# Perth Fremantle Corridor Study

## Report

This Report presents the evaluations of alternative public transport improvements in the urban corridor between Perth and Fremantle. The alternatives considered are a continuation of existing services, electrification of the existing rail service, and replacement of the railway with a busway.

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BUREAU OF TRANSPORT ECONOMICS

# PERTH-FREMANTLE CORRIDOR STUDY

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Director-General of Transport, Western Australia
Western Australian Government Railways
Perth Regional Transportation Study

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## SUMMARY

This report presents the evaluations of alternative public transport improvements in the urban corridor between Perth and Fremantle. The alternatives considered are a continuation of existing services, electrification of the existing rail service, and replacement of the railway with a busway.

The results show that the busway is the best alternative. At a discount rate of 7 per cent it has a net present value of $13.6 million, a benefit-cost ratio of 3.4 and an internal rate of return of 24 per cent. The corresponding results for the electrification are a net present value of $4.4 million, a benefit-cost ratio of 2.0 and an internal rate of return of 14 per cent.

A financial analysis indicated that the net present value, to public transport agencies, of cost savings and fare revenue increases, less the capital costs of the projects, would be $5.97 million for the busway and -$0.34 million for the electrification.

A general conclusion which may be drawn from this case study is that although a programme of electrifying rail services in Perth may be less beneficial overall than a busway programme, in either case a substantial capital investment in the Perth public transport system would be justifiable.

# INTRODUCTION

## Origin of the Study

A report 'Economic Evaluation of Capital Investment in Urban Public Transport' was prepared by the BTE in June 1972 for the Thirty-Sixth Meeting of the Australian Transport Advisory Council. The report included the results of evaluations of representative public transport improvement projects in four State capitals.

At the Thirty-Sixth Meeting, the Western Australian Minister for Transport advised that due to a recent change in State policy, the projects evaluated for Perth were not representative of the current programme of works for that city. Accordingly the BTE was asked to advise on the effect of the new programme on the conclusions of the Urban Public Transport Study report.

The main implication of the new programme of works for Perth is that electrification of existing railways is proposed instead of the busway construction previously planned.

The BTE was not in a position to evaluate the complete electrification plan, which is integrally connected with the central city underground proposal. However an analysis of the electrification of one of the branch lines would be consistent with the evaluations included in the Urban Public Transport Study and would indicate whether or not adoption of the new programme would reverse the general conclusion, reached in the previous study, that a substantial capital investment in the Perth public transport system would be economically justifiable.

The case study selected for this purpose was based on Project 20 of the Urban Public Transport Study report. This was an evaluation of a busway replacing the existing passenger railway service in the Perth-Fremantle corridor. In extending the original project data for the new analysis, the Western Australian authorities found that improvements could be made in the accuracy of the information previously supplied to the BTE. To maintain comparability of results, therefore, the BTE analysed both the original busway proposal and the new electrification proposal in the study described in this report.

