Ministry of Transport

Surface Transport Costs and Charges: Main Report

March 2005

Booz Allen Hamilton with Institute for Transport Studies, University of Leeds and associated consultants

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EXECUTIVE SUMMARY

1. REPORT PURPOSE AND SCOPE

This is the Main Report of an 'Investigation into Surface Transport Costs and Charges' undertaken on behalf of the Ministry of Transport, New Zealand. The study was undertaken by a consultant consortium led by Booz Allen Hamilton supported by the Institute for Transport Studies, University of Leeds (UK) and various sub-consultants. Inputs were also provided by the Bureau of Transport and Regional Economics, Commonwealth of Australia, which acted as a peer reviewer on behalf of the Ministry of Transport. The New Zealand Institute of Economic Research (NZIER) also acted as peer reviewers of this report.

The **overall study purpose** (as stated in the Terms of Reference) was:

"… to provide estimates of the costs imposed by road users and by rail users, and the payments they make for using each mode. This examination will take place in as disaggregated a way as permitted by available data. This information will assist the government to make decisions on the relative competitive position of road and rail for freight transport and of rail, bus and the private car for passenger transport."

It is important to know the costs of marginal increments of transport activity, and how prices encourage or suppress that activity, because transport directly or indirectly affects almost all aspects of modern life, facilitating economic and social activity by providing a vital link between suppliers and their markets. Transport has also been implicated in a number of environmental issues at both the local level (e.g. local air quality) and the global level (e.g. climate change). If the prices paid for transport are incomplete or wrong, or inconsistent between modes, then transport choices are likely to be distorted, and transport systems will exhibit symptoms of unsustainability and inefficiency, such as physical deterioration, congestion and inability to generate revenues sufficient to upgrade the network. Comparison of the full costs and charges for different types of transport will assist the government to make decisions on the relative competitive position of road and rail for freight transport and of rail, bus and the private car for passenger transport that has far-reaching effects on the economy and society as a whole.

The report (and this summary) proceeds through a number of sections:

‣ An outline of key characteristics of land transport in New Zealand (road and rail), including its provision and funding arrangements (sections 2.2 and 2.3);

‣ An examination of relevant cost concepts, including Short Run Marginal Costs (SRMC) and Fully Allocated Costs (FAC), their implications for pricing of transport services and their relationship to current transport user charges (sections 2.4, 2.5 and 2.6);

‣ A series of estimates based on currently available data of total costs and charges for transport (section 3.2), and of marginal costs and charges (section 3.3), drawing on five case studies covering urban passenger transport (car, bus and train), long-distance passenger transport (car, coach and train) and long-distance freight (truck and train).

‣ A concluding section on implications and limitations of the estimates for policy.

The report aims to establish a baseline of costs and charges in a specific recent year (financial year 2001/02), to form the first stage of an overall policy development and assessment process, but it does <u>not</u> recommend any particular pricing policy or approach. Its main focus

is on estimating costs and charges in the existing situation (with existing levels and quality of infrastructure), but it also considers matters relating to long-run pricing and investment (such as use of Long Run Marginal Cost in pricing). It considers all transport-related costs (both economic and financial), both 'externality' costs not borne directly by users as well as private costs incurred directly by users, and it considers charges covering both infrastructure and services. Its estimates are for the whole of New Zealand and, where feasible, disaggregated by road type, mode, and peak/off-peak travel.

The report reflects the structure of the rail industry at the time. The rail network and operations were both owned by TranzRail Holdings Ltd. The government has now repurchased the rail infrastructure. This is likely to result in higher charges for infrastructure than reflected in this document based on 2001/02 data. These changes make no fundamental differences to the key findings of the analysis.

Cost in general is a measure of what must be given up to obtain something else, and applies to both financial and non-financial items. For instance, environmental damage is a cost if resources must be diverted from other useful activity to restore environmental quality to what it was before the damage occurred. In this report, costs include all resources used up in transport services and infrastructure. Marginal Costs show the costs imposed by one extra unit of use of the service, and exclude fixed costs that are invariable with level of use.

Charges are payments made to an entity in connection with some aspect of transport activity, either to pay for a service provided or to provide a price signal to users. They may include variable charges (e.g. fuel tax per litre) and fixed charges (e.g. annual licence fees). This report presents some comparisons of total charges and total costs, and variable charges with marginal costs. The charges calculated here are what people are actually paying, with no judgment being made about what they should pay.

The broad framework of analysis identifies separate components of cost associated with additional transport activity, estimating these components, then recombining them to provide an indication of what costs transport creates, what transport users pay towards those costs, and the difference between these two. The perspective is that of costs and charges faced by those making transport decisions, hence transport users include private car owners and passengers on public transport, and road and rail freight businesses.

The full resource costs of transport can be broken down into:

1. direct private costs of transport (tax-exclusive costs of running and maintaining vehicles, traveller's time etc); plus

2. external costs borne by others in society, which include:

• network maintenance and regulatory costs borne by transport administrations;

• delays borne by other transport users as a result of congestion on the network;

• community-wide public goods and bads such as accident risk and pollution.

This study takes a similar approach in estimating four broad components of transport costs:

▸ A: Operator resource costs are the direct costs (exclusive of any taxes or other public levies) of operating and maintaining vehicles, and in addition the costs of travel time and accident damage costs covered by the operator (car driver or business). In the case of rail (but not road) transport, this category also includes the cost of providing infrastructure.

▸ B: Charges on operators are levies paid by users to public agencies to recover costs of providing the transport system. They include taxes on transport fuel, licensing fees, road user charges, and sundry other sources such as fines and parking fees.

▸ C: Provider/External (Social) Costs are those costs resulting from transport use that are not directly covered by transport users. For roads these include infrastructure operations and maintenance (external to drivers, although not to roading authorities), congestion costs on other transport users, accident costs on other users, and environmental costs (principally greenhouse gas emissions, local air quality impacts, noise impacts and impacts on waterways). For rail the principal external costs stem from environmental impacts, as congestion and accidents are largely internalised in network operations and reflected in the fares and rates set by the rail operator.

▸ D: End User Charges are freight rates offered by the rail company or by road freight companies, in the latter case comprising the operators' resource costs plus public charges imposed on them. In the case of passenger transport services, fares are handled differently and included as part of B.

These components are calculated (with slight variation between the Full Cost and Marginal Cost calculations) and then combined to produce estimates of:

▸ Operator Costs (Total or Marginal) = A + B

▸ Economic Cost (Total or Short Run Marginal Social Cost) = A + C

▸ Difference between external costs and charges = C – B

The inclusion of a cost item in this analysis does not necessarily imply that this should be included in the price paid by users, or that the gap between costs and charges has to be filled by new charges, as this depends on a number of factors, such as the practical feasibility of setting charges without creating new distortions in transport choices with wider impacts. But establishing the relative levels of costs created by different types of transport is a necessary first step in informing the process of policy improvement.

2. COSTING, PRICING AND INVESTMENT APPROACHES AND ISSUES

Section 2 of the report outlines the current organisation of road and rail transport in New Zealand, alternative concepts for defining the cost of transport, the role of capital cost in pricing, and optimal pricing and investment rules.

2.1 Government Interests in the Transport Sector

Governments traditionally have a range of interests in the transport sector. These include providing for appropriate regulation of market failures such as externalities and monopolistic behaviour, a role in the management of road networks, and sometimes an equity stake from investments in infrastructure. Governments also have a general interest in ensuring competitive conditions among transport services, to achieve appropriate transport without imposing undue cost on society.

The report was initiated in response to concerns that the effect of the mix of public and private transport providers, together with their different approaches to pricing and investment, might be causing inappropriate consumer choices and producer investment decisions. Improving the efficiency of transport pricing so that it more accurately reflects transport costs would improve national well-being by, for instance, reducing the incentive for transport choices that result in trips that do not cover the costs they impose on the transport system or the wider community. Improving the consistency of transport pricing between modes would help ensure that travel choices are based on the actual costs of transport modes, rather than on the basis of differences in charging policy.

NOT GOVERNMENT POLICY

In a fully commercial environment, prices would be set by the interaction of many producers and consumers ('the market'). However, there are a number of features of the transport sector that lead governments world-wide to intervene in transport markets to correct for market failures, to ensure that prices take account of wider social issues, or to set boundaries for charges where the provider has a monopoly. Such reasons provide a *prima facie* case for some form of government involvement or regulation, which may be justified if the resulting outcome is demonstrably worth more than the regulatory costs involved.

2.2   Current Transport Provision and Charges in New Zealand

2.2.1   Organisation and Ownership

The land transport sector in New Zealand involves several different forms of ownership and control. Rail services are mostly provided by a single entity, with sole responsibility for maintaining both track and rolling stock, and for ensuring safety standards. Roads are provided as a collective good, managed by various public agencies and jointly shared by a multiplicity of vehicle owners who use the network for commercial freight and passenger services, and also for private mobility. In brief:

‣ The rail system is privately owned and operated – although the land on which the tracks are laid is owned by the Crown and leased to the rail company for a nominal sum.

‣ Public roads are owned by public bodies, with Transit New Zealand managing state highways on behalf of the Government, and territorial local authorities managing their local roads. But investments in the road infrastructure have long been funded from contributions from road users, roughly in proportion to their use of the network.

‣ Freight transport services are privately owned and operated.

‣ Passenger transport services are generally privately owned and operated (except for two urban bus operations that remain as Local Authority Trading Enterprises). However, regional councils regulate (by defining services and fares), contract for and subsidise provision of local public transport services in the larger centres.

New Zealand is moving towards the model that has developed in Australia and elsewhere, whereby the infrastructure is under some form of public ownership and control but transport operations are undertaken by private companies or government commercial entities.

2.2.2   Charging for Transport Services and Infrastructure

Transport services in New Zealand are currently provided by private operators on a commercial basis, with some subsidy offered to urban passenger transport through competitive tendering processes that provide exclusive operating rights for the contract period. There are currently no price controls and no restrictions on entry for privately operated transport services, other than basic health and safety requirements. The freight and long-distance public passenger transport markets are competitive, with prices largely being dictated by the market. Road transport operators pay resource costs of their services plus charges for the use of infrastructure, which are reflected in the fares and rates they set.

In the case of the New Zealand railway system, the pricing of the rail infrastructure is an internal issue for Tranz Rail. It aims to maximise its financial return on the infrastructure assets, by pricing traffic based on 'what the market will bear' given the competitive situation. The Government was negotiating to buy back the track and associated infrastructure at the time of the study (it had already done so in the Auckland region).

Road **transport infrastructure** is funded by a so-called 'pay as you go' (PAYGO) system which recovers from road users each year the total public sector financial expenditure on the road system that year. Revenues come from petrol tax, road user charges on diesel vehicles, vehicle registration and relicensing fees, and a contribution from local authority rates. The New Zealand (PAYGO) system is a particular example of what is commonly known as a **fully allocated cost (FAC)** approach to the pricing of public road infrastructure, which is widely used internationally. Particular features of the New Zealand road financing system are that:

▸ Charges from the various revenue instruments are set to recover the total expenditure on roading (both maintenance and capital upgrades) in the year in which it occurs.

▸ As capital investments are recovered from annual revenues, no future depreciation or interest is charged.

▸ Costs are allocated between different classes of users by vehicle type using a model that allocates full costs according to administered principles of attribution and equity.

▸ No attempt is made to directly recover non-financial costs (e.g. environmental costs) from road users (although they do indirectly face the cost of environmental mitigation incorporated in road investment and maintenance work).

The current system of paying for roads is inherently inefficient because its charges are system-wide averages that do not reflect the costs imposed by particular users on particular routes. It may also be regressive in nature because of the fixed components in charges to road users, particularly rates and motor vehicle registration and relicensing costs. In the past such rough pricing may have been unavoidable because of the impracticality of monitoring road use in detail. Technological improvements such as electronic road pricing may be at hand within a few years to make more specific pricing technically feasible.

An efficient price is one which sets use charges at the marginal cost of supplying the service and creates the right signals to ensure that transport is only used when its benefits exceed its costs. Since network facilities such as roads have high initial installation and fixed costs, this recipe does not guarantee revenue will match expenditures in any one year. Another efficiency principle is that road users should be faced with the full costs their use of the network imposes on the wider community, so that they make decisions about transport use with full cost information. The question of how far it is feasible to extend the boundary of costs to include externalities in establishing charges for a transport system is not covered in any detail in this current report.

2.3   Alternative Cost Concepts as the Basis for Pricing

The report's Section 2.4 describes four alternative cost concepts that could be used to define the quantum of costs to be covered in a road pricing system:

▸ Fully allocated costs (FAC) and the PAYGO variant currently adopted in the NZ roads sector

▸ Short run marginal costs (SRMC)

▸ Long run marginal costs (LRMC)

▸ Marginal cost plus mark-up (MC Plus).

FAC/PAYGO is the most common approach adopted internationally to charging for public road infrastructure (as described above). It has the advantage of relative simplicity and an appearance of fairness, and emphasises full cost recovery.

SRMC is defined as the change in the total social costs resulting from a unit increase in use, based on the current level of infrastructure provision. SRMC is generally advocated as the basis for pricing in the economic literature because it provides a guide to the most efficient use of existing infrastructure.

LRMC is defined as the change in the total social costs resulting from a unit increase in use, allowing for capacity and infrastructure provision being optimally adjusted in the long run for the level of use. LRMC is seen as having a primary role in long term investment decisions. In terms of pricing, this report identifies advantages of applying LRMC, and discusses the practical difficulties in its estimation. It also notes that LRMC may be a good guide to the equilibrium value of the SRMC.

Unlike FAC/PAYGO, neither SRMC nor LRMC guarantee full recovery of actual costs or expenditures. The revenues they generate may be greater than or less than the annual expenditure on network maintenance. An alternative to FAC for meeting a target budget expenditure is described as **MC Plus,** which supplements SRMC with a mark-up to achieve the stated cost recovery or revenue target. One way to implement it would be with a two-part charge, with a variable charge covering the SRMC of use and a fixed charge (such as an annual licensing fee) to cover the remaining revenue needed to break even. Alternatively the remainder could be recovered by adding a mark-up to the SRMC component in a single-part charge. Using Ramsey pricing principles (differentiating between users by placing biggest mark-ups on the least price-sensitive users) and/or a two-part tariff could efficiently achieve the cost recovery target with minimal distortion in transport choices.

2.4 Capital cost and cost recovery

The report's Section 2.5 discusses issues of asset valuation and the cost of capital, and how these relate to charging a capital return. A number of valuation approaches are available.

▸ **Depreciated Historical Cost** is the original purchase or construction cost (including later improvements) less an allowance for depreciation based on an assumed economic life.

▸ **Depreciated Replacement Cost (DRC)** values the asset at its current replacement cost less an allowance for depreciation based on an assumed economic life, and differs from historical cost when costs have changed over time.

▸ **Optimised Depreciated Replacement Cost (ODRC)** values assets at the cost of replacing the functions performed by a currently optimal configuration of assets (rather than replacement of all the current assets). This excludes redundant or obsolete assets, and is relevant where technological or economic changes shift demand for services.

▸ **Opportunity Cost** is the value of an asset in its most productive alternative use, and is a measure of the cost to the economy (or a company) of continuing to use the asset for its current purpose. Only recoverable assets that can be salvaged or used elsewhere have an opportunity cost, and value in alternative use is net of the cost of converting it from its current use. Opportunity cost is a valuation principle implicit in all the replacement cost approaches, as it is used to value the resource inputs in defining replacement cost.

▸ **Deprival Value** is the loss that the current asset user would suffer if the asset was no longer available, and it combines elements of the concept of replacement cost and that of the value of revenue streams generated by the asset.

Opportunity cost is an economic concept for valuing assets, but the return on this basis may provide insufficient incentive for new investment to cover upgrade or expansion. Some return in excess of opportunity cost may be warranted, as provided by optimised depreciated replacement value. In practice, however, this is difficult to calculate, and the report calculates Depreciated Replacement Cost valuations in its section 3.

These valuations are indicative only and need to be treated with caution. The report shows separate DRC components for:

‣ Depreciating recoverable assets, such as track, signalling and telecommunications equipment for rail;[1]

‣ Non-depreciating recoverable assets, principally land, which is valued on the basis of adjacent land values;

‣ Non-recoverable sunk cost assets, including formation, tunnels and bridges (both road and rail).

In the case of the road network the asset calculations include no depreciating assets, only land and non-recoverable assets. Non-recoverable may be a fair description of road formation, base-courses and surfacing, but the road network also includes assets such as traffic signalling and lighting that are likely to be salvageable. These are difficult to value, and the road valuation may be understated as a result. Accordingly, the report has adopted the more practically tractable approach of including sunk costs in its valuation.

2.5   Pricing and Investment Rules across Public and Private Sectors

The study examines the pricing and investment rules that a government would adopt if its policy were to maximise net economic benefits from the transport system, and compares these with the pricing and investment rules that a profit-maximising company would adopt. The pricing and investment rules are considered separately: pricing is essentially a short-term efficiency issue, whereas investment is a long-term efficiency issue.

Pricing. Private companies will try to price above SRMC when they can, because their long run survival depends on covering their full costs. Budget constrained public agencies will also want to recover their full costs, and raise revenue to do so with minimal distortion in activity. The analysis shows that, if the government agency were to set prices on the MC Plus basis, this could result in an economic pricing rule very similar to the financial pricing rule of a private company **provided that any externality charges are dealt with similarly in both cases**. This approach should also ensure that consumer behaviour is as close as possible to that under the theoretically optimal SRMC, provided that private companies operate in a competitive or contestable market. This is likely to be the case for rail in New Zealand, and could be ensured for toll road companies through a competitive franchising system.

Investment. In the case of investments, no such similarity of rules can be identified. Private investments are guided by financial appraisals of an investment's expected profitability and return, with only items that affect the investors' liabilities appearing in the analysis. Public investment decisions are guided by social cost-benefit analysis, which has broader coverage and includes as a benefit the cost savings to existing customers (the change in 'consumer surplus'), which cannot, in general, be captured by private operators. This implies a role for schemes such as New Zealand's 'Alternatives to Roading' programme, under which private rail investments that can demonstrate favourable national net benefits can receive subsidy in place of further investment in public roads, improving balance between public and private sector investments.

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[1] The reusability of railway assets in the context of this report can only occur if there remains a significant railway in New Zealand.

3. APPRAISAL OF EXISTING COSTS AND CHARGES

This section presents a summary and the key conclusions from the study appraisals of existing costs and charges (as detailed in Chapter 3). It covers the Total Cost/Fully Allocated Cost results for the road system and the rail system; and the Short Run Marginal Cost results for urban passenger transport, long-distance passenger transport and long-distance freight transport. The main emphasis in these results is on comparisons between the externality/provider costs in each sector and charges currently levied on that sector. All costs and charges relate to financial year 2001/02, and charges exclude GST. **Differences between costs and charges do not necessarily imply that any change to current charges or pricing policies are necessary or appropriate.**

3.1 Total Cost/Fully Allocated Cost Appraisal

3.1.1 Road System – Total Costs and Charges

Table S1 presents a summary for the total road system of user resource costs, provider/external costs and the corresponding current charges. A number of distinct components are included in these calculations (as detailed in Annex B of the report).

User resource costs have been calculated by combining cost models for specific vehicle-types with estimates of vehicle kilometres travelled by each type in the base year. The largest components are vehicle operating costs (drawn from a model developed by the AA) and traveller time costs (using the standard values in Transfund's[2] Project Evaluation Manual). This is the largest component of road system total costs, but as road users already willingly cover these costs, it is the least important for policy purposes.

Road system operation and maintenance costs have been drawn from records of the relevant public agencies. They include administrative expenditures of Transfund, Transit New Zealand, Local Territorial Authorities, Ministry of Transport, LTSA, ACC, Police, Fire and Ambulance services, as well as maintenance expenditure and depreciation on road infrastructure.

The valuation of the road network used to calculate return on capital assets is based on Transit NZ's annual valuation update and data from territorial local authorities' annual reports. The total replacement value is $46.2 billion in current values or $37.3 billion in Depreciated Replacement Cost terms. The return is based on the latter figure with a cost of capital of 7% in real terms.

Accident costs are based on LTSA's database of accidents for calendar year 2001, using standard values for the social cost of accidents from Transfund's Project Evaluation Manual. These exclude cyclist and pedestrian accidents. Environmental costs have been calculated as:

‣ Greenhouse gases have been drawn from transport sector emissions reported by the Ministry of Economic Development, valued at $25/tonne CO_2 equivalent. This is the upper limit of the permissible range for a carbon charge under current Climate Change Policies, and therefore rather higher than Government expects the international price of emissions to be under the first Kyoto commitment period (2008-2012). This is only an indicative cost, as in the base year of 2002 there was no established market for attaching value to greenhouse gas emissions.

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[2] Transfund and the Land Transport Safety Authority (LTSA) were merged into a new entity effective 1 December 2004, called Land Transport New Zealand. We continue to refer to Transfund and LTSA in this document since they were operational at the time of this research.

▸ Other environmental effects are all location specific and estimates concentrate on their impacts relating to estimated vehicle kilometres travelled in 140 primary and secondary urban areas. Local air quality estimates are based on an Australian model expressing emissions cost as a function of urban population density. Water quality impacts are valued as mitigation costs of installing roadside barriers and stormwater infrastructure, converted to annual value. Noise impacts are based on the 1996 Land Transport Pricing Study – and are acknowledged as an area of data deficiency needing further work.

Congestion costs are not separately recorded as external costs, as they are imposed on road users by other road users. They are included in travel time under User Resource Costs.

User and related charges are drawn from records of relevant public agencies. They include motor vehicle fees, fuel excise tax revenues (including both those going to transport funding and those going to other Crown uses), road user charges, ACC levies, fire insurance levy, police fines and local authority rates.

TABLE S1: TOTAL ROAD SYSTEM PROVIDER/EXTERNAL COSTS AND CHARGES SUMMARY			
Item	Annual Figures - $ Billion (2001/02)		
	Full Cost Estimate[1]	Likely Range	
		Minimum	Maximum
User Resource Costs			
Vehicle operating and ownership costs	16.8		
Travel time	11.0		
Parking (CBD)	0.4		
Accidents (covered by users)	2.2		
Total	**30.4**		
Provider/External Costs			
Road System Operation and Maintenance:			
Maintenance	0.77	0.75	0.85
Operations and Administration	0.38	0.38	0.38
Accident Externalities	0.67	0.33	1.34
Environmental Impacts	1.17	0.60	2.40
Road System Infrastructure Capital Return:			
Recoverable Assets	0.75	0.30	0.98
Sub-total	**3.73**	**2.36**	**5.95**
Non-recoverable Assets	1.86	0[1]	2.42
Totals	**5.59**	**2.36**	**8.37**
Current Charges			
Fuel Excise	1.09		
Road User Charges	0.58		
Motor Vehicle Fees	0.57		
Other	0.10		
Roading Rates	0.29		
Total	**2.63**		

Notes [1] Taken from Table 3.1

Key findings may be summarised as:

▸ User resource costs are by far the largest component of the full cost of road transport.

▸ Current charges total $2.63 billion p.a., or $2.34 billion if local authority rates are excluded as not being a charge directly related to transport use.

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▸ The broadest estimate of total provider/external costs is $5.59 billion p.a., i.e. just over double the current charges. Over a third of the provider/external costs relate to the target return on road infrastructure assets.

▸ The best estimate of total provider/external costs excluding a return on non-recoverable assets is $3.73 billion, slightly above the current road user revenues (including rates and all petrol tax revenue).

▸ The likely minimum estimate for provider/external costs, assuming no charge on the non-recoverable assets, is $2.36 billion p.a. This is slightly less than the current level of charges.

▸ The likely maximum estimate for provider/external costs is $5.95 billion p.a. excluding a charge on non-recoverable assets, over twice the current level of user charge revenues. The corresponding figure including a return on non-recoverable assets is $8.37 billion p.a., over three times the current level of charges.

3.1.2   Road System – Fully Allocated Costs

These estimates of total road system user costs, user charges and provider/external costs are subject to further analysis in the report's section 3.2.3, to fully allocate costs by:

▸ Vehicle type   – principally cars and trucks
▸ Road type   – state highways and local roads
                   – urban areas and rural areas.

Infrastructure costs have been allocated across vehicle types by means of the Ministry of Transport's Road Cost Allocation Model (RCAM), which is already used to attribute shares of joint costs to different vehicle classes. Most other items are allocated across road types, areas or vehicle classes according to disaggregated estimates of vehicle kilometres travelled. The analysis involves a multitude of assumptions in allocating costs (many of which are not separable) and should be regarded as giving broad indications only.

The main findings in terms of comparing user charges with provider/external costs are:

Vehicle type

▸ The 'social cost recovery' (i.e. ratio of charges : provider/external costs) is significantly greater for cars than for trucks (whether or not costs include a return on non-recoverable assets).

Road and area type

▸ On total costs (including a return on non-recoverable assets), the 'social cost recovery' ratios are substantially higher for state highways than for local roads, and substantially higher for urban than for rural roads. The highest ratio applies to urban state highways (78%) and the lowest ratio to rural local roads (37%).

▸ If a return on non-recoverable assets is excluded, all these ratios increase, but there is less variation, with ratios ranging from 89% for urban state highways to 57% for urban local roads.

3.1.3   Rail System

The comparison between external costs and charges on the rail system is different in nature from that for the road system, as the infrastructure and operations occur within a single organisation (Tranz Rail Ltd) and thus issues of charging for infrastructure are internalised. Operator resource costs comprise the recurrent costs of operations (drawn from Tranz Rail records) and capital charges on assets, estimated as an average annualised charge for rollingstock, and a 7% return on DRC value of infrastructure, as for roads. This rate is well below the return that private bodies would find attractive enough to invest for, even in real

terms, especially in the railway sector. Operator charges levied on the railway by Government are relatively minor, and regulatory compliance costs are subsumed into the railway's costs and not calculated separately. External costs are principally components of environmental cost associated with the rail system, principally CO_2 and urban air quality, estimated on similar basis to these effects caused by roads.

The main findings are as follows:

▸ The main external costs imposed by the rail system relate to environmental impacts. These are estimated in the order of $11 million p.a.

▸ Charges levied on the railway are relatively trivial, at about $0.2 million p.a. (relating to a local authority diesel tax).

▸ The railway system receives public subsidies of $26 million p.a. for public funding to the urban passenger services (Auckland and Wellington).

Other significant findings in relation to the rail system relate to its overall financial viability. Taking all sectors together, it was found that:

▸ Total system revenue is $432 million p.a. (including $26 million public funding for the urban passenger services).

▸ Total recurrent costs are $322 million p.a. An appropriate capital charge to refurbish/replace rollingstock to maintain broadly its present age and condition would add $64 million, giving total costs of $386 million p.a.

▸ In the medium/long term, it will be necessary to renew/replace selected infrastructure assets (e.g. track, signalling, etc.). An appropriate capital charge on these recoverable assets (excluding land) is around $130 million p.a. This would increase total costs to $516 million p.a.

▸ It is evident that total railway system revenues are of a similar order to, but are currently less than, the amount needed to allow for replacement/renewal of assets at a sufficient rate to keep the railway in a steady-state condition.

3.2   Marginal Cost Analysis

Section 3.3 in the report presents estimates of short run marginal costs (SRMC) for comparison with charges currently associated with such travel. Marginal costs show the costs imposed by additional use of the service, and are estimated as costs per person kilometre travelled or per tonne-kilometre travelled. As such they are a useful starting point for considering the efficiency of road pricing in signalling to users the full consequences of their use of the transport system. However, they do <u>not</u> show the charge that would be necessary to recover the total costs of the transport system, as described in the previous section.

The marginal cost estimates follow the same broad approach as total cost estimation, in separately calculating user resource costs, user charges, and provider/external costs, but there are some differences in detail. Fixed cost components that do not vary with use are irrelevant to marginal cost considerations. From the perspective of marginal costs and price signalling, congestion is a separate external cost, representing the delay imposed on all other users of the system by the addition of one extra user.

Marginal costs also tend to vary with the characteristics of particular routes and trip types, so the report presents disaggregated estimates for urban passenger transport, long distance passenger transport, and freight transport for both general and specialised loads. Details of five cases studies covering these different transport types are presented in Annex E.

The estimation of marginal costs tends to be more 'bottom up' than the compilation of national aggregates in the full cost estimates. In estimating the marginal cost of freight transport, for instance, the estimation procedure on the Gisborne to Napier Freight case study anticipates an addition in future loads (from forest harvesting) and estimates the additional cost involved in shifting these loads by rail or by road. The road calculations uses estimates of the additional number of truck trips required to shift the additional volume of load, estimates the costs of those trips from a truck cost operating model, and the Road User Charges that would be paid on those trips. The additional road-wear generated by these trips has been estimated from an adjusted version of the road cost allocation model, congestion has been estimated from a specially developed model of the effect of new truck traffic in increasing encounters and slowing down other vehicles. Environmental costs have been estimated at standard emission rates per unit of fuel used for the whole trip in the case of CO_2, and in the case of local air quality as particulate matter emissions in those sections of road passing through urban areas.

In the other freight case studies where road and rail are competing - Auckland-Wellington mixed freight, and forest loads from Kinleith to Port of Tauranga - the incremental effect examined has been a transfer of a proportion of load from one mode to another. The other elements of cost are calculated in similar manner using data specific to each route, then converted to a cost per net tonne kilometre carried.

Passenger transport case studies compare the incremental external costs of car, minibus, coach and train on the cross-country route from Picton to Christchurch, and the choice of car, bus or train in peak and off-peak periods for the trip between Henderson and Central Auckland. The report also describes a more general analysis of Auckland and Wellington urban transport. Separate estimates are made for vehicle operating costs, travel time costs, accidents, road infrastructure maintenance, congestion and environmental costs, and converted to a cost per passenger kilometre. Public transport fares are treated as a user cost to the travelling end user, covering the resource cost of bus and train operations plus any road user charges and other public levies payable by those operations.

A number of elements in these marginal cost calculations amount to route-specific total costs averaged across the tonne kilometres carried or passenger kilometres travelled. As such, they may not exhibit all characteristics expected of short run marginal costs, such as a tendency to rise with increases in load because of diminishing returns from additional inputs employed. This is inevitable given the data currently available, the nature of the calculations, and their reliance on elements which are themselves standardised or national average values. The estimates can still provide useful indications of the likely incremental costs that would be experienced on the specific routes, and relative costs between modes on those routes, but they cannot be generalised to national figures or combined with similar results for other routes in any meaningful way.

Table S2 presents a summary of results comparing short run marginal provider/external costs and charges for urban passenger travel, long-distance passenger travel and long-distance freight transport. Marginal costs show the incremental costs imposed by an extra unit of use of the service: they do **not** indicate what charges would be necessary to recover the costs involved in the system.

3.2.1 Urban Passenger Transport

The report has analysed typical trips by car, bus and train in Auckland (general), Wellington, (general) and between Waitakere and Auckland CBD, based on:

▸ Travel between suburban areas and CBD
▸ Peak (commuter) trips and off-peak trips
▸ User pays full costs for parking
▸ Range of car occupancy levels (1-2 people/car).

The main findings in terms of comparisons between provider/external costs and current charges are, as summarised in Table S2:

Car

▸ Charges represent a small proportion of provider/external costs, which are dominated by congestion externality costs. This is true in both peak and off-peak periods.

Public Transport

▸ In peak periods, current user charges (fares) are around 40% of marginal provider/external costs for bus services, but a higher proportion (50% - 75%) for train services. Fares are also less than the operations and vehicle costs of both buses and trains, reflecting the influence of regional council subsidies in holding fares down.

▸ In off-peak periods, current charges are substantially greater than marginal provider/external costs (these are close to zero for off-peak train services).

3.2.2 Long-distance Passenger Transport

The analyses have been based on trips between Auckland and Wellington and between Christchurch and Picton, by car, coach/minibus and train. Car travel has been considered at a range of occupancy levels (1 to 3 people/car).

The main findings in terms of comparisons between provider/external costs and current charges are (refer Table S2):

Car

▸ Charges are less than (on average about two-thirds) the marginal provider/external costs. However, both provider/external costs and charges are small, typically around 5% of total travel costs for the private car user.

Public transport

▸ For coach travel, user charges (fares) are less than marginal provider/external costs, whereas for train travel, charges are significantly greater than the marginal costs (because for trains, marginal costs are significantly below average costs).

3.2.3 Long-distance Freight Transport

The report's analyses have focused on two main types of medium/long-distance freight movements, for which road/truck and rail/train compete with each other : general freight movements (as in the Auckland-Wellington analysis), and specialised product movements (as in bulk logging/forestry between Napier-Gisborne and Kinleith-Tauranga).

There are other distinctions between the examples chosen. The Kinleith-Tauranga example involves a dedicated forestry transport task whereas the Napier- Gisborne example involves adding new forestry loads to an existing line with other traffic (predominantly fertiliser at present). As the Gisborne line has suffered declining traffic and setbacks such as storm damage over recent years, the comparison of social costs between road and rail on this route

may be critical for the line's continued operation. The Napier study presents two estimates of marginal cost – one in the near term (1-5 years ahead) with loads having their current configuration, and one in the medium to long term (6-25 years ahead) with the expected increase in logging traffic.

The freight analyses have been conducted from the viewpoint of the operator rather than that of the end use customer with goods to despatch. As well as estimating Operator Resource Costs, Operator Charges and Provider/External Costs, the estimates also present a fourth item, End User charges, which are the freight rates offered by the road-freight or rail company. This enables comparison to be made between the rate paid per tonne kilometre carried with the short run marginal cost of each additional tonne kilometre.

Tranz Rail's operating expenditures internalise costs like infrastructure maintenance, safety management and traffic co-ordination, so the only significant externalities from rail included in these estimates are environmental impacts. Consequently, rail freight tends to have higher operational costs but low external costs, whereas road freight has lower operational costs but higher external costs comprising impacts of additional trucks on road wear, congestion, accidents and environmental effects.

In terms of comparisons between marginal provider/external costs and current charges, the main findings are (refer Table S2):

Truck

‣ Current charges (mainly RUC) are greater than the level of marginal provider/external costs (principally accident externalities and marginal road wear) in the specialised freight examples (Gisborne-Napier, Kinleith-Tauranga), but less than external costs in the general freight example (Auckland-Wellington).

‣ Freight rates per tonne kilometre comfortably exceed the marginal costs in all examples except the Napier-Gisborne line in the year 1-5 period, before increased loads become available.

Train

‣ The main marginal external cost associated with rail freight transport is from environmental impacts, although these are small relative to other cost items (most other costs are internalised within the rail business).

‣ This means the short run marginal social cost exceeds the marginal operator cost by a small amount (the marginal cost of environmental damage) in all examples of rail freight.

‣ Freight rates per tonne kilometre exceed short run marginal cost on the general freight route (Auckland-Wellington), but are less than operator costs with or without the addition of external costs in the two specialised freight examples.

Two other findings from the freight appraisal are also worth noting:

‣ For the primarily rural movements analysed, the environmental impact costs (per net tonne kilometre) are low for the two modes compared with urban impacts, but vary according to route-specific factors.

‣ For typical longer-distance general freight movements, which can be served by the rail network, both the operator cost rates and the marginal economic rates are quite similar for the two modes. This indicates that the choice of mode will often be finely balanced where it is dictated by either user cost considerations or economic considerations.

4. IMPLICATIONS AND LIMITATIONS OF ESTIMATES

This report has presented estimates of the societal costs of road and rail transport modes, both total costs and short run marginal costs. Total cost estimates can be informative of whether a transport system as a whole is recovering the costs incurred in providing and using the system. Marginal costs can be informative of the price that should be charged to ensure that those deciding on making transport decisions are aware of the full incremental cost their trip will entail, and desist from making trips whose costs exceed their benefits. There are limitations with the uses of the current estimates for informing transport policy.

