. 51
re cutoff b/c ratios

Why Option 1 omitted?
This is the real alternative.

note

The purpose of the NEAPTR working papers is to make all of the study information publicly available. As the name implies, they are working documents. Although they are prepared on the best available information, they are not final polished reports; minor discrepancies may therefore persist between this and other working papers, although every care is being taken to ensure that the work has been competently executed and reported.

In order that final decisions may be taken on the best available information, the attention of the study team should be drawn to any inadequacies in the papers which may be considered important by the reader. The study team will correct or amend this paper if necessary, or to incorporate amendments in subsequent papers or reports.

The views contained in this working paper are those of the NEAPTR team. These views do not necessarily represent those of the Government unless specifically stated to be so.

working paper information sheet

ECONOMIC ASSESSMENT

SYNOPSIS: This paper reports the economic evaluation of radial transport options. It considers the relative economic worth of these options, the distribution of costs and benefits and the financial implications of each.

GROUP NUMBER: 25

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POSITION IN STUDY STRUCTURE:

	STUDY STREAM							
STUDY STAGE	SOCIAL	ENVIRONMENT	LAND USE	TRAFFIC	ENGINEERING	ECONOMIC	PUBLIC INVOLVEMENT	OTHER
I								
II								
III						*		
IV								

NOVEMBER 1977

CONTENTS

long to achieve a reasonably full representation of the benefits of options which require large initial outlays.

We adopted an evaluation period of 1978-2006 inclusive (i.e. 29 years). The initial capital costs would occur in the first 4-7 years, depending upon the option.

At the end of the evaluation period some of the capital infrastructure and equipment would still have some useful life remaining. For each option a terminal value is included to represent this residual benefit.

2.3 The Price Year

It is important to the validity of cost-benefit evaluation that all costs and benefits are measured in the same money values, net of the effect of general price inflation; in other words the $ units should represent the same unit of account in terms of purchasing power. This is achieved by expressing all the costs and benefits in terms of the price level which obtains in a given year.

All costs and benefits in this evaluation were expressed in 1977 prices. Where cost inputs were provided in terms of the price levels of previous years they were updated to 1977 prices using the Australian Bureau of Statistics Consumer Price Index. The inflation factors thus derived are shown in Table 2.1.

TABLE 2.1

INFLATION FACTORS

PRICES EXPRESSED IN YEAR	INFLATION FACTOR TO 1977 PRICES
1974	1.50
1975	1.28
1976	1.14
1977	1.00

2.4 The Discount Rate

The purpose of discounting is to assess the aggregate value in a base year, of a stream of money values occurring in different years. It recognises two inter-related principles:

(i) It recognises that capital invested in an option has an 'opportunity cost', i.e. that the capital could earn a rate of return in other sectors of the economy if it were not used for the project being evaluated. This foregone rate of return should therefore be allowed for in the evaluation;

(ii) It recognises that the community has a preference for benefits which accrue sooner rather than later. The evaluation should therefore give early costs and benefits a greater weight than those occurring later.

In either case, the effect is to reduce or 'discount' the value of costs and benefits which occur in later years relative to those which occur in earlier years. But in practice the rate of discount normally used in transport evaluation does not necessarily meet satisfactorily either of the bases described above. This rate is 10% per annum in real terms (i.e. excluding the effects of inflation).

Specious?

In terms of basis (i) a real rate of 10% per annum is high. Assuming inflation at say 10% p.a. it is equivalent to allowing for a foregone rate of return of 20% in money terms. This is a comparatively high rate of return on capital invested in any sector of the economy, and is consequently a comparatively high 'opportunity cost' to set against the project.

Specious

Turning to basis (ii), implicit in using relatively high rates of discount for public sector investments is the assumption that society puts relatively little value on longer term benefits compared to short-term benefits. For example, a rate of discount of 10% p.a. reduces the present value of a given benefit 7 years hence, to only half the value if it were to occur now: and 11 years hence to only a third of its current value. Intuitively this seems to be quite severe, particularly since public authorities are generally thought to have a greater responsibility for protecting the long-term public good than perhaps an individual would.

In practice, the main justification for the convention of using a rate of discount of 10% is that it will act as a rationing device for scarce public funds, since in general for transport investments the higher the discount rate, the less projects will appear to be 'justified'. But even assuming that funds were satisfactorily rationed in the transport sector by a rate of 10%, the problem still remains that in many sectors of public investment, no comparable evaluation is attempted and other discount rates are implicitly assumed. An inefficient economic allocation of investment funds between sectors may thus occur, even with a consistently used discount rate in the transport sector.

Specious

Given that the case for a 10% rate of discount is based on consistency in the transport sector rather than any deep-seated economic reasoning, the evaluation was carried out using alternative rates of 10%, 7% and 3% per annum.

Specious

2.5 The Discount Year

The discount year is the base year to which the costs and benefits are discounted. Discounting to arrive at a 'present value' should not be confused with the procedure of converting all costs to a common prices level (section 2.3) which was concerned merely with adjusting cost inputs for inflation.

The discount year need not be the same as the prices year (1977). The discount year adopted was 1978 as it appears that this is the year in which the major investment decisions will need to be made. The value of the investment is therefore expressed as a 'present' value as at the time of the decision.

2.6 Summary of Parameters

Summarising parts 2. 2-2.4 the following parameters were used in the economic evaluation:

(i) An evaluation period 1978-2006 inclusive.

(ii) All money values are expressed in 1977 prices.

(iii) Cost and benefit streams are discounted at rates of 10%, 7% and 3% per annum.

(iv) Costs and benefit streams are discounted to 1978.

Section 3 turns to the measurement of the cost and benefit streams for each option.

This is false method.

3.0 COST AND BENEFIT ESTIMATES

3.1 Introduction

HELL

All costs and benefits are estimated in terms of their differences from the base case. This has been defined in the NEAPTR study as the current proposals of the Bus Service Planning Group. Those proposals are therefore not themselves evaluated, but provide a basis against which to assess the additional costs and benefits of the various options.

The costs and benefits included in the evaluation are:

CAPITAL OUTLAYS

- land acquisition costs; ✓
- construction of infrastructure; ✓
- vehicles and/or rolling stock. ✓

ANNUAL COST AND BENEFIT STREAMS

- net benefits to public transport users; ✓
- changes in fare revenue to public transport operators;
- changes in operating costs to public transport operators;
- travel benefits to private road users; costs also? at crossings?
- benefits from a reduction in road accidents. costs?

TERMINAL VALUES

- the residual value of the project at the termination of the evaluation period.

The remainder of part 3 describes the estimates made for these items. Typically the capital costs relate to the initial set-up costs, whilst the annual benefits were estimated for 1996. Part 4 therefore deals with the assumptions in the evaluation as to how the costs and benefits would be streamed over time.

3.2 Land Acquisition

Land costs for each option were estimated by the Valuation Department for Messrs. Kinnaird Hill de Rohan and Young Pty. Ltd. (subsequently referred to as Kinnaird Hill)*. The estimates include three components:

(i) The current value of land already in public ownership; Year of Valuation?

(ii) a notional 'replacement' price for areas of parkland (which are not amenable to a market valuation);

What is this!

(iii) future property resumptions required.

Table 3.1 shows the total land costs for each option and also the proportion attributable to future resumptions (item (iii) above). This distinction is important. All three cost items are true economic costs and were included in the economic evaluation. However, in determining future capital budgeting requirements items (i) and (ii) are excluded since they do not represent actual future cash outlays.

Costs underestimated by exclusions?

Ignores opportunity cost of capital tied up

* Reference 7.

TABLE 3.1

LAND ACQUISITION COSTS

OPTION NO.	DESCRIPTION	TOTAL LAND COSTS $(000'S)	FUTURE RESUMPTIONS (% OF TOTAL)
Base Cases		NIL	NIL
LRT OPTIONS			
21	LRT H/ST H/SP Route 1	7317	38%
22	LRT H/ST H/SP Route 2	8242	42%
23	LRT H/ST H/SP Route 3	23461	80%
31	LRT L/ST H/SP Route 1	4627	50%
32	LRT L/ST H/SP Route 2	6432	36%
BUSWAY OPTIONS			
52	Busway H/ST H/SP Route 2	7379	40%
53	Busway H/ST H/SP Route 3	22423	81%
62	Busway L/ST H/SP Route 2	6309	39%
62 (p)	Pull-on busway L/ST H/SP Route 2	6309	39%
HEAVY RAIL OPTIONS			
81	Heavy Rail, Corridor to TTP	8031	60%
82	Heavy Rail, N'field to TTP	2350	52%
83	Heavy Rail, N'field to Ingle Farm	470	0%

40% or $3,212,400 already owned

all land already in Govt ownership

!

smallest cost

3.3 Construction of Infrastructure

Construction costs were also estimated by Kinnaird Hill.* The total costs include all costs of construction of the right of way and associated bridges etc., the cost of service and route alterations, engineering and management, high standard stations, landscaping and noise protection, and an allowance for contingencies. These costs are summarised in the first column in Table 3.2 ('Total' column).

However, not all components of the total costs contribute to the benefits measured by the cost-benefit evaluation. The benefits to be gained by landscaping and noise control, and by high standard stations instead of basic utilitarian facilities, are not readily amenable to measurement in money terms. These expenditures are justified not by the travel time benefits which are included in the evaluation, but by an independent decision as to whether their benefits to the environment, and to travel comfort outweigh their additional costs to the project.** Thus, for evaluation purposes the costs of noise protection and landscaping and the extra costs of high standard stations are excluded. The remaining costs are referred to as 'active' capital since they actively contribute towards the benefits measured in the evaluation.

exclusion of costs?

Ignores Opportunity Cost of capital tied up.

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* Reference 7.

** The fact that noise control and landscaping are normal social requirements of such schemes may be argued to demonstrate that society (through its elected representatives) does in fact value the environmental benefits, at least as highly as the capital outlays involved.