## PROJECT DESCRIPTION

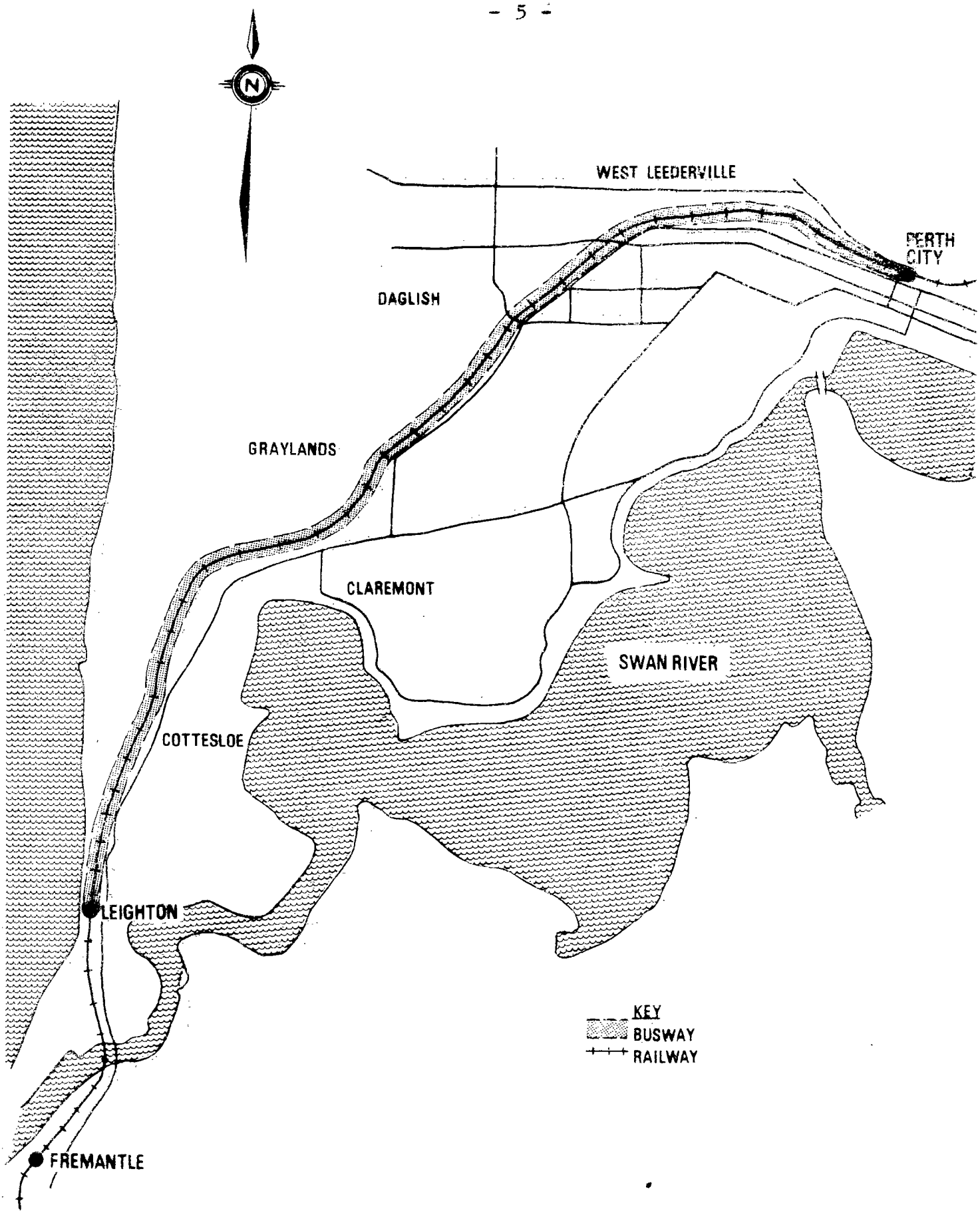
Public transport in the Perth-Fremantle Corridor at present consists of buses routed on surface streets and a rail service operating on the narrow gauge rail link between Fremantle and Perth (Fig. 1).

The proposed electrification would improve the existing rail service by the introduction of fast, modern passenger units. Some stations would be eliminated to improve train speeds, and better interchange facilities would be provided at the remaining stations. The central city station would be constructed below street level to reduce the visual impact of the railway and to improve surface communication in the central city.

The proposed busway would replace the railway between Perth and Leighton. Beyond Leighton, the railway is required for industrial service. Buses would collect passengers from residential areas and obtain access to the busway by special ramps. A new bus terminal, partly constructed underground, would be provided at the Perth end of the busway.

The existing railway serves industries and port facilities at Fremantle. If the busway were implemented an alternative railway access to Fremantle would be provided by construction of a narrow gauge railway, on the south side of the Swan River, between Kenwick and Cockburn Junction.

Fig.1




**PERTH - FREMANTLE CORRIDOR**

0 1 2
Miles

0 1 2 3 4
Kilometres

BTE 72-8

## METHOD OF EVALUATION

### Social-Economic

The basis for the evaluation of the alternatives was social-economic analysis. For each alternative, all quantifiable costs of travel associated with continuation of the existing conditions (base case) were compared with the total costs and benefits associated with the proposed improvement (project case). The evaluation took account of the costs of construction, vehicle purchase, public transport operation, road vehicle operation and the value of travel time.

A more detailed description of social-economic analysis and of the urban corridor computer model developed by the BTE for the evaluation of public transport proposals can be found in Annex D of the Urban Public Transport report.

### Financial

Financial analysis indicates the probable effect of a proposed public transport improvement on public transport authority costs and revenues. In the Perth-Fremantle corridor study this type of supplementary analysis was carried out using the BTE urban corridor model modified for the purpose.

The model calculates, over the evaluation period, the discounted differences in capital costs, in operating costs and in fare revenues between the base case and the project case. These costs and revenues are compared to indicate the net profit or loss, to public transport authorities, due to the project.

A more detailed description of the type of financial analysis used in the study is provided in the Annex to this report.