There are limitations in the data that have been used in preparing this report, with varying degrees of uncertainty surrounding different components of the analysis. Some of these are explored in the body of the report. Others are more subtle. One of the attractions of marginal cost pricing is the avoidance of distorting price signals that arise when prices are based on system-wide average costs which are poor representations of actual incremental costs incurred in different parts of the transport system. The report has customised its estimates to the circumstances of particular case studies. But on current data, it is impossible to avoid elements of system-wide average costs creeping back into parts of the analysis, for instance through the valuation of travel time and congestion, accidents and some aspects of road network maintenance. The resulting estimates may not have all the characteristics of real marginal costs, and inferences about marginal costs outside the case study areas cannot be made without more detailed examination of the characteristics in those areas.

The report is a tool for informing policy, providing data as a baseline for further work, but it does not offer policy solutions. The fact that a gap or imbalance may be identified in this analysis does <u>not</u> imply what should be done about it. Nor should gaps between costs and charges be interpreted as the amount by which the user should increase payment in order for the system to efficiently recover all costs directly from users. There is an important distinction to be drawn between efficient (economic) pricing, which is about signalling to users the full cost of their next increment of use, and cost recovery pricing, which is about financial balancing. Efficient pricing and balanced budgeting are two separate objectives and there are trade-offs to be made in pursuing them simultaneously through 'second best' measures like mark-ups on marginal cost pricing.

Marginal cost shows the costs imposed by extra use of the service. It does not reflect what charges would be necessary to recover the full costs involved in the system. It is an indicator which assists a company to set production at the short run profit-maximising level. However, for long run survival the company must cover its total/average costs. These two different objectives are informed by different cost measures.

The estimates in this report provide a snapshot of costs at a point in time, not a dynamic assessment of future costs, charges and levels of transport use under some 'improved' transport structure. Because people react to monetary incentives, any change in charges will induce a market adjustment. So even if data deficiencies could be overcome, new charges would be less than shown by the gap highlighted in a study of this type, and the ultimate optimal charge would be somewhere between the two extremes of status quo and apparent gap. So the gaps in this study must <u>not</u> be interpreted as recommended charges for government to apply.

A gap between costs and charges need not imply a charge will be applied, of whatever magnitude, because any response should be guided by the intervention that has the most beneficial outcome. For example, for environmental factors, the solution to noise pollution may be to apply standards rather than a user charge. For some cost issues that might be

identified, the transaction costs of correcting it through policy response may outweigh the costs of doing nothing.

There are also strong caveats to be placed on the estimates for return on infrastructure assets in this study, both because of uncertainties around the data and because of the relevance of sunk assets in providing revenue for future investment. New Zealand roading already has a process of project appraisal for guiding new investment into areas showing greatest net benefits. If efficiency in pricing and investment is an important objective, there is no economic reason to believe that raising charges to provide a return on sunk assets will improve the efficiency of future investment in the road network. However, not allowing for a return on sunk assets may place roading on a separate footing from commercial travel modes and alter the competitive position between road and rail.

This study will be most helpful in showing _relative_ situations, for example, with passenger transport, how much of the costs a car user covers in the peak versus the off-peak, or compared to a bus user or a train user on the same route. It provides an indication of how much of the costs the user is covering, by how much they be overpaying or underpaying in terms of SRMC in a given situation, and which mode choices in a given situation are likely to most nearly cover the society-wide costs they create.

As stated in the Terms of Reference, the study provides "...estimates of the costs imposed by road users and by rail users, and the payments they make for using each mode... This information will assist the government to make decisions on the relative competitive position of road and rail for freight transport and of rail, bus and the private car for passenger transport."

TABLE S 2: SUMMARY OF MARGINAL EXTERNALITY COSTS AND CHARGES COMPARISONS All figures in ¢/passenger km or ¢/net tonne km									
	Car/Truck			Bus/Coach			Train		
	Charge	Ext Cost	Charge: Cost %	Charge	Ext Cost	Charge: Cost %	Charge	Ext Cost	Charge: Cost %
Passenger Urban [1] Peak Off-peak	 1.9 – 3.8 1.7 – 3.3	 17.5 –51.8 4.7-19.9	 c 10% 17%-36%	 17-20 17-21	43.6-53.1% 6.9-11.4%	 38-47% 180-300%	 9-15 9-15	 12-24 0	 58-89% n.a.
Passenger – Long Distance [2]	1.2 - 1.3	1.7 – 1.9	c 65%	8-11	8.1-13.4	60-90%	12-171	6-8	c 139% - 260%
Freight – Long Distance	1.8 – 5.5	2.9 – 3.4	c 60%-170%				-	0.1-0.8	-

Notes: [1] _Relates to Auckland (general), Wellington (general) and Waitakere – Auckland CBD. Car figures focus on average car occupancies. – Covers car occupancies in range 1.0-2.0 persons/car_

(2) _Based on Auckland-Wellington and Picton-Christchurch travel. Car figures focus on average car occupancy (1.7)_

1   INTRODUCTION

1.1   This Report

This is the Main Report of an 'Investigation into Surface Transport Costs and Charges' undertaken on behalf of the Ministry of Transport, New Zealand.

1.2   Study Team

The study has been undertaken by a consortium of the following organisations /individuals:

‣ Booz Allen Hamilton (BAH), New Zealand and Australian practices – principal consultant
‣ Institute for Transport Studies, University of Leeds, UK (ITS)
‣ Montgomery Watson Harza (MWH)
‣ Ms Margaret Starrs (MM Starrs Pty Ltd)
‣ Mr Ian Moncrieff (Fuels and Energy Management Group).

Inputs were also provided by the Bureau of Transport and Regional Economics, Commonwealth of Australia (BTRE), which acted as a peer reviewer on behalf of the Ministry of Transport, as well as the New Zealand Institute of Economic Research (NZIER).

1.3   Overview of Study Scope

The **overall study purpose** (as stated in the Terms of Reference) was as follows:

"The purpose of this study is to provide estimates of the costs imposed by road users and by rail users, and the payments they make for using each mode. This examination will take place in as disaggregated a way as permitted by available data. This information will assist the government to make decisions on the relative competitive position of road and rail for freight transport and rail, bus and the private car for passenger transport."

The study was required to assess whether or not the existing charging system is sending the right pricing signals to influence transport user decisions in choosing between road and rail modes. It was to address whether prices are correctly and consistently related to costs, and to consider principally Short Run Marginal Costs (SRMC and, Fully Allocated Costs (FAC).

It should be emphasised that a divergence between prices and costs may be unavoidable and/or entirely appropriate in the context of economic and other policies. The identification of a divergence does not necessarily imply that a change in price is an appropriate policy response.

The study was to consider all transport-related costs (economic and financial) and charges, for both road and rail modes, covering both infrastructure and (where relevant) services. It was not required to consider coastal shipping or air modes.

In considering and comparing costs and charges, the charges of prime interest are those to end users (e.g. bus passengers) rather than those to 'intermediate' operators (e.g. bus companies). However, in terms of a full understanding of the situation, both sets of costs/charges are of interest.

The main focus of the study was on the existing situation and its implications for short/medium term pricing decisions. However, there was also an interest in long-run pricing issues, and the potential distortions resulting from the different investment

approaches in the public/roading sector (SCBA) and in the private/rail sector (IRR, etc.). One of the study tasks was to examine the case for and cost-effectiveness of pursuing an approach based on Long Run Marginal Costs (LRMC).

The study was essentially a 'baseline' study only, to establish the facts of the current situation, and to form the first stage of an overall policy development process. It is premature to attempt to draw any policy conclusions or recommendations at this stage. While the consideration and assessment of policy options would take place subsequently, the study was required to have due regard to the subsequent stages: the report was to identify theoretical and practical considerations that would need to be taken into account in the subsequent policy assessment stage.

The study investigations were to cover transport costs and charges for the whole of New Zealand, but were required to "*take place in as disaggregated a way as permitted by available data*". In practice, the provision of appropriate pricing signals is most important for two main groups of transport movements where there is the greatest competition between modes:

‣ Urban passenger transport – primarily competition between private car and public transport (secondarily rail versus bus).

‣ Long distance freight transport – competition between road truck and rail freight, in selected corridors.

Selected case studies were undertaken as an adjunct to the study for specific corridors/areas where there is substantial potential for competition.

1.4   Study Staging

The study was undertaken in four main stages:
‣ Stage A: Inception Stage
‣ Stage B: Initial Assessment
‣ Stage C: Refined Assessment
‣ Stage D: Final Reporting and Knowledge Transfer.

The **Inception Stage** (A) involved initial investigations of methodology and data issues, leading to the development of a specification and work plan for Stage B of the study.

The **Initial Assessment** (Stage B) involved a 'first pass' assessment of road and rail system costs and charges, and also addressed a number of policy and economic issues, in particular:

‣ The interactions between pricing and investment policies, and the comparability of investment policies between road and rail sectors.

‣ The feasibility, methodology and merits of pursuing a long-run marginal costing appraisal, to supplement the SRMC and FAC appraisals.

The **Refined Assessment** (Stage C) extended and expanded on the Stage B work, involving more detailed assessment in all analytical areas.

The **Final Reporting** (Stage D) involved completion of the analytical work (including taking into account the feedback on the Stage C report), completion of all reporting and data handover/knowledge transfer to the Ministry of Transport.

1.5 Overview of Study Reporting

This report provides the main reporting of the study. It is structured as follows:

‣ Chapter 2 – sets out the theoretical framework for the study and addresses key economic issues relating to this.

‣ Chapter 3 – provides an overview of and commentary on costs and charges appraisal results, for total/average costs and short-run marginal costs.

The main text is supported by five annexes, providing more detail on certain aspects of the work.

‣ Annex A – listing of working papers prepared during the study on the various analytical areas of work.

‣ Annex B – provides further details on each of the analytical areas of work (supporting Chapter 3, and summarising the separate working papers).

‣ Annex C – glossary of abbreviations.

‣ Annex D – explains the different systems used to classify commercial vehicles.

‣ Annex E - provides an overview of the five case studies – the aims, assumptions and main results of each. The five are: Napier-Gisborne freight; Auckland-Wellington freight; Waitakere-Auckland CBD urban passenger; Kinleith-Tauranga freight; Picton-Christchurch long-distance passenger.

References are given at the appropriate point in the text. More detailed documentation in each analytical area of work is provided in 16 'topic' working papers, and the five case study working papers as listed in Annex A and summarised in Annex E: these are contained in separate volumes.

2 METHODOLOGICAL ISSUES

2.1 Overview

This chapter considers key methodological issues underlying the study specification and assessment of costs and charges for road and rail modes, and the subsequent application of these results in the development of pricing and investment policies. These issues cover:

▸ different costing approaches (principally fully allocated costs, short-run marginal costs and long-run marginal costs)

▸ relationships between transport prices and costs

▸ implications of financial cost recovery

▸ implications of the different investment evaluation approaches in the road sector (applying social/economic criteria) and the rail sector (applying financial/ commercial criteria).

The chapter is arranged in the following sections. Section 2.2 considers the government interest in transport pricing and the national economic reasons why a government might wish to intervene in the market. Section 2.3 then looks at the current situation in New Zealand. The alternative cost concepts are discussed in Section 2.4 and the reasons for, and implications of, imposing a cost recovery target for pricing are discussed in Section 2.5. Section 2.6 looks at the difference between financial and economic decision rules for price setting and investment, and offers suggestions on how these might be reconciled if the individual decisions of travellers and shippers were to be based as closely as possible on the costs to society. Section 2.7 summarises the main conclusions of the chapter.

2.2 Government Interests in the Transport Sector

2.2.1 Role of Prices and Costs

This investigation aims to provide information to assist the Government make decisions on the relative pricing of the surface transport modes. It arises from a concern that the effect of the mix of public and private providers together with their different approaches to charging might be leading to inappropriate consumer choices and producer investment decisions. The Government is interested in determining the implications of different charging approaches on competitive neutrality – in particular the impact on mode shares and investment.

The setting of prices is not an end in itself - governments are interested in prices because they influence consumer and producer behaviour:[1]

▸ **For consumers**. Efficient prices enable consumers to relate the benefit they expect to receive to the cost of providing that good or service. Efficient prices guide the consumer to take actions that maximise national economic welfare.

▸ **For producers.** Prices indicate to producers the benefit they will get from producing goods or investing in capital and infrastructure. Efficient prices equate the benefit to the

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[1] Governments do also have a broader interest in price stability, equity, etc. The emphasis on pricing for economic efficiency in this analysis is not intended to deny the wider interests of governments in addressing equity, income distribution and many other price-related issues across the whole economy.

company with the benefit to society as a whole and thus ensure production and investment decisions are guided by the benefits to society.

In a fully competitive market, prices are set by the interaction of many consumers and producers ('the market') and the producers are 'price takers'. In a less competitive environment, a commercial enterprise will try to price at whatever the market will bear. The difference between the price a company can command and the cost of production determines:

▸ whether it is worth the company being 'in the market' at all; and

▸ whether the revenues received are sufficient to provide for investment in new capital/ infrastructure.

A company will remain in the market in the short run if the price is greater than the company's marginal cost of production, including the opportunity cost of any capital being utilised. In the long run a company will remain in the market if the price enables the company to cover its long run costs including any investment required.

In a commercial environment, companies have only limited control over the prices they can charge, prices being effectively set by the market. It is assumed that any argument over what pricing basis should be used is only relevant in the context of government intervention – to correct market failures, to ensure that prices reflect wider 'social issues'[3] or to regulate charges where the provider has a monopoly. These reasons for government intervention in the transport sector are discussed in the next section.

2.2.2   Reasons for Intervention in the Transport Sector – Market Failure

New Zealand has a predominantly free market economy. The Government relies primarily on the functioning of the market to determine the supply and price of traded goods and services. The transport sector is a notable exception.

Economic theory indicates that the market provides an optimum allocation of resources only if certain conditions hold true. These conditions relate to the following (see Gwilliam and Mackie, 1975):[4]

▸ externalities
▸ public goods
▸ economies of scale
▸ imperfect information
▸ indivisibilities

There are few markets where all the conditions for market optimality are fulfilled, and yet most products are produced and traded with minimal government intervention. Transport has traditionally been regarded as an exception and it is worth considering why this should be the case.

2.2.2.1   Externalities

Externalities are costs (or benefits) arising from consumption or production of a product that are experienced by other members of society but are not experienced by the person making the production or consumption decision. The market mechanism may fail if some goods are not priced, or the cost to society is different from the price seen by the decision-maker as the

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[3] Including a need to raise general revenue.

[4] Gwilliam K.M. and Mackie P.J. (1975). *Economics and Transport Policy*. George Allen & Unwin Ltd, London. p16-21.

result of the absence of a market or clearly defined property rights for a good or service. Congestion costs imposed by road users on other users are one example of this effect. Another is the effect on the environment of noise, fumes and visual intrusion.

Transport users (or groups of users such as motorists) could be seen as members of a self-contained club who collectively pay the costs they impose on each other. This is particularly relevant to congestion, where those who create congestion costs also suffer from the actions of others. When congestion costs are low, as is the case for infrastructure when there is plenty of spare capacity, this may be a reasonable approach. But in a world of heavy traffic and capacity limits, environmental emissions, accidents and parking costs, it becomes more appropriate to consider externalities as of relevance to society at large, and not simply as costs both imposed and incurred by the club members. Currently, congestion costs, environmental costs and some accident costs are not included in transport charges in New Zealand.

2.2.2.2   Public Goods

The defining characteristics of public goods are: (a) non-rival consumption (use by one person does not prevent use by another); and (b) non-excludability (it is difficult to exclude non-payers). Markets tend to under-provide public goods because commercial enterprises cannot 'capture' and thus charge for all the benefits. Transport services and infrastructure have some of the characteristics of public goods in situations of low demand. For example, bus services in low density areas often exhibit non-rival consumption – while excluding people by enforcing the payment of a fare is possible, this results in a net loss of economic welfare. Roads exhibit non-rival consumption when traffic is light. In both of these examples where there is high demand (congestion or overloading), their characteristics are more akin to private goods.

2.2.2.3   Economies of Scale

Economies of scale occur when the cost per unit of production decreases as production increases, i.e. the marginal cost is less than the average cost. One would expect significant economies of scale in the provision of transport infrastructure.[5] Urban public transport also exhibits economies of scale – not in the provision of the services, but in the benefits to passengers (the so-called Mohring effect where existing users benefit from the increased frequencies provided for new users).

Economies of scale can lead to natural monopolies because large companies have lower average costs than small companies.

2.2.2.4   Imperfect Information

Perfect information implies that consumers are aware of the price and the quality of rival products and how these will change over time. The market mechanism relies on people being able to compare prices and services to make rational informed decisions. If consumers are unaware of the costs of alternatives, the market mechanism will not function effectively. The most quoted transport example is the costs associated with owning and operating a private car. It is argued that some car users consider only the immediate operating costs and ignore other medium-term costs such as maintenance when making use decisions.

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[5] Small et al., 1989. *Road Works: A new Highway Pricing and Investment Policy*, Brookings Institute, found that the substantial returns to scale in pavement durability were offset by diseconomies of scope so that returns were nearly constant overall (Gómez-Ibáñez 1999 in *Essays in Transportation Economics and Policy* p. 126).

Imperfect information can lead to lags in or inappropriate structural adjustments to short term pricing signals. Perfect information is a theoretical, not a practical, concept but the absence of perfect information does not, by itself provide a justification for government intervention.

2.2.2.5   Indivisibilities

Indivisibilities are purchases which are made in large lumps. For example, roads have a minimum width so can in general only be provided or expanded in large increments. Gwilliam and Mackie[6] suggest that facilities of a type that are constructed infrequently, but on a very large scale may be under-provided by the market. We show later that one difference between financial and economic investment decision rules is that the former does not always 'capture' the benefit to existing travellers arising from large infrastructure investments.

2.2.3   Reasons for Intervention – Wider Impacts

One particular argument that is often put forward for government intervention in the provision of transport infrastructure or services is that they have a positive effect on the economic development of the area. If this effect occurs, and gives rise to so-called external benefits which are not reflected in the direct transport benefits, then the most likely explanation is that there are other market distortions, such as the failure of the labour market to adjust to regional unemployment. Such market failures could lead to a case for subsidising the cost of transport. However, the evidence for such positive external benefits of transport is limited; they appear to be very dependent on the circumstances of the particular case.[7]

It might be thought that this argument would be particularly relevant for remote rural communities whose production possibilities are severely hampered by the cost of transport to markets. Indeed this may be the case if the area has potential in a particular field of production and it is only the cost of transport that is making the location uncompetitive relative to other locations. But it is also the case that transport costs protect local markets in such locations and reduced transport prices may enable goods brought in from other locations that enjoy greater economies of scale to displace local production and to lead to a loss of jobs. Moreover it is not necessarily sensible in terms of overall economic policy to provide subsidies that encourage industry to locate in places where transport costs are relatively high.

The implication of this discussion is that it is more efficient to provide selective assistance to particular industries on regional development grounds than to provide blanket subsidies through adjusting prices for transport services or infrastructure.

2.2.4   Intervention Strategies and Issues

As described above, there are a number of reasons why market failure might be expected in the transport sector. However, such conditions present no more than a *prima facie* case for government intervention. There are many options available to policy makers in the face of market failure. While a full discussion of these is outside the scope of this study, the over-riding principle should be to treat the 'problem' as directly as possible, taking into account

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[6] Ibid

[7] Standing Advisory Committee on Trunk Road Assessment (1999), *Transport and the Economy*, Report to UK Department of the Environment, Transport and the Regions.

the costs of regulatory failure, and to only intervene where the benefits from the intervention exceed the costs. Before we can consider how this principle can be applied, we need to understand the current situation in the transport sector in New Zealand and the implications of adopting different bases for pricing.

2.3   The Current Situation in New Zealand

2.3.1   Organisation and Ownership of the Land Transport Sector

The surface transport sector in New Zealand involves several different forms of ownership and control. The rail system is privately owned and operated, although the land on which the tracks are laid is owned by the Crown and the Government is currently negotiating to buy back the track.[8] Public roads are owned by the Government through Transit New Zealand, and by territorial local authorities. Neither central nor local government operates freight transport services. Long distance and most urban passenger services are operated by private companies – the only exceptions being Local Authority Trading Enterprises (LATEs) which operate urban bus services in Christchurch and Dunedin and which are owned by territorial local authorities in those areas. LATEs are, in any case, required to operate commercially. Stewardship of urban public transport services in the larger centres nevertheless lies with regional councils, which set fares and service levels and contract for their provision.

The New Zealand situation is therefore moving towards the model that has developed in Australia and is increasingly common elsewhere, whereby the infrastructure is under some form of public ownership and control, while transport operations are generally undertaken by private companies or government commercial entities. Intervention in prices and services is generally limited to urban public passenger transport.

2.3.2   Pricing of Transport Services and Infrastructure

2.3.2.1   Pricing of Privately-Operated Services

There is currently no price control for privately operated transport services and no restrictions on entry other than compliance with basic health and safety regulations.[9] The freight and long-distance public passenger transport markets are competitive and prices are, to a large degree, dictated by the market. Some price discrimination does occur, with prices varying by direction (generally lower in the back-haul direction), season and service quality. Pricing to maximise revenue yield ('yield management') is becoming more common and is reflected in prices that are higher at times of high demand. It is reasonable to assume that, overall, prices cover costs.

2.3.2.2   Pricing of Government-Provided Infrastructure

The traditional approach internationally to charging for government-provided transport infrastructure is to measure the total cost of its provision and to allocate the total between users on some basis that is regarded as equitable. This is known as a **fully allocated cost (FAC)** approach. The costs that are allocated are the financial costs rather than the social

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[8] now completed

[9] In urban areas most services are operated under contract and there is competition for tenders which provide exclusive rights for the contract period.

costs to the country as a whole, which would include externalities. An awareness of the presence and impact of externalities is increasing, and means of 'internalising' externalities (i.e. incorporating them into the decision process), such as carbon taxes, are a matter of public debate. Transport prices in New Zealand do not explicitly include externality costs,[10] other than some specific contribution to accident compensation levies in road registration and fuel levies. We therefore refer to this as the financial FAC as distinct from the economic FAC.

One of the features of FAC is that it aims to provide full cost recovery (of either financial costs or economic costs as appropriate). It is not the only way of ensuring full cost recovery: the essential feature of FAC is that it uses one or more metrics ('cost drivers', e.g. vehicle kilometres, mass-kilometres) to allocate costs across the various user categories.

FAC are also sometimes called **average costs**. Averaging implies that the total cost is spread equally over all users. This may not be the case where the total cost incorporates some costs that are specific to certain types of user and other costs that are common to several types of user. In this case, the total costs are allocated by type of user by using different cost drivers. FAC is thus the preferred term unless users are homogeneous.

The approach adopted for roads in New Zealand is the so-called **'pay as you go' approach** (PAYGO), which is a particular case of the FAC approach. Under PAYGO, investment is charged directly to users in the year in which it is undertaken and no future depreciation or interest is charged. Only financial costs are included in the calculation. In New Zealand, road user charges (RUC) are determined based on the financial FAC, using this PAYGO approach to capital costs.

A significant proportion of roading costs (up to 50% of costs for local roads) are covered by rates, which are paid according to property values and largely unrelated to roading costs. Even with the notable 2003 Auckland example in which a substantial rate increase has been specified to be used for the transport network in the region, the rates are still not directly related to use. They represent a fixed cost from the transport user's point of view.

The motor vehicle registration and relicensing costs are fixed according to the vehicle type, so while the prices paid vary across the vehicle fleet, they are fixed at an annual rate per vehicle.

As far as road users are concerned, rates, motor vehicle registration and relicensing costs are totally unaffected by the amount they use the roads, therefore, they are fixed costs in any use decisions.

Fixed costs across the economy bring with them the issue of regressive charging. For a given vehicle type, lower income road users are expected to pay the same motor vehicle registration and relicensing costs as higher income road users. Likewise, for rates, for a given property value within each rating zone, lower income road users are expected to pay the same rates as higher income road users. It may be argued that rates are less regressive than a single fixed charge, since property values are related to income levels. However, the scale of rates charges to property owners is not closely related to incomes and as such will have equity implications.

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[10] The identification of externality costs in this study does not necessarily imply that the inclusion of an externality charge is either necessary or appropriate. Even where such charges are appropriate, the optimum charge is likely to be different from the cost identified in this report.

2.3.2.3   Consistency between Modes

A major issue which arises in New Zealand, as elsewhere, is the co-existence of one sector (roads) where pricing is set using FAC/PAYGO and investment rules are based on social cost-benefit considerations, and another sector (rail) where the rules are commercially based. A similar issue may arise within the roads sector if some roads are provided on a commercial basis (e.g. toll roads) but 'compete' with publicly-provided roads. Broadly there are two problems which arise: the first is that pricing policies differ across the sectors and this affects mode and route choices. The second is that the organisations in the two sectors will make investment decisions based on different criteria (see section 2.6).

2.4   Alternative Cost Concepts

The section reviews the various cost concepts commonly used or advocated as a basis for pricing. While there are variations between authors in the way some of these concepts are defined and used, we believe the definitions used here reflect a common understanding of their meanings. We start by considering the strengths and weaknesses of the FAC/PAYGO approach, as that is the present basis for the pricing of Government-owned transport infrastructure in New Zealand.

2.4.1   FAC and PAYGO

2.4.1.1   Definition

As discussed above (section 2.3.2.2), the **fully allocated cost** (FAC) approach is the allocation of total costs between users on some basis that is regarded as equitable. It is the traditional approach to charging for government-provided transport infrastructure.

2.4.1.2   Strengths

An important consideration in the setting of transport prices is that of cost recovery, i.e. setting prices in such a way that the total costs (however defined) associated with the transport system are recovered from users in total. This is a prime consideration with FAC. The importance of cost recovery is discussed further in Section 2.5.

Public Acceptability. One of the attractions of FAC and PAYGO as a basis for pricing government services is that they are simple concepts for people to understand. While that simplicity may prove somewhat illusory for those responsible for determining actual cost allocations over multiple users, to the public this will always be the simplest concept.

The PAYGO approach is administratively simple. It was introduced in New Zealand when the National Roads Board was formed in the 1960s and replaced a system where road expenditure was the subject of annual budget allocations from parliament. It is an approach strongly advocated by the World Bank and Asian Development Bank for developing countries, where the exigencies of the budgetary system often lead to maintenance being under-funded.

Equity. FAC is also generally perceived by the public as equitable. Infrastructure users collectively pay for the costs of providing the infrastructure, and the allocation of the costs between user classes is based on engineering formulae which can command a degree of acceptance. This is particularly important for government-provided services as it helps to take the political heat out of the issue. It ensures that costs in total are met by users, so that the sector is effectively self-financing. One consequence of this is that it helps discourage lobbying for an uneconomic level of investment, since users know they will collectively have

to pay. It does not eliminate lobbying entirely because there is still averaging over users, so one group can benefit at the expense of another.

FAC can be seen to be more equitable than pricing based on marginal costs (discussed in more detail later). Whereas average costs tend to be lower at peak times than at off-peak, because any 'fixed' costs are spread amongst more users, marginal costs tend to be higher at peaks (because the cost of carrying extra users is highest then) and lower off-peak. Although the public is now used to peak charging for telephone calls, airline flights and holiday accommodation, there is still a natural suspicion and a feeling of inequity and counter-intuitivism about charging more at the very time many people want to travel and travel conditions may be inferior.

2.4.1.1 Weaknesses

Averaging. A major problem with FAC and PAYGO approaches is that the resulting charges are network averages, and this can lead to price signals that do not reflect the underlying costs. For example, the maintenance cost of a road constructed to carry heavy axle weights is much lower per axle than a road that has not been adequately designed, yet the road user charge per kilometre is the same. Where prices are based on FAC, truck operators have no incentive to remain on the (well-constructed and thus low-cost) state highway when there is a shorter (but lower-standard and thus ultimately more expensive) local road alternative.

The degree of averaging could be reduced by moving towards more targeted pricing. The current charges are delivered through conventional tax systems relying on fuel taxes, vehicle licensing and road user charges that are not location-specific. These are weak proxies for the true cost 'drivers', and tend to mean that prices in some markets are higher than they should be while at other times and places users are paying far too little. However, improved targeting could lead to another problem with average costs – facilities and times where there is under-utilisation might involve relatively high charges, further discouraging their use.

Joint Costs. Many of the costs of providing road and rail infrastructure are joint within and between vehicle classes, so that there is no unique cost allocation methodology. The FAC concept in itself does not offer any guidance on how these costs should be shared. New Zealand has a road cost allocation model that attempts to address this issue for roads, but there remains scope for lobbying, especially on the allocation of costs across heavy versus light vehicles, petrol versus diesel fuel vehicles, and high mileage versus low mileage users.

FAC Cost of Capital. A major practical issue in quantifying FAC (as distinct from PAYGO) is the determination of the appropriate capital charges. The usual approach is to derive the capital charge as the discounted replacement cost (DRC) of the assets employed times a weighted average cost of capital (WACC). This will differ from the capital charge based on depreciated historical costs, particularly if the current system has excess capacity or if its assets would not be replaced in their current form (e.g. because the investment was not justified in the first place or is obsolete).

It appears inequitable, and is certainly inefficient, to charge existing users the full capital costs of replacing the existing set of assets like-for-like plus a rate of return on these assets. A less distortionary approach would be to only charge users for those assets that would be replaced (i.e. can be economically justified), and to do so at replacement cost in modern equivalent form. As a principle, this sounds simple, but in practice it requires detailed study and many disputable judgements. Moreover, if replacement in modern equivalent form would change other elements of cost, such as operating cost or wear and tear, then it seems inconsistent to base these on the existing assets and to base capital charges on something different. This problem applies to all pricing systems that attempt to recover the 'total cost'. This issue is discussed in more detail in Section 2.5.

PAYGO Issues. Although PAYGO does not have the asset-valuation problem, one of its weaknesses is that it charges capital improvements totally to current users. In circumstances where the level of investment varies over time, this method is neither fair nor efficient: on average users will be over-charged if the network is expanding and under-charged if it is running down. Meyrick[11] (in the context of long-distance road transport) points out that:

▸ *From the point of view of resource allocation, the PAYGO target is without meaning: it bears no consistent or predictable relationship to either the resources that have been consumed in providing the current stock of road track, or those that will be required to provide an efficient network for the future. It cannot therefore lead to prices that provide meaningful signals for demand management.*

▸ *As a pure cost recovery measure, it applies little pressure on road authorities to improve productivity or investment planning. Under PAYGO, 'current road expenditure has to be recovered, irrespective of its economic merit'.*

2.4.2   Short Run Marginal Costs

2.4.2.1   Definition of SRMC

Short run marginal cost (SRMC) is defined as the change in the total social cost resulting from a unit increase in demand at the current level of infrastructure provision.

Depending on the circumstances, the unit of increase may be (for example) vehicle kilometres, train kilometres, passenger or tonne-kilometres.

In practice, SRMC is often interpreted as the answer to the question, "Given the level of infrastructure provided, what is the additional social cost per (vehicle) kilometre of handling a specified increase (often 1%) in traffic?" This changes over time as the level of infrastructure provision and the level of traffic change. SRMC comprises the social costs experienced by the marginal user together with any costs that the user imposes on the rest of society (the 'externality' costs).

Social costs are incurred partly by the public authorities (for example road maintenance costs), partly by transport users (for example congestion costs) and partly by society at large (for example environmental and some accident costs). So both SRMC (and by implication MC Plus) and LRMC are social accounting concepts which go broader than the costs to the user.

The costs of providing infrastructure are only relevant to calculation of the SRMC inasmuch as they influence the level of capital stock: relevant costs are the costs of using the infrastructure such as the marginal maintenance, congestion and environmental costs of handling more traffic. Marginal maintenance costs will include the cost of accelerated renewals as a result of more intensive use, but not the costs of initial provision of infrastructure. Marginal costs are however not a good indicator for price-setting (see section 2.4.2.5).

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[11] Meyrick, S. 1994, 'Objectives of Road Pricing' in *Refocusing Road Reform,* J. Cox (ed.), Business Council of Australia, p. 244.

2.4.2.2   Optimal Resource Allocation

SRMC is advocated by many economists as the benchmark for pricing because it should lead to the maximisation of economic welfare.[12] This result arises because individuals weigh up the benefit to themselves of consuming another unit of the good in question against the overall cost to society of its production. If the price exceeds the SRMC, some potential consumers may be dissuaded from consuming (travelling) despite the benefit to them being greater than the cost to society. If the price to the consumer were less than SRMC, some people may consume (travel) despite the benefit to them being less than the cost to society.

2.4.2.3   Issues with Implementation of SRMC

Implementing prices based on short run marginal social costs would be complex. There are a number of issues which have led to an inability to implement marginal social cost pricing within the transport sector internationally. These include in particular:

‣ political and practical constraints;

‣ budgetary considerations; and

‣ distortions in other sectors.

Each of these is now considered in turn.

Political and practical constraints. Since elements of marginal social cost, especially congestion and environmental costs, vary strongly in time and space, marginal social cost pricing within the transport sector requires prices that do likewise. In particular it would be appropriate to charge a different rate per kilometre on urban roads than inter-urban roads, and in the peak than in the off-peak, as well as according to the characteristics – such as axle load and environmental performance – of the vehicle.

For rail, charging different rates at different times is not in principle a big problem: there is no great difficulty in recording infrastructure use and charging at different rates – indeed differential charges by route and time of day are common. The main practical constraint is the degree of pricing differentiation that is possible without confusing the passengers or freight shippers, or indeed the staff implementing it.

For road the difficulties are much greater. Standard ways of charging, such as annual licence duties or fuel taxes, clearly cannot be differentiated to the extent required for SRMC. New Zealand already has a more sophisticated tariff structure than most countries for heavy and diesel powered vehicles through the Road User Charges (RUC) system, but the charges still involve the same rate no matter where or when the vehicle is used. One possible way of implementing a full marginal social cost pricing system for roads would be by a GPS-based pricing system. However, that would involve substantial up-front costs. While a number of countries are installing or investigating systems that would allow such pricing (or elements of it) for heavy vehicles, its full implementation for all vehicles in any country is still some way off.

Congestion charges are regarded by the public with suspicion because they are seen as an extra tax. If congestion charging were to replace fuel tax rather than being an additional charge, it might gain greater acceptance. Simpler approaches, such as supplementary area-

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[12] In the Pareto sense that no one can be made better off without making someone else worse off. Note that if the existing investment is not optimal, pricing at SRMC will ensure efficient use of the existing facilities, but the prices may not be "optimal" from a long term perspective. For example, if there is under-investment in roads, the SRMC may be high – reducing demand to within the current capacity, but the long term optimum may be to invest in roads, leading to a lower charge and greater road use.

based charges in urban areas (such as that implemented recently in London) and tolls on congested inter-urban roads, are more often used. If not even this degree of complexity were judged publicly acceptable, then obviously the degree to which charging for the use of roads can be used to approximate to marginal social costs will be very limited.

Budgetary considerations. The second issue is that there is no guarantee that marginal social cost pricing will be consistent with government budgetary constraints. In some circumstances, for instance urban roads, marginal social cost pricing may lead to large financial surpluses; in others, e.g. inter-urban railways, it may involve deficits. There is no guarantee that the two will balance each other out.[13] Whilst one solution may be to fund deficits from general revenue, that has distorting effects on the economy. There may be fears that such subsidies will lead to inefficiency, although such fears may be minimised if the subsidies are allocated through competitive processes. The result may be a need to raise from the transport sector as a whole, or from particular parts of it, more revenue than would result from pure marginal social cost pricing. This issue is discussed further later in the chapter.