This ignores (1) Opportunity Cost of capital tied up

TABLE 3.2

CONSTRUCTION COSTS ($000'S)

OPTION NO.	DESCRIPTION	Land	TOTAL	'ACTIVE'
LRT OPTIONS				
21	LRT/H/ST H/SP Route 1	7,317	48,366	40739 19% 55683
22	LRT H/ST H/SP Route 2		50,906	43144 18%
23	LRT/H/ST H/SP Route 3		52,179	45836
31	LRT L/ST H/SP Route 1		34,828	27323 27%
32	LRT L/ST H/SP Route 2		39,499	31945 24%
BUSWAY OPTIONS				
52	Busway H/ST H/SP Route 2		42,293	31681 33%
53	Busway H/ST H/SP Route 3		44,840	35422 26%
62	Busway L/ST H/SP Route 2		34,328	23481
62 (p)	Pull-on busway L/ST H/SP Route 2		34,328	23481
HEAVY RAIL OPTIONS				
81	Heavy Rail, Corridor to TTP		160,623	149469
82	Heavy Rail, Northfield to TTP		45,925	40510
83	Heavy Rail, Northfield to Ingle Farm		17,680	14775
			actuals	?

3.4 Vehicles and/or Rolling Stock

Vehicle and rolling stock requirements were estimated by Messrs. DeLeuw Cather of Australia* for the plan year 1996. These estimates are summarised in Table 3.3. Figures in brackets show the requirements relative to the base case.

Vehicle requirements were costed at the following rates:

buses:	$100,000/bus
LRT cars:	$300,000/car
Heavy Rail Cars:	(for diesel-electric operation) $350,000/car.
Heavy Rail Power Units:	(for diesel-electric operation) $750,000/unit.
Heavy Rail Cars:	(for electric operation) $417,000/car, assuming 50% power cars at $550,000/car and 50% trailers at $285,000/car.

On the basis of these rates and the requirements shown in Table 3.3 the net vehicle/rolling stock costs compared to the base case are shown in Table 3.4. Options 82 and 83 (diesel-electric rail options) were assumed to require respectively 8 and and 4 power units in addition to passenger cars.

It should be noted that these costs are based on 1996 vehicle requirements. Total costs over the period must allow for replacement costs of some vehicles (in busway options) and also savings in base case bus replacement costs. These aspects are dealt with in section 4.

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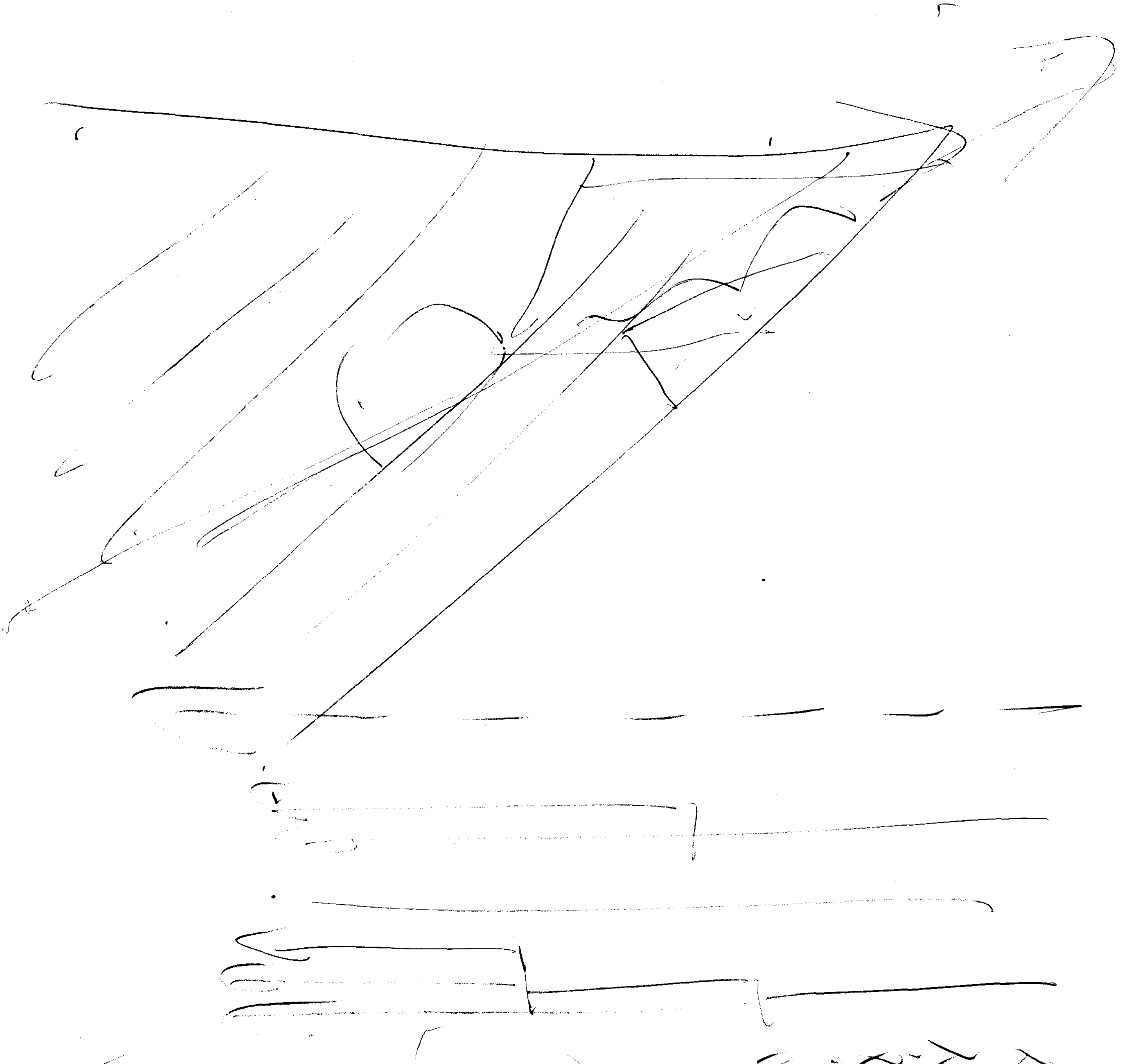
* Reference 8.



3.6 Public Transport Fares Revenue

The average fare per base case trip is assumed to remain constant between the base case and the options (thereby ignoring possible small differences due to differences in average trip length). The change in fare revenue to public transport operators compared to the base case is thus approximated by the total of fares paid by the generated passengers. We assumed an average fare of 25¢ per generated passenger trip (some 10% higher than the current average). Given the passenger generation figures shown in Table 3.5, the extra fare revenue in 1996 is shown in Table 3.7.

Wrong
All prices should be in 1977 terms
This adds 10% to transfer costs.

10% fare increase assumed
— Unfair - all figures should be in 1977 dollars.

TABLE 3.7

INCREASED FARE REVENUE FROM PUBLIC TRANSPORT (1996)

OPTION NO.	EXTRA PASSENGER TRIPS PER DAY	EXTRA PASSENGER TRIPS PER YEAR (000's)	TOTAL REVENUE ($000)
LRT OPTIONS			
21	4902	1519.62	380
22	4396	1362.76	341
23	4055	1257.05	314
31	4902	1519.62	380
32	4396	1362.76	341
BUSWAY OPTIONS			
52	3860	1196.60	299
53	3303	1023.93	256
62	3860	1196.60	299
62 (p)	6901	2139.31 highest	535
HEAVY RAIL OPTIONS			
81	3691	1144.21	286
82	-1310	-406.10	-102
83	-1354	-419.74	-105

deduct 10%

Each trip represents a loss to the STA !

3.7 Public Transport Operating Costs

This item includes both the annual operating costs (net of vehicle acquisition costs, which are treated as part of capital) and the costs of track maintenance. Total public transport operating costs in the base-case and the options were estimated in 1974 prices for 1996 conditions by DeLeuw Cather, as part of the Operations Study.* For evaluation purposes these were converted to 1977 prices by an inflation factor of 1.5. The resulting estimates of operating costs are shown in Table 3.8.

It should be noted that in some options there is a net saving in operating costs compared to the base-case. These savings are measured as a benefit in the evaluation. Increases in costs are included as a disbenefit.

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* Reference 8.

TABLE 3.8

PUBLIC TRANSPORT OPERATING COSTS (1996)
STUDY AREA - ALL MODES

ANNUAL OPERATING AND TRACK MAINTENANCE COST ($000'S)

OPTION NO.	TOTAL COSTS (1974 PRICES)	TOTAL COSTS (1977 PRICES)	DIFFERENCES FROM BASE-CASE (1977 PRICES)
Base-Case	10259	15388	-
LRT OPTIONS			
21	9091	13636	-1752
22	9153	13729	-1659
23	9204	13806	-1582
31	9091	13636	-1752
32	9153	13729	-1659
BUSWAY OPTIONS			
52	10722	16083	+695
53	10750	16125	+737
62	10722	16083	+695
62 (p)	10657	15985	+597
HEAVY RAIL OPTIONS			
81	8437	12655	-2733
82	8048	12072	-3316
83	8557	12835	-2553

What about 21
Frome Rd
Edwin S
King W Rd
" " St

3.8 Private Road User Benefits

The item includes two effects;

(i) time savings to road users due to the marginally higher road speeds obtained by the transfer of some trips from private to public transport.

(ii) time delays to road users at transit crossing points in those transit options with at-grade junctions (viz: options 31, 32, 62 and 62 (p)).

Item (i) was derived from the highway modelling work which was undertaken for the evaluation of a Freeway in the Modbury Corridor

Estimates of these benefits are therefore dealt with in Appendix A.

Delays at intersections of a transit route with the road system were extracted using the Commonwealth Bureau of Roads level crossing formula;

$$\text{Hourly delay} = nt = n \left[\frac{Rq(Rs/60 + q/(s-q)}{2(s-q)} \right] \text{ Mins.}$$

Where n = number of closures per hour

R = average duration of closure (mins).

q = traffic flow/hour (one direction)

s = saturation flow (one direction; assumed to be 2500 vehicles/hour for this exercise).