## TRAFFIC FORECASTS

### Passengers

Forecasts of public transport patronage for the existing rail service and for each of the alternative improvement projects were derived using patronage trends, projections by the Perth Regional Transportation Study and estimates of the elasticity of travel demand with respect to changes in travel time.(1)

For the base case, total daily rail trips at the maximum load point were forecast to increase from 6,800 in 1966 to 8,800 in 1986. Bus patronage was forecast, correspondingly, to increase from 22,500 to 29,200.

In applying the elasticity formula, 'perceived' time was used. This was defined as the door-to-door journey time, but with walking and waiting time doubled. The electrification would lead to lower perceived journey times for rail passengers than those same passengers could achieve on the busway. However, the busway would affect a larger tributary area, and over this extended area potential savings in journey times by busway would be much greater than potential savings by rail passengers. Consequently the increase in public transport patronage due to time savings would be much higher for the busway than for the electrification. For 1976, the year in which the projects would become operational, it was estimated that the trip ends, either generated or 'converted' from car travel, would be as shown in Table 1.

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(1) BTE Urban Public Transport report, Annex E.3.

TABLE 1 - FORECAST OF ADDITIONAL TRIP ENDS IN 1976

| Zone | Busway | Electrification |
|---|---|---|
| City | 3,010 | 820 |
| West Leederville | 610 | 130 |
| Daglish | 590 | 70 |
| Graylands-Claremont | 980 | 260 |
| Cottesloe-Leighton | 830 | 360 |

The estimates of generated and converted patronage took account of the re-routing of bus services to make effective use of the proposed new facilities. In the case of the electrification, transfer time penalties and the need to maintain some continuing bus services tended to limit the scope for bus-rail interchange. With the busway, many existing services could be diverted to take advantage of the busway over part of the journey. Busway patronage, therefore, would comprise existing rail patronage, bus passengers using diverted services, and additional patronage due to reduced journey times. Table 2 shows the total patronage forecasts for each proposal at 1976 and at 1986, the planning year for the Perth Regional Transportation Study.

TABLE 2 - FORECASTS OF TOTAL TRIP ENDS IN 1976 AND 1986

| Zone | Busway | | Electrification | |
|---|---|---|---|---|
| | 1976 | 1986 | 1976 | 1986 |
| City | 31,216 | 39,037 | 14,535 | 18,338 |
| West Leederville | 6,367 | 7,734 | 2,672 | 3,208 |
| Daglish | 3,583 | 3,386 | 1,120 | 663 |
| Graylands-Claremont | 5,955 | 7,224 | 3,707 | 4,584 |
| Cottesloe-Leighton | 12,334 | 17,302 | 8,400 | 12,871 |

Road Traffic

Forecasts of the road traffic which would use the main routes in the Perth-Fremantle corridor, for each project alternative, were derived from trends and from the forecasts of the Perth Regional Transportation Study. The traffic forecasts were consistent with the concept, used in the corridor model, that road space would be added incrementally to maintain traffic operation at the 'practical capacity' of the road system.

## COST ESTIMATES

### Capital Costs

The electrification would involve construction of overhead supply facilities, the associated power conversion and distribution works and some track improvements. Seven two-car passenger units would be required, each estimated to cost $300,000. Existing railway stations would be improved or removed.

The busway would replace the existing railway. To carry the forecast patronage, 22 additional buses would be required. The cost of the Kenwick-Cockburn Junction freight diversion rail link was also included in the busway estimate.

The costs of lowering the railway in the city area and the costs of a central underground bus terminal were considered to be mainly directed towards environmental improvement and accordingly were not included in the estimates.

TABLE 3 - CAPITAL COST ESTIMATES

($'000)

| Item | Busway | Electrification |
|---|---|---|
| Route construction | 2,900 | 2,653 |
| Passenger interchanges | 491 | 508 |
| Rolling stock | 506 | 2,100 |
| Freight diversion railway | 2,760 | .. |
| TOTAL | 6,657 | 5,261 |

Operating Costs

A considerable reduction in the cost of operating the railway would result from electrification. Some of the existing diesel rolling stock is antiquated, requiring considerable maintenance. The operating cost saving per electric unit would be $17,500 per annum, and fewer units would be required due to the higher speed of operation.

For the electrification it was assumed that savings due to closing some stations would be balanced by additional costs of maintaining expanded facilities, and serving more passengers at the remaining stations.

The cost of operating passenger interchanges, which is substantial for a railway, would be comparatively low for the busway because only one station would be involved, largely because fares would be collected by drivers. The cost of track maintenance would also be lower for a busway.