Distortions elsewhere. The third issue results from distortions elsewhere in the sector or the economy. This will be most significant where close substitutes or complements for transport are wrongly priced. This is particularly relevant to public transport in large urban areas where its prime competitor, the motor car, faces prices which are generally lower than SRMC. Subsidies for public transport are often promoted as an alternative to congestion pricing in order to achieve allocative efficiency (although the extent to which low public transport fares influence motor vehicle use is debatable).

The sectors of the economy within private industry do not explicitly practice marginal social cost pricing. To the extent that they are competitive sectors, market mechanisms should lead them to approximate marginal social cost pricing, but there may be many other distortions that lead to prices diverging from SRMC values.

There are broadly two possible ways of addressing the issue of distortions in the economy. The first is to trace through the effects of introducing marginal social cost pricing in transport throughout the economy using a general equilibrium model,[14] and then adjust the policy so as to try to achieve an optimum. The second is to try to identify specific problems and tackle those in a more targeted way. Generally the targeted approach is considered the more appropriate; although where significant distortions in charging for freight traffic are concerned, it may be felt that the importance of freight traffic throughout much of the economy justifies a general equilibrium approach.

2.4.2.4   Theory of 'Second Best'

While pricing based on SRMC is the preferred 'first best' approach under a set of standard assumptions, the theory of 'second best' deals with the issue of what can be done if universal marginal social cost pricing throughout the economy is not feasible. Lipsey and Lancaster (1956)[15] showed that it is the relative prices that determine the achievement of allocative efficiency.

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[13] Surpluses from urban road-user charges generally imply the need to expand the network and hence cannot be treated as a budget windfall. Whether the expansion can be justified depends on the specific costs and benefits of the case: surpluses may be short-lived if expansion proves warranted.

[14] General equilibrium models are economic models of the entire economy. They attempt to reflect the impact of changes in one sector on all other sectors.

[15] Lipsey, R.G. and Lancaster, K. *The General Theory of the Second Best*. Review of Economic Studies. Vol. 24 (1956), 11-32.

This suggests that, although the circumstances that may lead to the need to go for a 'second best' solution rather than pure marginal social cost pricing may greatly complicate the issue, they do not lead to a totally different approach. Cost recovery or equity considerations may require prices in excess of SRMC, but the starting point for transport charges should nevertheless be the marginal social cost. This leads to the possibility of a '**Marginal Cost Plus**' pricing regime, and this is discussed later in this chapter (Section 2.4.4).

2.4.2.5   Application for Price-Setting ('Health Warning')

Marginal costs are the costs imposed by one extra user of the service. They do not reflect what charges would be necessary to recover the costs involved in the system.

It should also be noted that, whilst comparing the level of short run marginal social cost computed at existing traffic levels with current prices indicates the **direction** in which prices should be adjusted to optimise the use of existing resources, it **does not** indicate the optimal price. This is because the effect of traffic changing in response to the charges will be to change the value of the SRMC. Initially, charges on heavily-used facilities would be high and charges on poorly-used facilities would be low but as traffic adjusts to the charge the utilisation of the facility will change. Furthermore, the current SRMC may be a poor guide to the future level of charges because the current capacity may not be optimal. If capacity is below the optimal level, the SRMC is likely to be high: increasing the capacity to the optimal level would then result in a reduction in the SRMC, possibly below the current price. Similarly if current capacity is too high, SRMC may be unrealistically low.

A clear distinction needs to be made between implementing SRMC pricing (or prices based on any other cost concept for that matter) and setting prices equal to the costs calculated in this study.

2.4.3   Long Run Marginal Costs

2.4.3.1   Definition of LRMC

Long run marginal cost (LRMC) is defined as the change in the total social cost resulting from a unit increase in demand allowing for capacity and infrastructure provision being optimally adjusted in the long run for the level of demand.

Thus, whereas SRMC leads to the most efficient use of the existing infrastructure, and may be high if capacity is limited because of inadequate investment, prices based on LRMC reflect the optimal network. Clearly SRMC on an optimal network should equal LRMC. [16]

2.4.3.2   Arguments for a Long Run Perspective

One argument for the use of long run marginal social cost as the basis of pricing would arise if there are lags in people's adjustment to price signals. If the lag in consumers' adjustment to prices were long, it might be that LRMC pricing would actually lead to a better overall allocation of resources, especially if it were possible to adjust capacity quickly to demand. For example, if a new motorway was priced low following construction because initially it had spare capacity and thus the SRMC was low, it might encourage housing developments in the areas served. This would drive up demand for travel and thus the SRMC – but not

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[16] Hau, T 1998 'Congestion Pricing and Road Investment' in *Road Pricing, Traffic Congestion and the Environment.*

until many people had committed to living in the area. A price that reflected the long term situation (i.e. the LRMC) might lead to better location decisions.[17]

Such lags in consumers' adjustment are most likely to exist where location and land use decisions are involved, for instance in commuting or freight markets. At the least, this argument is likely to provide a reason for smoothing the fluctuations in the short run marginal cost approach, for instance to avoid a big change in price once new infrastructure is provided.

Another reason for smoothing fluctuations in pricing is the need to provide a system that users can readily understand. There is a trade-off between economic efficiency and the preference of users for simplicity and stability.

2.4.3.3 LRMC and the Optimum Network

As noted above, if the network is optimal SRMC should equal LRMC. A starting point for determining an optimal road network would be to compare the SRMC under optimum pricing with the LRMC. If the SRMC is greater than the LRMC then this would suggest a case for capacity expansion. The optimum decision rule for capacity expansion is discussed further in Section 2.6.2.

2.4.3.4 Policy Implications

It can be shown that differences between short and long run marginal costs can be explained by lags in the adjustment of capacity to its optimal level, and by the presence of indivisibilities which mean that capacity can only be adjusted in 'lumps'. This suggests that, while the optimum policy might be to price based on SRMC, the LRMC provides the best guide as to what the long-run equilibrium value of the SRMC would be.

Even then, measurement difficulties mean that these cost concepts will always be difficult to quantify in practice. Measuring the LRMC is not a trivial task. Consider for example the LRMC for peak road capacity. It is relatively easy to determine the cost of adding an extra lane to an existing road, but this lump of capacity will cater for more than just one marginal vehicle. To get a cost per vehicle, we might consider dividing the cost (amortised over the asset life) by the number of peak-time vehicles it would (or perhaps could) carry. There is also the question as to whether adding a lane to a particular road is the optimal response.

While the above arguments have been put forward in the context of urban road infrastructure, there is no reason why they should not be generalised.

2.4.4 'Marginal Cost Plus' Approach

2.4.4.1 Definition of MC Plus

'Marginal Cost Plus' is defined as an approach whereby charges are set such that the total revenue will cover all costs in a way that minimises the difference in mode shares and total transport task from what would occur if prices were equal to SRMC.

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[17] Of course other solutions are possible, e.g. publishing the expected long term price but providing 'introductory offers' at the lower SRMC based price.

2.4.4.2   The MC Plus Concept

Full cost recovery is identified as one of the features of the FAC approach, but as discussed in section 2.5, this can result in prices that are not allocatively efficient (i.e. they do not promote the efficient use of resources). However, FAC is not the only way of achieving full cost recovery. It is possible to pursue allocative efficiency and full cost recovery at the same time. A number of modifications to the pure marginal cost approach exist that can enable a cost recovery target to be achieved with minimum distortion (i.e. minimum variation from the mode shares and total transport task achieved by SRMC pricing). This leads to a concept that we call 'Marginal Cost Plus'.

The MC Plus approach may be viewed as an attempt to combine the pricing efficiency objective with the long term investment optimisation objective. The degree to which each of these objectives are pursued depends on the overall objectives of the government.

2.4.4.3   Ramsey Pricing and Two-Part Tariffs

The modifications to SRMC pricing that are advocated by economists to meet cost recovery objectives with the minimum of distortion are:

▸ **Ramsey pricing.** Ramsey pricing minimises variation in mode shares from SRMC by means of higher mark-ups over marginal costs for market segments that are relatively price insensitive (the mark-ups are inversely proportional to the relative price elasticities of the different segments).

▸ **Two-part tariffs.** By combining a fixed fee for the right to use infrastructure with a variable component based on SRMC, a 'two-part tariff' can be designed that meets financial constraints but retains marginal cost pricing for infrastructure use.

Two-part tariffs and Ramsey pricing are not necessarily alternatives - there are significant efficiency gains from pricing using Ramsey pricing principles in both segments of a two-part tariff.[18]

Generally a mixture of these two approaches will ensure that any particular cost recovery target is reached with the minimum of distortion to the market. For instance, if annual vehicle licence fees do not have a substantial effect on vehicle ownership, then they may be an efficient way of meeting budget constraints.[19]

Meeting some part of the fixed costs of rural roads from local rates on property can be seen as a form of two-part tariff. Part of the cost of people locating in rural areas is the fixed costs of providing the infrastructure to serve them: hence directly charging for these services ensures that location decisions are more soundly based.[20] It can be shown that rates based on land value provide a reasonable approximation to a fair distribution of road costs.[21]

MC Plus is not a straightforward approach, bringing with it all the problems of SRMC plus other issues to be addressed. Additional issues arise in terms of setting the target, and

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[18] For a discussion on the use of Ramsey pricing and two part tariffs to achieve full cost recovery in the context of road user charges, see Clough, P. and Gale, S. *Are Road User Charges Competitive?* NZ Institute of Economic Research, Wellington. July 1993. p 32.

[19] On the other hand they may be considered inequitable to the extent that they absorb a bigger share of the income of less well-off people.

[20] Another argument for this is that improvements in transport infrastructure enhance local property values and hence a contribution from the beneficiaries does not seem unreasonable.

[21] Travers Morgan. *Road Rating Issues - Report to ECNZ,* Wellington February 1994.

thereby establishing the size of the 'plus' element; setting charges to collect this difference; and there is also room for manoeuvre for the government in how and to whom the pricing policy should apply. These choices bring with them implications for behavioural change, equity of charges, financial targets, and efficiency of charging.

2.4.5   Comparison of the Cost Approaches

2.4.5.1   Difference between Average and Marginal Costs

As noted earlier, neither short run nor long run marginal cost approaches guarantee that total infrastructure cost recovery will be achieved. A big plus for the current practice of using PAYGO is that it ensures that the users pay their way. Neither SRMC nor LRMC pricing guarantee that the full costs of operating a road or rail system will be recovered because, under situations of increasing returns to scale, the marginal cost will be less than the average cost. Figure 2.1 illustrates why, when there are increasing returns to scale, charging the marginal cost does not recover full (average) costs. The charge must equal or exceed the average cost for an operator to at least break even. In the figure, the quantity of goods is Q, and the slope of the lines represents the average and marginal costs. Revenue from average cost pricing is the rectangle TIQO, and revenue from marginal cost pricing is the rectangle TIJM. Clearly the revenue from marginal cost pricing is less than the revenue from charging the average costs.

Hence, if either SRMC or LRMC is adopted as the basis for pricing, there is a likelihood that either subsidies will be needed or some sort of adjustment to raise more revenue will be required. This requirement provides the rationale to consider the MC Plus approach.

Figure 2.1 Comparison of Marginal and Average Costs
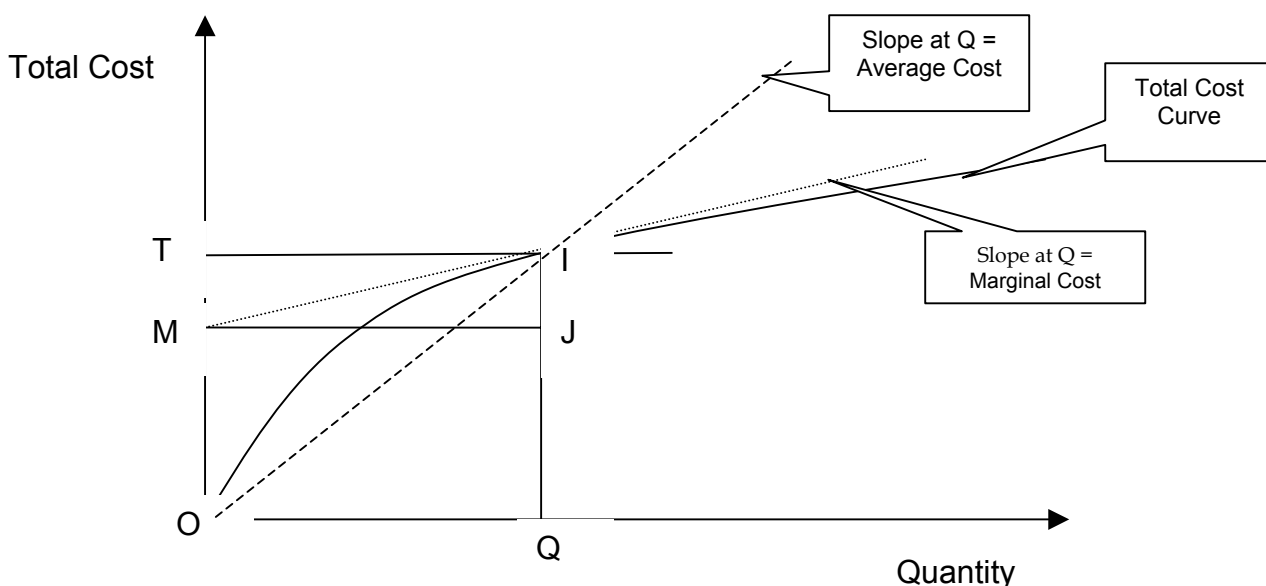
The opposite situation to that depicted in Figure 2.1 occurs in congested conditions. When an additional vehicle attempts to join a congested traffic flow, it slows all other traffic. Once the demand exceeds a certain point, the delay imposed on existing traffic is greater than the average travel time, i.e. the cost imposed on other motorists exceeds the average costs. Under these circumstances, marginal cost pricing may more than recover infrastructure costs. There is nevertheless no guarantee that surpluses in congested conditions will off-set

shortfalls in other situations.[22] Nor is it clear that such cross-subsidies are in the public interest since, when marginal costs exceed average costs, it indicates a potential need for investment.

2.4.5.2   Cost Recovery Issues

Value to Society

Assume that a road is priced at SRMC. This ensures that people only use the road when the benefits to them are more than the costs they impose on society. Some users will benefit by a lot, others by little. For the marginal user the benefit just exceeds the incremental social cost. But the calculation assumes that the road is already there. How do we know that the road is justified in the first place? Society is better off with the road if the sum of the benefits to all users exceeds the sum of all the costs. If all traffics are meeting their SRMC, there is still no guarantee that collectively the benefits equal or exceed the total costs. If they are meeting their FAC, there is such a guarantee. Full cost recovery is thus a legitimate economic objective. A goal of recovering all costs of infrastructure also puts a much-needed discipline on large capital projects, where inevitably an 'optimism bias' occurs.

Allocative and Productive Efficiency Considerations

Economic efficiency is concerned with the issues of allocative efficiency (the type, level and price of service provided) - often characterised as 'doing the right thing'; and productive efficiency (minimising the costs of a given level of service) - characterised as 'doing the thing right'.[23] A third efficiency concept, dynamic efficiency, relates to efficiency over time and concerns innovation and productivity growth. For our purposes we can consider dynamic efficiency as ensuring that the right decisions are taken such that both allocative and productive efficiency are maximised through time.

As discussed earlier, economic theory prescribes the use of SRMC as a means of ensuring that, for a given level and disposition of investment, the quantity and mix of outputs produced maximises the benefits to society,[24] i.e. SRMC is a means of promoting allocative efficiency.[25]

Competition between companies is now recognised as a major spur to productive efficiency. Regulatory reform in the transport industry in New Zealand over the last 20 years has been primarily about encouraging competition in order to achieve productive efficiency.[26] The evidence suggests that the loss of productive efficiency associated with the former regulatory environment was significant compared with any gain in allocative efficiency it

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[22] David Newbery (Newbery DM. *Pricing Congestion: Economic Principles relevant to Pricing Roads. 1990).* demonstrated the conditions under which congestion pricing would cover infrastructure costs. Gómez-Ibáñez 1999 in *Essays in Transportation Economics and Policy (p. 126)* noted that Small et al., (1989) 'found few joint costs, so marginal cost pricing would generate roughly the revenues the highway agencies needed'.

[23] Liebenstein, H. *Allocative Efficiency v. X-Efficiency*, in Edwin Mansfield (ed) Micro-Economics: Selected Readings, Norton: New York 1979.

[24] Hotelling, H. *The General Welfare in Relation to Problems of Taxation and of Railway and Utility Rates*, Econometrica, Vol. 6 (1938), 242-269.

[25] It is not the only way of promoting allocative efficiency - the traditional forms of transport licensing were primarily concerned with allocative efficiency, but used regulations rather than prices in an attempt to achieve it. For example the 40 mile restriction on road competition with rail reflected a belief that railways were more efficient for longer distances. Restrictions on competition in the bus industry reflected the belief that a single operator would be more efficient.

[26] Road user charges were seen an allocative efficiency measure, but the main reason for their introduction was to enable a competitive market to develop.

may have achieved.[27] The requirement to cover costs is seen as being consistent with a competitive transport sector and thus with the promotion of productive efficiency.

Even in the road sector, which has publicly-owned suppliers with some local monopoly power, the discipline provided by the requirement to meet all costs out of current revenue, coupled with a Board on which users (i.e. payers) are represented, has been successful in driving down road construction and maintenance costs in New Zealand.

2.4.5.3   Summary of Cost Approaches

The cost and revenue categories generally included in each cost concept are given in Table 2.1 (this table focuses on the roads sector, but the cost categories could also apply to the rail sector). These are set out for illustrative purposes – actual implementation of the concepts, particularly FAC and PAYGO, can differ in details. Practical applications also differ according to the boundary of costs included in the applications – for instance the extent to which it is feasible to incorporate external effects like accident costs into the costs of system operation. The main points to note are:

▸ Only FAC includes the cost of historic capital employed.

▸ SRMC and LRMC relate to an additional vehicle, while FAC and PAYGO are averaged over all vehicles.

▸ SRMC and LRMC include non-financial costs. These are sometimes included in FAC (i.e. the economic FAC), but not in PAYGO as currently applied in New Zealand.

▸ Marginal Cost Plus attempts to combine the economic efficiency of SRMC with the benefits of full cost recovery shown by FAC. Marginal cost plus is not shown explicitly in the table. It takes SRMC as a minimum, with increments depending on the price elasticity of specific customer groups.

2.5   Capital Costs and Cost Recovery Issues

While full cost recovery is a simple enough concept, questions arise when we start looking at the detail. What costs are to be recovered? Full cost recovery implies recovering the cost of capital employed, but how do we calculate this cost?   Estimating the cost of capital involves valuing the assets and applying a cost of capital rate to the value obtained.

2.5.1   Asset Valuation Concepts

Assets may be valued in a number of ways, including depreciated historical cost, replacement cost, cost in alternative uses, etc. This section looks at some concepts used for the valuation of assets. Since the intention is to compare prices with costs, we are not concerned with the value implied by the revenue stream generated: to use this measure of value would create circularity.

The main conclusion is that the appropriate valuation to be used depends on its purpose:

▸ **Depreciated Historical Cost** is the original purchase or construction cost (including subsequent improvements) less an allowance for depreciation based on an assumed economic life.

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[27]Cost savings of up to 30% of operating costs were observed in the urban bus industry following the move to commercial operators and competitive tendering.

▸ **Depreciated Replacement Cost (DRC)** values the asset at its current replacement cost less an allowance for depreciation based on an assumed economic life. This differs from historical cost in times of inflation or for assets where the costs have changed over time.

▸ **Optimised Depreciated Replacement Cost (ODRC)** values assets based on the cost of replacing the functions performed rather than the assets themselves, and is particularly relevant where technological change has changed the way a function might be undertaken in the future. Redundant or obsolete assets are excluded.

TABLE 2.1:	COMPARISON OF COST AND CHARGE CONCEPTS			
Category	**SRMC**	**LRMC**	**FAC**	**PAYGO**
COSTS Return on capital	Not relevant	Not relevant	Return on capital employed (however defined)	Not relevant
Infrastructure costs	Mainly wear & tear costs that can be related to increased vehicle km	Wear & tear costs that can be related to increased vehicle km Capital cost of increasing capacity	Include all costs associated with upkeep of existing infrastructure – operations, maintenance and depreciation	Include all costs (capital and recurrent) in given year
Service provider operating costs	Cost of an additional vehicle km	Cost of an additional vehicle km	All costs associated with providing services – operating, maintenance, depreciation, cost of capital	All costs
Congestion	Costs imposed by one user on all other users of the transport system	Not included if capacity expansion leaves existing traffic unaffected	Not relevant. These costs are both imposed and borne by the infrastructure users – and on average cancel out (refer text)	Not relevant. These costs are both imposed and borne by the infrastructure users – and on average cancel out (refer text)
Mohring effect[28]	Benefits of increased service frequencies due to additional vehicle km	Benefits of increased service frequencies due to additional vehicle km		
Accidents	External costs of an additional vehicle km, including the increase/decrease in accident risk due to increased traffic	External costs of an additional vehicle km, including the increase/decrease in accident risk due to increased traffic	Overall external costs, attributed to user groups on the basis of responsibility	Not relevant
Environmental costs	Costs of an additional vehicle km	Costs of an additional vehicle km	Costs of all vehicle kilometres	Not relevant
CHARGES Fuel excise duties and road user charges	Revenue associated with an additional vehicle km	Revenue associated with an additional vehicle km	Total revenue from fuel excise duties and road user charges	Total revenue from fuel excise duties and road user charges
Motor vehicle registration and licensing	Revenue relating to an additional vehicle km – motor vehicle registration is included only for those vehicles where an increase in vkm would require expansion of the vehicle fleet (e.g. HCVs, PSVs)	Revenue relating to an additional vehicle km – motor vehicle registration is included only for those vehicles where an increase in vkm would require expansion of the vehicle fleet (e.g. HCVs, PSVs)	All motor vehicle registration charges	All motor vehicle registration charges
GST	On all costs	On all costs	On all costs	On all costs
Fares, freight tariffs	Associated with an additional vehicle km	Associated with an additional vehicle km	All fares, tariffs	All fares, tariffs
Traffic fines	Associated with an additional vehicle km	Associated with an additional vehicle km	All traffic fines	All traffic fines

[28] Mohring H. and Turvey R., Optimal Bus Fares, Journal of Transport Economics and Policy, Volume IX, 1975.

‣ **Opportunity Cost** is the value of the asset in its most productive alternative use. This is a measure of the cost to the economy (or the company) of continuing to use the asset in its current use. Opportunity cost is a valuation principle that can be used to value inputs in all the replacement cost approaches. In using it to value transport infrastructure, only recoverable assets (i.e. assets that can be recovered and used elsewhere) have an opportunity cost. For example, the cost of tunnels and earthworks are generally not recoverable. Where some or all the value of the asset can be realised, but there are costs associated with recovery or conversion of the asset to the alternative use, that cost must be deducted from the value of the asset in its alternative use.

‣ **Deprival Value** is the loss that the current asset user would suffer if the asset was no longer available. It combines elements of the concept of replacement cost and that of the value of the revenue stream generated by the asset.

2.5.2 Use of the Valuation Concepts

The valuation used for infrastructure assets needs to reflect the use to which the figures are to be put. DRC is a measure of the current value of assets that previous governments and users have put into the transport system – calculated at current dollar values. It is a number the government should be aware of. But it is not the value of the current assets either to its owner (in the case of the railway) or the government.

ODRC is arguably a better measure of the value of the assets for an ongoing business, as it excludes obsolete and non-productive assets. We make the further distinction between depreciating assets – i.e. assets that eventually need to be replaced such as vehicles, track, pavements - and non-depreciating assets such as tunnels, land and earthworks. To keep the business going, revenue will need to be sufficient to replace the depreciating assets.

If the network is contracting, the assumption of an ongoing business no longer holds. Dis-investment decisions need to be made based on the value of the network assets in their best alternative use, i.e. their opportunity cost.

The way that asset valuation concepts might be used is demonstrated by the following test:

‣ Does the benefit to users exceed the value of the assets in their best alternative use (less the cost of recovery)? If not, the assets should be sold. The test of this condition is that prices cover the opportunity cost of capital.

‣ Does the benefit to users exceed the cost of maintaining the business as a going concern? If not, re-investment in those assets may not be justified. The test of this condition is that prices cover the ODRC of depreciating assets (i.e. those assets that wear out over time and need replacement).

‣ Does the benefit to users justify expansion of the business? Investment decisions will have to be taken on a case-by-case basis, but one would expect expansion to be justifiable if prices cover ODRC on all assets.

The New Zealand Commerce Commission observes that *"Opportunity cost is the correct economic concept for the valuation of assets…. when what is to be determined is the cost to society of using an asset"* but notes that this *"… does not work very well when what is being considered is investment in new specialised assets. It is for this reason…that regulators like the Commerce Commission permit regulated entities to earn a return on the value of a*

specialised asset greater than its opportunity cost – typically...its optimised depreciated replacement value (ODRC)".[29]

In Chapter 3, we calculate the DRC as an indication of the value of the resources currently utilised in the transport industry. We adopt the conventional straight line approach to depreciation, which does result in higher values than if a geometric depreciation approach were used. To help the reader choose an appropriate measure, we show separately the DRC component based on depreciating items only, and that component comprising non-recoverable ('sunk') items. The former includes track, signalling and telecommunications (for rail); while the latter includes formation, tunnels and bridges (both road and rail). Land is non-depreciating but recoverable. Its valuation is more problematic. We provide a valuation based on the value of adjacent land. As roads and other transport infrastructure can confer value on adjacent sites, in urban areas this is likely to overstate the realisable value of transport land. In practice in rural situations, both road and rail land holdings are likely to have high recovery costs that will render the recoverable value near zero.

2.5.3   Cost of Capital

Companies create value for their shareholders by earning a return on the invested capital that is above the cost of that capital. WACC (Weighted Average Cost of Capital) is an expression of this cost and is used to see if certain intended investments or strategies or projects or purchases are worth undertaking. WACC is expressed as a percentage, like interest. So for example if a company works with a WACC of 12%, then this means that only (and all) investments should be made that give a return higher than the WACC of 12%.

The cost of capital for any investment, whether for an entire company or for a project, is the rate of return capital providers would expect to receive if they were to invest their capital on a project elsewhere with the same risks. In other words, the cost of capital is an opportunity cost.

The weight of evidence indicates that rail projects tend to require higher rates of interest to attract finance. This suggests a possible case for using a higher WACC for rail than for road.

It may be that the reason for the higher interest rates relates to the environment in which the money is being raised rather than an inherent characteristic of the modes. Rail projects tend to be promoted as commercial or quasi-commercial projects and the return on assets often depends on the commercial success or otherwise of the project. Roads are more commonly constructed as public goods. Repayments of bonds issued to raise money for publicly constructed roads are normally not tied to the performance of the roads. Unless the road is tolled, there is, in any case, no direct linkage between the traffic using the road and the funding body's revenue. Even toll roads are commonly promoted as public-private partnerships with some form of public underwriting of the returns.

Looked at another way, the differences in interest rates are likely to reflect the actual risks to the investor in the particular project rather than the mode itself. A bond issue underwritten by the NZ Treasury to construct transport infrastructure would attract the same rate irrespective of the mode. A private company raising money to build the same infrastructure, with revenue to come from users without any guarantees from the government, would need to pay a risk premium irrespective of the mode.

From the policy standpoint, the Government wants to understand the relative costs of road and rail transport. While government should be made aware of cost differences that may

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[29] Commerce Commission. *Review of Asset Valuation Methodologies: Electricity Lines Businesses' System Fixed Assets*. Discussion Paper, October 2002

arise because of ownership or funding differences, the comparison should be made using a common cost of capital.

2.5.4   Issues re Charging a Capital Return

Requiring full cost recovery including a return on assets employed differs from the current approach to the calculation of Road User Charges (RUC) which allocates costs on the PAYGO principle where the capital 'charge' is an allocation of the cost of new work in the year in question. Inclusion of the cost of capital employed is seen by some as imposing a significant additional cost. They may argue that road users already pay the return on the road infrastructure capital through forgoing the return on their previous investment. Road users may point out that no one other than road users (and to a lesser extent rate payers) has contributed to funding the roads for very many years; and may argue that if road users are now going to be charged with this return, they should also be credited with the same sum as their share of the returns on these past investments.

If asset lives are long and are depreciated geometrically at the discount rate (d) rather than on a straight line basis, and network expenditure is in a steady state, then the DRC of the network is 1/d times the annual capital expenditure and PAYGO will give the same capital charge as applying a cost of capital (d) to the DRC. That is, if the expenditure under PAYGO already includes an element of new capital expenditure, adopting a charge on capital need not result in additional costs to motorists at all.

It would be fortuitous if this result were to emerge from current PAYGO arrangements. However, the Commerce Commission ruling only indicates that some return in excess of opportunity cost of assets is appropriate to ensure investment for future infrastructure growth, not that this should be pegged to a return on assets accumulated over the past in configurations that are hardly likely to be optimal for the future. Moreover, road investment in New Zealand has long been subject to investment appraisal processes that have not been directly dependent on the return on assets.

2.6   Optimum Pricing and Investment Decision Rules

In this section, we develop and compare optimum pricing and investment rules for an infrastructure provider or a service provider, depending whether the provider is acting to maximise financial returns or acting to maximise national economic benefits. In general, commercial entities might be expected to act to maximise financial returns and government entities to maximise national economic benefits, but to avoid any terminology bias we simply refer to these as financial and economic decision rules.

We consider pricing and investment separately. Pricing is essentially a short-term efficiency issue whereas investment is a long-term efficiency issue. To simplify this discussion, we initially ignore externalities other than congestion. Environmental externalities could, in principle, be incorporated into both the financial and economic pricing rules. We refer to this issue explicitly in Section 2.6.1.4.

2.6.1   Pricing

In a perfectly competitive market, pricing issues would not need consideration, as competition would force firms to charge the market price, and the market price would reflect the short run marginal cost (refer Section 2.2.1). But most transport infrastructure has strong natural monopoly characteristics:

▸ Rail systems are subject to major economies of traffic density. For example it is generally not worth providing two or more rail routes of similar quality between the same two points because it is much more efficient to deal with the traffic by means of a single route. In the New Zealand context, Tranz Rail has a monopoly in terms of rail freight services, although it faces intense competition from other modes for most traffic movements.

▸ Roads in New Zealand have monopoly characteristics, with no competition for the majority of flows they carry – although competition does exist on some significant urban and inter-urban corridors. For this exposition we assume commercial road providers are possible. We would expect them too to be effective monopolies within their corridors (although there may be exceptions, particularly in urban areas).

▸ Urban bus services also have some natural monopoly properties because of the Mohring effect.

We therefore consider that, because of the absence of perfect competition in the transport market, both private and public transport infrastructure providers and some transport service providers have some power in setting prices (i.e. are not simply price-takers). However, the road freight industry is highly competitive and prices in this sub-sector are market-driven.

2.6.1.1   Financial Pricing Rule

The financial pricing rule (in the absence of price regulation) is assumed to be profit maximisation. For transport services and for rail infrastructure, the optimum price involves a trade-off between price and volume such that the difference between revenue and cost (i.e. profit) is maximised. If the consumers are homogeneous in terms of costs and elasticity, there will be one price that maximises the profit; but if differential pricing is possible, the revenue from a given level of traffic (and thus costs) is maximised when prices reflect what the traffic can bear (i.e. are inversely related to the elasticities). A commercial operator would introduce a two-part tariff if by doing so it increased revenue for a given level of traffic.

A commercial company will always require the price to exceed SRMC – which in this case is the cost to the operating company of providing for a marginal user. The profit maximising price will depend on the elasticity of demand.

A similar argument applies to wear-related road costs, where the SRMC can be thought of as the cost of bringing forward rehabilitation of the road as a result of its use. A private toll operator would want to charge at least this cost.

For road infrastructure in congested conditions, the dominant component of the SRMC might be the cost of congestion. Although this is an economic rather than a financial cost, it can be shown that pricing at or above SRMC will always raise more revenue than pricing below.[30] A commercial operator would therefore aim to charge at SRMC (or higher if this generated more revenue).

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[30] If the capacity is not constrained as for a lightly used road, the SRMC is zero, so the case is trivial. If capacity is constrained, it can be shown that pricing less than SRMC results in the demand exceeding the capacity of the road – thus the extra demand cannot be served and the lower price simply results in lower revenue. There is one other (unlikely) case where when the road is at capacity the elasticity is greater than 1.0. In this case the revenue maximising charge results in demand less than the road's capacity. The SRMC is then the loss of utility of the last user to be 'tolled off' which must be less than or equal to the price. So the general result still applies.

2.6.1.2   Economic Pricing Rule

In the absence of budget constraints, assuming that transport efficiency is the objective and assuming raising revenue is costless, the economic pricing rule is to price at marginal social cost (SRMC) as this ensures efficient resource utilisation.

In practice decisions are inevitably budget constrained, and, for reasons discussed earlier, it is generally appropriate to seek full cost recovery. The pricing rule should therefore be to raise revenue up to the funding constraint in a way that will minimise distortion from the SRMC baseline. As discussed in Section 2.4.4.3 this implies the use of Ramsey pricing with or without a two-part tariff.

2.6.1.3   Comparing the Rules

We conclude that under a funding constraint, the commercial and the government pricing rules are essentially the same and are effectively marginal cost plus pricing (with the exception of externalities, as discussed below).

Note that having the same rule does not necessarily result in the same price. The resulting price would only be the same if:

‣ The government agency has a profit maximisation remit or the budget constraint is equal to the maximum profit the profit maximiser can earn. This might apply in a competitive or perfectly contestable market.

and

‣ Either the cross-elasticities between the modes are zero, or both agents take account of the elasticities in the same way. The latter is possible if both agents are revenue maximising and set their prices based on the observed responsiveness of the market.

Congruence between financial and economic rules may be achievable through a regulatory framework. For example, if the right to provide and/or operate infrastructure was tendered competitively and the winning bidder was the company able to guarantee a certain level of service for the lowest toll regime, this might result in the profit maximiser operating on the same budget constraint as the government agency.

2.6.1.4   Externalities

For clarity, we have considered the pricing rules independently of the issue of externalities. In the presence of externalities or second best considerations, if these can be expressed in terms of units of inputs or units of outputs they will form part of the SRMC and would therefore be included in the economic analysis. If they can be incorporated into a tax or a bounty they would be included in the financial pricing rule.

In regard to externalities, it is pertinent to ask whether transport should be singled out to 'pay its way' if other generators of externalities are exempt? As observed by Newbery and Santos:

> *'If the Government considers that polluters should pay taxes to internalise external costs, then this principle would logically apply to all sources of such pollutants, perhaps differentiated if the damage done varies with source'.*[31]

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[31]   Newbery, D, & Santos, G. 1999, *Road Taxes, Road User Charges and Earmarking, p. 11,* available at http://www.econ.cam.ac.uk/dae/people/newbery/output-download.htm.

Clearly addressing externalities of one generator while not addressing them for a close substitute could have perverse effects (as does, for example, enforcing higher safety standards on rail than on road). However for goods that are not substitutes it seems unlikely that differential treatment would reduce the efficacy of any externality charges.

2.6.2   Investment

2.6.2.1   Financial Investment Rule

The financial investment rule is simply stated as:

Invest if the increase in revenue exceeds the cost of the investment (both expressed in present value terms at the company's weighted average cost of capital).

The case that interests us is where the investment increases capacity. Then in general the revenue maximising price will be lower after the investment has taken place. Unless it is possible to discriminate between old and new traffic (perhaps possible for rail, almost certainly not for road infrastructure), there will be a revenue loss from the existing traffic. This price reduction for existing traffic is a 'benefit' from the project that a commercial operator cannot 'capture'. The net revenue increase is equal to the increase in traffic times the new price *less* the old traffic times the change in price.