The 1996 NEAPTR estimates of affected traffic volumes are shown in Table 3.9, together with our assumptions as to directional flows.

We assumed the following closure characteristics;

(i) Each closure lasts 33 seconds;

(ii) 30 closures/peak hour and 6 closures/off peak hour for low-standard LRT options.

(iii) 40 closures/peak hour and 10 closures/off peak hour for low standard busway options.

Applying the delay formula, the resultant delays for the LRT option are shown in Table 3.10.

TABLE 3.9

VEHICLE FLOWS ON ROADS CROSSED BY LOW STANDARD OPTIONS (1996)

	24 HOUR DAILY	AVERAGE PEAK HOUR		AVERAGE OFF-PEAK HOUR	
		Major Direction	Minor Direction	Major Direction	Minor Direction
Smart Road	8000	480 (6%)	208 (2.6%)	238 (2.97%)	194 (2.43%)
Reservoir Road	14000	840 (6%)	364 (2.6%)	416 (2.97%)	340 (2.43%)
Grand Junct. Rd.	19000	1140 (6%)	494 (2.6%)	564 (2.97%)	462 (2.43%)
Lyons Rd.	10000	600 (6%)	260 (2.6%)	297 (2.97%)	243 (2.43%)
Darley Rd.	25000	1750 (7%)	750 (3.0%)	680 (2.72%)	555 (2.22%)
O.G. Road	23000	1150 (5%)	492 (2.14%)	745 (3.24%)	610 (2.65%)
L. Portrush Rd.	23000	1150 (5%)	492 (2.14%)	745 (3.24%)	610 (2.65%)
Stephens Tce.	16000	800 (5%)	342 (2.14%)	518 (3.24%)	424 (2.65%)
Park Tce.	35000	1750 (5%)	749 (2.14%)	1134 (3.24%)	928 (2.65%)

What about
Frome
King William

TABLE 3.10

DELAYS AT ROADS CROSSED BY LOW STANDARD LRT (1996)

Intersection	Total Delay (vehicle mins)	
	Average Peak Hour	Average Off-Peak Hour
Smart Road	63	7
Reservoir Road	130	14
Grand Junction Rd.	211	20
Lyons Rd.	83	9
Darley Rd.	569	25
O.G. Road	214	29
L. Portrush Rd.	214	29
Stephens Tce.	121	18
Park Tce.	568	55

The annual costs of delay were based on:

(i) 4 peak hours and 12 off-peak hours/day

(ii) 310 days/year

(iii) Average cost of delay of $2.19/hour/occupant (see Appendix B) at an occupying rate/vehicle of 1.4.

On this basis, the estimated 1996 cost of delay to road traffic caused by a low standard LRT facility would be $177,000/year. The equivalent cost for a busway would be $250,000/year.

3.9 Accident Benefits

You're right the diversion is modest — less than 1.5% !

A reduction in road accident costs would be a small, but not insignificant economic benefit, even at modest levels of diversion of road users to public transport. The data available is not sufficient to make more than a crude estimate of the correct order of magnitude of this item. To achieve this, a method was derived from Commonwealth Bureau of Roads procedures. These procedures express accident rates for surface streets as a function of average vehicle speeds, viz;

$$R = 31.827/Vs + 0.622$$

Where R = the casualty-accident rate per million vehicle kms.

Vs = the mean speed on the road section considered.

Using this formula we assumed;

(i) the levels of passenger diversion from private to public transport shown in Table 3.5.

(ii) a base-case car occupancy rate from these trips of 1.2 persons/car (i.e. less than the overall average of 1.4/car).

De Leuw Cather used 1.1

(iii) a base-case average journey speed over the study area over 24 hours of 30km/hr, giving an accident rate of 1.68 accidents/million-veh-kms.

(iv) a base-case average car trip length of 12km per vehicle trip.

(v) the CBR cost estimate of \$9600/casualty-accidents (1974 prices) updated to \$14,400/ casualty accident (1977 prices).

Table 3.11 shows the calculation of accident cost savings in 1996 on the basis of these assumptions.

TABLE 3.11

ACCIDENT COST SAVINGS (1996)

OPTION NO*	Trips from Road Pass/day	Trips from Road veh-km/year (mill)	Accidents per million veh-km	Annual Cost Saving $000's
LRT OPTIONS				
21	4902	15.196	1.68	368
22	4396	13.628	1.68	330
23	4055	12.570	1.68	304
31	4902	15.196	1.68	368
32	4396	13.628	1.68	330
BUSWAY OPTIONS				
52	3860	11.966	1.68	289
53	3303	10.239	1.68	248
62	3860	11.966	1.68	289
62 (p)	6901	21.393	1.68	518
HEAVY RAIL OPTIONS				
81	3691	11.442	1.68	277

* An annual expansion factor from daily to annual trips of 310 is assumed. For options 82 and 83 which have less public transport passengers than the base-case, the possible accident disbenefits have been ignored.

3.10 Terminal Value of Project

The year 2006 is the final year of the evaluation period. It is ten years after the plan year, which is a reasonable extrapolation for strategic planning, and means that depending upon the option, benefits are measured over a period of 23 to 26 years. However, the end date chosen is arbitrary. The purpose of including a terminal value is to recognise that the various elements of fixed capital investment tied up in the chosen scheme is likely to have a continuing value to society thereafter.

assumed benefits for 30 more years to year A.D. 2036 !

As an estimate of this value we assumed that each option would continue to earn a net annual benefit at the 2006 value for a continuing period up to a total of 30 benefit years in total for that option. We therefore added 8, 7, or 6 extra years benefits for options which open in 1985, 1984 or 1983 respectively. This is a neutral assumption in the sense that the benefits of the public transport system to society post-2006 might be either greater or less than our current estimate of their value in 2006. It therefore increases the evaluation period for benefits to 30 years in all options, but does not extrapolate either an increasing nor decreasing value of benefits after 2006. The extra years' benefits were discounted at 10% per annum to 2006 regardless of the rate of discount used to discount all values, including terminal values, to 1978. This effectively allows for a higher degree of uncertainty attached to post-2006 values.

Table 3.12 shows the calculation of terminal values.

! suspect

30 − 23 = 7   30 − 26 = 4

7, 6, 5 or 4.

TABLE 3.12

CALCULATION OF TERMINAL VALUES (2006)

OPTION NO.	Net Benefit 2006 ($000's)	Additional Years Added	Total Discount Factor*	Terminal Value ($000's)
LRT. OPTIONS				
21	12594	8	5.334	67176
22	10626	8	5.334	56679
23	9273	8	5.334	49462
31	10044	7	4.867	48884
32	10282	7	4.867	50042
BUSWAY OPTIONS				
52	7004	7	4.867	34088
53	4747	7	4.867	23104
62	6518	6	4.354	28379
62 (p)	10311	6	4.354	44894
HEAVY RAIL OPTIONS				
81	9584	8	5.334	51121
82	1411	8	5.334	7526
83	2075	6	4.354	9034

* The sum of the discount factors for the additional years, at 10% p.a. to a base year 2006.

4.0 STREAMING THE COSTS AND BENEFITS OVER TIME

4.1 Phasing of Land and Construction Costs

Kinnaird Hill developed a preliminary implementation programme for certain options viz. LRT options and low standard busway. We used these as a guide to the likely implementation programme of all options. Taking 1978 as year 1 of the programme, the assumed phasings of total land and capital construction costs are shown in Table 4.1.

Within this profile of total land and construction costs, we assumed that all costs in 1978 would be land costs. The remaining balance of the land costs was then allocated to 1979 and 1980 in the proportions 67% and 33% respectively. It was assumed that land already acquired and any parklands used would be brought into preparation stage at the same rate as new resumptions are made. Total land costs in each year of the period 1978-1980 were therefore divided into future resumptions and the remainder by the proportions shown in Table 3.1.

Of the construction costs, only the active capital was included in the evaluation (Table 3.2) The active capital was assumed to be a constant proportion of total construction costs in each year of construction.

Ignores opportunity cost of capital in noise prot, stations etc.

TABLE 4.1

PHASING OF CAPITAL EXPENDITURE (LAND & CONSTRUCTION)

OPTIONS	% OF COSTS INCURRED IN YEARS:								
	1978	1979	1980	1981	1982	1983	1984	1985	TOTAL
21,22,23,81,82	2	12	14	18	22	22	10	(scheme opens)	100
31,32	2	14	15	28	29	12	(scheme opens)	-	100
52,53	3	12	28	23	26	8	(scheme opens)	-	100
62,62(p)	3	12	31	26	28	(scheme opens)	-	-	100
83	3	15	27	27	28	(scheme opens)	-	-	100

4.2 Phasing of Vehicle/Rolling Stock Acquisition

The preliminary implementation programme also formulated a time-profile for the acquisition of vehicles/rolling stock prior to scheme opening. We assumed that 80% of the 1996 vehicle rolling stock requirements would be purchased prior to opening and allocated the remaining 20% of costs to 1990. The preliminary implementation programme assumed for the initial 80% of new vehicle costs is shown in Table 4.2.

For the busway options, 52, 53, 62 and 62(p), the buses acquired will not last the duration of the evaluation period. We have assumed an average bus life of 13 years and thus a recurrence of the capital costs 13 years after their first year of use.

In addition to the new vehicle/rolling stock requirements the non-busway options have a net saving of buses compared to the base case and this was included as a negative capital cost in the evaluation. These savings also need to be phased. DeLeuw Cather estimated the total number of buses required in the base case in 1976 and 1996 and in all the options in 1996. Table 4.3. shows the bus acquisition programme we assumed for evaluation purposes between these two dates, for the base case and the options.

The fleet savings were included in the evaluation in the years shown in Table 4.3. In addition, the savings are repeated 13 years subsequently, to allow for the reduction in bus replacement costs relative to the base-case.