No allowance was made in the busway evaluation for any benefit to railway freight operation, south of the Swan River, due to the Kenwick-Cockburn Junction rail link.

Estimates of the savings in operating costs in 1976 are shown in Table 4.

TABLE 4 - OPERATING COST SAVINGS IN 1976

($'000)

| Item | Busway | Electrification |
|---|---|---|
| Vehicles | 138.0 | 318.5 |
| Passenger interchanges | 250.0 | .. |
| Track maintenance | 48.0 | -10.0 |

User Costs

The basis for the calculation of user costs is detailed in Annex D of the Urban Public Transport report. As for the previous study, the value of personal time was taken to be one cent per minute for in-vehicle time and two cents per minute for walking and waiting time.

Fares

The present schedule of fares is the same for both bus and rail, and ranges from a minimum charge of 10 cents, to 30 cents for a 10 mile (16 kilometre) trip. As for other values used in the study, fares were assumed to remain constant (in 1972 values) over the evaluation period.

Salvage Value

A salvage value was estimated for the diesel rail cars and other equipment which could be re-used elsewhere in the rail system. The value of $1.06 million associated with the busway was based on continuation of diesel rail services on other urban branch lines. A lower value of $0.23 million for diesel cars was estimated for electrification, on the assumption that such a programme would be extended to the complete urban rail system.

## RESULTS

### Social-Economic Evaluation

The results of ths social-economic evaluation, for discount rates of 7 per cent and 10 per cent, are shown in Table 5.

TABLE 5 RESULT OF SOCIAL-ECONOMIC EVALUATION

($'000)

| Item | Busway | | Electrification | |
|---|---|---|---|---|
| | 7% | 10% | 7% | 10% |
| Capital cost | 5,636 | 5,330 | 4,334 | 4,000 |
| Total benefits | 19,216 | 13,456 | 8,765 | 6,105 |
| Net present value | 13,580 | 8,126 | 4,431 | 2,105 |
| Benefit-Cost ratio | 3.4 | 2.5 | 2.0 | 1.5 |

The benefit-cost ratio at a discount rate of 7 per cent is 3.4 for the busway and 2.0 for the electrification. The internal rates of return are 24 and 14 per cent respectively.

A breakdown of benefits, according to the categories used in the urban corridor model, is shown in Table 6. As described in the Urban Public Transport report (Annex D, p. 13), these categories do not provide a precise indication of the distribution of benefits. However it is clear that the higher potential gain that railway electrification could confer on existing rail passengers would be greatly outweighed by the lower operating costs, the benefits to new passengers and the benefits to traffic on the road system, which would be associated with construction of the busway.

TABLE 6 - COMPOSITION OF TOTAL BENEFITS

($'000 discounted at 7%)

| Benefit Category | Busway | Electrification |
|---|---|---|
| Public transport authority operating cost (base case patronage) | 9,504 | 4,185 |
| Base case public transport users | 1,667 | 2,169 |
| Generated public transport users | 1,648 | 30 |
| Users converted from road (benefit reduced by the increased operating costs) | 618 | 166 |
| Remaining road users | 1,417 | 68 |
| TOTAL | 14,854 | 6,618 |

Sensitivity Tests

Some inputs to the economic evaluation, notably patronage forecasts and time value, are subject to errors of estimation. Tests were made, therefore, to establish whether or not the merit of the two alternatives is sensitive to changes in these estimates. As public transport is labour intensive and the relativity of wages to other estimates used in the evaluation may alter, a sensitivity test was also made using an increased labour cost.

TABLE 7 - RESULTS OF SENSITIVITY TESTS

($'000 discounted at 7%)

| Assumption | Benefit-cost ratio | |
|---|---|---|
| | Busway | Electrification |
| Best estimate of all values | 3.4 | 2.0 |
| No growth in patronage | 2.7 | 1.7 |
| All patronage growth generated trips | 3.0 | 1.8 |
| Travel time value increased by 50 per cent | 3.7 | 2.1 |
| Travel time value reduced by 50 per cent | 3.0 | 1.8 |
| Labour cost of public transport operation increased by 50 per cent | 5.5 | 2.6 |

The results shown in Table 7 indicate that each alternative would remain economically justifiable over a wide range of variation in the value of key evaluation data. The order of preference of the two alternatives is unlikely to be changed by any likely error of estimate in the input data. Both alternatives are relatively insensitive to the value of travel time. Any increase in the relative cost of labour would favour the busway.