2.6.2.2   Economic Investment Rule

We indicated in Section 2.4.3 that infrastructure capacity is optimal if the SRMC and LRMC are equal. This implies that investment may be warranted if SRMC > LRMC. The CE Delft study[32] quotes a decision rule by Erik Verhoef which states that *"the time to expand road capacity at a particular location is when the revenues from an optimised congestion charge levied on new, additional capacity are precisely sufficient to fund the capital costs of that capacity".*

It can readily be seen that the Verhoef rule is the same as the conventional rule for small changes in capacity.[33] Unfortunately there are problems with indivisibilities – both temporally and spatially. If infrastructure can only be incremented in lumps, expanding capacity whenever SRMC > LRMC may result in over-investment. On the other hand, the Verhoef rule, which guarantees that the last unit of investment is valued precisely at cost (and that all preceding increments are valued at greater than or equal to their cost), may result in under-investment if the total willingness to pay exceeds the cost of the additional capacity.

We will call this first rule the *ex ante* rule and the Verhoef rule the *ex post* rule:

‣ The **ex ante** rule values the benefit as the original price times the difference in volume. It therefore may overstate the benefit if the price falls as a result of the investment.

‣ The **ex post** rule values the benefit as the final price times the difference in volume. It therefore may understate the benefit if the price falls as a result of the investment.

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[32] CE Delft. Returns on Roads: Optimising Road Investments and Use with the 'User Pays Principle', Main Report. 2002

[33] The "optimised congestion charge" is effectively SRMC - AVC. The LRMC as used above includes the travel time cost of the incremental vehicle, so the Verhoef rule is:

$$(SRMC – AVC) * Q = (LRMC – AVC) * Q$$

The true value of the benefit must be somewhere between these extremes. On average it will be half way between the two, and the benefit from the investment will be equal to the average of the old and the new prices times the increase in traffic.

2.6.2.3 Comparison of Financial and Economic Investment Appraisal

In the preceding two sub-sections, we derived the financial benefits to the entity from investment in new capacity and compared them with the economic benefits. Table 2.2 compares the components generally included in economic and financial appraisals.

It can be shown (see Box 2.1) that the principal difference between the economic decision rule and the financial decision rule is that the economic rule 'captures' the change in consumer surplus and counts this as a benefit – i.e. the economic return will be higher than the financial return on a given project by an amount equal to the consumer surplus. Thus for example, **at given prices**, the commercial NPV on a toll road would be significantly lower than the social NPV.

TABLE 2.2: ECONOMIC AND FINANCIAL APPRAISALS COMPARED	
Economic Appraisal	***Financial Appraisal***
Capital Costs	Capital Cost
Social discount rate	Commercial WACC
Operating Costs	Operating Costs
Revenues	Revenues
Consumer surplus	
Non-user Benefits and Costs (Congestion, Environment, Planning)	
- to society as a whole	***- to the investing agent***

Box 2.1 Financial and Economic Decision Rules

The financial decision rule is

$$B_c = P_{new} * (T_{new} - T_{old}) - (P_{old} - P_{new}) * T_{old}$$

The economic decision rule is

$$B_g = 0.5 * (P_{old} + P_{new}) * (T_{new} - T_{old}).$$

Subtracting B_c from B_g, we see that the difference between the economic (government) and the financial (commercial) pricing rule is:

$$B_g - B_c = 0.5 * (T_{new} + T_{old}) * (P_{old} - P_{new}).$$

This is the conventional "rule-of-a-half" measure for the consumer surplus. The consumer surplus is the difference between what the consumer is willing to pay, and the price charged by the infrastructure owner. It is an economic benefit, and thus is included in social cost benefit analysis . The consumer surplus resulting from a change in prices is approximated by the old traffic times the change in price plus the change in traffic times half the change in price. The factor of one half applied to the change in traffic leads to the name "rule of a half".

There is a countervailing factor which applies to some transport investments. Suppose that competing facilities (ports, airports, railways) are subject to increasing returns to scale. Then, as traffic is abstracted to a new facility, the existing facility will suffer a fall in revenue that is likely to be accompanied by a less than proportionate change in costs. Thus the existing facilities become less efficient. This is a system effect on enterprises elsewhere in the economy, and it should be entered in a comprehensive cost-benefit analysis. It will not appear in a financial appraisal unless the other facilities are owned by the same company. This effect is included specifically in NZ 'Alternatives to Roading' (ATR) analyses, where the reduction in road user charge revenue is included and off-set against the reduction in road maintenance costs. It is not common for studies to include the opposite effect – e.g. the reduction in efficiency of the rail service following a road improvement – except potentially where comprehensive urban transport models are applied.

2.6.3   Regulatory Implications

Having discussed the pricing and investment rules that apply to economic and financial entities and seen how they differ, we now identify whether and how these differences might be addressed through regulatory intervention. We consider both pricing and investment, within modes and between modes.

2.6.3.1   Pricing – Within Mode

We have seen that the economic and financial pricing rules are remarkably similar, differing only in that the price charged by a government agency acting on the basis of an economic analysis might be capped at a point where the budgetary constraint is met, whereas a commercial agency faces no such constraint. Whether this would result in a different price in practice depends on the degree to which prices are in any case constrained by competitive considerations.

If we assume that the financial price is indeed higher than the price based on economic considerations, there will be a loss of consumer surplus for users under financial pricing, but this can be seen as a transfer payment and need not concern us from an economic viewpoint. More seriously some potential users will be dissuaded, which represents an allocative efficiency loss. Whether this justifies regulatory intervention depends on the direct and indirect costs of regulation and the deadweight loss from taxation on the difference in revenue between the approaches.

If the optimal financial price is higher than the economic price and the economic price is based on covering all costs including a market return on capital, the commercial agent may be making 'supernormal' profits. Such profits would attract interest from other potential operators, which will tend to counter-balance the relative disincentive to invest we noted when discussing the investment rule. We note this when we consider investment below.

Finally if the economic price differs from the financial pricing rule because it takes account of second-best considerations, there may be a warrant for regulation to achieve the required prices. This is considered to be the case in the urban transport sector, where the current approach adopted is for a government agency to 'own' the services, making pricing and service level decisions, but to contract out their actual operation. Even here, the possibility of using shadow prices may be contemplated (as in 'Patronage Funding').

2.6.3.2   Pricing – Between Modes

When we consider pricing between modes, then even if both modes follow the same pricing rules, it does not follow that this will lead to an efficient outcome. If both road and rail price

at SRMC, the distribution of traffic should be efficient in theory. But if the proportionate mark-ups on SRMC required in order to meet budget constraints are different, the resulting relative prices will also differ. As noted in Section 2.4.2.4, it is the relative prices that are relevant.

If road users were charged at short run marginal social cost and the rail sector were able to practice perfect price discrimination, then the difference in pricing approach would not create an inefficiency problem. Perfect price discrimination on rail would mean that all output would be produced that can cover at least its marginal cost, so the output level would be the same as with marginal cost pricing. The willingness to pay of freight customers for rail transport would be an appropriate measure of the social benefits of the use of rail. Indeed if perfect price discrimination may be applied,[34] then under certain conditions it is only worth maintaining services that can cover total costs in this way (Joy, 1971). This is a particularly tough test. It is effectively saying that the railway is only worth maintaining if the *average* cost of carrying the traffic by rail is less than the *marginal* cost by road. That is, it assumes the road is a given and that the railway is a marginal activity.

In reality railways generally have only limited ability to price-discriminate. Railways therefore cannot be expected to capture the entire consumer surplus created by the existence of the rail service. Thus if roads were charged at SRMC while rail was required to act commercially, it is likely that some rail services would not be provided or would be closed even where their operation was in the national interest.

Overall it would appear that adopting 'Marginal Cost Plus' as a government pricing rule would come much closer to ensuring efficient allocations between and within modes than either the present FAC/PAYGO approach to government charges or a pure SRMC approach. An issue remains as to how to set the cost recovery target – with the implication from this analysis being that it should be set so that on average, the resulting rail and road prices are the same as would obtain if the financial constraint were applied across both modes together rather than to each independently.

2.6.3.3   Investment – Within Mode

For investment, we have seen from previous sections that the economic and financial rules give identical results for a given project only in conditions of:

▸ zero consumer surplus; and
▸ zero externalities; and
▸ zero effects elsewhere in the economy.

Where these assumptions do not hold, there is a *prima facie* case for government intervention. Externalities and effects elsewhere in the economy could, in theory, be addressed by specific taxes or credits. The consumer surplus issue is harder to address.

In the case of urban passenger services, government intervention is the norm throughout the world. In New Zealand these services operate under contract to regional councils, which determine pricing and investment decisions. The main issues are externalities and the interaction with the demand for private car travel. Finding a means of reconciling commercial and social investment criteria is difficult if not impossible.

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[34] This is more likely to apply for freight traffic, provided that there is no regulation preventing negotiation to obtain the best price for each traffic flow, than for passenger, where naturally such negotiations are impossible. It is also more likely to be the case for an integrated railway than for a separate track authority.

The issue with private road infrastructure investment decisions is the inability of private infrastructure operators to capture the change in consumer surplus from new investments: this could be expected to result in under-investment relative to a government agency maximising social benefits. For this reason, private road investments internationally are generally limited to high volume corridors, and are typically also subject to government scrutiny using social cost-benefit analysis to measure all the costs and benefits of a proposal.

Our analysis suggests that it might be possible to develop a regulatory structure that provided the right signals to private investors: assuming private roads are operated as franchises, highly profitable routes would attract rival bids, so the bidding process could be used to attract either rival routes or operators willing to expand capacity, thus counteracting the private infrastructure operator's tendency to under-invest.

Nevertheless, given the very location-specific impacts of transport investment and its wider influence on land use and development, there is a strong argument either for the government to be responsible for investment decisions itself or for a regulator to examine them on the basis of social cost-benefit analysis. This process is, in any event required where investment requires compulsory land purchase or is large enough to require an environmental impact report.

2.6.3.4   Investment – Between Modes

The different investment criteria between public sector entities using economic appraisal and private sector operators using financial appraisal raises a concern that this will lead to a higher propensity to invest in one mode than the other. In the private sector, investments will not be made, or services will be withdrawn, because the private sector operators are unable to capture the value of the benefits they would provide (such as reduced congestion on the roads). This is the situation in New Zealand, where rail infrastructure is provided by a private operator (Tranz Rail) and road infrastructure is provided by public agencies.

On the other hand the use of cost-benefit analysis does not guarantee that correct decisions are made.[35] It is likely that the cost-benefit approach used to evaluate road investments leads to under-statement of costs and over-statement of benefits, because there is not the same penalty for error as a commercial enterprise faces. Furthermore, the failure to set prices based on marginal social costs exaggerates the cost-benefit case for new investments in congested conditions.

Given that there will be differences between financial and economic cost-benefit appraisals, where are they likely to be most significant? In practice the approaches are likely to be:

▸ Closest for freight – which is largely not on the most environmentally sensitive urban roads and where negotiation with individual customers over price is possible.

▸ Next closest for long distance passengers – which again is largely outside urban areas and where considerable price differentiation is possible.

▸ Farthest away for urban passengers – which has the highest external costs and 'second best' external benefits, and a need for simple tariffs which limits the amount of price differentiation possible.

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[35] Generally, transport projects seem to overestimate the revenue flows and underestimate the construction costs. The HM Treasury Green Book specifies the adjustment required for the 'optimism bias'. See also Bent Flyvbjerg et al. *Megaprojects and Risk: An Anatomy of Ambition* (Paperback - 13 February, 2003).

One way to overcome the difference between the approaches would be to use social cost-benefit analysis for rail investments that have intermodal implications. Transfund New Zealand's Alternatives to Roading (ATR) procedures are designed to do just this. For rail freight, they facilitate investment in rail services in situations where externalities or incorrect pricing of the road make rail economically preferable despite the investment not being justified commercially.

Intervention in long-distance passenger services is also possible under ATR procedures, although it appears that the level of consumer surplus, external benefits and other effects that the operator is unable to capture would generally be low. However, it should be noted that ATR policy has had little impact on investment in rail freight infrastructure and services.[36]

In urban areas, the ATR procedures allow public transport investments to be evaluated taking into account the reduction in traffic congestion they bring. An alternative way to bring commercial operators closer to the economic investment rule is to introduce incentives for the furtherance of government objectives. An example of this approach is output-based funding of public transport, with 'bounties' paid for increasing passenger kilometres.

In terms of the impact of pricing policy on investment decisions, it is not possible to derive any general results. Where the investment appraisal is purely financial, the case for new investment will be understated if the consumer surplus and external benefits outweigh the external costs, as is likely to be the case for rail. For this reason the current pricing and investment regime in New Zealand may have a tendency to bias investment towards road rather than rail. However this effect will tend to be reduced, or possibly reversed, by the practice of adopting a cut-off benefit: cost ratio greater than 1.0 for road schemes.

2.7   Summary and Conclusions

Governments throughout the world take an active interest in the price and supply of transport infrastructure. The New Zealand government is no exception. This chapter has considered the case for government intervention in the transport sector. This is not a general treatise on the role of government – rather it attempts to answer the question "given that the government relies primarily on market forces in other sectors, what is it about the transport sector that leads governments world-wide to play such an active part in regulation and service/infrastructure provision?" A number of economic warrants for intervention are identified. It is noted that while these provide a *prima facie* case for some form of regulation or involvement, intervention itself must be justified by showing that the improvement achieved is worth the costs involved.

If there are justifications for the government taking an interest in transport prices, what prices should the government aim for? FAC (and the PAYGO version) is by far the most common approach internationally to pricing government infrastructure. It has advantages which include its simplicity and appearance of fairness. FAC emphasises cost recovery: this is important for private operators and is a contributing factor to ensuring the productive efficiency of all operators. FAC and PAYGO nevertheless have some drawbacks, and these are identified.

SRMC is generally advocated as the basis for pricing in the economic literature, because it ensures the most efficient use of existing infrastructure. There are, however, a number of

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[36] Note also that in 2004, the ATR activity class for freight funding was abolished and replaced with Rail and Sea Freight which is aimed at service funding. The National Land Transport Fund is not to be used to fund rail freight infrastructure (this is funded through ONTRACK).

practical and theoretical issues with its use, which is why pure SRMC pricing is not seen in the real world.

LRMC is also advocated for pricing by some economists. The chapter identifies circumstances under which LRMC may be preferable to SRMC as a pricing rule and notes that, even if SRMC were to be used for pricing, the current value of the LRMC may be a good guide to the equilibrium value of the SRMC. LRMC has a role in investment decisions.

Neither SRMC nor LRMC guarantee cost recovery. Cost recovery is not just a financial issue: there are economic efficiency reasons why we would want services to be able to recover their total costs. While cost recovery is a feature of FAC, FAC is not the only way of achieving it. There are ways of achieving cost recovery by adjusting prices based on marginal costs, using Ramsey pricing and/or two-part tariffs that ensure minimum distortion from the outcome that would pertain under marginal cost pricing. We call this Marginal Cost Plus pricing.

Drawing on the previous sections, the chapter develops pricing and investment rules that a government could adopt if its policy were to maximise the net economic benefit from the transport system, and then compares these with the pricing and investment rules that a profit maximising company would adopt. This has significant implications for New Zealand where a private railway is competing with other operators that use infrastructure provided by a government agency (it also applies to privately-operated toll roads). It is shown that if the government agency were to adopt Marginal Cost Plus prices (and assuming any externality charges are applied similarly in both cases), this could result in a pricing rule that is very similar to the pricing rule of a private company. It should also ensure consumer choices are as close as possible to those made under SRMC (and thus to the theoretically optimal). It would be necessary to ensure that private companies were operating in a competitive or contestable market. This is likely to be the case for rail in New Zealand, and could be ensured for toll road companies through a competitive franchising system.

No such similarity in rules can be identified in the case of investments, although again Marginal Cost Plus pricing ensures recovery of costs and thus net transport system benefits. Where investments are large, the optimum economic rule is to use social cost benefit analysis to guide investment decisions. Social cost benefit analysis includes the cost savings to existing customers (the change in 'consumer surplus') as a benefit. This benefit cannot, in general, be captured by private operators. This implies a need for schemes such as New Zealand's 'Alternatives to Roading' programme to ensure that an economically-warranted balance between public and private investment is maintained.

In the light of the theoretical background and appraisal in this chapter, the next chapter presents our analyses of current (2001/02) fully allocated costs, short-run marginal costs and corresponding charges for New Zealand's road and rail systems, both in aggregate and for their key sub-sectors.

3   COSTS AND CHARGES APPRAISAL

3.1   Introduction

This chapter presents the key findings from the analytical work of the study. As outlined in the terms of reference and discussed in the previous chapter, this work has focused on two main costing approaches:

‣ **Total Costs/Fully Allocated Costs (FAC)** approach (Section 3.2). This approach involves assessment of aggregate costs and corresponding charges for the NZ surface transport system overall, divided first into its two main modal components – the road system and the rail system – each of which is then further sub-divided.

‣ **Short Run Marginal Costs (SRMC)** approach (Section 3.3). The work under this approach has focused particularly on those sub-sectors in which there is the closest competition between modes, i.e. urban passenger transport, longer-distance passenger transport and longer-distance freight transport.

Under each costing approach, the appraisal provides estimates of costs (fully allocated or marginal) and corresponding charges, split between:

‣ A: User/Operator Resource costs, i.e. those resource costs (including travel time) directly incurred by the user/operator

‣ B: User/Operator Charges, i.e. charges (non-resource costs) directly paid by the user/operator

‣ C: Provider Costs and External Costs, separated into 'financial' costs and 'social' costs.

These component estimates are then used to derive:

‣ A+B =   Total (fully allocated or marginal) costs faced by the user/operator: these are the costs that drive user/operator behaviour, including mode choice decisions.

‣ A+C =   Total (fully allocated or marginal) resource costs: these represent the economic costs to society associated with the transport system and its maintenance and operation.

‣ C–B =   Difference between provider/external costs incurred and charges levied, either overall or at the margin.

The prime interest of the study is in comparing the charges currently levied (item B) with the provider/external costs incurred (item C). This is a measure of current 'socio-economic cost recovery' (rather than the narrower concept of financial cost recovery underlying the current charging system); and this provides a foundation for the development of a more economically-efficient charging regime.

The inclusion of the user/operator resource costs (item A) in the appraisal provides additional useful information:

‣ The total user/operator costs (A+B) represent the costs and charges as perceived by the user/operator, which are the key influence on travel decisions, including choice of mode. Thus the modal comparisons of total user/operator costs are important in understanding choice of mode, including highlighting those situations in which there is close competition between modes.

‣ Information on the charges (item B) compared with the total costs (A+B) sheds light on the magnitude of charges levied relative to total user/operator transport costs. This is

helpful in assessing the likely degree of user/operator response (in terms of mode switching or travel generation/suppression) to any changes in charging policies that might be contemplated.

The findings presented in this chapter are very much a summary of the detailed analytical work undertaken in the study. Further detail is provided in two levels of reporting:

▸ Annex B of this report provides a summary of the work done and the key outputs in each of the 13 main analytical areas.

▸ A set of individual working papers (as listed in Annex A, available separately) contains the full documentation of the work in each analytical area and including for five specific case studies, as summarised in Annex E.

Given the nature of the subject matter, it will be recognised that the level of precision (uncertainty) of the analysis results differs considerably in different analytical areas. In general, direct financial costs and charges (e.g. road expenditure, fuel excise revenues) may be derived with high precision; whereas estimates for most externality costs (e.g. congestion, environmental pollution) will be much more uncertain. While most of the figures presented in this chapter focus on single best ('point') estimates for each item, specific comment is made on the level of precision/uncertainty of these estimates where the overall results and conclusions are sensitive to this uncertainty (i.e. for major cost and charge items with relatively low levels of precision). The uncertainties associated with the key estimates are important to keep in mind when interpreting the results throughout this chapter.

Except as specifically noted, all analyses in this study relate to the situation in financial year 2001/02, in terms of costs, charges, traffic volumes, etc. All financial amounts are thus expressed in NZ$2001/02. All figures are presented on a GST-exclusive basis, unless otherwise noted.

3.2 Total Cost/Fully Allocated Cost Appraisal

3.2.1 Introduction

This section presents results of the Total Cost/Fully Allocated Cost analyses, i.e. the total costs of transport system operation, by sector, and the corresponding revenues raised from user charges.

These assessments are undertaken for each of the main transport system sectors, i.e.:

▸ Road system – in aggregate, and sub-divided by vehicle type (cars and trucks principally) and by road type

▸ Rail system – in aggregate, and sub-divided by market sector (rail freight, long-distance passenger and urban passenger).

As described above, the assessment provides total cost and charge estimates, split between:

▸ A: User/Operator Resource Costs (directly incurred)
▸ B: User/Operator Charges
▸ C: Provider and External (Social) costs.

From these estimates are derived:

▸ A+B = Total costs faced by the user/operator (the costs that drive user/operator behaviour)
▸ A+C = Total resource costs (the total economic costs to society)
▸ C–B = Difference between the provider/external costs incurred and the charges levied.

The treatment of land and infrastructure costs in the Total Cost/Fully Allocated Cost appraisals is worthy of particular comment. As discussed in Chapter 2, the depreciated replacement cost (DRC) methodology has been adopted as the basis for asset valuation in the study. A return on the value of the assets has been calculated based on the DRC valuation, multiplied by a weighted average cost of capital (WACC) rate. This return on infrastructure is the largest single item in the Total Costs for both road and rail systems.

However in the case of many historic infrastructure assets, the economic (opportunity) cost of the assets may be considerably less than the DRC value (refer Section 2.5.2). As outlined there, we have therefore split infrastructure assets and their associated return into three categories:

▸ **Recoverable, depreciating assets.** These comprise assets that depreciate and need to be periodically replaced, and have a significant opportunity cost in alternative use. These are principally rail track, signalling and telecommunications equipment.

▸ **Recoverable, non-depreciating assets.** These comprise assets that do not depreciate and do not need periodic replacement, but have a significant opportunity cost in alternative use. The only item in this category is land.

▸ **Non-recoverable assets.** These are specialised ('sunk') assets that have no opportunity cost in alternative use, and generally do not need to be replaced (or only over a very extended timescale). These include formation, tunnels and bridges (both road and rail).

In the following sub-sections we detail the Total Cost/Fully Allocated Cost and Charge estimates for first the road system (Section 3.2.2 for Total Costs, Section 3.2.3 for Fully Allocated Costs) and then the rail system (Section 3.2.4).

3.2.2   Road System – Total Costs

3.2.2.1   Overview

Table 3.1 summarises the Total Cost analyses for the road system. A graphical summary of these results is given in Figures 3.1A and 3.1B.

3.2.2.2   Key Features of Results

Key features of the results at the system aggregate level include the following:

User resource costs (A)

▸ User (direct) resource costs dominate the overall results, together totalling some $30.4 billion p.a. The main components of this are vehicle operating (resource) costs including vehicle capital charges ($16.8 billion p.a.) and traveller time costs including any congestion delays ($11.0 billion p.a.).

▸ The third largest component ($2.24 billion) is the proportion of road accident costs experienced by users, other than the amounts paid through insurance premiums (which are included with vehicle operating costs) and ACC premiums.

▸ The remaining component ($0.36 billion) is an estimate of the user costs (assumed equal to the resource costs) for parking in central city areas.

User and related charges (B)

▸ Direct user and related charges add a further $2.6 billion p.a. to the financial costs of vehicle operations. The main components of these charges are fuel excise duty, road user charges (RUC) and motor vehicle licensing/registration fees. Also included here is the money paid in local authority rates which is spent on local roads.

Provider and external costs (C)[37]

▸ Government cash expenditure on maintenance/operation of the existing road system (i.e. excluding improvements) totals $1.1 billion p.a. (Sub-Total Financial Provider/ External Costs less Infrastructure Capital Return items) of which $0.75 billion is the direct costs for maintenance of the road system.

▸ In addition, Total Costs include an infrastructure capital return target (7% of depreciated replacement cost) of $2.61 billion p.a. Of this amount, some $0.75 billion p.a. relates to land, a 'recoverable' asset (having an opportunity cost in alternative use, on which a return might be expected); while the major part, $1.86 billion p.a., relates to non-recoverable ('sunk') assets with no alternative use, on which the economic justification for expecting a return is arguable (refer earlier discussion).

▸ There is also a small economic depreciation charge, in the order of $0.02 billion p.a. (representing the estimated difference between actual maintenance expenditure and expenditure required to maintain the value of the network).

▸ Total 'financial' provider/external costs (including return on infrastructure) thus total $3.7 billion p.a.: however, 50% of this relates to the target return on non-recoverable ('sunk') assets.

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[37] It is noted that there are other externalities affecting people's health resulting from the decision to choose a motorised mode of transport versus walking or cycling which have positive benefits on people's health. Conversely, the choice to drive or catch public transport may have negative health effects on people's health if their level of physical activity is reduced. This externality is acknowledged but is not assessed in this report.

- ‘Social’ costs amount to a further $1.8 billion p.a., of which $1.2 billion p.a. relates to environmental costs and the remainder to accident externalities.

- Thus the total provider/external costs total some $5.6 billion p.a. (including the $1.9 million potential return on sunk assets).

	A	B	C	D	E	P
2	**TABLE 3.1: TOTAL ROAD SYSTEM COST ANALYSES (2001/02 Statistics)**					
3	**Cost Item**				**Total Costs-$M**	**Notes**
9	**A: USER RESOURCE COSTS**					
10	Vehicle Operating & Ownership Costs	Car			11707.7	
11		LCV			2942.8	
12		MCV			794.8	
13		HCVI			344.2	
14		HCVII			956.6	
15		Other			59.4	
16					**16805.5**	
17						
18	Travel Time	Car			7434.5	
19		LCV			2355.4	
20		MCV			617.9	
21		HCVI			201.7	
22		HCVII			420.1	
23		Other			0.0	
24		Sub-Total			**11029.6**	
25						
26	Parking (CBDs)	Car			**357.0**	
27						
28	Accidents	Car			1952.0	
29	(not incl elsewhere)	Truck			70.0	
30		M/Cycle			218.0	
31		Bus			4.0	
32		Sub-Total			**2244.0**	Excludes Cyclists & Pedestrians ($405M)
33						
34	**Total User Resource (A)**				**30436.1**	
35						
36	**B: USER & RELATED CHARGES**					
37	Motor Vehicle Fees	NRF			196.2	
38	Motor Vehicle Fees	ACC	Car	166.3		
39			Truck	30.0		
40			Bus	1.0		
41			M/Cycle	3.7		
42			Other	1.6		
43			SubTotal		202.6	
44	Motor Vehicle Fees--Residual	ACC			160.5	Covers past costs
45	Motor Vehicle Fees	LTSA			8.3	
46	Fuel Excise	NRF			456.8	
47	Fuel Excise	ACC	Car	49.6		Covers forward costs
48			Truck	10.5		
49			Bus	0.4		
50			M/Cycle	0.3		
51			Other	0.4		
52			SubTotal		61.2	
53	Fuel Excise	Crown			531.5	
54	Fuel Excise	Other			29.4	
55	RUC	NRF			583.7	
56						
57	Insurance Levy (Fire Service)				17.9	
58						
59	Police Fines				81.6	
60						
61	**Sub-Total User Charges**				2329.7	
62						
63	Roading Rates--TLAs				288.7	Assumed=TLA Local Roading expenditure
64	**Total User/Related Charges (B)**				**2618.4**	

	A	B	C	D	E	P
66	**C: PROVIDER/EXTERNAL COSTS**					
67						
68	Infra. Capital Return: Non-recoverable Assets				1862.0	Assets with no significant alternative value
69	Infra. Capital Return: Recoverable Assets				750.0	Assets with opportunity cost (land)
70	Infra. Maintenance Expenditure				755.0	
71	Infra. Economic Depreciation				20.0	
72						
73	Admin. Transfund				8.5	
74	Admin. Transit				26.6	
75	Admin. TLAs				6.8	
76	Research				2.7	
77						
78	Admin. LTSA S(A)P				27.9	
79	Admin. MOT				53.1	
80	Admin. ACC				14.2	Excludes Cyclist & Pedestrian (2.6)
81						
82	Police				173.4	
83	Fire Service				37.9	
84	Ambulance Services				6.5	
85						
86	**Sub-Total 'Financial' $**				**3744.6**	
87						
88	Accidents-Externality				670.0	Excludes Cyclist & Pedestrian Accidents
89						
90	Environmental: Air Pollution				442.0	
91	Environmental: Water Quality				28.0	
92	Environmental: Water Quantity				98.0	
93	Environmental: Noise				289.0	
94	Environmental: Climate Change				317.0	
95						
96	**Sub-Total 'Social' $**				**1844.0**	
97						
98	**Total Provider/External Costs (C)**				**5588.6**	

Figure 3.1A: Total Road System Costs - Overview
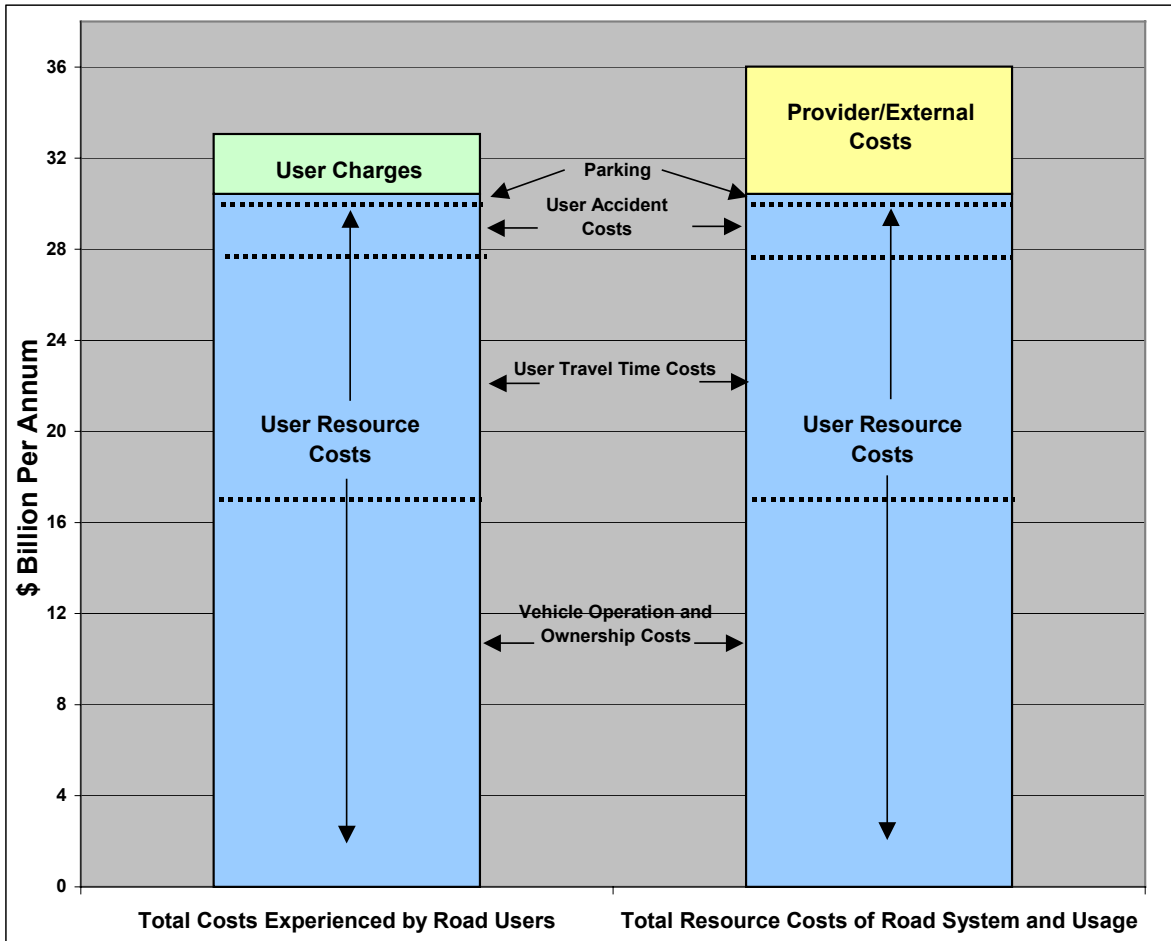
Figure 3.1B: Total Road System Costs - Main Components of User Charges and Provider/External Costs
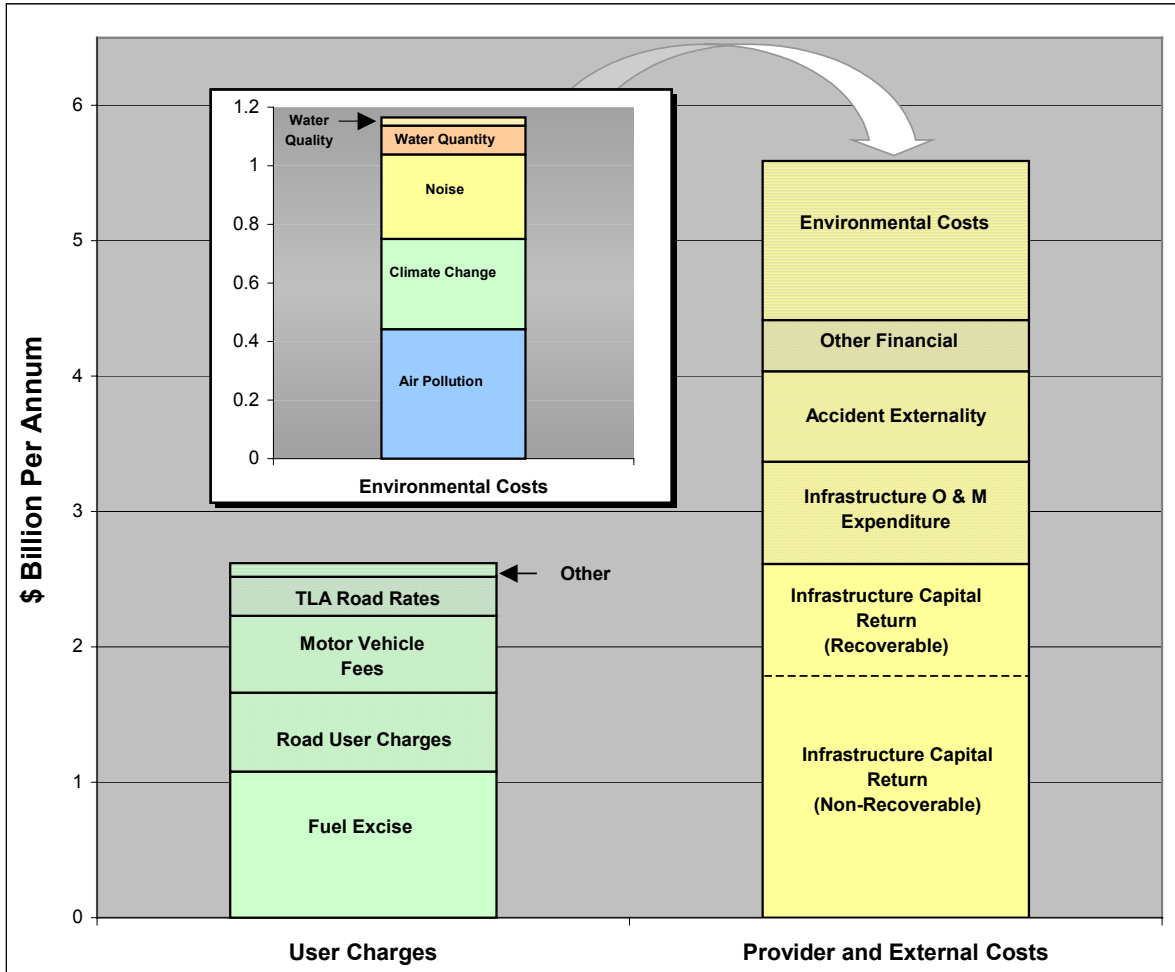
Summary

▸ Total costs faced by the user/operator (i.e. A + B) amount to some $33.1 billion p.a. Only some $2.6 billion p.a. (8%) of this amount is user and related charges, the remainder being resource costs incurred directly by users. This illustrates that government charges comprise only a small component of total costs incurred by road users.