TABLE 4.2

PHASING OF CAPITAL EXPENDITURE

(VEHICLES/ROLLING STOCK ACQUISITION)

OPTIONS	% OF COSTS INCURRED IN YEARS:						
	1979	1980	1981	1982	1983	1984	TOTAL*
21,22,23,81,82	10	20	20	20	20	10	100
31,32	4	28	28	28	12	-	100
52,53	-	20	30	30	20	-	100
62,62(p)	20	30	30	20	-	-	100
83	20	30	30	20	-	-	100

* Total is 80% of new vehicle/rolling stock requirements.

TABLE 4.3.

BUS ACQUISITION EXPANSION PROGRAMMES (NON-BUSWAY OPTIONS)

	BASE CASE	21	22	23	31	32	81	82	83
1976 fleet	268	-	-	-	-	-	-	-	-
1981 fleet	300	300	300	300	300	300	300	300	300
1986									
fleet increase	+25	+10	+10	+10	+10	+10	+10	0	0
fleet size	325	310	310	310	310	310	310	300	300
fleet saving*	-	-15	-15	-15	-15	-15	-15	-25	-25
1991									
fleet increase	+25	+10	+10	+10	+10	+10	+10	0	0
fleet size	350	320	320	320	320	320	320	300	300
fleet saving*	-	-15	-15	-15	-15	-15	-15	-25	-25
1996									
fleet increase	+21	+19	+18	+18	+19	+18	+16	-1	-1
fleet size	371	339	338	338	339	338	336	299	299
fleet saving*	-	-2	-3	-3	-2	-3	-5	-22	-22

* buses are saved relative to the base case and the total savings over the years 1986, 1991 and 1996 correspond to those given in Table 3.3.

4.3 Time-Profile of Public Transport User Benefits

The primary estimates of public transport user benefits were made for 1996, the plan year (Section 3.5). The level of such benefits in other years will depend primarily on:

(i) changes in the demand level over time;

(ii) changes in the real value of time savings, over time.

Demand in the base case is expected to increase from 89530 public transport trips in 1976 to 136538 trips in 1996, a compound annual growth rate of 2.133% p.a. Real values of time savings are assumed to grow at a rate of 2.0% p.a. These increases are assumed to occur throughout the evaluation period giving an annual growth rate in benefits of their equal to their product, viz: 4.2%.p.a. Both benefits to base case public transport trips and to generated trips were assumed to grow at this rate. On this basis Table 4.4 shows the ratio of public transport user benefits in key years to the level of benefits measured in 1996.

0

TABLE 4.4

TIME-PROFILE OF PUBLIC TRANSPORT USER BENEFITS

BENEFITS IN YEAR	AS A PROPORTION OF BENEFITS IN 1996.	
1986	0.664	66%
1991	0.814	81%
1996	1.000	100%
2001	1.227	123%
2006	1.503	150%

Real values of time savings increased

0

4.4 Time-Profile of Public Transport Fares Revenue

The increased fares to the public transport operator were also estimated for 1996 (Section 3.6). To phase this benefit we assumed that the 1996 ratio of generated passengers to base case passengers is achieved in the first scheme year and that this ratio remains constant throughout the evaluation period. These benefits would thus increase at the same rate of increase as base case passengers namely 2.133% p.a. On this basis Table 4.5 shows the estimated increased fare revenue in some key years as a proportion of the level of increased fare revenue in 1996.

TABLE 4.5

TIME-PROFILE OF PUBLIC TRANSPORT FARES REVENUE

BENEFITS IN YEAR	AS A PROPORTION OF BENEFITS IN 1996
1986	0.810
1991	0.900
1996	1.000
2001	1.111
2006	1.233

4.5 Time-Profile of Public Transport Operating Costs

We related this profile to the assumed acquisition programme for new vehicles and/or rolling stock. In all options we assumed 80% of the 1996 vehicle requirements are available from the opening year to 1990 and the other 20% available thereafter for the remainder of the period (Section 4.2).

Running under economic capacity 1990-96 by 20%

Since the operating cost methodology was based on average costs/vehicle-kilometre, we assumed for simplicity that operating benefits/disbenefits would also be at 80% of the 1996 level in the years from opening until 1990, and that the 1996 estimate would apply thereafter

4.6 Time-Profile of Private Road User Benefits

As discussed in Part 3.8, these consist of two elements. The streaming time savings to road users due to higher road speeds is dealt with in Appendix A with the annual estimates.

The disbenefits in low standard LRT and busway options caused by road closures at intersections were phased by calculating the costs in both 1996 and a notional situation with 1976 flows and 1976 values of time. The compound annual growth rate in this disbenefit was thus identified as 6.88% p.a. On this basis, Table 4.6 shows the level of disbenefit in some key years as a proportion of the level of disbenefit in 1996.

TABLE 4.6

TIME-PROFILE OF ROAD USER DISBENEFITS AT TRANSIT INTERSECTIONS

BENEFITS IN YEAR	AS A PROPORTION OF BENEFITS IN 1996
1986	0.514
1991	0.718
1996	1.000
2001	1.395
2006	1.944

4.7 Time-Profile of Accident Benefits

In the methodology developed for the estimation of these benefits (Section 3.9) the accident benefits are proportional to the number of passengers transferring from road to public transport.

Accident benefits are therefore assumed to grow at the same rate as generated public transport passengers, so that the factors given in Table 4.5 (for the increase in fares revenue) are applicable also to accident benefits.

4.8 Terminal Values

Terminal values, by definition, are allocated exclusively to the year 2006.

5.0 EVALUATION RESULTS

5.1 Introduction

In this section we compare the economic merit and characteristics of the options in terms of;

(i) the benefit/cost ratios (B/C) and the net present values (NPV);

(ii) the distribution of costs and benefits between transport user groups, the operators and the community at large; taxpayer - deficits?

(iii) comparison of low standard with high standard facilities;

(iv) pull-on busway operation versus express services only;

(v) capital budgeting requirements of each option in the period 1978 - 1985.

Summary Tables are given in Section 5 to illustrate the various economic aspects discussed. However, a detailed computer tabulation of all the cost and benefit inputs in each option, fully streamed over time, is available if required, together with the corresponding discounted magnitudes.

5.2 Sensitivity of Results

For the B/C ratios and NPV's of each option, we also include minimum and maximum estimates which define the range within which the estimates are statistically likely to fall, given that;

(i) the range of each cost and benefit item is normally distributed about the mean (the input estimate)

(ii) the distributions are symmetrical

(iii) the distributions are independent.

Under these conditions the statistical confidence that the NPV and B/C ratios fall within the ranges calculated is the same as the confidence that the individual estimates fall within a specified range. We assume that these individual estimates may vary with equal confidence limits, within the following ranges;

50% more realistic

- Capital costs: plus or minus 15%
- Public transport user benefits: plus or minus 25%
- Public transport fare revenue benefits: plus or minus 25%
- Public transport operating cost benefits: plus or minus 25%
- Benefits to road users: plus or minus 30%
- Accident benefits: plus or minus 30%
- Terminal values: plus or minus 30% or 100%

Thus assuming that there is 90% confidence that the actual individual estimates fall within this range, we may be 90% confident that the B/C ratios and NPV's fall within the range specified in the result tables.

Although the individual cost and benefit items are not fully independent (contrary to condition (iii) above) the analysis tends to be dominated by the major cost and the major benefit items (for which the estimates are independent). Therefore the analysis is sufficiently robust to produce good indicative results.

Due to uncertainty in forecasts and the necessarily broad nature of some of the estimates, the ranges given for the B/C ratios and NPV's should be considered at least as important as the actual estimates.

5.3 Comparison of Economic Worth

The benefit cost ratio (B/C) of an option is defined as

$$\frac{\text{the discounted value of annual net benefits plus terminal values}}{\text{the discounted value of capital costs}}$$

Disbenefits in the numerator are included as negative values and tend to reduce the magnitude of the B/C ratio. Capital cost savings (of vehicles) are included as negative values in the denominator and tend to increase the B/C ratio. Table 5.1 compares the B/C ratios of the options at annual rates of discount of 10%, 7% and 3% respectively.

TABLE 5.1

COMPARISON OF BENEFIT/COST RATIOS

			Discount Rate = 10% p.a.				Discount Rate = 7% p.a.			
			Benefits (000's) $	Costs (000's) $	B/C	Range of B/C	Benefits (000's) $	Costs (000's) $	B/C	Range of B/C
LRT Options										
H/ST	21	C-M-low	34295	46190	0.74	0.69 - 0.79	56666	50396	1.12	1.04 - 1.21
H/ST	22	C-H-G-T	28663	50140	0.57	0.53 - 0.61	47410	54755	0.87	0.80 - 0.93
H/ST	23	C-P-G-T	24829	63957	0.39	0.36 - 0.42	41100	69882	0.59	0.55 - 0.63
L/ST	31	C-[illegible]-M-low	34021	35643	0.95	0.89 - 1.02	54335	38519	1.41	1.31 - 1.51
L/ST	32	C-H-G-T	29321	42231	0.69	0.65 - 0.74	47431	45643	1.04	0.97 - 1.12
Busway Options										
H/ST	52	C HG	14719	37111	0.40	0.36 - 0.43	24891	41097	0.61	0.55 - 0.66
	53	C-PNT	8288	52697	0.16	0.14 - 0.17	14472	57919	0.25	0.23 - 0.28
L/ST	62	C-H-G	13838	31140	0.44	0.41 - 0.48	23016	34359	0.67	0.62 - 0.73
L/ST	62(p)	C-H-G	22077	26247	0.84	0.78 - 0.91	36644	28445	1.29	1.18 - 1.41 Highest
Heavy Rail Options										
	81	C-TPP	28491	123745	0.23	0.21 - 0.25	46561	135341	0.34	0.31 - 0.38
	82	N-TPP	9746	39505	0.25	0.22 - 0.27	14847	42536	0.35	0.31 - 0.39
	83	N-IF	12689	14874	0.85	0.78 - 0.94	18783	14956	1.26	1.14 - 1.38

Highest

without any attempt to use feeder lines

potentially Highest

Cont'....

TABLE 5.1 Cont'....

COMPARISON OF BENEFIT/COST RATIOS

Discount Rate = 3% p.a.