Financial Analysis

The results obtained for the financial analysis of the project alternatives are shown in Table 8. For the busway, the total gain to public transport authorities in cost savings and revenue increase was estimated as almost double the capital cost, both being discounted at 7 per cent over a 20 year evaluation period. For the railway electrification, it was estimated that the reduction in operating costs and the increase in fare revenue when discounted, would cover almost 90 per cent of the capital costs of the project.

TABLE 8 - RESULTS OF FINANCIAL ANALYSIS

($'000 discounted at 7%)

| Item | Busway | Electrification |
|---|---|---|
| Capital cost | 5,458 | 4,334 |
| Operating cost savings | | |
| Rail service | 8,592 | 3,210 |
| Bus service | -1,346 | .. |
| Fare revenue increase | | |
| Rail service | -5,138 | 542 |
| Bus service | 8,263 | .. |
| Salvage value | 1,062 | 228 |
| NET PRESENT VALUE | 5,975 | -354 |

## CONCLUSION

The results of the evaluations indicate that the construction of a busway between Perth and Leighton, and the corresponding rail electrification alternative are each economically justifiable. The busway would also be an attractive investment solely from the point of view of public transport finance. The electrification is estimated to increase the financial loss in public transport operation by the relatively small net present value of $344,000.

Taken as an isolated project the busway would be much the better investment. At a discount rate of 7 per cent, the total discounted economic benefit would be $9.1 million greater than for the electrification. The total discounted financial benefit would be $6.2 million greater.

The costs and benefits of building the Perth terminal below ground level were not taken into account in either evaluation. However the estimated cost of a lowered busway terminal is substantially less than for a lowered railway terminal.

The evaluation also takes no account of a number of other significant differences between the two improvement alternatives. The railway would have some remnant value for goods service and may have a greater effect in minimising air pollution. (In view of the greater patronage of the busway and the greater effects on road traffic, this latter conclusion is not necessarily true.) There also would be some social costs involved in the conversion of staff from railway service to bus service.

On the other hand the busway would have an important social and economic advantage in that it could be used by ambulance, police and fire vehicles, as well as by a controlled number of commercial vehicles.

The case study is not meant to provide evidence on the economic merit of current proposals for an underground railway and the complete electrification of the suburban railway system in Perth. However it does support the view that electrification of the suburban branch lines may be economically justified.

ANNEX

# FINANCIAL ANALYSIS

## Introduction

The selection of the best alternative for a public transport improvement should be based on a social-economic evaluation in which all costs and benefits to the whole community are assessed. The evaluation used in the study approximates to this ideal. However, in practical decision making it is also important to appreciate the financial implications, to the agencies concerned, of any particular investment proposal.

Public transport improvements would directly affect the finances of one or more public transport agencies. Less directly, they could also affect many other public and private agencies by changing the use of motor vehicles. For example the Commonwealth Government could lose tax revenues due to decreased use of motor vehicles. Local government could lose revenue from parking. Private enterprise could be affected by changes in expenditure associated with motor vehicles and in changes in people's behaviour relating to shopping, work location and recreational activities. Effects which could be even more widespread are those relating to changes in urban land use and development.

The degree to which it is feasible to take account of these financial implications depends on the magnitude of the project, the significance of the particular 'spillover effect' and the availability of appropriate data. For projects of the type described in this report it is probably sufficient to confine the financial analysis to the effect on the public transport agencies most directly concerned. These effects primarily relate to the cost of the improvement, to changes in fare revenues and to changes in the costs of operating and maintaining the public transport services.

The actual financing of an improvement is a related issue which may be affected by legislative or funding restrictions. However, the purpose of an evaluation is to demonstrate the potential economic and financial merit of a particular proposal. The presumption is made that the results, in themselves, will be influential in changing existing constraints, if the proposal has adequate merit. For this reason an evaluation should be unconstrained by existing financial and institutional circumstances.

Corridor Model Extension

In designing the model used for the economic evaluation of projects included in the Urban Public Transport report, time did not permit incorporation of a financial analysis. This omission has now been rectified and the extended model was used in the revised evaluation of the Perth-Fremantle corridor.

The financial analysis is confined to the period ending at the 20th year after a proposed improvement would become operational. The changes in capital and operating costs due to the project and attributable to public transport authorities are taken directly from the base case and project case input to the corridor model. The corresponding changes in fare revenues are calculated from the patronage forecasts and the recorded weighted fare for travel between each corridor section and the central city. The weighted fare accounts for seasonal tickets, child concessions and any welfare concessions not covered by reimbursements. A standard trip length frequency distribution (for the city) for each mode is applied to the forecast trip ends, for each year, in each corridor section. Fare revenue is then calculated using the fare schedules for each mode.