▸ Total resource costs associated with the road system in New Zealand (i.e. A + C) amount to some $36.0 billion p.a. Again the great majority of this amount ($30.4 billion, 84%) comprises direct user resource costs, the remainder comprising provider/external costs.

▸ Total provider/external costs (C) total some $5.6 billion p.a. This is substantially greater than the total user charges (B) of some $2.6 billion p.a. This indicates that, in social cost accounting terms, road users in total are not fully 'paying their way': the extent of 'social cost recovery' of the provider/external costs is less than 50%.

▸ However, the case for a return on sunk assets is arguable. Excluding this item, the provider/external costs total some $3.7 billion p.a., and the 'social cost recovery' increases to 70%.

3.2.2.3 Additional Comments on Results and Sensitivity

The following provides additional commentary on the precision/uncertainty in key components of the Total Cost results and the extent to which this may affect the main conclusions from the analyses. It thus focuses on cost/charge items which are large, subject to substantial uncertainty, and significantly impact on key results.

User resource costs

▸ While the main cost items under this heading are large and subject to a moderate degree of uncertainty, this is regarded as not of primary importance as it does not affect the key User Charges versus External Costs comparisons.

▸ The smallest item (CBD parking costs) is subject to perhaps the greatest uncertainty. The figure given is based on estimates of the numbers of CBD car parks in the 12 largest centres in New Zealand (each with population over 50,000) multiplied by typical daily parking charges in each of these centres. It thus approximates to the costs motorists would expect to pay for CBD parking in these centres. We note that the figure given may be on the high side, as some motorists may not pay for their parking either directly or indirectly; but it may be on the low side, as it excludes non-CBD areas and smaller centres.

User and related charges

▸ Most of these charge items are financial payments to Government agencies and hence are known with precision.

▸ Rates raised by TLAs and used for local roading have been included under this heading ($289 million). It may be argued that these are not a 'user charge' under a strict definition, and should not be included here. This would further increase the shortfall between the User Charges and the External Costs.

Provider and external costs

▸ This area of costs is subject to the greatest uncertainty. Of the total of $5.6 billion in this area, approximately $1.1 billion represents direct expenditures by central government,

and is known with considerable precision. The remaining $4.5 billion has significant degrees of uncertainty attached.

▸ Just over half this amount ($2.61 billion) is for the return on infrastructure capital, calculated at 7% (WACC) of the estimated depreciated replacement cost (DRC) of the road system and divided into two components: - the return on the non-recoverable (sunk) assets of $1.86 billion and that on recoverable assets (land) of $0.75 billion.

▸ In regard to the former item, uncertainty in the estimate may be considered in two components:

  – The DRC value may be subject to uncertainty of perhaps between +20% and –40% as a broad estimate. (The downside figure reflects that the depreciation may, in economic terms, be more realistically approximated by a constant % p.a. diminishing value pattern rather than the straight-line pattern assumed.)

  – The 7% WACC rate has been assessed as highly likely to be in the range 6% to 8%, implying a further uncertainty range of around +/- 15%.

  Together these suggest an uncertainty range around the best estimate for the economic return on the non-recoverable assets of about +30% to –50%: this results in the best estimate of $1860 billion, with a range of $930 million to $2420 million. However, as noted above, it is arguable whether any return can be justified on this component.

▸ In regard to the recoverable assets (land), the uncertainty in the estimate may be considered in three components:

  – Uncertainty in the (D)RC value: as the land does not depreciate, this uncertainty is likely to be less than for the non-recoverable and depreciating assets (above)

  – Uncertainty in the costs involved in converting the land to its alternative use: these may be considerable, meaning that the real opportunity cost of the land is considerably below its 'replacement cost' estimate

  – Uncertainty in the WACC rate, as for non-recoverable assets (above).

▸ Taking these factors together, we estimate an uncertainty range for the economic return on the recoverable assets (land) of about +30% to –60%: this results in the best estimate of $750 million, with a range of $300 million to $975 million.

▸ After the return on capital, the next largest item is the environmental cost components, about $1.2 billion taken together. Our broad judgement would be for a sensitivity range perhaps between half and double this value (i.e. $0.6 billion to $2.4 billion).

▸ The third largest item is the accident externality costs of some $0.7 billion. This represents about 19% of total accident costs. Given the difficulties inherent in estimating this accident component, a plausible range could again be between half and double this value (i.e. $0.33 billion to $1.34 billion).

▸ If all these provider/external cost items were at the low end of their cost range, and the return on non-recoverable assets were omitted, then the total would reduce from $5.6 billion to about $2.4 billion; while at the high end of their range (including the return on non-recoverable assets) the total would increase to about $8.4 billion. Given that the user and related charges are known with relative precision, we might conclude with some confidence that provider/external costs are at minimum broadly equal to (but slightly lower than) current total user charges; and at maximum are over three times current charges.

3.2.3   Road System – Fully Allocated Costs

3.2.3.1   Overview

This section presents a breakdown of the road system Total Costs results from the previous section, by two separate dimensions:

‣ Vehicle type – principally between cars and trucks

‣ Road type – by state highway/local roads, with each then broken down further between urban and rural areas.

The results are given in Table 3.2A (by vehicle type) and Table 3.2B (by road type), with a graphical summary of key results in Figure 3.2.

It should be emphasised that these analyses involve a large number of allocation assumptions in splitting cost items which, in many cases, are not readily separable (e.g. infrastructure capital return and maintenance expenditure are not, in general, separable by vehicle type). While the allocation assumptions are detailed in the tables, some of the key assumptions may be summarised as follow:

User resource costs

‣ Vehicle operations and ownership costs – based on vehicle kilometre (VKT) estimates by road and vehicle type.

User charges

‣ Motor vehicle fees – by road type, based on VKT estimates

‣ Fuel excise and RUC – by road and vehicle type, based on VKT estimates

‣ TLA rates – by urban/rural in proportion to local road maintenance expenditure.

Provider/external costs

‣ Infrastructure capital – by vehicle type, based on MoT Road Cost Allocation Model (RCAM)

‣ Roading administration – by vehicle type, based on RCAM administration allocations

‣ Accident externality – direct analyses from LTSA data

‣ Environmental impacts – based on emission rates, etc. by vehicle type and VKT data, with only climate change (GHG) impacts applying outside urban areas.

3.2.3.2   Key Features of Results

Figure 3.2 illustrates the key features of the results, with further comments as follows.

Vehicle type

‣ Full allocation results have been produced for only two vehicle types – cars and trucks. Data problems preclude reliable results for other vehicle types (bus, motorcycle, etc.), or a further breakdown by truck type.

‣ The results indicate that cars account for 70% of user resource costs (trucks 29%), 64% of user charges excluding TLA rates (trucks 34%), and 60% of provider/external costs (trucks 39%).

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
			Grand	Car			Truck			Bus	M/Cycle	Other	Not	Misc	Notes Re Allocation
			Total		LCV	MCV	HCV1	HCV2	Total				Alloc		
2	TABLE 3.2A: TOTAL & AVERAGE ROAD SYSTEM COST ANALYSES--BY VEHICLE TYPE														
3	2001/02 statistics						All figures excl GST								
4			Total Costs-$M												
8	A: USER RESOURCE COSTS														
9	Veh. Operating & Ownership Costs		16805.5	11707.7	2942.8	794.8	344.2	956.6	5038.4			59.4			Bus, M/cycle not calculated
11	Travel Time		11029.6	7434.5	2355.4	617.9	201.7	420.1	3595.1						Bus, M/cycle, Other not calculated
13	Parking (CBDs)		357.0	357.0											
15	Accidents		2244.0	1952.0					70.0	4.0	218.0			405.0	Misc (405)=Cyclists & Pedns (not incl in Total)
16	(not including elsewhere)														
17	Total User Resource (A)		30436.1	21451.2	5298.2	1412.7	545.9	1376.7	8703.5	4.0	218.0	59.4	0.0		
19	USER & RELATED CHARGES														
20	Motor Vehicle Fees	NRF	196.2	150.1					26.7	0.8	1.7	16.8	0.0		
21	Motor Vehicle Fees	ACC	202.6	166.7					30.1	0.7	3.7	1.5	0.0		Allocated using proportions from bottom-up
22	Motor Vehicle Fees-Residual	ACC	160.5	131.8					23.8	0.8	2.9	1.2	0.0		calculations
23	Motor Vehicle Fees	LTSA	8.3	4.8					2.5	0.3	0.1	0.7	0.0		
25	Fuel Excise	NRF	456.8	403.5					44.8	3.3	2.3	2.8	0.0		Allocated using MWH split between cars and trucks
26	Fuel Excise	ACC	61.2	54.0					6.0	0.4	0.3	0.4	0.0		and fuel consumption by vehicle type figures for bus,
27	Fuel Excise	Crown	531.5	469.5					52.2	3.8	2.7	3.3	0.0		motorcycle and other
28	Fuel Excise	Other	29.4	26.0					2.9	0.2	0.1	0.2	0.0		
30	RUC	NRF	583.7		109.7	29.6	185.3	250.6	575.1	8.6			0.0		Allocated using same proportions as in total road expenditure 2001/02
32	Insurance Levy (Fire Service)		17.9	13.4	2.7	0.6	0.3	0.9	4.5	0.1			0.0		Allocate as RCAM Police expenditure
34	Police Fines		81.6	64.4	12.3	2.3	0.8	1.7	17.0	0.2			0.0		Alloc as Total VKT--ref Road Infra WP, Table B8
36	Sub-Total User Charges		2329.7	1484.1	124.6	32.5	186.3	253.2	785.6	19.2	14.0	26.8	0.0		
38	Roading Rates--TLAs		288.7										288.7		Cannot allocate by veh type
39	Total User/Related Charges (B)		2618.4	1484.1					785.6				288.7		

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
41			Grand	Car			Truck			Bus	M/Cycle	Other	Not	Misc	
42			Total		LCV	MCV	HCV1	HCV2	Total				Alloc		
43	C: PROVIDER/EXTERNAL COSTS														
44	Infra. Cap. Return: Non-recoverable Assets		1862.0	1049.4	280.8	118.0	76.1	319.9	794.8	17.8	0.0	0.0	0.0		Allocate as RCAM Total Road Mtce expenditure
45	Infra. Cap. Return: Recoverable Assets		750.0	422.7	113.1	47.5	30.7	128.9	320.1	7.2	0.0	0.0	0.0		Allocate as RCAM Total Road Mtce expenditure
46	Infra. Maintenance Expenditure		755.0	425.5	113.9	47.8	30.9	129.7	322.3	7.2	0.0	0.0	0.0		Allocate as RCAM Total Road Mtce expenditure
47	Infra. Econ. Depn.		20.0	11.3	3.0	1.3	0.8	3.4	8.5	0.2	0.0	0.0	0.0		Allocate as RCAM Total Road Mtce expenditure
48															
49	Admin Transfund		8.5	5.1	1.3	0.5	0.3	1.2	3.3	0.1	0.0	0.0	0.0		Allocate as RCAM Road Admin (excl PT) exp.
50	Admin Transit		26.6	16.1	4.1	1.5	0.9	3.9	10.3	0.2	0.0	0.0	0.0		Allocate as RCAM Road Admin (excl PT) exp.
51	Admin TLAs		6.8	4.1	1.0	0.4	0.2	1.0	2.6	0.1	0.0	0.0	0.0		Allocate as RCAM Road Admin (excl PT) exp.
52	Research		2.7	1.6	0.4	0.1	0.1	0.4	1.0	0.0	0.0	0.0	0.0		Allocate as RCAM Road Admin (excl PT) exp.
53													0.0		
54	Admin LTSA S(A)P		27.9	22.0	4.2	0.8	0.3	0.6	5.8	0.1	0.0	0.0	0.0		Allocate as RCAM LTSA exp.
55	Admin MOT		53.1	41.9	8.0	1.5	0.5	1.1	11.1	0.1	0.0	0.0	0.0		Allocate as RCAM MoT exp.
56	Admin ACC		14.2	12.3					0.4	0.0	1.4	0.1	0.0	2.6	Allocate as ACC payouts. Misc (2.6)=Cyclists & Pedns (not incl in Total)
57															
58	Police		173.4	129.5	26.2	5.9	2.5	8.7	43.3	0.6	0.0	0.0	0.0		Allocate as RCAM Police expenditure
59	Fire Service		37.9	28.3	5.7	1.3	0.6	1.9	9.5	0.1	0.0	0.0	0.0		Allocate as RCAM Police expenditure
60	Ambulance Services		6.5	4.9	1.0	0.2	0.1	0.3	1.6	0.0	0.0	0.0	0.0		Allocate as RCAM Police expenditure
61		1882.6													
62	Sub-Total 'Financial' $		3744.6	2174.5	562.8	226.7	143.8	601.1	1534.9	33.8	1.4	0.1	0.0		
63															
64	Accidents-Externality		670.0	509.0					177.0	1.0	-22.0	5.0	0.0	-314.0	Accident analyses. Misc=Cyclists & Pedns (not incl in Total)
65															
66	Environmental: Air Pollution		442.0	149.0	96.0	89.0	32.0	69.0	286.0	7.0			0.0		Allocate as per Environmental WP and Annex B12
67	Environmental: Water Quality		28.0	22.5	4.3	0.6	0.2	0.3	5.4	0.1			0.0		
68	Environmental: Water Quantity		98.0	78.9	15.0	2.3	0.7	0.9	18.9	0.2			0.0		
69	Environmental: Noise		289.0	200.0	38.0	29.0	9.0	11.0	87.0	2.0			0.0		
70	Environmental: Climate Change		317.0	220.0	42.0	25.0	9.0	19.0	95.0	2.0			0.0		
71															
72	Sub-Total 'Social' $		1844.0	1179.4	195.3	145.9	50.9	100.2	669.3	12.3			0.0		
73															
74	Total Provider/External Costs (C)		5588.6	3353.9	758.1	372.6	194.7	701.3	2204.2	46.1	1.4	0.1	0.0		
75															
76	Alloc Charges:P/E Costs (%):														
77	Overall		47%	44%					36%						
78	Excl Return on Non-recov Assets		70%	64%					56%						
79															
80	A+B = Total User Costs		33054.5	22935.3					9489.1				288.7		
81	A + C = Economic SRMC		36024.7	24805.1	6056.2	1785.4	740.6	2078.0	10907.6	50.1	219.4	59.5	0.0		
82	C- B = Provider/External Costs - Charges		2970.2	1869.8					1418.6				-288.7		

	A	B	C	D	E	F	G	H	I	J
2	TABLE 3.2B: TOTAL & AVERAGE ROAD SYSTEM COST ANALYSES--BY ROAD TYPE									
3	2001/02 statistics					All figures excl GST				
4						Total Costs-$M				
5										
6			Grand	State Highways		Local Roads		Not	Misc.	Notes re Allocation
7			Total	Urban	Rural	Urban	Rural	Alloc.		
8	A: USER RESOURCE COSTS									
9	Vehicle Operations & Ownership Costs		16805.5	3398.8	4896.2	5848.6	2661.9	0.0		
10										
11	Travel Time		11029.6	2529.5	2688.3	4363.5	1448.3	0.0		
12										
13	Parking (CBDs)		357.0					357.0		
14										
15	Accidents (not included elsewhere)		2244.0	274.8	984.2	466.2	518.7	0.0	405.0	Misc = Cycleists & pedestrians; allocate Urban:Rural 744:1509 in proportion to Accident Perceived costs (excl Cyc/Pedn); then SH:LR in proportion to VKT
16										
17	Total User Resource (A)		30436.1	6203.1	8568.7	10678.4	4628.9	357.0		
18										
19	B: USER & RELATED CHARGES									
20	Motor Vehicle Fees	NRF	196.2	41.5	55.4	70.3	29.0	0.0		
21	Motor Vehicle Fees	ACC	202.6	43.0	57.1	72.7	29.9	0.0		
22	Motor Vehicle Fees-Residual	ACC	160.5	34.0	45.3	57.5	23.7	0.0		Allocated using annual km by road type by vehicle type and applying to Table 3.1A
23	Motor Vehicle Fees	LTSA	8.3	1.7	2.4	2.9	1.3	0.0		
24										
25	Fuel Excise	NRF	456.8	97.5	128.3	164.4	66.7	0.0		
26	Fuel Excise	ACC	61.2	13.0	17.2	22.0	8.9	0.0		Allocated using annual km by road type by vehicle type and applying to Table 3.1A
27	Fuel Excise	Crown	531.5	113.4	149.3	191.2	77.6	0.0		
28	Fuel Excise	Other	29.4	6.3	8.3	10.6	4.3	0.0		
29				29.4						
30	RUC	NRF	583.7	68.5	215.5	147.8	151.9	0.0		Allocated using annual km by road type by vehicle type and applying to Table 3.1A
31										
32	Insurance Levy (Fire Service)		17.9	2.8	6.8	4.7	3.6	0.0		Allocated as Admin LTSA
33										
34	Police Fines		81.6	17.2	23.1	29.1	12.2	0.0		Allocated as total VKT
35										
36	Sub-Total User Charges		2329.7	468.3	708.6	773.2	409.1	0.0		
37										
38	Roading Rates--TLAs		288.7	0.0	0.0	105.5	183.2	0.0		Alloc to LR Urban:Rural in proportion to LR O&M expenditure
39	Total User/Related Charges (B)		2618.4	468.3	708.6	878.7	592.3	0.0		
40										

	A	B	C	D	E	F	G	H	I	J
			Grand	State Highways		Local Roads		Not	Misc.	Notes re Allocation
41	C: PROVIDER/EXTERNAL COSTS		Total	Urban	Rural	Urban	Rural	Alloc.		
43	Infra. Capital Return: Non-recoverable Assets		1862.0	71.4	525.0	462.4	803.2	0.0		Allocate SH:LR in proportion to Valuation: then U:R in
44	Infra. Capital Return: Recoverable Assets		750.0	28.7	211.5	186.3	323.5	0.0		proportion to O&M expenditure
45	Infra. Maintenance Expenditure		755.0	32.8	241.2	175.7	305.2	0.0		Allocate according to O&M expenditure
46	Infra. Econ Depn		20.0	0.9	6.4	4.7	8.1	0.0		Allocate according to O&M expenditure
47										
48	Admin. Transfund		8.5	0.4	2.7	2.0	3.4	0.0		Allocate according to O&M expenditure
49	Admin. Transit		26.6	3.2	23.4	0.0	0.0	0.0		Allocate according to SH O&M expenditure
50	Admin. TLAs		6.8	0.0	0.0	2.5	4.3	0.0		Allocate according to LR O&M expenditure
51	Research		2.7	0.6	0.8	1.0	0.4	0.0		Allocate as total VKT
52										
53	Admin. LTSA S(A)P		27.9	4.3	10.6	7.3	5.6	0.0		Allocate Urban:Rural 1457:2026 in proportion to Accident costs (excl Cyc/Pedn); then SH:LR in proportion to VKT
54	Admin. MOT		53.1	11.2	15.0	19.0	7.9	0.0		Allocate as total VKT
55	Admin. ACC		14.2	2.2	5.4	3.7	2.9	0.0	2.6	Allocate as Admin LTSA. Misc=Cyclists/Pedns(2.6, not incl in Total)
56										
57	Police		173.4	36.5	49.1	61.9	25.9	0.0		Allocate as total VKT
58	Fire Service		37.9	5.9	14.4	10.0	7.6	0.0		Allocate as Admin LTSA
59	Ambulance Services		6.5	1.0	2.5	1.7	1.3	0.0		Allocate as Admin LTSA
60										
61	Sub-Total 'Financial' $		3744.6	199.0	1108.1	938.2	1499.4	0.0		
62										
63	Accidents-Externality		670.0	179.9	121.1	305.1	63.9	0.0	-314.0	Accident analyses. Misc=Cyclists & Pedns (not incl in Total)
64										Allocate Urban:Rural 485:185 in proportion to Accident External costs (excl Cyc/Pedn); then SH:LR in proportion to VKT
65	Environmental: Air Pollution		442.0	98.0	0.0	344.0	0.0	0.0		Allocate as per Environmental WP and Annex B12
66	Environmental: Water Quality		28.0	6.0	0.0	22.0	0.0	0.0		
67	Environmental: Water Quantity		98.0	22.0	0.0	76.0	0.0	0.0		
68	Environmental: Noise		289.0	64.0	0.0	225.0	0.0	0.0		
69	Environmental: Climate Change		317.0	33.0	124.0	113.0	47.0	0.0		
70										
71	Sub-Total 'Social' $		1844.0	402.9	245.1	1085.1	110.9	0.0		
72										
73	Total Provider/Ext Costs (C)		5588.6	601.8	1353.3	2023.3	1610.2	0.0		
74										
75	Alloc Charges:P/E Costs (%):									
76	Overall		47%	78%	52%	43%	37%			
77	Excl. Return on Non-recov Assets		70%	88%	86%	56%	73%			
78	A+B = Total User Costs		33054.5	6671.4						
79	A + C = Economic SRMC		36024.7	6804.9	9922.0	12701.7	6239.1	357.0		
80	C- B = Provider/External Costs - Charges		2970.2	133.6	644.7	1144.6	1017.9	0.0		

NOT GOVERNMENT POLICY

Figure 3.2: Road System Allocated Costs - Comparisons of User Charges and Provider/External Costs
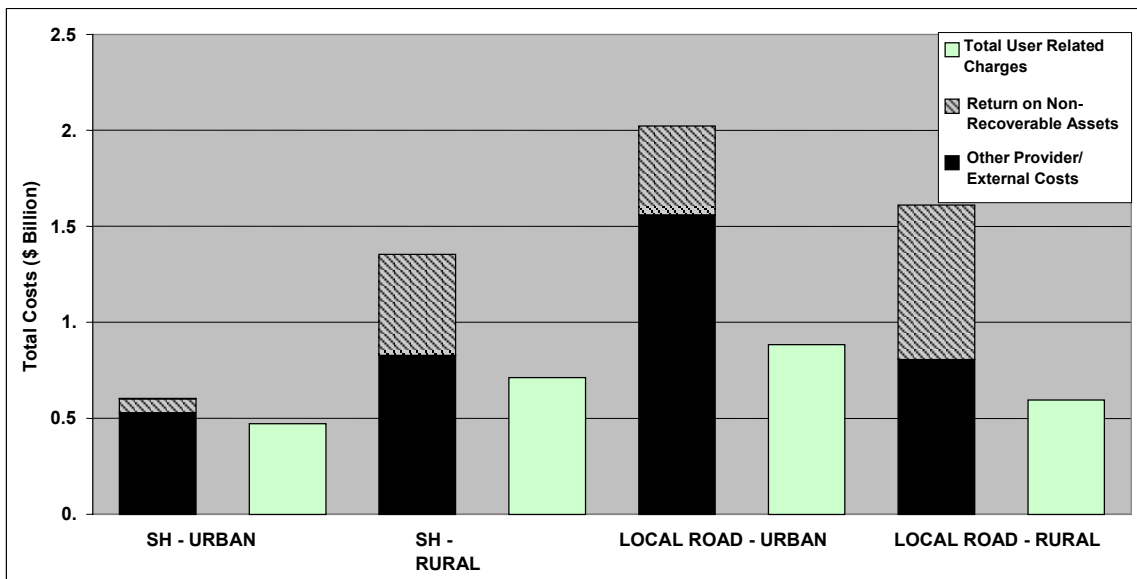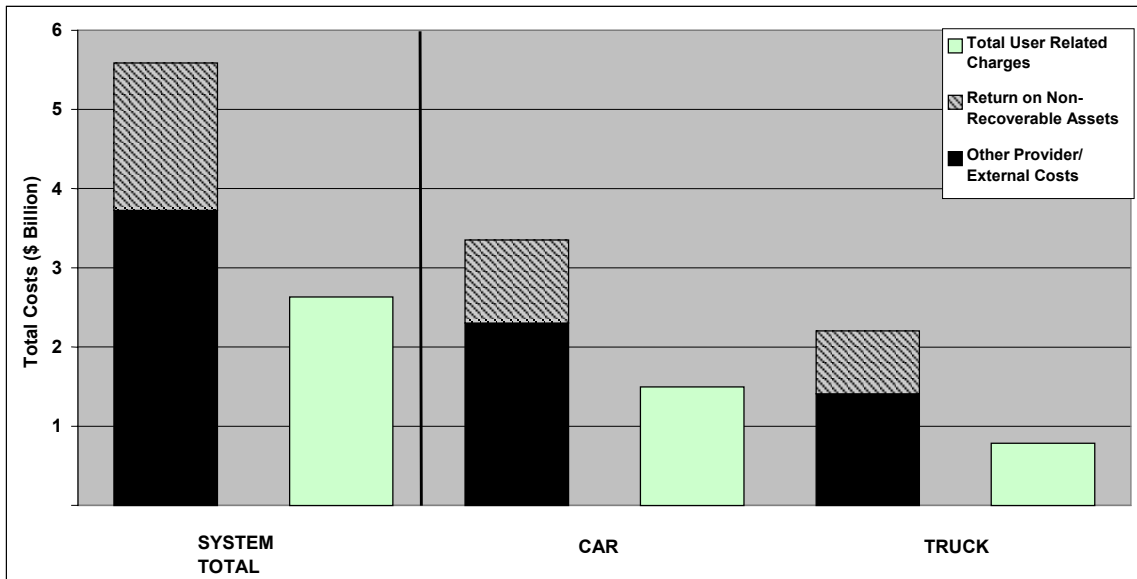
SOCIAL COST RECOVERY SUMMARY (Ratio Charges: Provider/External Cost)	System total	Car	Truck	SH-Urban	SH - Rural	Local road - Urban	Local road - Rural
Overall	47%	44%	36%	73%	52%	43%	37%
Excluding Non-recoverable Assets	70%	64%	56%	83%	86%	56%	73%

NOT GOVERNMENT POLICY

▸ In terms of 'social cost recovery' (i.e. user charges as a proportion of total provider/external costs, including the return on non-recoverable assets), cars recover 45% of allocated costs while trucks recover significantly less, at 36%. The overall social cost recovery is 42% excluding TLA rates, or 47% including these.

▸ As discussed in the previous section, all these cost recovery rates would increase substantially if the target return on non-recoverable assets were omitted from the provider/external costs. On this basis, car cost recovery increases to 65%, while truck cost recovery increases to 56%.

Road Type

▸ Allocation results have been produced for four road/area types, i.e. urban and rural state highways, urban and rural local roads.

▸ The most heavily-trafficked road type (urban state highways) accounts for 20% of total user resource costs, contributes 19% of total user charges (excluding TLA rates), but is responsible for only 11% of provider/external costs.

▸ Conversely, the least-trafficked road type (rural local roads) accounts for 16% of total user resource costs, pays 18% of total user charges (excluding TLA rates), but is responsible for 29% of provider/external costs.

▸ In terms of 'social cost recovery' (i.e. user charges as a proportion of total provider/external costs, including the return on non-recoverable assets), urban state highways show the highest performance (78% recovery) and rural local roads the lowest (37%). Cost recovery appears to be strongly correlated with traffic intensity.

▸ If the target return on non-recoverable assets is omitted, all the social cost recovery figures increase significantly but the pattern of variation becomes less clear. Urban state highways still show the highest performance (89% cost recovery), followed closely by rural highways (86%) and then rural local roads (74%).

3.2.4   Rail System

3.2.4.1   Overview

Table 3.3 summarises the Total Cost analyses for the rail system. These are on a generally comparable basis to the analyses for the road system (Table 3.1), although there are some differences reflecting the different nature of the rail sector.

Total rail costs have been broken down into three main sectors with further sub-sectors:

▸ Freight   -   rail
                   -   road (the Tranz Rail distribution business)
▸ Urban Passenger -   Auckland (AKL)
                   -   Wellington (WLG)
▸ Long-distance passenger (the Tranz Scenic business).

To provide an appraisal of economic costs and charges from the viewpoint of the rail operator, relevant costs and charges have been divided into three groups (as for roads):

▸ Operator resource costs
▸ Operator charges (by Government)
▸ External resource costs associated with the operation.

In addition, to examine the financial viability of the sub-sectors, a fourth group has been included:

▸ User charges (i.e. fares and freight payments by end users).

Operator resource costs comprise two main elements: operator recurrent costs and operator capital charges (infrastructure and rollingstock). Capital charges have been estimated on a similar basis to that for roads, based on a 7% WACC rate:

▸ For rollingstock, an average annualised charge has been estimated, based generally on refurbished/second-hand assets (generally similar in standard to the existing assets) and corresponding economic lines. (For illustration, the average annualised costs for new assets have also been shown.)

▸ For infrastructure, capital charges have been derived as 7% of DRC values, as for roads.

As discussed in the earlier section (3.2.1), we have sub-divided infrastructure assets and the target return on them into three groups:

▸ 'Recoverable', depreciating assets, which have a significant opportunity cost and need periodic replacement. These are taken as track (and sidings), signalling and telecommunications.

▸ Recoverable, non-depreciating assets, which have a significant opportunity cost but do not need periodic replacement. Land is the only item in this category.

▸ 'Non-recoverable' (sunk) assets, which have no significant value in an alternative use. These are taken as existing formation, tunnels, bridges, culverts and electrical power.

Taking a long-run view, a commercial railway would need to earn sufficient to replace the 'recoverable' depreciating assets, but not necessarily to earn a return on the other two categories of assets.

Operator charges comprise those external charges levied on the railway (by Government) – these are relatively minor in the NZ context. (Any regulatory costs imposed by Government which are already internalised into the railway's costs are not included here.)

External costs are principally the components of environmental costs associated with the rail system which are not internalised (i.e. mitigated or funded by the operator).

User charges are simply the fare and freight revenues paid by end users of the rail services (together with any ancillary revenues received by the operating companies).

The public funding paid by Auckland/Wellington regional councils to support the urban rail passenger services is shown separately. From the operator viewpoint, this may be regarded as an additional user revenue: while from the economic perspective it is an external subsidy to the rail system and its users.

Table 3.3 shows the results for the NZ rail system in total, and also splits these down between the three main sectors. Figure 3.3 summarises the underlying financial performance of each of the three sectors from the operator viewpoint.

In splitting the overall results across the three sectors, a number of assumptions have had to be applied, principally in relation to the treatment of infrastructure assets (in all other aspects the sectors are largely separable):

▸ The long-distance passenger (Tranz Scenic) business is already effectively separated: it does not own any significant infrastructure assets, but pays Tranz Rail a charge covering its use of the Tranz Rail infrastructure.

▸ For the Auckland urban passenger services, we have adopted the infrastructure split made when Tranz Rail sold the assets (to the Government).

▸ For the Wellington urban passenger services, we have allocated infrastructure assets on a 'prime user' basis. The urban services have been regarded as prime user for the system as far as Paraparaumu and the Wairarapa: the route sections concerned involve extensive tunnels and thus correspondingly high infrastructure (but 'sunk') costs.

3.2.4.2   Key Features of Results – Main Sectors

Key features of the results for each of the three main sectors are now summarised.

Rail Freight

▸ Total rail freight (line haul) revenue was some $328 million. This equates to an average $24.10 per (net) tonne or 8.8¢/net tonne km.

▸ Total freight recurrent costs (including track renewal) were some $235 million. Including rollingstock replacement (to retain broadly current age and condition), costs would be $287 million. An economic return at 7% on the depreciated value of the recoverable assets (excluding land) would involve a further $113 million, giving a total of $400 million.

▸ It is evident that current revenues are sufficient to fund rollingstock replacement, but insufficient to also fund an adequate economic return on the recoverable (depreciating) assets. Clearly the revenues do not begin to cover the economic costs of land and other infrastructure assets (e.g. tunnels and formation), which equate to around $362 million p.a. for the freight system. (Note that Tranz Rail purchased many of these infrastructure assets effectively at well below their DRC valuation.)

Long-distance Passenger (Tranz Scenic)

▸ Total revenue was some $22.7 million. This equates to an average $44 per passenger or 17.7¢ per passenger km.

▸ Total recurrent costs were $20.1 million. Economic capital charges to replace or refurbish rollingstock to approximately its current condition would be around $3.5 million p.a., giving total operating costs of $23.6 million p.a. This indicates that current revenues are marginally below the level required for the business to continue to operate viably with broadly its current asset base or equivalent.

▸ The Tranz Scenic business owns minimal infrastructure assets, and therefore the above represents its full financial position (the recurrent cost estimates include a charge for the use of the Tranz Rail track and infrastructure).