		Benefits (000's) $	Costs (000's) $	B/C	Range of B/C	
LRT Options						
H/ST	21	120666	56680	2.13	1.92 - 2.35	
H/ST	22	101099	61701	1.64	1.49 - 1.80	
H/ST	23	87742	78913	1.11	1.01 - 1.22	
L/ST	31	110761	42613	2.60	2.37 - 2.85	
L/ST	32	98621	50584	1.95	1.77 - 2.14	
Busway Options						
H/ST	52	54834	48399	1.13	1.02 - 1.25	
	53	33128	67243	0.49	0.44 - 0.55	
L/ST	62	49813	40386	1.23	1.12 - 1.36	
L/ST	62 (p)	79121	32192	2.46	2.19 - 2.75	
Heavy Rail Options						
	81	97662	153237	0.64	0.58 - 0.70	
	82	27987	46352	0.60	0.54 - 0.67	
	83	34449	13939	2.47	2.21 - 2.77	Highest

The net present value is the discounted sum of benefits minus the discounted sum of costs. It summarises the same information as the B/C ratio but expresses the worth of the options in absolute $ terms rather than as a ratio of benefits to capital costs. Table 5.2 gives the NPV's of the options at the alternative rates of discount of 10%, 7% and 3% p.a.

On the basis of the results in Tables 5.1 and 5.2, Table 5.3 shows the comparative ranking of options under B/C and NPV criteria for the alternative discount rates.

TABLE 5.2

COMPARISON OF NET PRESENT VALUES

Option No.	Discount Rate = 10%		Discount Rate = 7%		Discount Rate = 3%	
	NPV ($m)	Range of NPV	NPV ($m)	Range of NPV	NPV ($m)	Range of NPV
LRT Options						
H/ST 21	-11.9	-14.6 to -9.2	6.3	2.2 to 10.3	64.0	54.3 to 73.6
H/ST 22	-21.5	-24.1 to -18.8	-7.3	-11.1 to -3.6.	39.4	31.1 to 47.7
H/ST 23	-39.1	-42.1 to -36.1	-28.8	-32.7 to -24.9	8.8	1.1 to 16.5
L/ST 31	-1.6	-3.9 to 0.6	15.8	12.6 to 19.1	68.1	60.9 to 75.4
L/ST 32	-12.9	-15.4 to -10.5	1.8	-1.6 to 5.2	48.0	40.6 to 55.5
Busway Options						
H/ST 52	-22.4	-24.5 to -20.3	-16.2	-19.0 to -13.5	6.4	1.0 to 11.9
H/ST 53	-44.4	-46.9 to -41.9	-43.4	-46.4 to -40.5	-34.1	-38.6 to -29.6
L/ST 62	-17.3	-19.1 to -15.5	-11.3	-13.7 to -9.0	9.4	4.8 to 14.0
L/ST 62(p)	-4.2	-6.1 to -2.2	8.2 best	5.3 to 11.1	46.9 best	40.2 to 53.6
Heavy Rail Options						
81	-95.3	-102.2 to -88.3	-88.8	-96.8 to -80.8	-55.6	-66.8 to -44.3
82	-29.8	-31.9 to -27.6	-27.7	-30.3 to -25.1	-18.4	-22.0 to -14.8
83	-2.2	-3.5 to -0.9	3.8	2.2 to 5.4	20.5	18.0 to 23.0
	best		best potentially		best potentially	

TABLE 5.3

RANKING OF OPTIONS BY ECONOMIC PERFORMANCE

Discount Rate = 10%		Discount Rate = 7%		Discount Rate = 3%	
B/C	NPV	B/C	NPV	B/C	NPV
31	31	31	31	31	31
Ingle Farm → 83	83	62 (p)	62 (p)	83	21
62 (p)	62 (p)	83	21	62 (p)	32
21	21	21	83	21	62 (p)
32	32	32	32	32	22
22	62	22	22	22	83
62	22	62	62	62	62
52	52	52	52	52	23
23	82	23	82	23	52
82	23	82	23	81	82
81	53	81	53	82	53
53	81	53	81	53	81

31 = LRT low Standard Corridor North MacKinnon Kens W.

Two general features are apparent from the rankings:

(i) Ranking the options in order of B/C ratios and NPV's gives broadly similar results;

(ii) Reducing the rate of discount does not greatly alter the ranking in terms of B/C ratios or NPV's. ← Bullshit Not true

It moves Option 21 LRT up from 4th to 2nd rank.

The exception to this is option 83, the Northfield Rail extension to Ingle Farm, which does not perform so well in NPV terms at lower rates of discount. On the basis of these features, it is possible to generalise about the relative economic merit of the options.

Relatively good:-

Options which tend to perform relatively well under NPV and B/C ratios, for all rates of discount are;

31	LRT L/ST (Corridor-Ninth-Mackinnon-King William)
62(p)	Busway L/ST - (Pull-on operation/Corridor-Hackney-Grenfell)
83	Heavy Rail (Northfield extension to Ingle Farm)
21	LRT H/ST (Corridor-Mackinnon-King William)

Medium:-

Options which tend to fall in the middle of the range under NPV and B/C ratios, for all rates of discount are;

32	LRT/LST (Corridor-Hackney-Grenfell-Topham)
22	LRT H/ST (Corridor-Hackney-Grenfell-Topham)
62	Busway L/ST (Corridor-Hackney-Grenfell)
52	Busway H/ST (Corridor-Hackney-Grenfell)

Relatively poor:-

Options which tend to perform relatively poorly under NPV and B/C ratios for all rates of discount are;

23	LRT H/ST	(Corridor-Payneham-Grenfell-Topham)
53	Busway H/ST	(Corridor-Payneham-Grenfell-Topham)
81	Heavy Rail	(Corridor to Tea Tree Plaza)
82	Heavy Rail	(Northfield extension to Tea Tree Plaza)

Ask economists

The summary above expresses the comparisons in relative terms. However, it is sometimes considered appropriate by financing authorities to impose a cut-off level of B/C, which must be achieved for the capital expenditure to be 'justified'. To preclude further consideration of certain options on the basis of such a cut-off rate is, in our view, invalid. This view is based on the fact that social and environmental considerations may be considered to add to or deduct from the overall case for particular options and in practice often do change the final ranking of the so-called 'justified' schemes. If such changes to the overall worth and ranking of projects is valid for projects which are above a particular economic threshold, then it is equally valid to allow options below that threshold to receive a similar consideration.

Subject to this qualification, it is useful to note the absolute level of B/C ratio in comparison to a benchmark (and not a cut-off rate) of B/C = 1 (i.e. benefits = costs).

At a 10% rate of discount only option 31 falls in a range which may exceed B/C = 1 (0.89 - 1.02).

At a 7% rate of discount a B/C ratio exceeding 1 may be achieved by options 31, 21, 32, 62(p) and 83.

At a 3% rate of discount a B/C ratio exceeding 1 is achieved by all options except 53, 81 and 82. In other words, the discounted benefits do not exceed the discounted costs in these options at any of the discount rates tested.

Having discussed the overall results, we now turn to more specific elements of them. We deal first with the distribution of costs and benefits.

5.4 Distribution of Costs and Benefits

The distributional analysis considers four main groups involved in transport;

(i) public transport users

(ii) private road users

(iii) the public transport operators

(iv) the community as a whole

For each of these groups we isolate their net benefit or costs:

public transport users: Basically time savings	are allocated the benefits to base-case public transport users and to generated passengers
private road users: time savings	are allocated the benefits of relief to the road system, net of any increase in delays at intersections with at-grade facilities.
public transport operators:	are allocated the difference from the base-case in net income, being the net effect of fare revenue and annual operating cost differences.
the community as a whole:	are allocated the capital costs of the system, less any accident reduction benefits.

taxpayers

In the sense that the public transport operators are public authorities, the final two groups can validly be aggregated, but for purposes of exposition, they are shown separately. Terminal values are not allocated (in principle they could be thought of as part of the benefits to a future generation). Table 5.4 shows the distribution of discounted costs and benefits at a 7% rate of discount. The magnitudes would be different for other rates of discount but the essential pattern is the same.

Is this in 1996 ?
for that year ?

TABLE 5.4

DISTRIBUTION OF COSTS AND BENEFITS ($M AT 7% DISCOUNT RATE)

NET BENEFITS OR NET COSTS (-) TO:-

OPTION NO.	Pub Trans Users	Road Users	Pub Trans Operators	Community at large	Terminal Values	NPV*
LRT OPTIONS						
Mackinnon 21	2.6 11.6 min 17.3 5.3	12.3	14.4 -33.4	-47.8	10.1	6.3
Hackney 22	1.6 14.2 min 12.0 3.5	11.1	13.5	-52.5	8.5	-7.3
Payneham 23	15.8 min 8.5	10.2	12.8	-67.8	7.4	-28.8
31	~~18.65 min 18.4~~	10.3	15.6 -20.2	-35.8	7.4	15.8
32	19.68 min 12.7	10.1	14.6	-43.2	7.5	1.8
BUSWAY OPTIONS						
52	10.6	9.9	-2.8	-38.9	5.1	-16.2
53	4.4	8.2	-3.4	-56.1	3.5	-43.4
62	11.2	8.3	-3.1	-32.0	4.3	-11.3
62(p)	11.2	14.9	-0.4 -24.7	-24.3	6.8	8.2
HEAVY RAIL OPTIONS						
81	7.4	9.1	20.4	-133.4	7.7	-88.8
82	-7.9	? 0	21.6	-42.5	1.1	-27.7
83	-1.7	0	19.2 +4.2	-15.0	1.4	3.8

Capital cost +

* The NPV may differ slightly from the row totals due to rounding errors.

Table 5.4 demonstrates the following broad conclusions:

(i) On similar routes LRT options tend to give public transport user benefits significantly greater than busway options.

Vital reason

(ii) Options which include Northfield heavy rail extensions to Tea Tree Plaza (82) and to Ingle Farm (83) give negative public transport user benefits (this means that the base-case public transport system in the North-East area is better for public transport passengers as a whole than the systems evaluated in these options). This is caused at least in part by a sub-optimal bus service in these options, see Section 3.5.

(iii) Benefits to road users are substantial in both LRT and busway options and in option 81 (Heavy rail in the Corridor to Tea Tree Plaza). This is due to the congestion relief expected on the roads c.f. the base-case. Since options 82 and 83 do not attract any extra passengers, there is no such benefit. [illegible] would.

(iv) There is a considerable increase in the net income (i.e. income minus expenditure) of public transport operators compared with the base-case in both LRT and Heavy Rail options, and a small reduction in net income in busway options. This is almost wholly due to the estimated reduction in public transport system operating costs in the LRT and Heavy Rail Options, as opposed to an increase in system operating costs in busway options. This difference in costs can be attributed, in the main, to higher crew costs for the busway options.

(v) Costs to the community at large differ greatly and are dominated by differences in the capital outlays. Differences in these outlays between routes and standards are considerable. For LRT options the discounted community costs are 90% higher in the most expensive option (23) compared to the cheapest (31). For busway options, these costs are 130% higher in the most expensive option (53) compared to the cheapest option (62(p)). For heavy rail options the costs are nearly 900% greater in the most expensive option (81) compared to the cheapest option (83). Clearly, the community costs and in particular, the capital outlays tend to dominate the overall differences in NPV's and B/C ratios.

5.5 High Standard Versus Low Standard Options

The LRT and busway options may be built either to a high standard, that is with grade-separated road junctions, or to a lower standard, that is with road junctions at-grade. It is important to consider whether the extra costs of grade-separation are justified by the extra benefits. Table 5.5 shows the extra costs and benefits of a high standard facility over a low standard facility on similar routes.

AH P.C.

Route option 31 is not exactly comparable with 21 since the former includes the Ninth Avenue route variant. The extra costs of 21 are thus not entirely due to grade-separation. This difference is not sufficient to affect the conclusion that the additional costs of grade-separation are not justified by the additional benefits gained. In all cases the incremental NPV is substantially negative.

Apart from the bias in 31 vis-a-vis 21, the extent of the at-grade advantage is somewhat overstated by the evaluation methodology which assumed that at-grade public transport speeds could be achieved equal to the grade-separated speeds.

The benefits of grade separation were thus calculated as the avoidance of delays to road traffic at intersections. In practice, some reduction in transit speeds might also occur with at-grade facilities, even assuming (as does the evaluation) that the transit mode has absolute priority over road traffic. The extent of the speed reduction would depend upon the efficiency of the barrier triggering system and associated safety standards. No explicit allowance has been made for the cost of control systems or disbenefits caused by speed reductions. However, it is very unlikely that this would be sufficient to upset the substantial NPV differences shown between the low standard and high standard options.

TABLE 5.5

ECONOMIC WORTH OF GRADE-SEPARATION ($M)

L/ST Option No.	H/ST Option No.	Discount Rate = 10% p.a. Extra Costs of H/ST	Extra Bens of H/ST	Incremental NPV	Discount Rate = 3% p.a. Extra Costs of H/ST	Extra Bens of H/ST	Incremental NPV
LRT Options							
31	21	10.5	0.3	-10.2	14.1	9.9	-4.2
32	22	7.9	-0.6*	-8.5	11.1	2.5	-8.6
Busway Options							
62	52	6.0	0.9	-5.1	8.0	5.0	-3.0

* Benefits are greater in 32 than in 22 since earlier opening of 32 dominates the disbenefit of low-standard design.

5.6 Pull-On Versus Express Busway

Options 62 and 62(p) are busway options along the same route. However, Option 62 assumes exclusive express-bus operation with extensive feeder service, whereas Option 62(p) has some express services but also allows considerable use of the busway by service buses.

In economic terms, the pull-on operation is superior. From Tables 5.1 and 5.2 it can be seen that 62(p) has lower costs (due to smaller vehicle requirement) and greater benefits. The incremental NPV of 62(p) over 62 ranges from \$13.1M at a discount rate of 10% to \$37.5M at a discount rate of 3%. On the basis of this evidence, a pull-on mode of operation represents a considerably more efficient use of a busway than an exclusive express-bus mode of operation.

5.7 Capital Investment Requirements

This section describes the capital costs of each option prior to opening. These are intended as a guide to scale and approximate timing of investment outlays which would be required in each of the options over the next few years, assuming the implementation programme used in the evaluation. The costs are actual cash outlays in 1977 prices and are not discounted. They also,

Opportunity Costs of tied capital are ignored

(i) exclude the value of land already in public ownership and the notional parkland replacement cost, which are not future financial outlays.

(ii) include the 'non-active' capital items such as high-standard stations, noise control costs and landscaping costs.

On this basis, the costs are shown in Table 5.6 for periods 1978 - 1980, 1981 - 1983, and 1984.

Any detailed implementation plan for a particular option would inevitably differ from the programme assumed in the evaluation, but the general scale and profile of costs would probably be similar. Table 5.7 summarises the total capital expenditures on a per annum basis.

TABLE 5.6

ANALYSIS OF CAPITAL EXPENDITURE, (SM) 1977 PRICES

Options	1978-1980 land	1978-1980 const.	1978-1980 veh/ r.s.	1978-1980 total	1981-1983 land	1981-1983 const.	1981-1983 veh/ r.s.	1981-1983 total	1984 const.	1984 veh/ r.s.	1984 total	Total 1978/1984 land	Total 1978/1984 const.	Total 1978/1984 veh/ r.s.	Total 1978/1984 total
LRT Options															
H/ST 21	2.8	8.3	4.8	15.9	-	34.5	9.5	44.0	5.6	1.6	7.2	2.8	48.4	15.9	67.1
H/ST 22	3.5	8.3	5.3	17.1	-	36.7	10.7	47.4	5.9	1.8	7.7	3.5	50.9	17.8	72.2
H/ST 23	12.9	5.0	5.6	23.5	5.9	39.6	11.2	56.7	7.6	1.6	9.2	18.8	52.2	18.4	89.4
L/ST 31	2.3	6.7	5.1	14.1	-	28.1	10.8	38.9	-	-	-	2.3	34.8	15.9	53.0
32	2.3	7.8	5.7	15.8	-	31.7	12.1	43.8	-	-	-	2.3	39.5	17.8	59.6
Busway Options															
H/ST 52	3.0	13.0	1.4	17.4	-	29.3	5.6	34.9	-	-	-	3.0	42.3	7.0	52.3
H/ST 53	12.7	13.3	1.6	27.6	5.5	31.5	6.2	43.2	-	-	-	18.2	44.8	7.8	70.8
L/ST 62	2.5	12.4	3.5	18.4	-	21.9	3.5	25.4	-	-	-	2.5	34.3	7.0	43.8
62(p)	2.5	12.4	1.2	16.1	-	21.9	1.3	23.2	-	-	-	2.5	34.3	2.5	39.3
															2nd lowest.
Heavy Rail Options															
81	4.8	39.2	4.2	48.2	-	104.6	8.4	113.0	16.9	1.4	18.3	4.8	160.7	14.0	179.5
82	1.2	11.2	4.2	16.6	-	29.9	8.4	38.3	4.8	1.4	6.2	1.2	45.9	14.0	61.1
83	-	7.7	3.3	11.0	-	10.0	3.3	13.3	-	-	-	-	17.7	6.6	24.3
				lowest											lowest.

TABLE 5.7

ANNUAL CAPITAL EXPENDITURES ($M) 1977 PRICES

Options	1978-80 $M/Year	1981-1983 $M/Year	1984 $M/Year
LRT Options			
H/ST 21	5.3	14.7	7.2
H/ST 22	5.7	15.8	7.7
H/ST 23	7.8	18.9	9.2
L/ST 31	4.7	13.0	-
L/ST 32	5.3	14.6	-
Busway Options			
H/ST 52	5.8	11.6	-
H/ST 53	9.2	14.4	-
L/ST 62	6.1	8.5	-
L/ST 62(p)	5.4	7.7	-
Heavy Rail Options			
81	16.1	37.7	18.3
82	5.5	12.8	6.2
83	3.7	4.4	-

6.0 SUMMARY AND CONCLUSIONS

The purpose of cost-benefit is to inform the process of public choice between the alternative uses of society's resources. As such, it provides a rational framework within which to draw together and compare diverse considerations, such as capital costs and travel time savings, public transport operating costs and road accidents. The strength of the method is therefore not in producing a single unassailable output or answer, but in a systematic treatment of the questions or inputs. This strength should not be under-rated, but it is important too that the limitations of the information provided are recognised. More specifically;

(i) various important decision variables are not included in the cost-benefit analysis, for example social and environmental impact, political feasibility, capital availability, etc.

(ii) certain basic parameters of the method are by no means universally accepted, for example, the values of time savings, the value of accident reduction, the right discount formula, the correct relationship between road speeds and vehicle flows.

(iii) the cost and benefit estimates made at this stage are necessarily of a lower order of accuracy than would be possible in the detailed design of a particular option.

(iv) options have not necessarily been optimised at this stage and detailed design of any option could reveal areas of possible cost savings, more beneficial modes of operation and integration with other public transport services, and opportunities for a more efficient staging of construction and opening.

Whilst recognising these limitations, the evaluation provides the best evidence available at this stage of planning regarding the economic performance of the options. Certain conclusions can and should therefore be drawn. These are:

Busway versus LRT

On the same route and at the same standard;

(i) the economic performance of LRT and a pull-on busway is similar; an express-only busway is less efficient than either pull-on busway or LRT;

(ii) LRT provides greater benefits to public transport users;

(iii) LRT is more expensive in terms of capital outlays to develop the system.

Standards

(iv) the additional construction cost of grade-separating either LRT or busway from the road system do not appear to be justified by the additional benefits.

Routes

(v) for either LRT or busway options, route 3 (via Payneham Road) performs substantially worse than other route options in economic terms.

PL why?

(vi) of the other routes available for LRT or busway options, those which enter the City Centre via North Adelaide (for example, the Mackinnon Parade/King William Street, and the Ninth Avenue/Mackinnon Parade/King William Street options) perform better than those which enter via the west (for example, Hackney Road/Grenfell Street). east?