TABLE 3.3: TOTAL RAIL SYSTEM COST ANALYSES							
2001/02 statistics				All figures excl GST			
		Total	Freight		Urban Passenger		Long-Dist
		Rail	Rail	Road (1)	AKL	WLG	Passenger
		System					
ASSET VALUATION -- INFRASTRUCTURE($Mill)							
Replacement Basis							
Non-Recov Assets	Formation	1312.8	1250.2		22.5	40.1	
	Tunnels	4704.3	3572.3		73.6	1058.4	
	Bridges/Culverts	1469.0	1374.0		27.4	67.6	
	Elect Power	141.0	87.6		0.0	53.4	
	Sub-Total	7627.1	6284.1		123.5	1219.5	
Recoverable Assets	Track	1583.0	1452.6		47.5	82.9	
	Sidings	404.0	355.1		32.2	16.7	
	Signals	502.0	428.3		30.8	42.9	
	Telecomms	606.0	583.4		15.2	7.4	
	Land	461.5	354.1		68.7	38.7	
	Sub-Total	3556.5	3173.5		194.4	188.6	
	Total Infra	**11183.6**	**9457.6**		**317.9**	**1408.1**	
Depr Rep Basis							
Non-Recov Assets	Formation	1020.0	970.0		18.0	32.0	
	Tunnels	3739.0	2833.3		58.9	846.8	
	Bridges/Culverts	1005.0	936.5		19.2	49.3	
	Elect Power	102.0	70.6		0.0	31.4	
	Sub-Total	5866.0	4810.4		96.1	959.5	
Recoverable Assets	Track	803.0	734.7		23.7	44.6	
	Sidings	211.0	185.8		16.1	9.1	
	Signals	**276.0**	234.5		15.4	26.1	
	Telecomms	**111.0**	104.9		4.6	1.5	
	Land	**462.0**	354.6		68.7	38.7	
	Sub-Total	1863.0	1614.5		128.5	120.0	
	Total Infra	**7729.0**	**6424.9**		**224.6**	**1079.5**	
ASSET VALUATION -- ROLLINGSTOCK($Mill)							
Replacement New Basis	Locos	413.1	378.0			8.1	27.0
	Wagons	548.0	546.0				2.0
	Railcars	351.0			56.3	294.8	
	Carriages	105.9				32.4	73.5
	Total	**1418.0**	**924.0**		**56.3**	**335.3**	**102.5**
Replacement as Exist Basis	Locos	153.0	140.0			3.0	10.0
	Wagons	337.2	336.0				1.2
	Railcars	64.9			12.5	52.4	
	Carriages	20.5				4.5	16.0
	Total	**575.6**	**476.0**		**12.5**	**59.9**	**27.2**
CAP CHARGES--INFRA($Mill pa)							
Infra @ 7% DRC	Non-Recov Assets	410.6	336.7		6.7	67.2	
	Recoverable Assets	130.4	113.0		9.0	8.4	
	Total Infra	**541.0**	**449.7**		**15.7**	**75.6**	
CAP CHARGES--ROLLINGSTOCK($Mill pa)							
Rolling stock @ 7% PMT	Locos	33.3	30.5		0.0	0.7	2.2
on new value (2)	Wagons	44.2	44.0		0.0	0.0	0.2
	Railcars	28.3	0.0		4.5	23.8	0.0
	Carriages	8.5	0.0		0.0	2.6	5.9
	Sub-Tot R/stock	**114.3**	**74.5**		**4.5**	**27.0**	**8.3**
Rolling stock @ 7% PMT	Locos	16.8	15.4		0.0	0.3	1.1
on existing value(2)	Wagons	37.0	36.9		0.0	0.0	0.1
	Railcars	7.5	0.0		1.8	5.8	0.0
	Carriages	2.9	0.0		0.0	0.6	2.3
	Sub-Tot R/stock	**64.3**	**52.3**		**1.8**	**6.7**	**3.5**
RECURRENT COSTS ($Mill)							
Recurrent Costs		**321.7**	**234.9**	**23.5**	**10.9**	**32.3**	**20.1**

		Total	Freight		Urban Passenger		Long-Dist
		Rail	Rail	Road (1)	AKL	WLG	Passenger
		System					
OPERATOR COSTS SUMMARY($Mill)							
Recurrent Costs		**321.7**	**234.9**	**23.5**	**10.9**	**32.3**	**20.1**
R/stock Cap Charge--Exist		**64.3**	**52.3**		**1.8**	**6.7**	**3.5**
Infra Cap Charge--Recov Assets		**130.4**	**113.0**		**9.0**	**8.4**	**0.0**
Infra Cap Charge--Non-recov Assets		**410.6**	**336.7**		**6.7**	**67.2**	**0.0**
Recurrent+R/stock(Exist)		**386.0**	**287.2**	**23.5**	**12.7**	**39.0**	**23.6**
Recurrent+R/stock(Exist)+Infra(Recov)		**516.4**	**400.2**	**23.5**	**21.7**	**47.4**	**23.6**
USER CHARGES ($Mill)							
Freight Rev		357.3	327.9	29.4			
Pass Rev		48.9			4.5	21.7	22.7
Total		**406.2**	**327.9**	**29.4**	**4.5**	**21.7**	**22.7**
EXTERNAL COSTS ($Mill)							
Accidents-Externality		N/A					
Envl: Air Pollution		6.3					
Envl: Water Quality		0.0					
Envl: Water Quantity		0.0					
Envl: Noise		N/A					
Envl: Climate Change		5.0					
Total		**11.3**					
EXTERNAL CHARGES ($Mill)							
Diesel Tax (LAPT)		**0.2**					
PUBLIC FUNDING ($Mill)					**8.3**	**17.5**	
TRANSPORT TASK (Mill)							
Freight Tonnes		16.6	13.6	3.0			
Freight Tonne Km		3739.1	3714.1	25.0			
Passengers		12.9			2.2	10.2	0.5
Passenger Km		404.7			34.4	242.3	128.0
AVERAGE COSTS & CHARGES							
(1) Per Tonne or Passenger ($)							
User Revenue			24.1		2.0	2.1	43.9
User Revenue + Public Funding			24.1		5.8	3.8	43.9
Recurrent Costs			17.3		5.0	3.2	39.0
Recurrent+R/stock(Exist)			21.1		5.8	3.8	45.8
(2) Per Tonne Km or Passenger Km ('c)							
User Revenue			**8.8**		**13.1**	**9.0**	**17.7**
User Revenue + Public Funding			**8.8**		**37.2**	**16.2**	**17.7**
Recurrent Costs			**6.3**		**31.7**	**13.3**	**15.7**
Recurrent+R/stock(Exist)			**7.7**		**36.9**	**16.1**	**18.5**
Note (1) Covers freight handling and pick-up/delivery functions.							
(2) PMT=Amortisation function (Excel)							

Figure 3.3 Total Rail System Costs and Charges

NOT GOVERNMENT POLICY
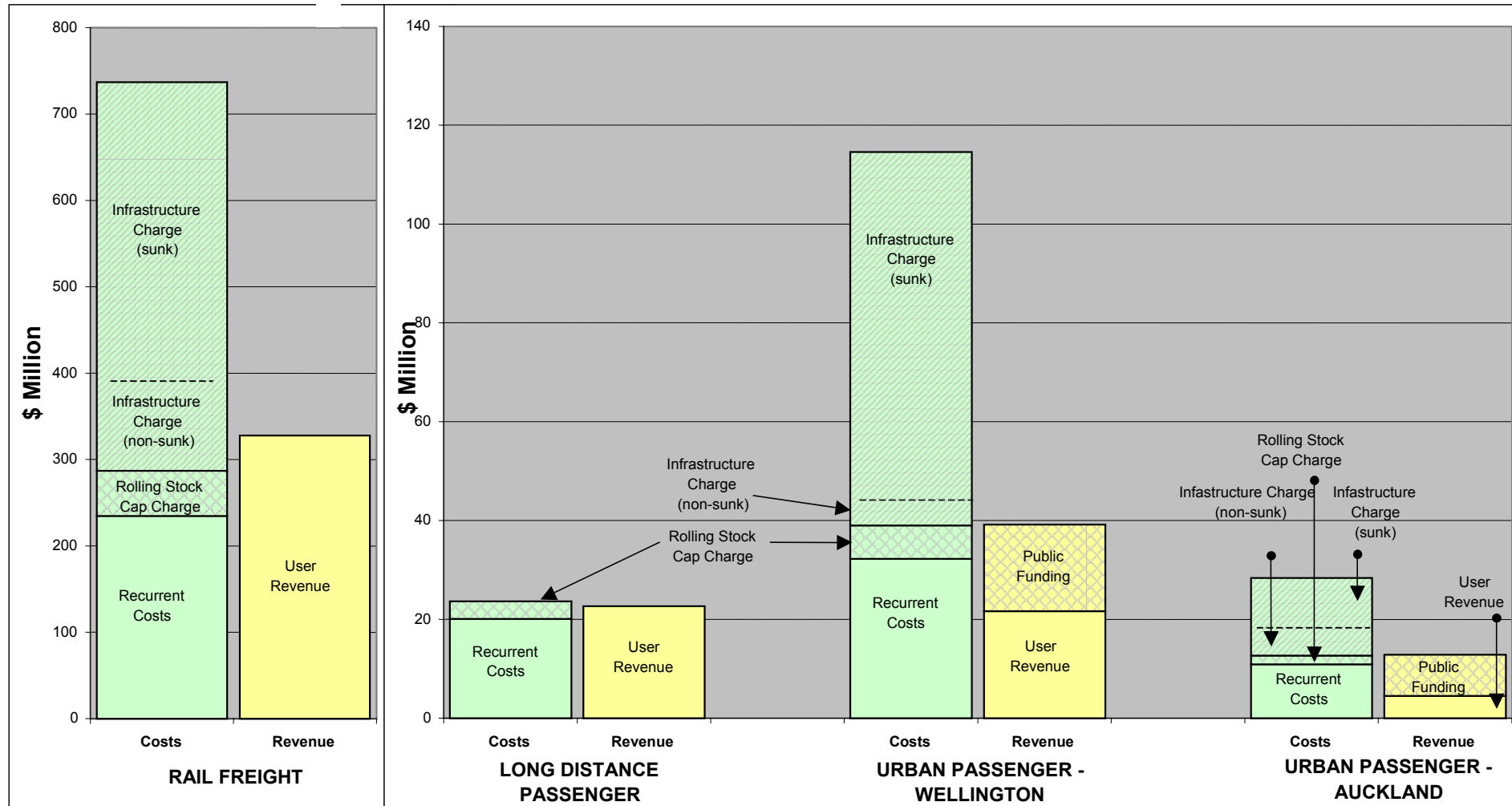
Urban Rail Passenger (Tranz Metro)

▸ The Wellington urban passenger services[38] earned passenger revenue of $21.7 million, averaging some $2.13/passenger or 9¢/pkm. The corresponding Auckland figure was $4.5 million, averaging some $2.05/passenger or 13¢/pkm.

▸ Total recurrent costs were $32.3 million for Wellington and $10.9 million for Auckland, i.e. substantially greater than fare revenues.

▸ Including rollingstock capital charges (assuming replacement to similar age/condition), total costs for Wellington would be $39.0 million: the corresponding cost recovery ratio (i.e. total fare revenue: total costs) would be 56%. For Auckland, total costs would be $12.7 million (assuming replacement to similar age/condition): the corresponding cost recovery ratio would be 35%.

▸ The current public funding level for Wellington ($17.5 million) results in total revenue of $39.2 million: this is significantly greater than the recurrent costs and would be just sufficient to allow the existing rollingstock to be maintained in existing condition (however, recent practice has been not to fund any capital items except in the case of agreed rollingstock refurbishment programs). For Auckland total revenue of $12.8 million would again appear just sufficient to allow existing rollingstock to be maintained in existing condition.

▸ In the case of Wellington, economic capital charges on urban rail passenger infrastructure (based on infrastructure for which these services are the prime user) amount to some $8 million p.a. for recoverable (depreciating) assets and a further $67 million for other passenger assets (including considerable length of tunnels). In the case of Auckland, the corresponding figures are $9 million p.a. and a further $6.7 million p.a. In both cases it is apparent that current revenues do not even begin to cover these costs.

3.2.4.3   Key Features of Results – External Costs and Charges

By analogy with the roads sector appraisal (Table 3.1 etc.), the railway as a whole imposes some external costs on the rest of society and incurs some external charges – although in both cases these are much less significant than those for the road system (in the railway case, the infrastructure is internal to the business; while in the road case the infrastructure is external to the operations, and thus associated with external costs and charges). Table 3.3 includes the external cost and charge estimates for the rail system:

▸ The main external costs relate to environmental impacts (excluding those already internalised, e.g. disposal of waste water). These are estimated in total at around $11 million p.a. (noise impacts have not been valued at a national level).

▸ External charges are very minor. The local authority petroleum tax on diesel fuel is estimated to amount to $0.2 million p.a. for rail operations.

▸ The public funding to the urban passenger services in Auckland and Wellington (total $25.8 million p.a.) could also be mentioned here, as an external subsidy.[39]

▸ In addition, we note that the land used for the railway is leased to Tranz Rail for a nominal sum. Based on its estimated value, an economic charge (based on 7% of value) would be around $32 million p.a.

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[38] This section excludes the Wellington to Palmerston North *Capital Connection* service.

[39] A public subsidy is also paid to buses and included in the marginal costs analysis.

3.2.4.4 Additional Comments on Results and Sensitivity

The main Total Cost results for the rail system are subject to perhaps a lesser degree of uncertainty than those for the road system, discussed earlier:

▸ As in the roading case, a major issue is whether a return can be justified on non-recoverable infrastructure assets. Such a return, at 7% WACC, would amount to some $410 million p.a. for the rail system overall.

▸ For recoverable assets, as in the roading case we estimate an uncertainty range of about +30% to -60%: this results in a best estimate of $130 million p.a., with a range of between about $50 million and $170 million.

▸ The estimated environmental costs are small (relative to the road system), so that even a doubling of these costs would have a small effect on the overall results.

The major issue highlighted by the Total Cost results for the rail system is that, while the total revenue for the rail system as a whole ($432 million, including $26 million public funding for the urban passenger services) is sufficient to cover operating costs and allow for rollingstock replacement at similar standards to the existing (total $395 million), it can cover only a small proportion of the economic capital charge on recoverable, depreciating infrastructure assets ($98 million p.a.), which will require to be renewed in the medium/long term.

3.3 Marginal Costs and Charges Appraisal

3.3.1 Introduction

This section presents results of the short-run marginal cost (SRMC) analyses, i.e. the marginal social costs of additional travel (on the present road/rail system) and the charges currently levied on such travel. As discussed in Chapter 2, SRMC provide the appropriate starting point in the formulation of pricing policies based on economic efficiency considerations. It must be noted that marginal costs show the costs imposed by extra use of the service: they do <u>not</u> reflect what charges would be necessary to recover the total costs involved in the present system (which was the focus of the previous section).

These appraisals focus on the situations with the main potential for inter-modal competition, i.e.:

▸ Urban passengers – car, bus, train
▸ Long distance passengers – car, coach, train
▸ Long distance freight – truck, train.

Results from the five different case studies (details of which are reported in the separate working papers) are summarised under the appropriate headings.

Similar to the Total Cost appraisal and as discussed in Section 3.1, in each case the appraisal provides marginal cost and charge estimates associated with additional (marginal) trips for:

▸ A: User/Operator Resource Costs (directly incurred)
▸ B: User/Operator Charges
▸ C: Provider and External (Social) Costs.

From these estimates are derived:

▸ A+B = Total (marginal) costs faced by the user/operator
▸ A+C = Total marginal economic costs (SRMC)
▸ C–B = Difference between marginal provider/external costs imposed and charges levied.

This last term (C-B) is of particular interest, as it reflects any discrepancy between provider/externality costs imposed by the marginal trip and charges levied on the trip maker (user/operator).

The term (A+B) is also of interest, as it reflects the total costs experienced by the marginal user, which are relevant to their mode choice decision.

It should be noted that, for short-run marginal costing, historic capital expenditures (and a return on them) are of no relevance: the only capital costs of relevance are where infrastructure expenditure may be brought forward as a result of increased traffic volumes, or where additional (or replacement) rollingstock may be required.

3.3.2 Urban Passenger Transport

3.3.2.1 Overview

The SRMC appraisals for urban passengers have been undertaken for three different cases:

▸ Auckland: typical trips, of 10km length, between suburban areas and Auckland CBD, by each of three modes (car, bus, train).

- Wellington: typical trips, of 10km length, between suburban areas and Wellington CBD, by each of the three modes.

- Waitakere – Auckland: typical trips between Waitakere (within easy reach of Waitakere railway station) and Auckland CBD (trip length approximately 20km), by each of the three modes (this represents Case Study 3).

The results are detailed in Table 3.4A (Auckland), 3.4B (Wellington) and 3.4C (Waitakere). Graphical summaries are also presented:

- Figures 3.4A (Auckland), 3.4B (Wellington) and 3.4C (Waitakere) – summary of user resource costs, user charges and provider/external costs for each of the three modes (car, bus, train)

- Figures 3.4D (Auckland) 3.4E (Wellington) and 3.4F (Waitakere) – more detailed breakdown of user charges and provider/external costs for each mode.

All figures have been shown per person kilometre of travel, for comparative purposes: as appropriate, these are derived from figures per trip or per vehicle km. For car mode, figures have been derived for several occupancy levels (see below). In all cases figures are presented separately for weekday peak periods and for other (off-peak) periods.

In the presentation of data in these figures, please note the following:

- The maximum and minimum values for social costs for buses for the Auckland and Wellington urban passenger data in Figures 3.4A and 3.4B, and in Figures 3.4D to 3.4F reflect the fact that the user economy of scale (Mohring) effect varies with base frequency of the service. The analysis has been carried out for typical routes with both higher and lower frequencies, as represented in Table 3.4A row 6, which shows marginal service frequency assumptions), and row 20, columns J and K which show the economies of scale in cents per person km.

- In Figures 3.4D to 3.4F, the dotted line represents the **total** external costs. Some of the costs are negative, i.e. they provide a net social benefit. In order to represent all of the social costs individually on the charts, the costs are totalled and each is labelled separately, and the benefits are shown in the boxes next to the costs, with the dotted line representing the net total cost to society.

The following points in particular should be noted on the derivation of the estimates shown:

- The car analyses have been carried out separately for the three cases, in particular allowing for the different marginal costs of congestion. The train analyses have also been carried out separately for the three cases. The bus analyses are based primarily on Auckland data, relating to operations, costs and user charges: these have then been adjusted for application in the Wellington analysis.

- For cars, the results are particularly sensitive to the car occupancy assumptions. We therefore present results for three occupancy rates: 1.0 persons/car (i.e. driver only); average occupancy (peak 1.4, off-peak 1.6); and 2.0 persons/car.

- For a given person, costs of travel time (per person hour) have been assumed equal on the three modes. It might be argued that costs should be higher for car mode, particularly for drivers, as they are unable to make much effective use of their driving time. Such an adjustment would reduce the relative attractiveness of the car mode from

the results presented. However, it could also be argued to the contrary, that people are less averse to spending a given amount of time in a car rather than on a bus/train.

▸ The bus and train analyses are presented from the perspective of the end user (passenger) rather than the operating company. Thus passenger fares are treated as a user charge; and operator resource costs (such as RUC) are treated as a provider/external cost. Similarly, the car analyses are presented from the perspective of the car user (who may also be regarded as the 'operator').

▸ For car parking, user costs are based on parking in CBD areas (for which public transport is most competitive), on the assumption that car users pay the full costs of their parking. However, we would note that:

   – for travel destinations outside CBD areas, parking resource costs and user charges (if any) tend to be much lower than the estimated figures for CBD areas

   – in some (but a minority) of cases, car users will not pay their full cost of parking, either directly or indirectly (e.g. through salary sacrifice for employees)

   – in other cases, car users may pay full costs, but on a medium-term (e.g. annual) basis rather than a day-to-day basis. In such a case, the costs are not relevant to day-to-day decisions on choice of mode.

3.3.2.2   Key Features of Results

In terms of the **total user costs** (i.e. A+B), which are the key influence on travel behaviour and mode choice, key findings are as follows (these findings apply to all three cases except where noted):

▸ For **public transport travel,** user costs are dominated by the time component, with fares accounting for a lesser proportion (around one-quarter) of the total.

▸ For **car travel**, the two largest user cost components are travel time and (where these apply) parking charges: car operating costs are of somewhat lower magnitude.

▸ In terms of total user costs, for typical trips in both Auckland and Wellington, assuming average car occupancy and car users paying CBD parking charges, the lowest cost mode in peak periods is train, followed by car and then bus. Train has a clear advantage: the higher costs for car reflect particularly the parking charges; and the higher costs for bus reflect its longer travel times. However, the more detailed Waitakere case study shows a lower cost for car than train: this reflects the higher (and probably more realistic) access costs to train that have been estimated in this case.

▸ In the off-peak, in both the Auckland and Wellington analyses, there is little to choose between car (at average occupancy) and train in terms of user costs, but with bus costs being higher; but again the Waitakere case study shows a significantly lower cost for car than for train (and bus).

▸ With single car occupancy, car becomes the highest cost mode in the peak in all three cases; while with 2.0 people/car, it becomes the lowest cost mode in the off-peak in all cases.

▸ If car users do not pay parking charges (either because their parking is paid by an employer, or for trips to non-CBD areas where parking is free), then the picture changes significantly. Car is then the lowest user cost mode in both time periods.

▸ These results are broadly similar in the Auckland and Wellington typical trip cases, and are consistent with commonly-experienced modal preferences.

▸ The Waitakere case study presents a slightly different picture, with car (average occupancy) having the lowest user cost in both peak and off-peak. This is largely due to the high time costs for rail (and bus) in the corridor – with door-to-door travel times significantly longer than by car.

In terms of **provider/external (social) costs** (item C), key findings, applying in all three cases, are:

▸ **For car travel,** the dominant cost component is congestion. All other components are relatively small. (In cases where parking is subsidised, the subsidy could be categorised as a provider/external cost, and would be of similar order of magnitude to the congestion costs.)

▸ For **bus services**, the marginal operating costs are the single largest component (particularly in peak periods), but partly off-set by the user economies of scale effect. Congestion costs are also significant for peak bus travel.

▸ For **train services**, marginal operating costs are the dominant item for peak travel, but are generally almost zero at other times.

▸ Road infrastructure marginal maintenance/operating costs are a very small cost component in all cases.

When **comparing charges (B) with external costs (C),** key findings are:

▸ For car travel, the charges levied (fuel duty) are only a very small proportion (generally 10% to 30%) of the provider/external costs, in both time periods. For instance, for Auckland, car user charges (fuel duty) are around 2-3¢/pkm compared with provider/external costs of around 25¢/pkm in the peak and less than half this in off-peak periods.

▸ For bus travel, charges (fares) are around 40% of external costs in the peak, but around double the external costs in the off-peak.

▸ For train travel similarly, charges (fares) are significantly less than the external costs in the peak, but substantially greater than costs in the off-peak.

If a pricing policy for urban passenger transport based on SRMC were to be pursued, then these results would suggest that:

▸ For car travel, charges should be substantially increased, in both peak and off-peak periods.

▸ For both bus and train travel, charges should be significantly increased in peak periods, but reduced in off-peak periods.

However, as noted earlier, marginal costs do not reflect what charges would be necessary to recover the total costs involved in the existing system.

3.3.2.3   Additional Comments on Results and Sensitivity

The following provides additional commentary on the accuracy/uncertainty in the key components of the urban passenger marginal cost results, particularly as regards comparison between the total user charges and the total provider/external costs (the comments cover all three cases together, except where noted.

Car Travel

▸ For car travel, user charges are only a small proportion of external costs in all cases. This result assumes that parking is provided on a full commercial basis; and the disparity would be even greater where parking is subsidised.

▸ Aside from any parking subsidy, the main external cost component is congestion. Even if true congestion costs were half the figures estimated, user charges would remain substantially less than external costs. Plausible variations in the other external cost components (e.g. environment, accident externalities) would have smaller impacts.

▸ As noted above, variations in car occupancy will have significant effects on user costs for car relative to bus and train. However, they will have no effect on the relativities between car user charges and car provider/external costs, although they will affect the absolute differences.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	TABLE 3.4A: URBAN PASSENGER MARGINAL COSTS AND CHARGES: AUCKLAND														
2	Mode	CAR								BUS				TRAIN	
3		Per Person Km		Per Person Km		Per Person Km		Per Vehicle Km		Per Person Km				Per Person Km	
4	Peak/Off Peak	Pk	O/Pk	Pk	O/Pk	Pk	O/Pk	Pk	O/Pk	Pk		O/Pk		Pk	O/Pk
5	Vehicle Occupancy	1.0	1.0	1.4	1.6	2.0	2.0			9	9	18	18		
6	Marginal Source Frequency									Low	High	Low	High		
7	Item														
8	A. TOTAL USER (PRIVATE) COSTS: RESOURCE														
9	1. Operations & Vehicle Costs	15.4	14.6	11.0	9.1	7.7	7.3	-	-	-	-	-	-	–	–
10	2. Operations – Time	21.6	17.8	21.6	17.8	21.6	17.8	-	-	58.0	58.0	58.0	58.0	34.8	34.8
11	3. Accidents Internal (NOS)	-3.3	5.2	-2.4	3.3	-1.7	2.6	-9.8	13.2	-1.1	-1.1	0.7	0.7	-	-
12	4. Parking Costs	60.0	30.0	42.9	18.8	30.0	15.0	-	-	-	-	-	-	-	-
13	B. TOTAL USER (PRIVATE) COSTS : CHARGES														
14	1. Fuel duty	3.8	3.3	2.7	2.1	1.9	1.7	-	-	-	-	-	-	–	–
15	2. Fares	-	-	-	-	-	-	-	-	20.3	20.3	21.0	21.0	13.0	13.0
16	C. PROVIDER/EXTERNAL (SOCIAL) COSTS														
17	1. Road Infrastructure O&M	0.1	0.1	0.1	0.1	0.1	0.1	5.0	5.0	0.6	0.6	0.3	0.3	–	–
18	2. Operations & Vehicle Costs	-	-	-	-	-	-	-	-	45.3	45.3	9.4	9.4	22.5	0.0
19	3. Congestion Externality	36.0	16.0	25.7	10.0	18.0	8.0	108.0	48.0	12.0	12.0	2.7	2.7	–	–
20	4. User Economies of Scale	-	-	-	-	-	-	-	-	-13.9	-7.0	-5.5	-2.8	–	–
21	5. Accident Externality	-3.0	2.3	-2.1	1.4	-1.5	1.2	-12.2	5.9	-1.4	-1.4	0.3	0.3	–	–
22	6. Environmental	1.8	1.5	1.3	0.9	0.9	0.8	32.8	26.7	3.6	3.6	1.5	1.5	–	–
23	TOTALS														
24	A. User Costs: Resources	93.7	67.6	73.1	49.0	57.6	42.7	-	-	56.9	56.9	58.7	58.7	34.8	34.8
25	B. User Costs: Charges	3.8	3.3	2.7	2.1	1.9	1.7	-	-	20.3	20.3	21.0	21.0	13.0	13.0
26	C. Provider/External Costs	34.9	19.9	24.9	12.4	17.5	10.0	-	-	46.2	53.1	8.7	11.4	22.5	0.0
27	A+B = Total User Costs	97.5	70.9	75.8	51.0	59.5	44.4	-	-	77.2	77.2	79.7	79.7	47.8	47.8
28	A + C = Economic SRMC	128.6	87.5	98.0	61.4	75.1	52.7	-	-	103.2	110.1	67.4	70.1	57.3	34.8
29	C- B = Provider/External Costs - Charges	31.1	16.6	22.2	10.4	15.6	8.3	-	-	25.9	32.8	-12.3	-9.6	9.5	-13.0
30	FOOTNOTES														

31

32 **B9-C9:** From Car Op Cost Model – marginal resource costs and charges for car use (excl GST). Assumes congested flow in peak, interrupted in off-peak

33 **B10-C10:** Based on VOC Model (PEM) `occupancy 1.4 peak/1.6 off peak. Average speed 40.3 km/hr peak, 48.8 km/hr off-peak for AKL; 49.0 km/hr peak, 65.1 km/hr off-peak for WLG. VTTS per person hour = $8.55 peak, $8.83 off-peak.

34 **B19 & C19:** From WP on Road congestion Costs Table 2.2.

35 **B11-C11 & H11-I11 & B21-C21 & H21-I21:** From WP on Social Costs of Road Crashes. MC taken as = -1.1 * AC (peak), = 1.25*AC (off peak).

36 **J10-O10:** Assume average VTTS $8.70/hour, average speed (door-to-door) 15 km/hr for bus, 25km/hr for train.

37 **J15-O15 & O18:** From WP on Costs of UPT Operations, Tables 3.2, 2.1.

38 **J20-M20 & J18** From WP on Costs of UPT Operations, Table 5.1. Assumes service: patronage elasticity + 1.0 peak/0.33 off-peak; b=0.3; peak headways 10/20 mins, off-peak headways 15/30 mins; average trip length 6.7 kms.

39 **J17-M17 & J19-M19:** From WP on Costs of UPT Operations, Table 3.2. Ave Pass kms: veh kms ratio = 9.0 peak, 6.0 off-peak.

40 **N18:** From WP on Costs of UPT Operations, Tables 4.2, 4.4

41 **H19-I19:** Assumes marginal congestion costs for buses = 3*rate for cars.

42 **B12-C12:** Based on CBD parking costs - $10 peak, $4 off-peak and 10 km 1-way trip

43 **B17-C17 & H17-I17** From WP on Marginal Road Infrastructure Costs (Adjusted RCAM): uses average of urban SH and urban LR values.

44 **B22-C22 & H22-I22:** From Table B12.4: assumes congested flow in peak, interrupted in off-peak

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	TABLE 3.4B: URBAN PASSENGER MARGINAL COSTS AND CHARGES: WELLINGTON														
2	Mode	CAR						BUS						TRAIN	
3		Per Person Km		Per Person Km		Per Person Km		Per Vehicle Km		Per Person Km				Per Person Km	
4	Peak/Off Peak	Pk	O/Pk	Pk	O/Pk	Pk	O/Pk	Pk	O/Pk	Pk		O/Pk		Pk	O/Pk
5	Vehicle Occupancy	1.0	1.0	1.4	1.6	2.0	2.0			9	9	18	18		
6	Marginal Source Frequency									Low	High	Low	High		
7	Item														
8	A. TOTAL USER (PRIVATE) COSTS: RESOURCE														
9	1. Operations & Vehicle Costs	15.4	14.6	11.0	9.1	7.7	7.3	-	-	-	-	-	-	-	-
10	2. Operations – Time	17.8	13.4	17.8	13.4	17.8	13.4	-	-	58.0	58.0	58.0	58.0	34.8	34.8
11	3. Accidents Internal (NOS)	-3.3	5.2	-2.4	3.3	-1.7	2.6	-9.8	13.2	-1.1	-1.1	0.7	0.7	-	-
12	4. Parking Costs	50.0	20.0	35.7	12.5	25.0	10.0	-	-	-	-	-	-	-	-
13	B. TOTAL USER (PRIVATE) COSTS : CHARGES														
14	1. Fuel duty	3.8	3.3	2.7	2.1	1.9	1.7	-	-	-	-	-	-	-	-
15	2. Fares	-	-	-	-	-	-	-	-	20.3	20.3	21.0	21.0	9.0	9.0
16	C. PROVIDER/EXTERNAL (SOCIAL) COSTS														
17	1. Road Infrastructure O&M	0.1	0.1	0.1	0.1	0.1	0.1	5.0	5.0	0.6	0.6	0.3	0.3	-	-
18	2. Operations & Vehicle Costs	-	-	-	-	-	-	-	-	45.3	45.3	9.4	9.4	10.1	0.0
19	3. Congestion Externality	28.0	5.4	20.0	3.4	14.0	2.7	84.0	16.2	9.3	9.3	0.9	0.9	-	-
20	4. User Economies of Scale	-	-	-	-	-	-	-	-	-13.9	-7.0	-5.5	-2.8	-	-
21	5. Accident Externality	-3.0	2.3	-2.1	1.4	-1.5	1.2	-12.2	5.9	-1.4	-1.4	0.3	0.3	-	-
22	6. Environmental	1.8	1.5	1.3	0.9	0.9	0.8	32.8	26.7	3.6	3.6	1.5	1.5	-	-
23	TOTALS														
24	A. User Costs: Resources	79.9	53.2	62.1	38.2	48.8	33.3	-	-	56.9	56.9	58.7	58.7	34.8	34.8
25	B. User Costs: Charges	3.8	3.3	2.7	2.1	1.9	1.7	-	-	20.3	20.3	21.0	21.0	9.0	9.0
26	C. Provider/External Costs	26.9	9.3	19.2	5.8	13.5	4.7	-	-	43.6	50.5	6.9	9.6	10.1	0.0
27	A+B = Total User Costs	83.7	56.5	64.8	40.3	50.7	34.9	-	-	77.2	77.2	79.7	79.7	43.8	43.8
28	A + C = Economic SRMC	106.8	62.5	81.3	44.0	62.3	37.9	-	-	100.5	107.4	65.6	68.3	44.9	34.8
29	C- B = Provider/External Costs - Charges	23.1	6.0	16.5	3.8	11.6	3.0	-	-	23.3	30.2	-14.1	-11.4	1.1	-9.0
30	FOOTNOTES														
31															

32 **B9-C9:** From Car Op Cost Model – marginal resource costs and charges for car use (excl GST). Assumes congested flow in peak, interrupted in off-peak

33 **B10-C10:** Based on VOC Model (PEM)occupancy 1.4 peak/1.6 off peak. Average speed 40.3 km/hr peak, 48.8 km/hr off-peak for AKL; 49.0 km/hr peak, 65.1 km/hr off-peak for WLG. VTTS per person hour = $8.55 peak, $8.83 off-peak

34 **B19 & C19:** From WP on Road congestion Costs Table 2.2.

35 **B11-C11 & H11-I11 & B21-C21 & H21-I21:** From WP on Social Costs of Road Crashes. MC taken as = -1.1 * AC (peak), = 1.25*AC (off peak).

36 **J10-O10:** Assume average VTTS $8.70/hour, average speed (door-to-door) 15 km/hr for bus, 25km/hr for train.

37 **J15-O15 & O18:** From WP on Costs of UPT Operations, Tables 3.2, 2.1.

38 **J20-M20 & J18** From WP on Costs of UPT Operations, Table 5.1. Assumes service: patronage elasticity + 1.0 peak/0.33 off-peak; b=0.3; peak headways 10/20 mins, off-peak headways 15/30 mins; average trip length 6.7 kms.

39 **J17-M17 & J19-M19:** From WP on Costs of UPT Operations, Table 3.2. Ave Pass kms: veh kms ratio = 9.0 peak, 6.0 off-peak.

40 **N18:** From WP on Costs of UPT Operations, Tables 4.2, 4.4

41 **H19-I19:** Assumes marginal congestion costs for buses = 3*rate for cars.

42 **B12-C12:** Based on CBD parking costs - $10 peak, $4 off-peak and 10 km 1-way trip

43 **B17-C17 & H17-I17** From WP on Marginal Road Infrastructure Costs (Adjusted RCAM): uses average of urban SH and urban LR values.