Heavy Rail to Tea Tree Plaza

(vii) Heavy rail options to Tea Tree Plaza either in the Corridor or via Northfield extension perform substantially worse than LRT or busway.

Northfield Extension to Ingle Farm

(viii) A heavy rail extension via the Northfield line to Ingle Farm performs relatively well in overall economic terms, but achieves this through high operating cost savings and low capital costs, and in its present form does not provide any positive benefits to public transport users as a whole. This could possibly be overcome with further refinements of the bus system (both radial and feeder services).

APPENDIX A: ROAD USER BENEFITS AND THE FREEWAY ALTERNATIVE

A.1 Introduction

This section considers two main evaluation tasks;

(i) the calculation of road user benefits in alternative public transport options achieved by diverting some travellers from private to public transport.

(ii) the economic evaluation of a Freeway in the corridor, as an alternative to the public transport systems evaluated.

These are clearly inter-related items of work since they both depend upon the conditions which will prevail in the future on the base-case road network in the Study Area. In establishing what these conditions would be, we faced the following problems;

(i) the non-availability of a traffic assignment consistent with future travel conditions;

(ii) imperfect knowledge as to the precise relationship between traffic flows, road capacities and travel speeds.

In light of these data limitations, we adopted a methodology agreed with the NEAPTR team, which in our view gives reasonable estimates for the comparisons required.

We would emphasise that for any more detailed planning of the road system in the area, it should not be considered an adequate substitute for a more robust modelling exercise.

A.2 Definition of the 1996 Base-Case Road Travel Conditions

The major components needed to calculate the travel speeds on roads in the 1996 base case are:

(i) A speed/flow relationship

(ii) A capacity for each section of road

(iii) An estimate of the future volume of traffic on each section of road.

The speed/flow relationship used was the Bureau of Public Roads (BPR) formula;

$$S = \frac{So}{\left[1 + 0.15\left({}^{V}/_{C}\right)^{4}\right]}$$

where; S is the road speed in m.p.h.

So is the free-flow speed.

V is the one way hourly volume of traffic on the section of road

C is the capacity of the section of road

The major roads in the corridor are the Main North East Road (M) and the Lower North East Road (L). We divided each of these roads into three sections with break points at Lower Portrush Road and Sudholz - Darley Road.

To calculate the capacity of each of these sections of road in a manner consistent with the BPR formula, we used peak hour travel time data collected in 1974 for the Commonwealth Bureau of Roads Australian Roads Survey, together with estimates of 1974 peak hour traffic volumes from the S.A. Highways Department published figures. Assuming a free-flow speed (based on the Urban Transport Planning System default values) for each type of road and area, we worked through the BPR formula backwards to calculate a volume Capacity Ratio consistent with the observed travel speed. The volume data then converted this to a capacity figure. The assumed free-flow speeds, observed speeds and calculated capacities are given in Table A.1.

TABLE A.1

CALCULATED CAPACITIES AND TRAVEL SPEEDS FOR 1974

Road	Section*	Observed Speed (m.p.h.)	Free Flow Speed (m.p.h.)	Capacity (veh/hr)
M	(i)	15.8	25	798
	(ii)	23.9	28	1669
	(iii)	29.2	34	1164
L	(i)	18.8	25	943
	(ii)	20.4	28	1091
	(iii)	29.6	34	895

* Section (i) Park Terrace - Lower Portrush Road
(ii) Lower Portrush Road - Darley Road
(iii) Darley Road - Reservoir Road

The volumes of traffic travelling in each direction on each section of road during a peak and an off-peak hour were estimated from an assignment of 1996 trips to a 1976 network. The volumes had been assigned on an 'all-or-nothing' basis to routes built using 1971 highway speeds and the data available was in the form of 24 hour two-way volumes on the roads. To split these volumes into directional peak and off-peak volumes, we used the factors in Table A.2.

Previous validation of the NEAPTR traffic models led to over-assignment of trips of 14% on average, on roads in the network. We therefore factored down the two-way 24 hour volumes by 14% before applying the above factors, to give the 1996 base case volumes shown in Table A.3.

TABLE A.2

PEAK AND OFF-PEAK HOUR FACTORS

Period	No. Per Day	Hourly Percentage of Daily Flow	Major/Minor Direction
Peak Hour	4	8%	60/40 section (i)
			70/30 sections (ii) and (iii)
Off-Peak Hour	12	5.6%	55/45

TABLE A.3

1996 BASE CASE PEAK AND OFF-PEAK DIRECTIONAL VOLUMES

Period	Road	Direction	Section		
			(i)	(ii)	(iii)
Peak	M	Major	2147	3034	2167
		Minor	1430	1300	929
	L	Major	1610	1926	1445
		Minor	1073	826	619
Off-Peak	M	Major	1386	1680	1200
		Minor	1118	1354	968
	L	Major	1040	1066	800
		Minor	838	860	645

We further assumed that 1996 road capacities in the peak will have increased by 10% due to improved vehicle design, driver behaviour and minor traffic management improvements and also that increased urbanisation around Tea Tree Plaza will cause the free flow speed on the outer sections of the two roads to reduce to 28 m.p.h.

The resultant speeds and time taken to traverse each section of road by direction, peak and off-peak, are given in Table A.4. These are the travel conditions we have used for the base case when calculating any of the benefits to road users from the options.

TABLE A.4

1996 BASE CASE TRAVEL TIMES AND SPEEDS

Period	Road	Direction	Section (i)		Section (ii)		Section (iii)	
			mph	mins	mph	mins	mph	mins
Peak	M	Major	5.0*	22.7	13.2	12.1	12.6	8.5
		Minor	12.2	9.3	27.0	5.9	26.9	4.0
	L	Major	13.4	9.7	14.0	10.6	16.5	7.3
		Minor	21.3	6.1	27.1	5.5	27.4	4.4
Off-Peak	M	Major	10.6	10.7	24.3	6.6	23.9	4.5
		Minor	15.8	7.2	26.3	6.1	26.1	4.1
	L	Major	20.5	6.4	24.6	6.0	25.6	4.7
		Minor	22.9	5.7	26.5	5.6	26.9	4.5

* Where the calculated speeds were less than 5 m.p.h. we assumed a 5 m.p.h. minimum.

A.3 ROAD USER BENEFITS IN PUBLIC TRANSPORT OPTIONS

Using the base-case conditions as defined in Section A.2, we calculated the benefits gained by road users due to some travellers being diverted from the road onto public transport. The majority (60%) of mode-switchers were assumed to do so in the peak hours (i.e. 15% per peak hour) leaving a relatively small number per average off-peak hour. We assumed the effect on off-peak travellers to be insignificant and only calculated the effect in the peak hours.

To convert forecasts of the mode switchers from passengers generated to vehicles moved, we assumed an occupany of 1.2 per vehicle. The average occupancy is estimated to be 1.4, but we have assumed a lower figure for the mode switchers. It was assumed that the mode switchers would otherwise have driven the full length of the corridor in the major direction and would be drawn equally from each of the main roads. The number of vehicles removed from each road in the peak hour is given in Table A.5 for each option.

Using the base-case speed flow relationships and volumes, we calculated the travel time savings for the remaining road users in each option.

The hourly time savings were then multiplied by the value of vehicle occupants time (i.e. $2.19 per occupant X 1.4 occupants per vehicle in 1996). The peak hour savings were expanded to a 1996 total using a factor of 4 (peak hours/day) X 310 (average days/year).

Table A.6 gives the daily vehicle time savings and annual cost saving for each option in 1996.

TABLE A.5

VEHICLE TRIPS REMOVED FROM EACH MAIN ROAD (1996)

Options	Daily Mode Switchers*	Peak Hour Vehicle-Trips/Road (major direction)
21 and 31	4902	306
22 and 33	4396	275
23	4055	254
52 and 62	3860	241
53	3303	206
62(p)	6901	432
81	3691	230

* The mode switchers are the generated public transport passengers given in Table 3.5. Options 82 and 83 have less public transport trips than the base-case, but any possible adverse effects in the road system have been excluded.

TABLE A.6

VEHICLE TIME SAVINGS IN 1996

Option	Daily Vehicle Time Savings (hours)	Annual Cost Savings ($'000)
21 and 31	1929	1834
22 and 33	1743	1657
23	1606	1526
52 and 62	1515	1440
53	1257	1194
62(p)	2514	2389
81	1436	1365

A similar exercise was carried for Option 21 using 1986 values of time and a 1986 base-case constructed in a similar way to the 1996 figures (excluding the 10% increase in capacity). This yielded an annual cost saving of $558,000.

This implied an annual growth rate of these benefits of 12.64% and they were streamed over time accordingly. Table A.7 shows the proportion of benefits in some key years to the level of benefits in 1996.

TABLE A.7

TIME-STREAMING OF ROAD USER BENEFITS
IN PUBLIC TRANSPORT OPTIONS

Benefits in Year	As Proportion of Benefits in 1996
1986	0.304
1991	0.551
1996	1.000
2001	1.813
2006	3.287

A.4 Road User Benefits in the Freeway Alternative

To evaluate the benefits to road users in the Freeway alternative, we needed to identify three groups of travellers on each of the main road sections namely those who:

I use Roads* in the base-case and continue to do so in Freeway option;

II use Roads in the base-case and switch to Freeway in Freeway option.

III use other roads in base-case and switch to Roads in Freeway option.

*Roads stands for either the Main North East Road (M) or the Lower North East Road (L).

These groups are identified because of the different benefits gained by each. Group I gains the reduction in travel time on the main Roads due to lower volumes. Group II gains the reduction in travel time by switching from the Roads to the Freeway.

Group III was assumed to gain a time saving of an average of half the gain per trip in Group I.

The available data from which to estimate the peak and off-peak directional volumes for the three groups was the NEAPTR unrestrained assignment of two way 24 hour traffic. The procedures followed were to;

(i) Reduce volumes for 14% over-assignment, to be consistent with the base-case.