44 **B22-C22 & H22-I22:** From Table B12.4: assumes congested flow in peak, interrupted in off-peak

TABLE 3.4 (C): URBAN PASSENGER MARGINAL COSTS AND CHARGES (cents) - CASE STUDY 3 - WAITAKERE TO AUCKLAND

Item	CAR								BUS						TRAIN			
	Per Vehicle Trip		Per Vehicle Km		Per Person Km		Per Person Km		Per Vehicle Km		Per Person trip		Per Person Km		Per Person trip		Per Person Km	
	Pk	O/Pk	Pk	O/Pk	Pk (Occ=1.4)	O/Pk (Occ=1.6)	Pk (Occ=2.0)	O/Pk (Occ=2.0)	Pk	O/Pk	Pk	O/Pk	Pk	O/Pk	Pk	O/Pk	Pk	O/Pk
Vehicle Occupancy (Marginal)					1.4	1.6	2.0	2.0					9.0	18.0				
Trip Distance--Actual			20	20									19.0	19.0			22.0	22.0
Trip Distance--Standardised (Note 1)			20	20									20.0	20.0			20.0	20.0
A. TOTAL USER (PRIVATE) COSTS: RESOURCE																		
1. Operations & Vehicle Costs			15.4	14.6	11.0	9.1	7.7	7.3										
2. Operations – Time			28.5	17.2	28.5	17.2	28.5	17.2			991	943	49.5	47.1	933	1024	46.6	51.2
3. Accidents Internal (Note 2)			-3.3	5.2	-2.4	3.3	-1.7	2.6	-9.8	13.2			-1.1	0.7				
4. Parking (Note 3)	1066.7	533.3	26.7	13.3	19.0	8.3	13.3	6.7										
B. TOTAL USER (PRIVATE) COSTS : CHARGES																		
1. Fuel duty			3.8	3.3	2.7	2.1	1.9	1.7										
2. Fares											336	336	16.8	16.8	302	302	15.1	15.1
C. PROVIDER/EXTERNAL (SOCIAL) COSTS																		
1. Road Infrastructure O&M			0.1	0.1	0.1	0.1	0.1	0.1	5.0	5.0			0.6	0.3				
2. Operations & Vehicle Costs											679	139	33.9	6.9	446	0	22.3	0.0
3. Congestion Externality			52.0	1.0	37.1	0.6	26.0	0.5	156.0	3.0			17.3	0.2				
4. User Economies of Scale											-41.4	-43.2	-2.1	-2.2				
5. Accident Externality			-3.0	2.3	-2.1	1.4	-1.5	1.2	-12.2	5.9			-1.4	0.3				
6. Environmental			2.7	2.3	1.9	1.4	1.4	1.2	53.4	42.9			5.9	2.4			1.9	9.3
TOTALS																		
A. User Costs: Resources			**67.2**	**50.3**	**48.0**	**31.5**	**33.6**	**25.2**					**48.4**	**47.9**			**46.6**	**51.2**
B. User Costs: Charges			**3.8**	**3.3**	**2.7**	**2.1**	**1.9**	**1.7**					**16.8**	**16.8**			**15.1**	**15.1**
C. Provider/External Costs			**51.8**	**5.7**	**37.0**	**3.6**	**25.9**	**2.9**					**54.3**	**7.9**			**24.1**	**9.3**
A+B = Total User Costs			**71.0**	**53.6**	**50.7**	**33.5**	**35.5**	**26.8**					**65.2**	**64.7**			**61.7**	**66.3**
A + C = Economic SRMC			**119.0**	**56.0**	**85.0**	**35.0**	**59.5**	**28.0**					**102.8**	**55.8**			**70.8**	**60.4**
C- B = Provider/External Costs - Charges			**48.0**	**2.4**	**34.3**	**1.5**	**24.0**	**1.2**					**37.5**	**-8.9**			**9.0**	**-5.8**

Note (1): Standardised distance has been used for all modes to assist comparability of results per passenger-km

Note (2): Not Otherwise Specified

Note (3): Parking for bus and train is included in other overhead costs which are passed on through fares

NOT GOVERNMENT POLICY

Figure 3.4A (1): Urban Passenger Marginal Costs and Charges

Auckland MC – Peak
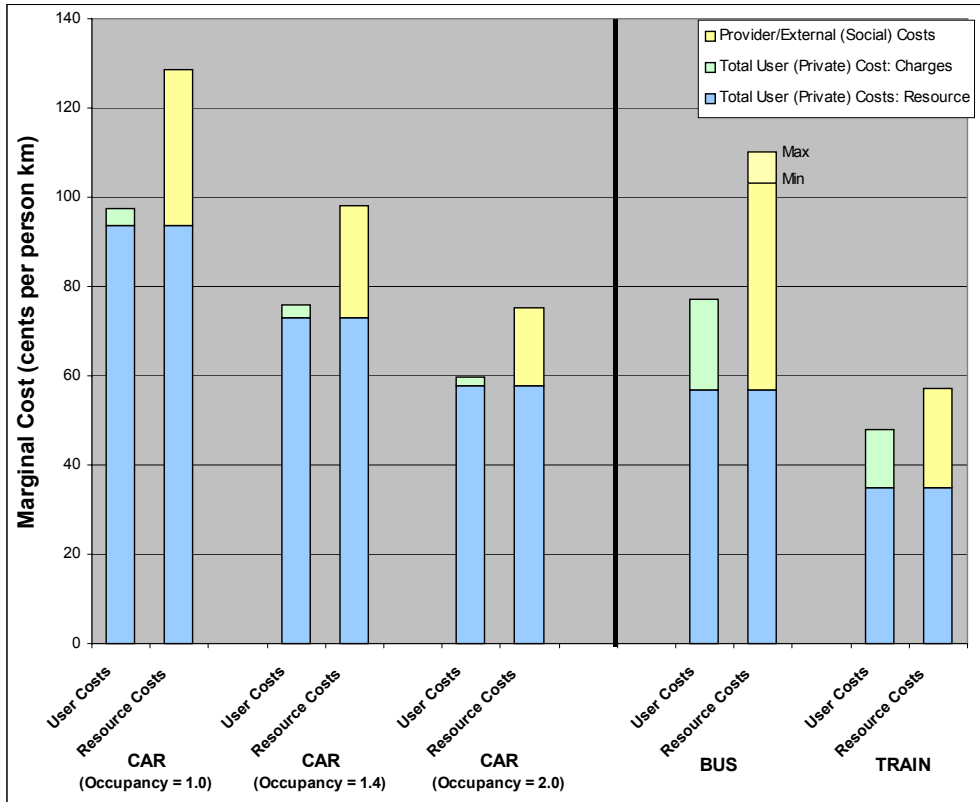
Figure 3.4A (2): Urban Passenger Marginal Costs and Charges

Auckland MC – Off-Peak
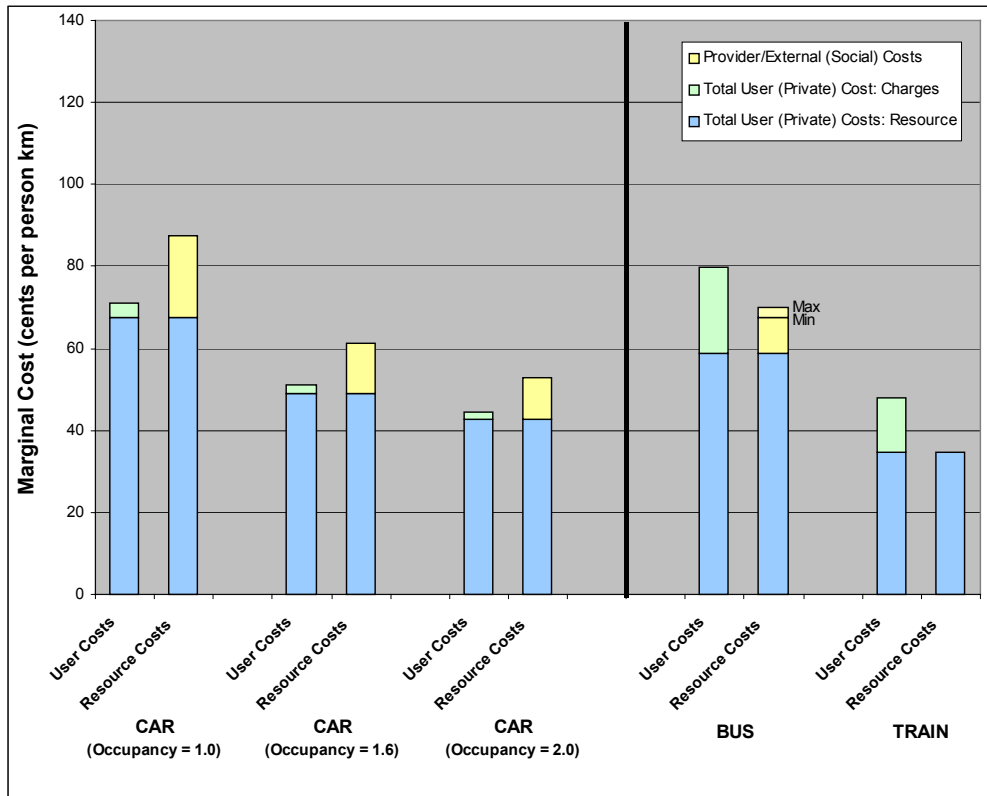
Figure 3.4B (1): Urban Passenger Marginal Costs and Charges

Wellington MC – Peak
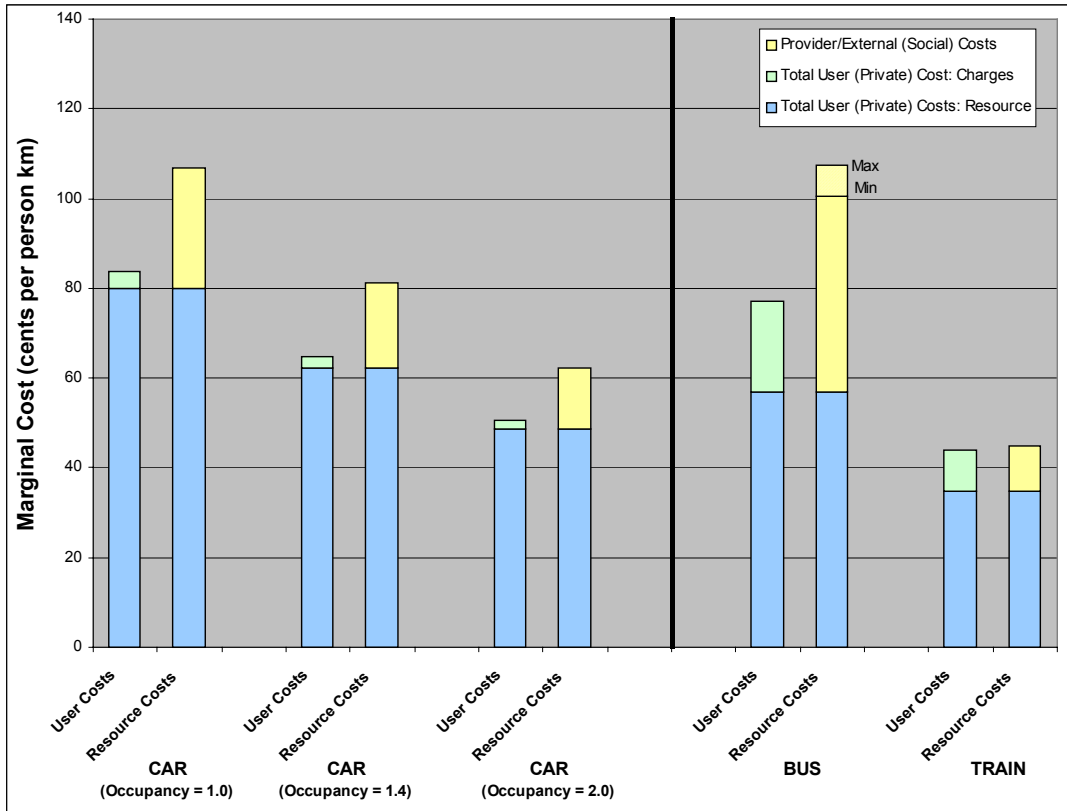
Figure 3.4B (2): Urban Passenger Marginal Costs and Charges

Wellington MC – Off Peak

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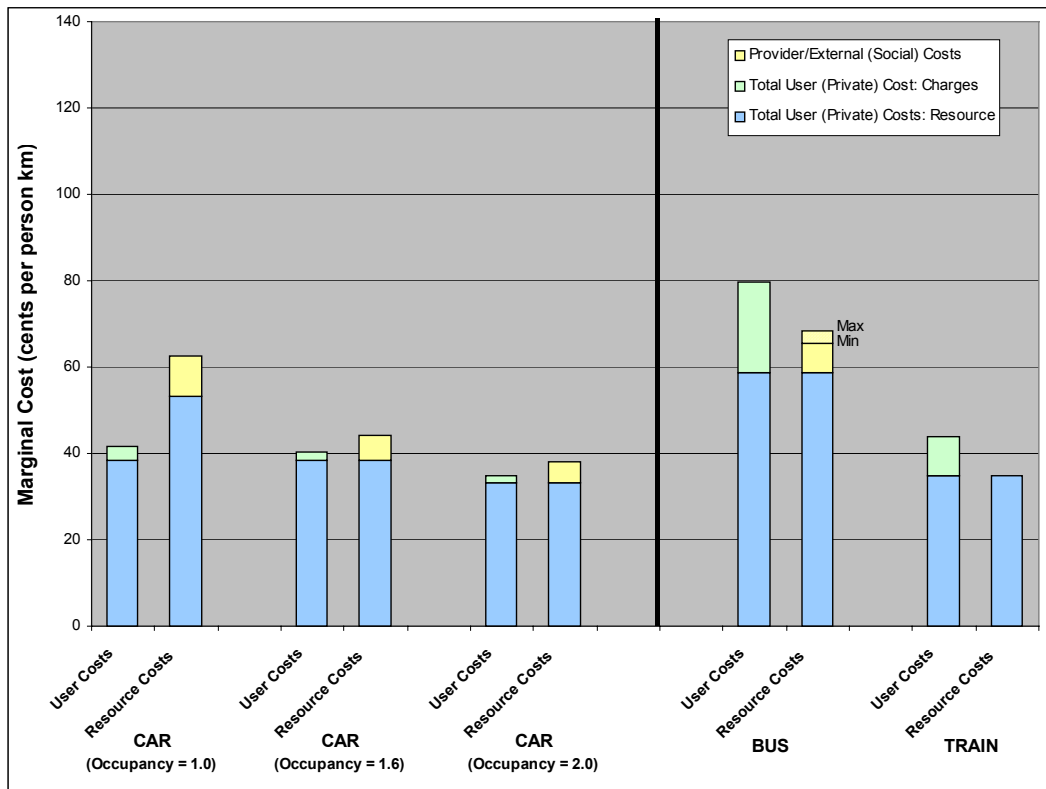
Figure 3.4D (1): User Passenger Marginal Costs and Charges – Main Components of User Charges and Provider/External Costs

Auckland MC Peak

Figure 3.4D (2): User Passenger Marginal Costs and Charges – Main Components of User Charges and Provider/External Costs

Auckland MC Off-Peak

NOT GOVERNMENT POLICY

Figure 3.4E (1): User Passenger Marginal Costs and Charges – Main Components of User Charges and Provider/External Costs

Wellington MC Peak

NOT GOVERNMENT POLICY

NOT GOVERNMENT POLICY

Figure 3.4E (2): User Passenger Marginal Costs and Charges – Main Components of User Charges and Provider/External Costs

Wellington MC Off-Peak

NOT GOVERNMENT POLICY
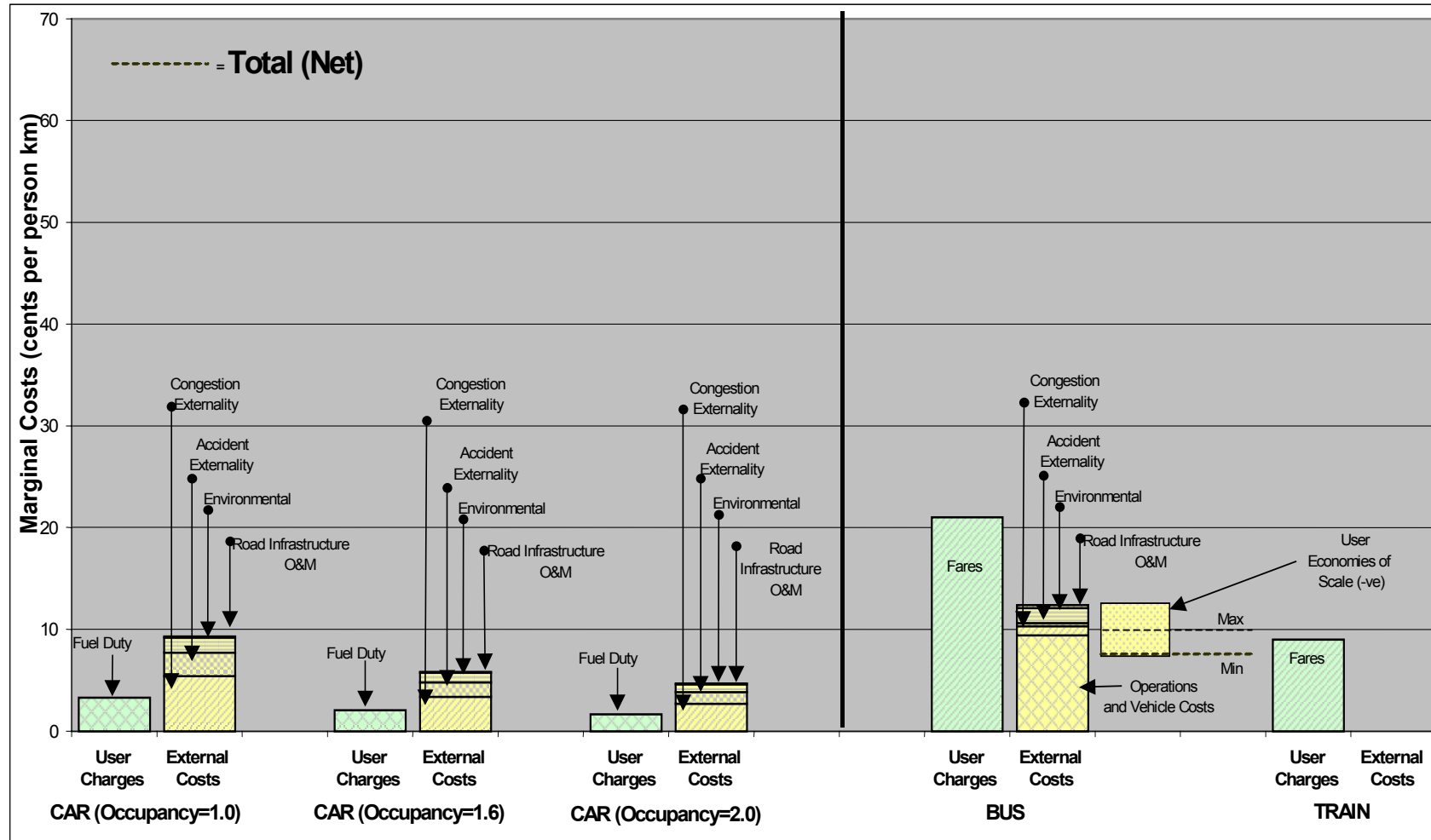
Figure 3.4F (1): User Passenger Marginal Costs and Charges – Main Components of User Charges and Provider/External Costs

Waitakere – Auckland, Peak

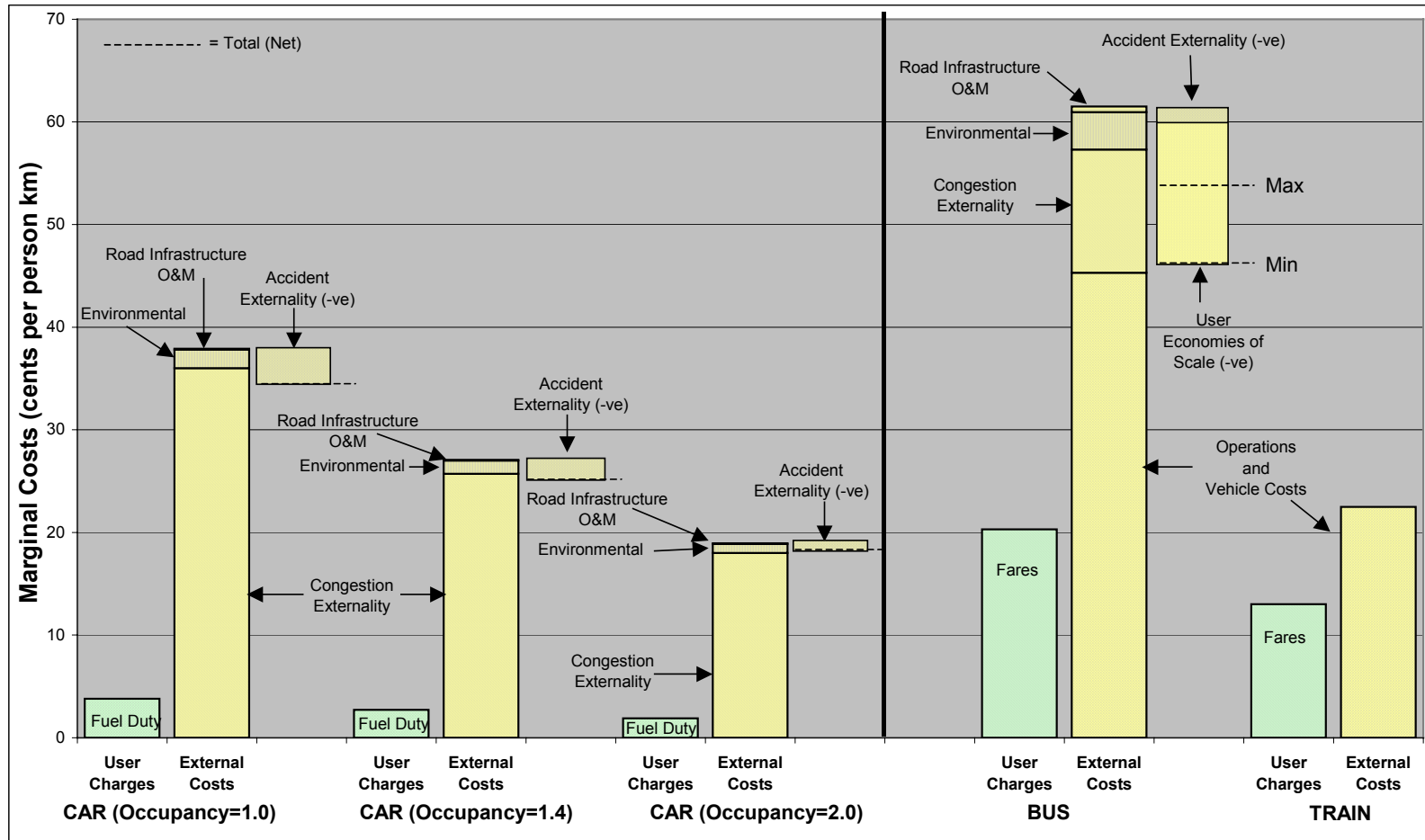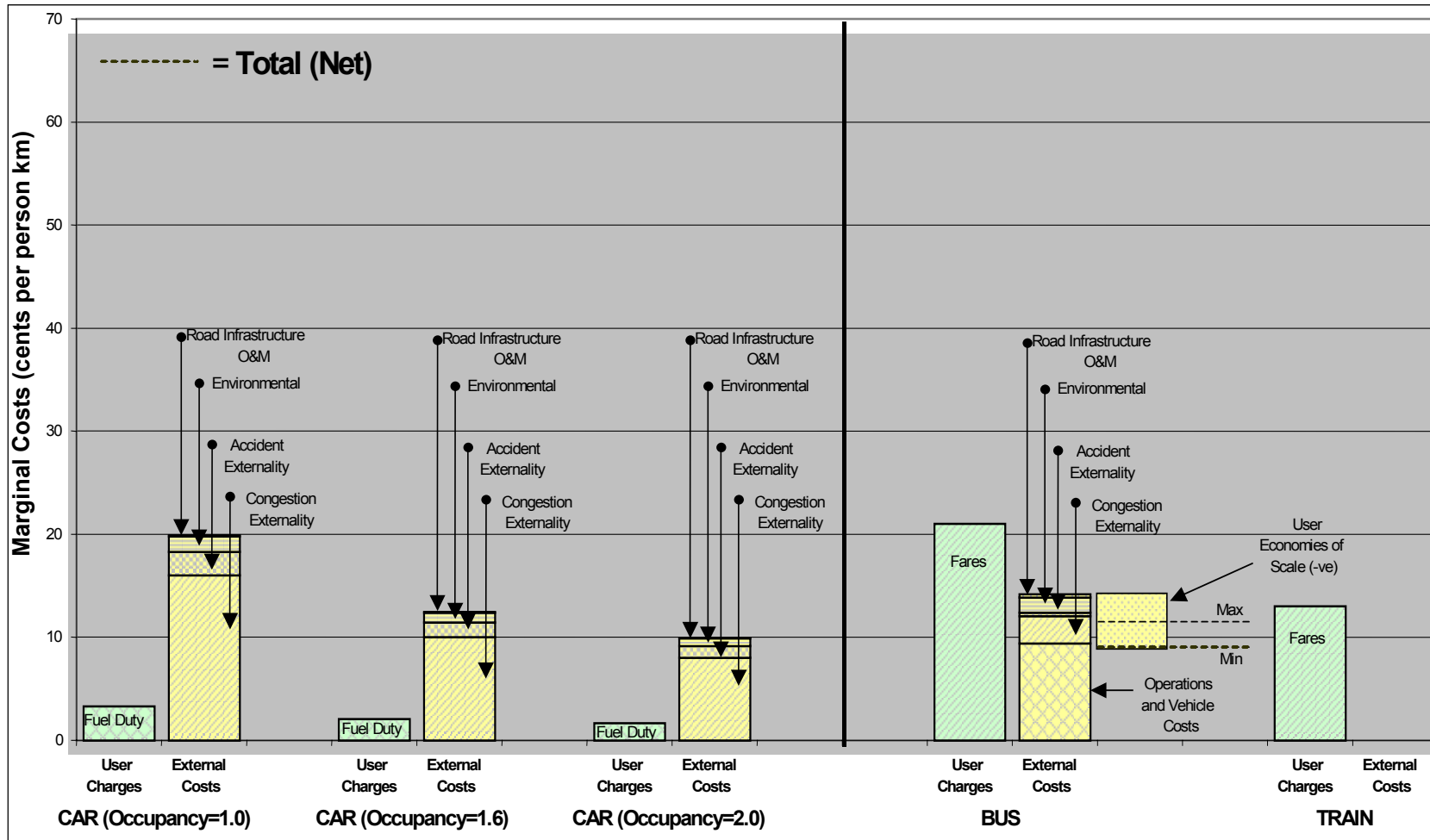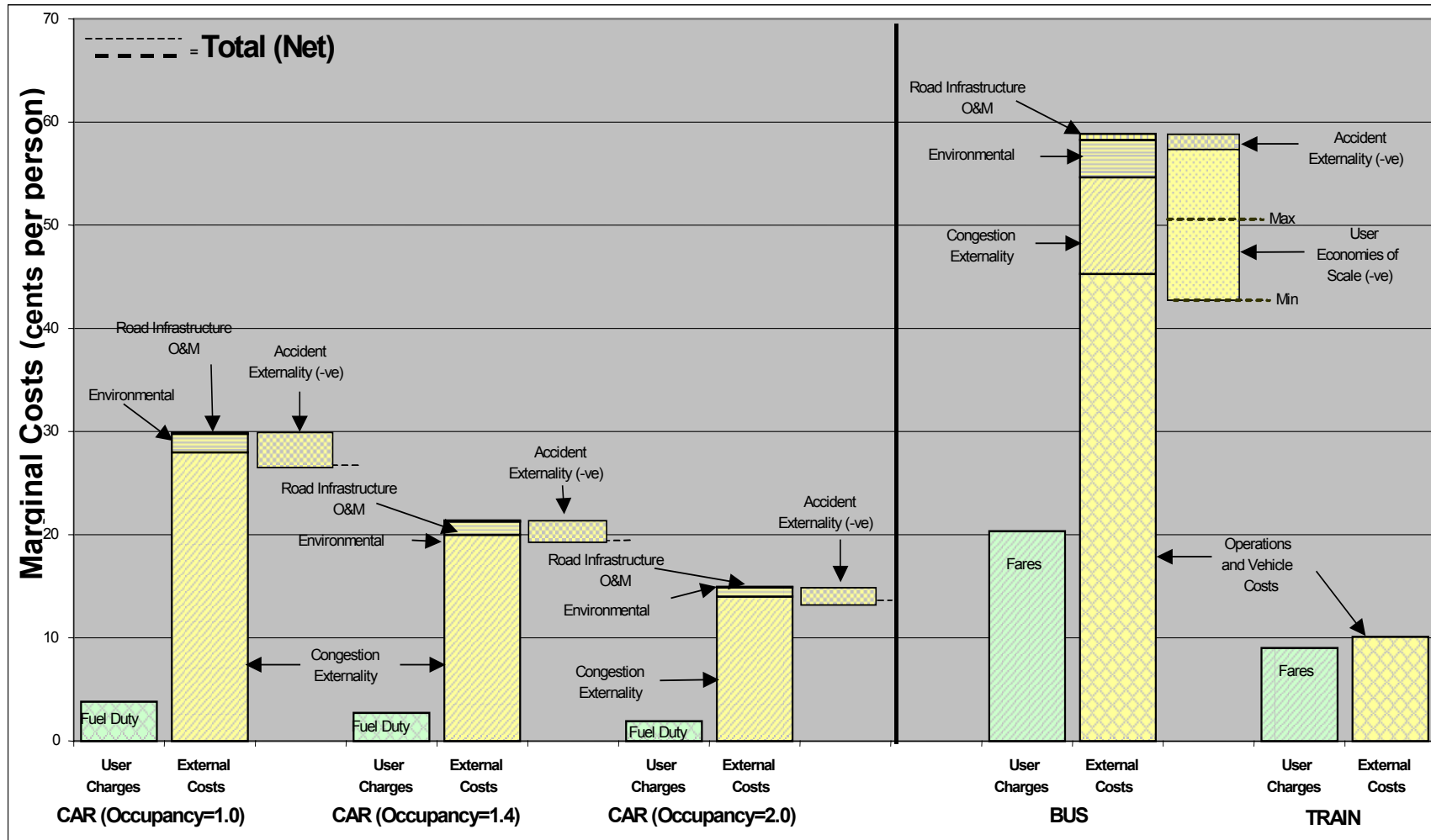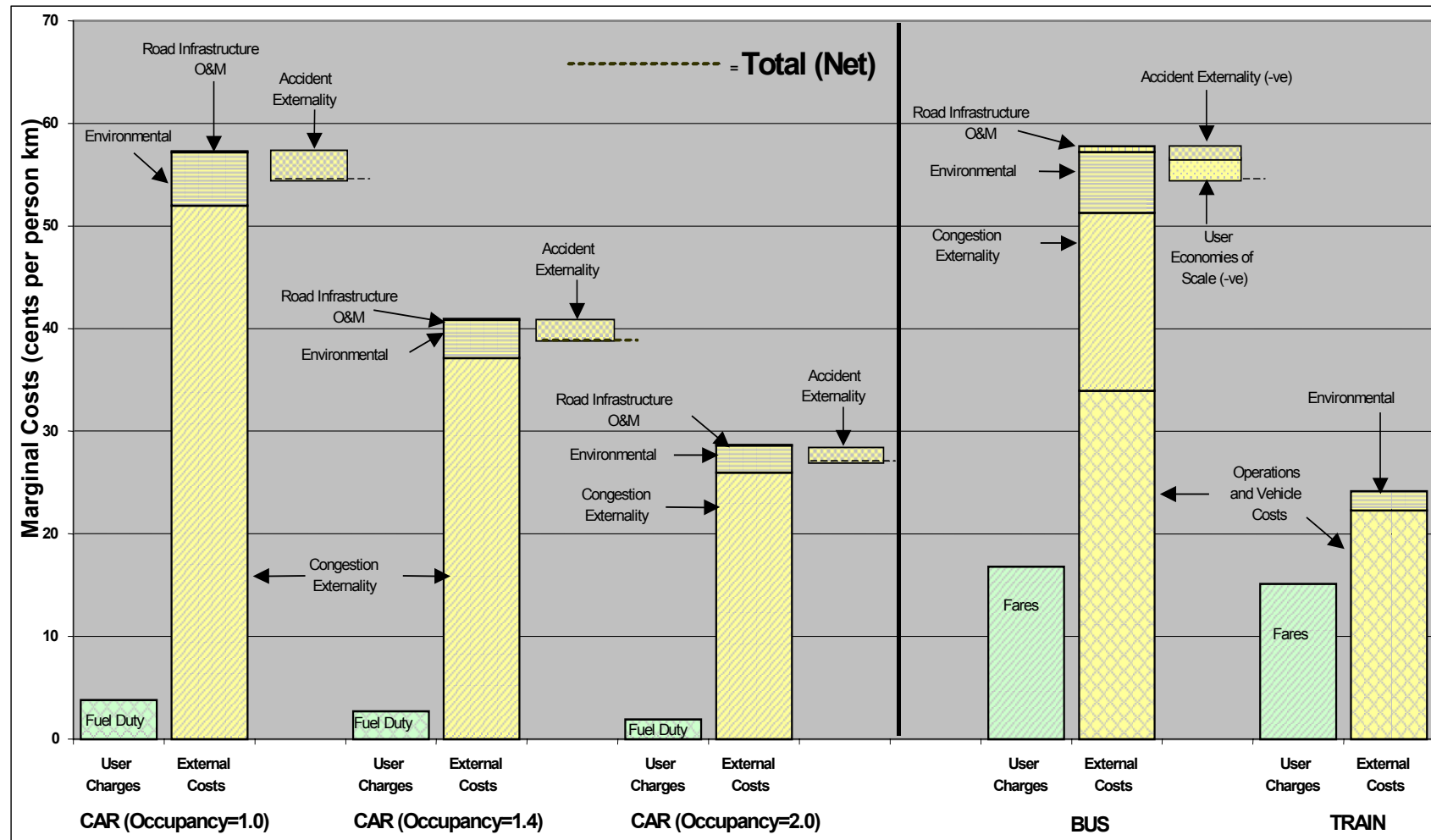**Figure 3.4F (2) - Urban Passenger Marginal Costs and Charges - Main Components of User Charges and Provider/External Costs**

Waitakere - Auckland, Off-Peak

NOT GOVERNMENT POLICY

NOT GOVERNMENT POLICY
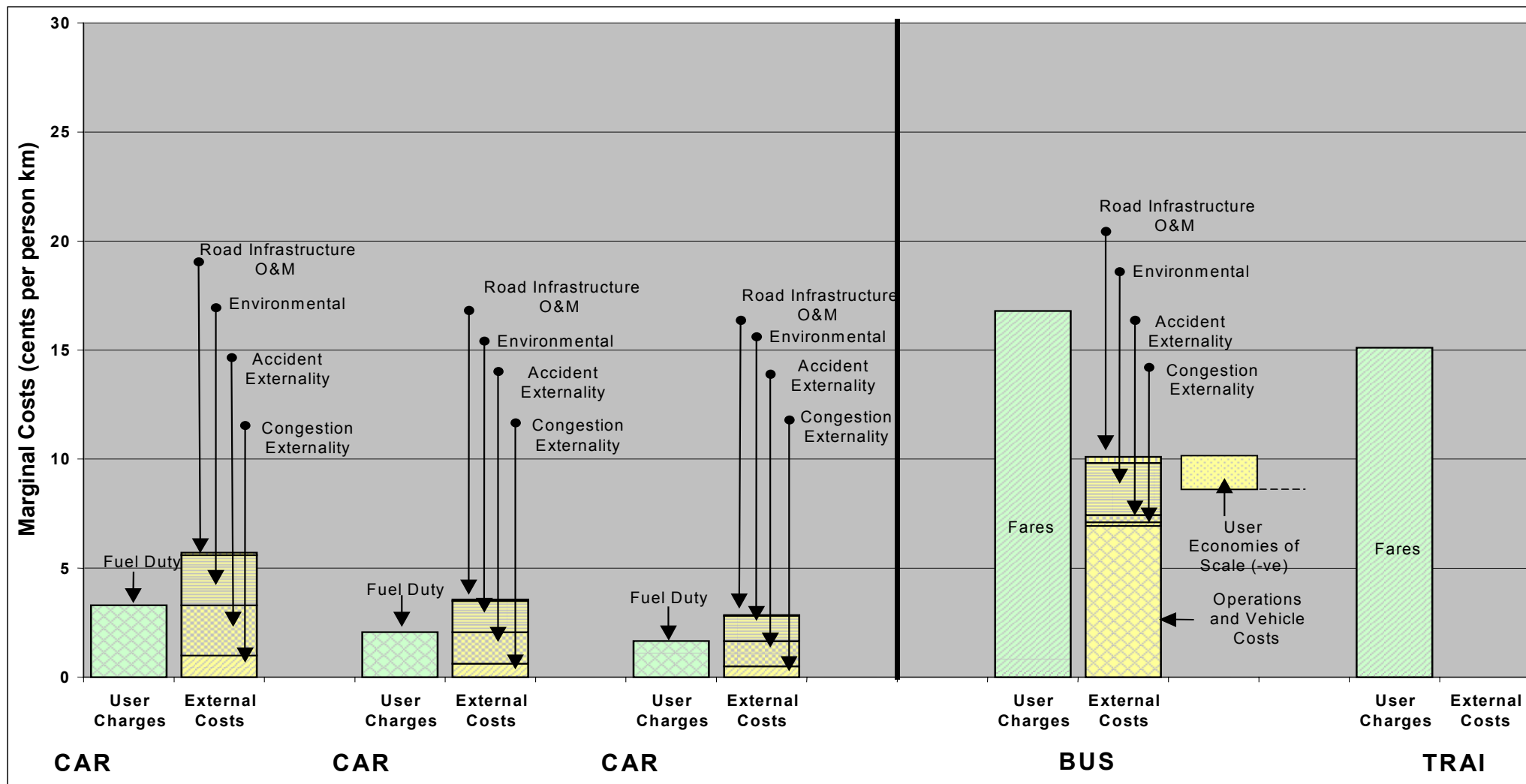
Bus Travel

▸ The 'base' results show that in the peak bus charges are less than half marginal provider/external costs, but in the off-peak around double marginal costs.

▸ In the **peak**, the main provider/external cost component is the marginal bus operator costs. These have been estimated with reasonable precision as a city-wide average rate, although they will undoubtedly vary from situation to situation.

▸ The other significant provider/external cost components are the congestion externality and the user economies of scale. Any plausible variation in these will have limited impact on the overall comparison results.