(ii) Assume the same percentage diversion from each main Road to Freeway.

(iii) Use (ii) above to estimate the number of trips in Groups I and II.

(iv) Estimate the number of trips in Group III as the balance of trips on the Roads as given in the Freeway option.

(v) Apply the peak and off-peak factors as described in section A.2.

The results for 1996 are given in Table A.8.

The speeds on the roads were then calculated (assuming freeway capacity of 2625 vehicles in each direction and a free-flow speed of 50 m.p.h.) and the appropriate time savings calculated for each group. The daily and annual time savings were then calculated (using 4 peak hours, and 12 off-peak hours per day, and 310 days per year) and the annual time savings multiplied by 1996 values of road user time savings to give annual benefits.

A similar exercise was carried out for 1986 (assuming a 3% p.a. traffic growth 1986-96). The growth in benefits 1986-1996 implied an annual compound growth rate of 10.25% of benefits and this was used to stream the benefits over time. The 1996 and 1986 daily time savings and annual costs are given in Table A.9.

TABLE A.9

DAILY TIME SAVINGS BY ROAD AND PERIOD AND ANNUAL COST SAVINGS

1996 AND 1986

	Road	Period	Daily Vehicle Time Savings (h)	Annual Cost Savings ($M)
1986	M	Peak	2462	
		Off Peak	2348	
		Total	4810	3.750
	L	Peak	882	
		Off Peak	1432	
		Total	2314	1.804
		Total		5.554
1996				
	M	Peak	6036	
		Off Peak	5331	
		Total	11367	10.804
	L	Peak	2110	
		Off Peak	2034	
		Total	4144	3.939
		TOTAL		14.742

A.5 Economic Evaluation of a Freeway Alternative

For consistency with the public transport options we evaluated the freeway on the assumption of its joint use as a busway, with pull-on busway operation (similar to that in option 62(p)). It has been assumed that the full freeway capacity would be shared, that is there would be no exclusive lanes for the buses. The busy entry route into the City is assumed to be route 2 (Corridor-Hackney Road-Grenfell Street).

Apart from the road user benefits (which were measured in Section A.4) we included the following costs and benefits;

Land and Construction Costs

These were estimated by Kinnaird Hill to be approximately $8.054m for land including future resumptions, land already in public ownership and the replacement costs of parkland, and $58.645m for construction, of which $44.790 are active capital costs. As with the public transport options only the active proportion of construction costs were included in the evaluation (see Section 3.3).

The land and construction costs for the freeway were assumed to be phased over time in the same pattern as for high speed LRT options (Section 4.1).

Vehicles

The extra cost of buses required for the bus on Freeway service was assumed to be the same as for the pull-on busway (Option 62(p)), with a similar profile of cost committment over time (Section 4.2).

Benefits to Base Case Public Transport Users:

Due to inter-action with road traffic, it is unlikely that buses in the freeway option could maintain the same speed and reliability as buses on an exclusive busway. As an order of magnitude estimate, we allocated to base-case public transport passengers a level of travel benefits of two thirds of those calculated for the pull-on busway option (Option 62(p)).

Public Transport Operating Costs:

These were assumed to be the same as for the pull-on busway (Option 62(p)).

Freeway Maintenance Costs:

Although part of maintenance costs is in fact implicit in the public transport operating costs, we included a further estimate of the additional road maintenance costs of a freeway. Based on rates given in earlier Highways Department work (updated to 1977 prices) we assumed an annual increase in road maintenance costs of $500,000 per annum.

Terminal Value of the Project:

We used the same methodology as for the public transport options (Section 3.10) and assumed a continuation of the 2006 net benefits at a constant rate for an extra 8 years (giving 30 years of benefits in the evaluation).

These were discounted at 10% p.a. to 2006. The value of terminal assets on this basis is $210.6M in 2006.

Other Benefits:

We did not include any of the other benefit items of the public transport options, viz;

(i) net benefits to generated passengers;

(ii) extra fare revenues from generated passengers;

(iii) accident reduction benefits.

It is extremely unlikely in practice that the benefits of the freeway to the level of service on public transport would be greater than the benefits afforded to the level of service for private motorists. It is therefore difficult to envisage any significant diversion of travellers for private to public transport and hence (i) and (ii) above are excluded. Accident rates on freeways are in general lower than on surface streets, but the accidents themselves tend to be more severe. Any net reduction in accident costs is therefore likely to be small in comparison to other items.

On the basis of the cost and benefit estimates above the economic performance of the freeway option (with pull-on bus operation) is summarised in Table A.10.

TABLE A.10

ECONOMIC WORTH OF BUS ON FREEWAY

Indicator	Discount Rate 10%	Discount Rate 7%	Discount Rate 3%
Discounted value of benefits ($000's)	71912	126695	292212
Discounted value of costs ($000's)	40806	45029	52107
B/C ratio	1.76	2.81	5.61
Range of B/C ratio*	1.59 - 1.95	2.49 - 3.17	4.83 - 6.47
NPV ($m)	31.2	81.7	240.1
Range of NPV* ($m)	25.0 - 37.3	70.0 - 93.3	209.0 - 271.2

BIGGEST OF ALL

* Ranges of B/C and NPV are based on the methodology and the estimated ranges of individual items as described in Section 5.2.

A.6 Comparison of Freeway with Public Transport Options

In this section we compare various economic aspects of the Freeway option (including pull-on buses) with the most efficient LRT and exclusive busway options evaluated, i.e. options 31 and 62(p) respectively. Table A.11 compares the B/C and NPV estimates.

Using the same methodology described in Section 5.4, Table A.12 compares the distribution of costs and benefits between transport user groups, the transport operator and the community at large.

TABLE A.11

COMPARISON OF ECONOMIC WORTH

	Freeway	LRT (31)	Busway (62(p)
10% Rate of Discount			
B/C ratio	1.76	0.95	0.84
Range of B/C ratio	1.59 - 1.95	0.89 - 1.02	0.78 - 0.91
NPV ($m)	31.2	-1.6	-4.2
Range of NPV ($m)	25.0 - 37.3	-3.9 tc 0.6	-6.1 to -2.2
7% Rate of Discount			
B/C ratio	2.81	1.41	1.29
Range of B/C ratio	2.49 - 3.17	1.31 - 1.51	1.18 - 1.41
NPV ($m)	81.7	15.8	8.2
Range of NPV ($m)	70.0 - 93.3	12.6 - 19.1	5.3 - 11.1
3% Rate of Discount			
B/C ratio	5.61	2.60	2.46
Range of B/C ratio	4.83 - 6.47	2.37 - 2.85	2.19 - 2.75
NPV ($m)	240.1	68.1	46.9
Range of NPV ($m)	209.0 - 271.2	60.9 - 75.4	40.2 - 53.6

TABLE A.12

DISTRIBUTION OF COSTS AND BENEFITS

($m at 7% Discount Rate)

COMPARISON OF NET BENEFITS OR NET COSTS (-) TO:-

Options	Public Transp Users	Road Users	Public Transp Operators	Community at large	Terminal Values	NPV
Freeway	6.5	96.2	-4.0	-48.7*	31.7	81.7
LRT (31)	18.4	10.3	15.6	-35.8	7.4	15.8
Busway (62p)	11.2	14.9	-0.4	-24.3	6.8	8.2

* The additional costs of freeway maintenance over and above the base-case, together with the capital costs, are allocated to the community at large.

The distribution shows clearly the much greater benefits afforded to road users by a freeway option (which is also reflected in the terminal values). The magnitude of this benefit is clearly the main reason for the better economic performance of the freeway option than other options, despite higher capital costs (reflected in community costs) and lower benefits to public transport users. It may be noted that even if these benefits were only half their estimated level, the Freeway option would still have a higher NPV and B/C ratio than the other options.

In terms of capital budgeting over the next few years, the freeway would involve the highest expenditures.

Using the same methodology as applied in Section 5.7, Table A.13 compares the annual capital expenditures (undiscounted) for the periods 1978-80, 1981-83 and 1984.

In summary, the Freeway option performs substantially better in economic terms than LRT or busway options, due to a high level of road user benefits but it provides less benefits to public transport users, and is more expensive in capital cost outlays.

TABLE A.13

COMPARISON OF ANNUAL CAPITAL EXPENDITURES

($m 1977 Prices)

Options	1978 - 1980 $m/Year	1981 - 1983 $m/Year	1984 $m/Year
Freeway	5.1	14.5	7.1
LRT (31)	4.7	13.0	-
Busway (62(p))	5.4	7.7	-

APPENDIX B: VALUES OF TRAVEL TIME SAVINGS

B.1 Private Road Traffic

The Bureau of Transport Economics travel time values were used to evaluate road user costs and benefits. The proportions of traffic between cars, light goods and heavy goods was based on figures supplied by the Department of Transport. Cars were split into business trips and private trips in the ratio of 30%/70%.

The values are given in Table B.1.

The 1976 average value of $1.29 was converted to 1977 prices by an inflation factor of 1.4 (from Table 2.1). In addition, the real value was assumed to grow at 2% p.a. Thus the 1977 value of time for private road traffic is $1.50/occupant/hour. By 1996, the plan year, this grows at 2% p.a. to $2.19/occupant/hour.

TABLE B.1

VALUES OF TIME (JUNE 1976 PRICES)

Vehicle Type	$/Occupant	Proportions
car (business)	1.50	.2745
car (private)	1.00	.6405
light goods	2.75	.0500
heavy goods	2.88	.0350
	1.29	1.0000

B.2 Public Transport

Public transport in-vehicle time savings were valued at the same rate per person as private car motorists, i.e. at $1.00 per hour (1976 prices). The real value again was assumed to increase at 2% p.a. Wait time savings for public transport have been found in various studies to be valued by passengers at a higher rate than in-vehicle time savings. The evaluation assumed a weighting factor of 2.

The 1977 values of time used were therefore $1.16/passenger/hour and $2.32/passenger/hour for in-vehicle and wait time savings respectively. By 1996 these grow at 2% p.a. to $1.69/passenger/hour and $3.38/passenger/hour respectively.