▸ Thus the peak period bus finding appears generally robust to plausible variations in input costs.

▸ In the **off-peak**, the main provider/external cost component is again the marginal bus operator costs. As for the peak these will vary from situation to situation: they could be zero in some cases (routes and time periods with reasonably light loadings); they could be up to about three times the typical value (i.e. up to about 28¢/pkm) in other cases.

▸ The other off-peak provider/externality cost components are relatively small, and plausible variations will have small overall impacts.

▸ Thus the off-peak bus finding is particularly sensitive to the assumption on marginal bus operator costs. While on average the provider/external costs are less than half the current charges, in other cases they could exceed these charges. The critical factor influencing this result is the level of loading of the existing off-peak services, and the extent to which additional services would be required to accommodate additional passengers.

Train Travel

▸ The 'base' results for train travel show that in the peak train charges are between 10% (Wellington) and 40% (Auckland) below provider/external costs; while in the off-peak marginal provider/external costs are zero.

▸ Most of the above comments for bus travel also apply to train travel, so we focus here on the differences.

▸ For **peak** periods, the Wellington charges and costs only differ by about 10%. This is well within the variations in the marginal provider costs over a range of situations. In Auckland the result that charges are about 60% of marginal costs appears reasonably robust to plausible variations in costs.

▸ For **off-peak** periods, train marginal costs are close to zero in both centres, on the basis that the existing train services have adequate spare capacity. We consider this to be a robust result.

3.3.3   Long Distance Passenger Transport

3.3.3.1   Overview

Two different cases have been analysed for long-distance travel by car, coach and train, analogous to the preceding appraisals for urban passengers:

▸ Auckland – Wellington: typical trips by car (various levels of occupancy), coach and train.

▸ Picton – Christchurch : typical trips by car (various levels of occupancy), coach, minibus (shuttle vehicle) and train. (This represents Case Study 5.)

The results are detailed in Tables 3.5A and 3.5B, with graphical summaries in Figures 3.5A and 3.5B.

The following points in particular should be noted on the basis and derivation of the estimates shown:

▸ Figures have been derived first per vehicle kilometre (where appropriate) and then converted to per person kilometre rates using relevant average vehicle occupancy estimates. In the case of car travel, the appraisal has covered not only an average occupancy rate (1.7 persons/car) but also a low rate (1.0) and a high rate (3.0).

▸ Figures relate to travel between central city areas in each case (for public transport, effectively the relevant terminals). If allowance were to be made for coach/train passengers accessing these terminals in each city, this would increase the attractiveness of the car mode relative to the public transport modes.

▸ Costs of travel time (per person hour) have been assumed equal on the three modes. It might be argued that, in practice, costs should be higher for car mode, in particular for drivers, as they are (in general) unable to make much effective use of their driving time. However, a contrary argument is that people prefer the privacy aspect of their own car, with ready access to music, etc.

▸ Unlike in the urban passenger analyses, no distinction has been made between 'peak' and 'off-peak' periods. (Any peaking issues are primarily between seasons and days of the week, particularly in terms of spare capacity and hence marginal costs on coach and train services.)

▸ As in the urban passenger appraisal, the coach and train analyses are presented from the perspective of the end user (passenger) rather than the operating company. Thus passenger fares are treated as a user charge; and operator resource costs (i.e. excluding RUC etc.) are treated as a provider/external cost.

3.3.3.2   Key Features of Results

The following highlights the key features of the results.

In terms of total **user costs** (i.e. A+B), which are the key determinant of mode choice, key findings are as follows:

▸ For **car travel,** the two largest user cost components are travel time and vehicle operating costs.

▸ For **public transport travel,** the two largest user cost components are travel time and fares.

▸ In terms of total user costs, at average car occupancy, for the Auckland - Wellington case car costs are very similar to the costs for coach and train. However, for a trip involving only one person, car costs increase to 43.2¢/pkm, i.e. substantially higher than for coach or train; whereas with three people in the party, car costs reduce to 24.8¢/pkm. For the Christchurch – Picton case, coach/minibus costs are somewhat lower than for car at average occupancy, but train costs somewhat higher.

In terms of **provider/external (social) costs** (item C), aside from public transport operations/vehicle costs, all other costs are relatively small, with accident externality costs

being the most significant: road infrastructure maintenance, congestion externality costs and environmental costs are each 0.5¢/pkm or less for all three modes.

When **comparing charges (B) with external costs (C),** key findings are:

▸ For **car travel,** the user charges levied (fuel duty, at 1.2-1.3¢/pkm for average occupancy) are somewhat less than external costs (1.8-1.9¢/pkm).

▸ For **coach travel,** the user charges (fares) are about equal to the marginal operations/ vehicle (resource) costs: this result arises because marginal operations/vehicle costs approximate to average costs in the coach business. However, the fares are not sufficient to also cover the other externalities.

▸ For **train travel**, the fares are significantly greater than the marginal operations/vehicle costs, and more than cover the full external costs. This result reflects economies of scale in the train operations, with marginal costs being significantly below average costs.

If a pricing policy for long-distance passenger transport based on SRMC were to be pursued, then these results would suggest that:

▸ For **car travel**, charges should be increased slightly – although any impact on modal choice could be expected to be small, as current charges account for only around 5% of total user costs.

▸ For **coach travel**, charges (fares) should be increased slightly to match provider/external costs, although major change is not indicated.

▸ For **train travel**, charges (fares) should be significantly reduced to better align with marginal costs. This might be done through a subsidy to the operator, to reflect the difference between average and marginal costs.

3.3.3.3   Additional Comments on Results and Sensitivity

The following provides additional commentary on the sensitivity of the key results to any uncertainties in the key input components, particularly as regards the comparison between the total user charges and the total provider/external costs.

Car Travel

▸ The 'base' estimates show that the current charges are somewhat below the provider/external costs. The largest component of these costs is that associated with accident externalities (1.1¢/pkm at average occupancy), which remains subject to significant uncertainty. The second largest externality component is the congestion costs (up to 0.5¢/pkm), but which varies considerably by route.

▸ These cost versus charge comparisons are affected in absolute terms, but unaffected in relative terms, by variations in car occupancy.

	A	B	C	D	E	F	G	H
1	TABLE 3.5A: LONG DISTANCE PASSENGER MARGINAL COSTS AND CHARGES							
2	Mode	CAR			COACH		TRAIN	
3		¢ per Person Km (*)	¢ per Person Km	¢ per Person Km	¢ per Vehicle Km	¢ per Person Km	¢ per Vehicle KM	¢ per Person Km
4	Vehicle Occupancy	1.0	1.7	3.0		16.4		
5	Item							
6	A. TOTAL USER (PRIVATE) COSTS: RESOURCE							
7	1. Operations & Vehicle Costs	12.7	7.5	4.2	-	-	-	-
8	2. Operations – Time	15.6	15.6	15.6	-	19.4	-	18.6
9	3. Accidents Internal (NOS)	12.6	7.4	4.2	3.4	0.2		
10	B. TOTAL USER (PRIVATE) COSTS : CHARGES							
11	1. Fuel duty	2.2	1.3	0.7	-	-	-	-
12	2. Fares	-	-		-	10.8	-	11.0
13	C. PROVIDER/EXTERNAL (SOCIAL) COSTS							
14	1. Road Infrastructure O&M	0.2	0.1	0.1	4.0	0.2	-	-
15	2. Operations & Vehicle Costs	-	-		172.0	10.5	-	7.8
16	3. Congestion Externality	0.9	0.5	0.3	1.4	0.1	-	-
17	4. User Economies of Scale	-	-		-	-	-	-
18	5. Accident Externality	1.8	1.1	0.6	14.7	0.9		
19	6. Environmental	0.4	0.2	0.1	1.8	0.1	-	0.1
20	TOTALS							
21	A. User Costs: Resources	40.9	30.5	24.0	-	19.6	-	18.6
22	B. User Costs: Charges	2.2	1.3	0.7	-	10.8	-	11.0
23	C. Provider/External Costs	3.3	1.9	1.1	-	11.8	-	7.9
24	A+B = Total User Costs	43.1	31.8	24.8	-	30.4	-	29.6
25	A+C = Economic SRMC	44.2	32.4	25.1	-	31.4	-	26.5
26	C-B = Provider/External Costs - Charges	1.1	0.6	0.4	-	1.0	-	-3.1
27	FOOTNOTES							

28	(*) also per vehicle-km since occupancy=1
29	**A1-H1:** Analyses relate to AKL-WLG trip, based on the following assumptions
30	- Distance (road) = 657 kms
31	- Travel time (incl c 1.5 hour stops): Car 9.0 hrs, Coach 11.2 hrs, Train 10.7 hrs.
32	- Average number in party 1.7
33	- Calculations based on CBD-CBD (public transport terminal) times (adjustment for door-door times would favour car mode).
34	**B7 & B11:** From Car Operating Cost Model WP (marginal costs of car use): uses rural conditions, LoS A/B (uncongested)
35	**B8 & F8 & H8:** Based on VOC model (PEM) VoT ($19.38/veh hr or $11.40/person hr) converted to rate per km based on above journey times (average speeds Car 73km/hr, Coach 58.7km/hr, Train 61.4km/hr).
36	**B14 & E14:** From Marginal Road Infrastructure Costs WP (Adjusted RCAM figure, rural SH)
37	**B16 & E16:** From Road Congestion Costs WP (relates to busier sections of rural SH network). Coach assumed same as truck.
38	**B19 & E19:** From Environmental Impacts WP (GHG only – assumes other environmental impact costs very small outside urban areas). Buses assumed same rate as HCVI trucks.
39	**F12:** From Long Distance Coach Services WP, Table 1 (AKL-WLG)
40	**F4:** From Long Distance Coach Services WP: average loading 16.4 pass km/veh km.
41	**E15:** From Long Distance Coach Services WP: total operating cost of $1.91/veh km (53 seater coaches), less 10% for RUC.
42	**H12 & H15:** Except as noted, taken from Long-Distance Rail Passenger Services WP (average of figures for Northerner and Overlander services).
43	**H19:** Indicative estimate

Table 3.5B: Marginal Costs and Charges - Picton to Christchurch (CS 5)

All figures are cents		CAR			COACH				MINIBUS (shuttle)				TRAIN	
Item	Note	Per Vehicle Km	Per Person Km	Per Person Km	Per Vehicle Km	Per Person trip	Per Person Km	Per Person Km	Per Vehicle Km	Per Person trip	Per Person Km	Per Person Km	Per Person trip	Per Person Km
Vehicle Occupancy	1	1	1.7	3			15	20			6	8		
Trip Distance--Actual		350	350	350	350	350	350	350	350	350	350	350	351	351
A. TOTAL USER (PRIVATE) COSTS: RESOURCE														
1. Operations & Vehicle Costs	2	12.70	7.47	4.23										
2. Operations – Time	3		6.44	6.44		2730.00	7.80	7.80		2730.00	7.80	7.80	2773.16	7.90
3. Accidents Internal	4	12.70	7.47	4.23	3.40		0.23	0.17	8.05		1.34	1.01	0.00	0.00
B. TOTAL USER (PRIVATE) COSTS : CHARGES														
1. Fuel duty	2	2.20	1.18	0.73										
2. Fares	5				161.62	2828.43	8.08	8.08	54.86	2400.00	6.86	6.86	5896.80	16.80
C. PROVIDER/EXTERNAL (SOCIAL) COSTS														
1. Road Infrastructure O&M		0.58	0.34	0.19	9.40		0.63	0.47	1.24		0.21	0.16		
2. Operations & Vehicle Costs					173.58		11.57	8.68	56.38	2466.80	9.40	7.05	2106.00	6.00
3. Congestion Externality		0.18	0.11	0.06	0.55		0.04	0.03	0.27		0.05	0.03		
4. User Economies of Scale														
5. Accident Externality	4	1.80	1.06	0.60	14.70		0.98	0.74	8.25		1.38	1.03	0.00	0.00
6. Environmental		0.42	0.25	0.14			0.18	0.13			0.29	0.22		0.37
TOTALS														
A. User Costs: Resources		25.40	21.38	14.90			8.03	7.97			9.14	8.81		7.90
B. User Costs: Charges		2.20	1.18	0.73			8.08	8.08			6.86	6.86		16.80
C. Provider/External Costs		2.98	1.76	0.99			13.40	10.04			11.31	8.49		6.37
A+B = Total User Costs		**27.60**	**22.56**	**15.64**			**16.11**	**16.05**			**16.00**	**15.66**		**24.70**
A + C = Economic SRMC		**28.38**	**23.14**	**15.90**			**21.42**	**18.01**			**20.46**	**17.29**		**14.27**
C- B = Provider/External Costs - Charges		**0.78**	**0.58**	**0.26**			**5.31**	**1.96**			**4.46**	**1.63**		**-10.43**

Notes

1 Assuming 1/3 occupancy on coaches (IC data) & 1/2 on minibuses, plus sens tests

2 from Car Op Cost WP Table 4.2

3 Using PEM values for car passenger, "other" purpose

4 Minibus taken as the average of coach and car

5 Coach & train calc as per resp WPs; minibus averaged from operator information

NOT GOVERNMENT POLICY

Figure 3.5A: Long Distance Passenger – Marginal Costs and Charges
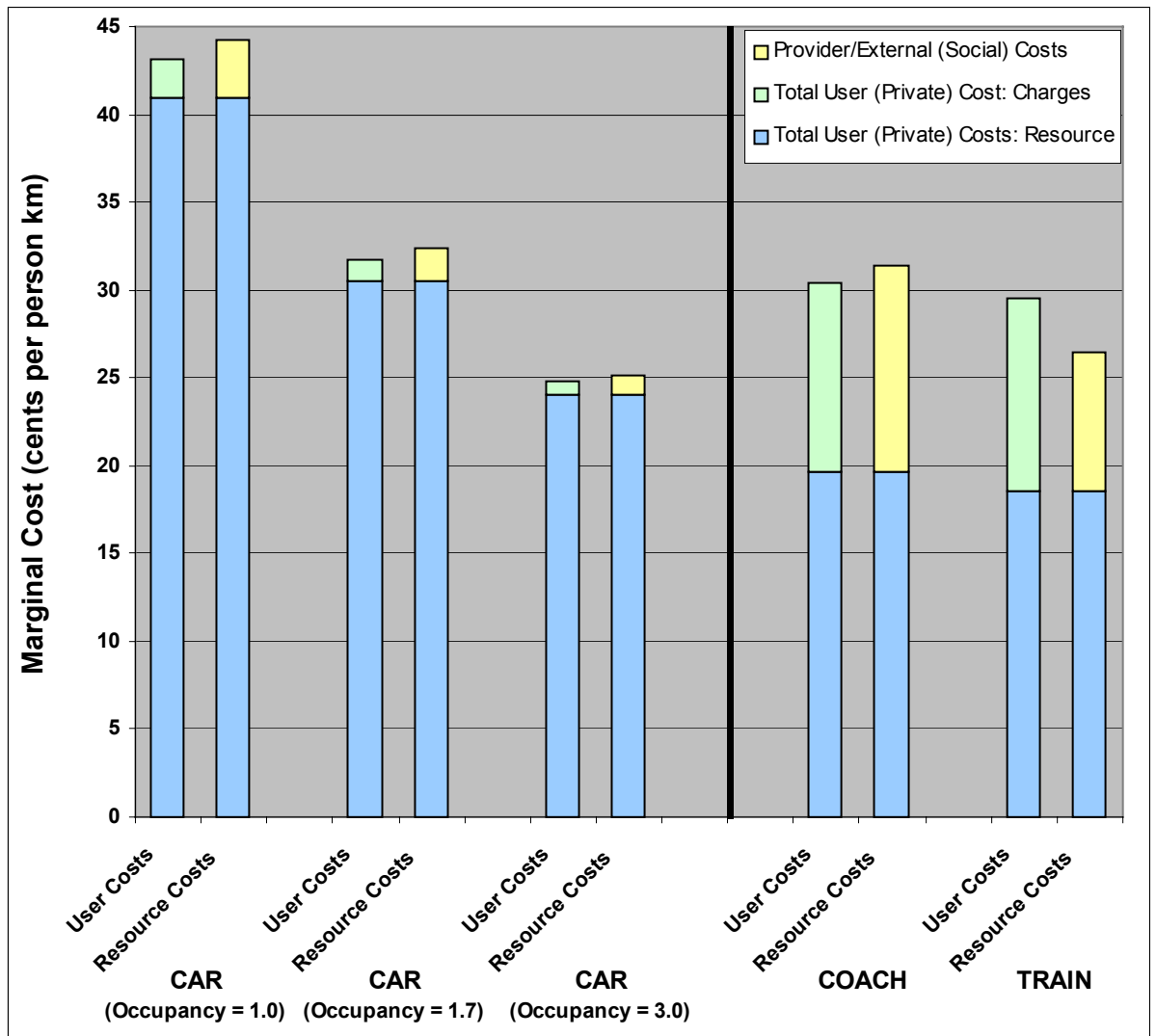
Figure 3.5B: Passenger Marginal Costs and Charges – Picton to Christchurch
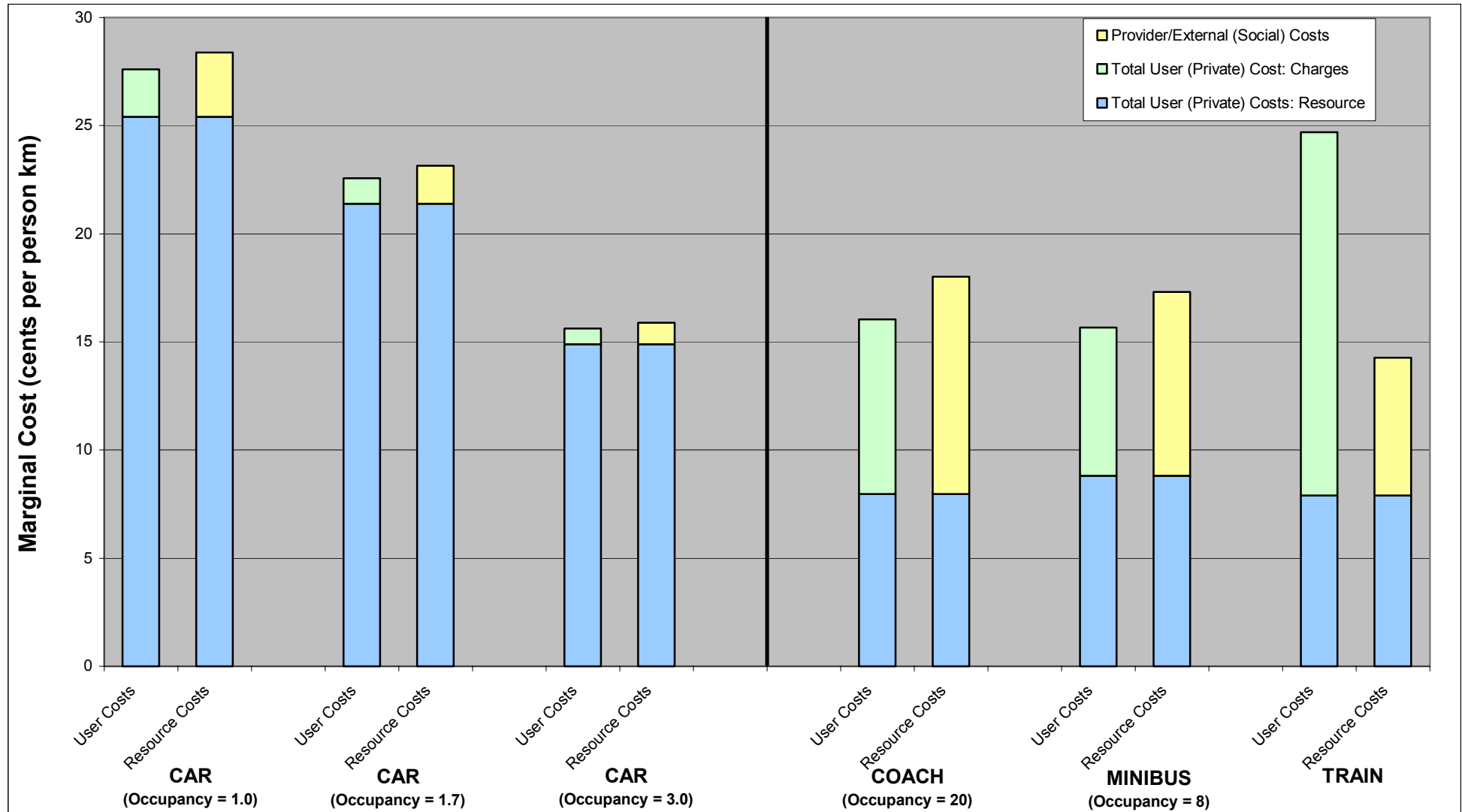
Figure 3.5C: Long Distance Passenger – Main Components of User Charges and Marginal Provider/External Costs
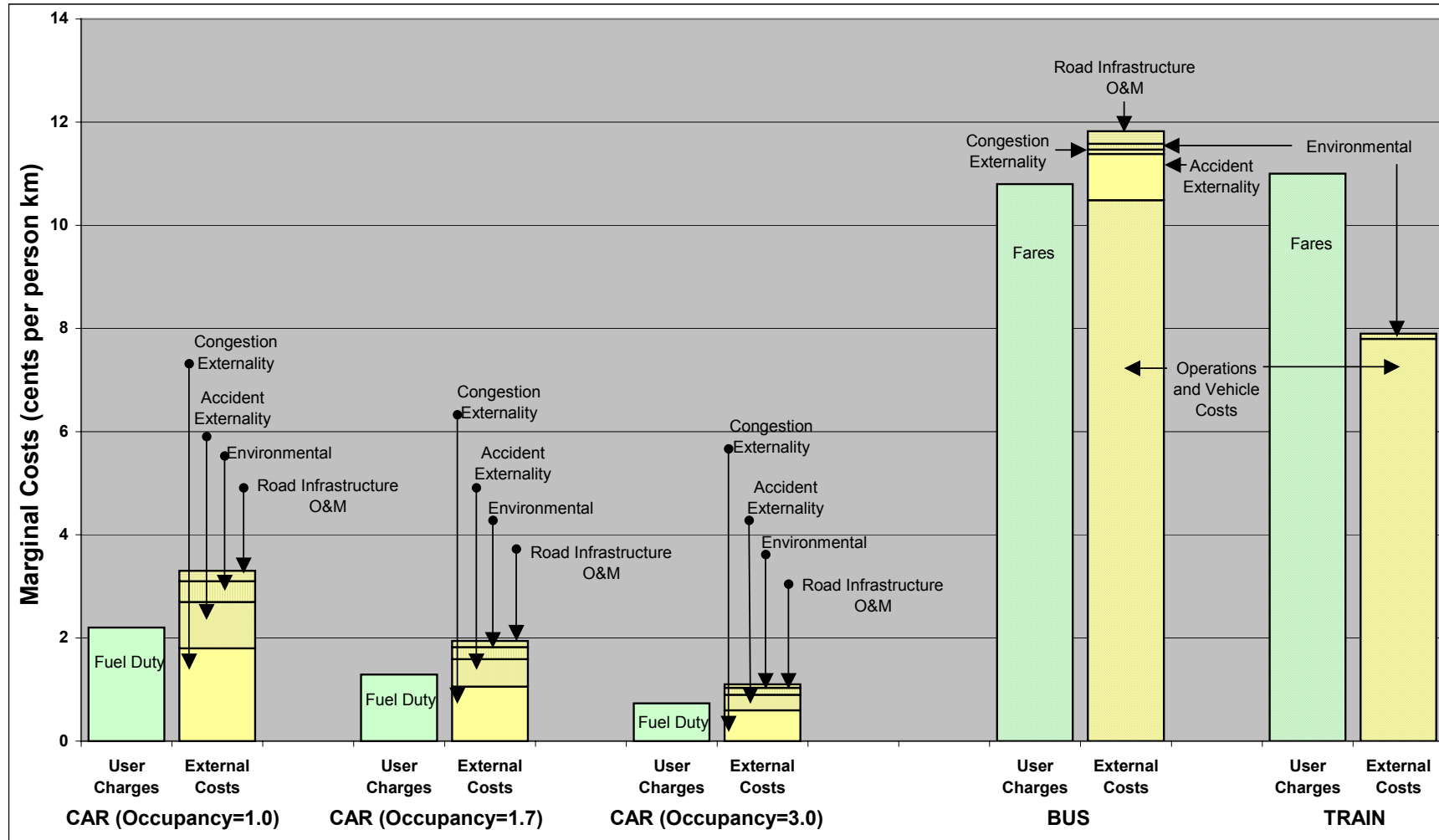
Figure 3.5D: Long Distance Passenger Marginal Costs and Charges: Picton to Christchurch - Main Components of User Charges and Provider/External Costs

NOT GOVERNMENT POLICY
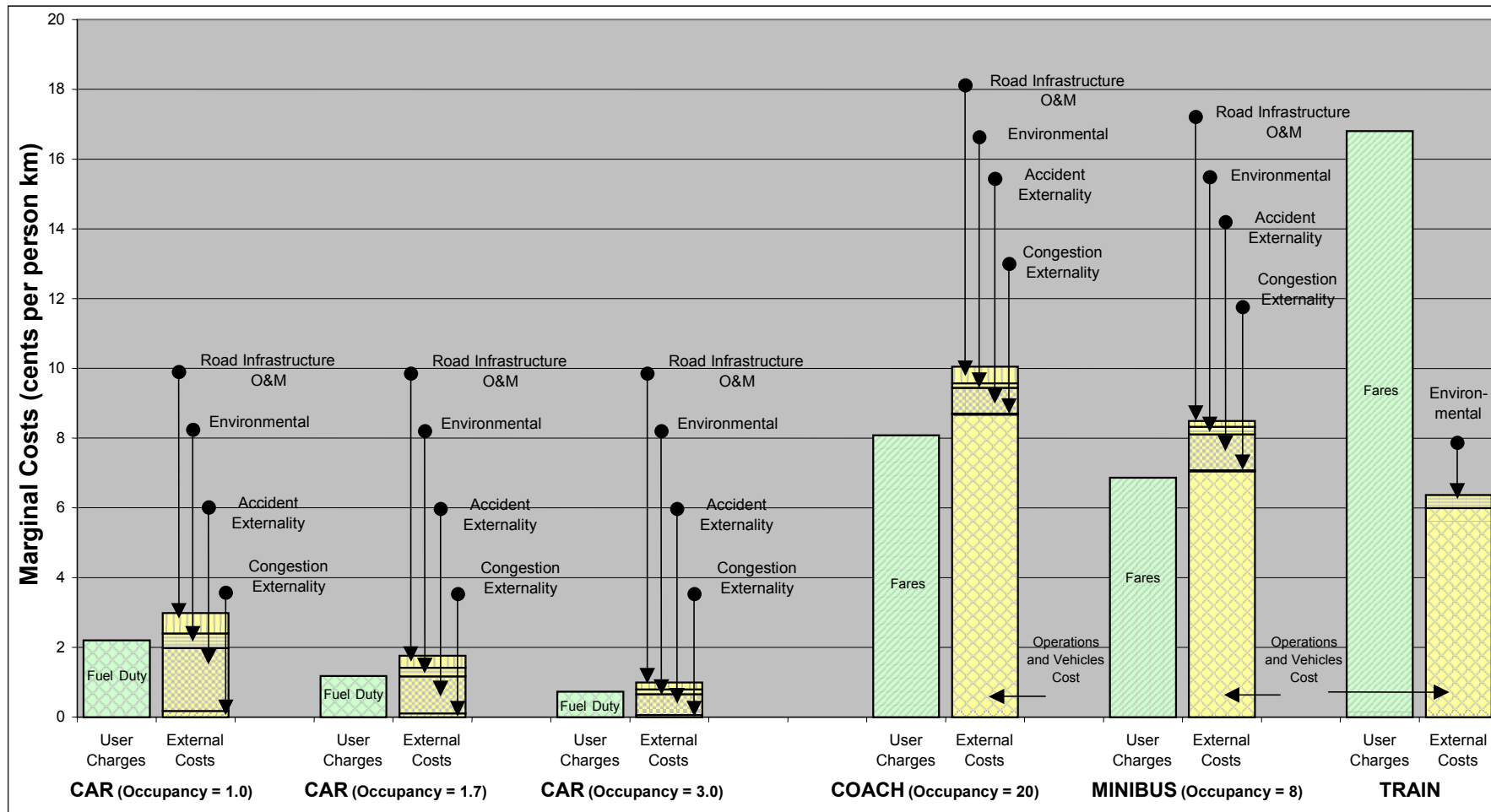
Coach Travel

▸ The 'base' estimates indicate that current charges for coach travel are around 10-15% below the total provider/external costs. The costs are dominated by the operator costs, where it is assessed that marginal costs typically equate to average costs. The other external cost components are relatively small: the largest of these is the accident externality, which while subject to significant uncertainty, accounts only around 10% of the total.

▸ We consider that plausible variations in these external cost components are unlikely to have a substantial impact on the overall result. However, we note that there are likely to be many situations where additional passengers can be carried at low marginal operator costs (e.g. on most routes in the winter season): in these cases the charges (fares) will be substantially greater than the marginal operator costs.

Train Travel

▸ The 'base' estimates indicate that current charges are, on average, significantly above marginal provider/external costs. This result reflects that the train services operate on a commercial basis, that marginal costs are significantly below average costs, and that the other external costs are relatively low.

▸ This would seem to be a robust conclusion, certainly for the services on average. In many cases, the marginal costs of carrying additional passengers are likely to be below the figure estimated here; while marginal costs are only likely to exceed average costs if additional passengers were concentrated in peak situations (e.g. peak season, popular services) rather than broadly pro-rata across all services.

3.3.4   Long Distance Freight Transport

3.3.4.1   Overview

The SRMC appraisals for long-distance freight movements have been undertaken for three different cases, in each case comparing costs for movement by truck and train:

▸ Napier – Gisborne, focusing on those traffics for which train is a feasible alternative (in particular future movements of logs and forestry products). This is detailed in Case Study 1 (see Annex E).

▸ Auckland – Wellington, focusing on movements of general freight. This is detailed in Case Study 2.

▸ Kinleith – Tauranga, focusing on movements of logs and forestry products that are now carried on this route. This is detailed in Case Study 4.

Most of the current freight on the Napier-Gisborne route is fertiliser with timber and timber products expected to be the major items in a few years time. The main purpose of this case study was to examine the effect of a transfer to road of logging and processed word products presently carried by rail in 2003 (year 1). This study therefore assessed the marginal costs of the freight forecasts about the volume of log and processed wood products vary, but it is expected that a projected increase in traffic will occur from 2008 onwards (year 6).

The Auckland to Wellington case study sought to identify the marginal costs and charges associated with long distance freight between Auckland and Wellington. The dominant movement direction is southbound with approximately 450,000 tonnes carried by rail p.a. from Auckland to Wellington, while only 250,000 tonnes p.a. are carried in the reverse direction. The freight being carried is generally mixed with no single product dominant.

The Napier to Gisborne case study examined the effect on marginal costs and charges of transferring 10% of the freight from road to rail). This methodology was then used in the Auckland to Wellington freight case study, and a 10% switch from rail to road was modelled. The findings relate only to a comparison of *current* road and rail capacities.

The Kinleith to Tauranga case study estimates the MC of the relatively specialised transport service supplied by the two modes. The goods transported are logs, pulp and paper, and sawn timber products, which are taken over a distance of around 110km from Kinleith to the port of Tauranga. This case study compares the marginal social costs of carriage by rail and road of the current freight traffic which includes logs, pulp and paper, and sawn timber products.

The results of the appraisals for the three cases are detailed in Table 3.6, with graphical summaries in Figures 3.6A to 3.6C.

The Table 3.6 structure is similar to that for long-distance passenger travel (Tables 3.5A, 3.5B). The main analyses are presented from the viewpoint of the operator, i.e. items A, B and C. In addition item D shows the charges as faced by the end user: for trucks we take these as equal to the costs (including profit margin) faced by the operator (i.e. A+B).

The following points in particular should be noted on the basis and derivation of the estimates shown:

‣ The main focus has been on freight flows for which road/truck and rail/train modes would be most closely competitive. These are typically the longer-distance flows of general freight between origins and destinations both on the rail network. The trucks involved would typically be A-trains or B-trains. However, they also include some specialist freight flows, such as the logs and forestry products between the Kinleith area and the Port of Tauranga (Case Study 4).

‣ For all the case studies, the analyses have assumed that the balance of traffic movements between the two directions is similar to the balance of the existing traffic movements. (Different marginal cost figures would result if either the dominant or non-dominant direction were considered separately.)

‣ For trucking, estimates have been derived first on a per vehicle kilometre basis, and then converted to a per net tonne kilometre basis using relevant average load data for the relevant truck traffics. Marginal costs have been taken as equal to average costs (which include a profit margin).

‣ For rail, estimates have been derived from a train operations and costing model, and reflect marginal costs for typical 'non-bulk' and 'bulk' traffic currently carried by Tranz Rail. The model indicates that marginal line-haul costs are typically about 70% - 75% of average costs. The 'non-bulk' figures are of most relevance here, as road and rail are generally more closely competitive for such traffics.

‣ The figures for 'bulk' rail traffics relate to the line-haul task only (e.g. siding-siding movements). For 'non-bulk' traffics, typical pick-up/delivery and handling charges have been estimated in addition and are shown in brackets: they may not be applicable for all such traffics (this aspect is addressed in more detail in the case studies).

3.3.4.2   Key Features of Results

The key findings may be summarised as follows:

Trucks

▸   For trucks, operator costs (A+B) are 13.0¢/NTK on the Napier-Gisborne route. They are lower in the Auckland–Wellington case at 11.6¢/NTK and notably higher in the Kinleith-Tauranga case at 20.3¢/NTK. Roading infrastructure costs for Napier-Gisborne are higher due to local topography conditions.

▸   Operator charges (principally RUC) average around one-quarter of these total costs, depending on the vehicle type assumed and the distance involved. On the Napier-Gisborne route, road user charges (per veh km) are higher than the typical national figures due to trucks in use for carrying timber traffic being larger than average. Road user charges paid on this route exceed provider/external costs by around 20% in each year. Similarly, on the Kinleith-Tauranga route, road user charges are above average due to the use of logging trucks. On the Auckland-Wellington route, road user charges are lower than the national average because of the type of truck (B train) which has been assumed to carry the freight transferred from rail; this effect is accentuated in the cost per tonne-km because the case study load factor is above the average. Charges on this route represent about 60% of the external costs while at the average level, charges are about twice the costs.

▸   For trucks, in the Napier-Gisborne and Kinleith-Tauranga cases, the provider/ external costs are less than the charges, but the reverse is true for the Auckland–Wellington analysis. These variations reflect differences in vehicle types (hence RUC rates), accident costs and infrastructure costs in the different corridors.

▸   For Napier-Gisborne, congestion costs are above the typical national figures, due largely to the nature of the road and the high proportion of heavy vehicles, while accident costs are about three times the national average. On the Auckland-Wellington route, congestion costs are above the national average due to 76km which go through urban areas, particularly in Auckland and Wellington.

▸   Also on the Auckland-Wellington route, accident costs, both internal and external are above the national average; this may be due to specific factors such as geography, road geometry and traffic volumes on SH1. Maintenance costs for this section of road are higher than the national average. The environmental costs are above average because of the section of the route in southern Auckland.

▸   On the Kinleith-Tauranga route, accident costs, both internal and external are above the national average. Maintenance costs for this section are higher than the national average, and the route is subject to more congestion than the national average.

Trains

▸   For trains, the marginal operator costs for the line-haul task are significantly lower than for trucks, except in the early period of the Napier-Gisborne case study (years 1-5). But where pick up/delivery and handling tasks are involved, total marginal costs for non-bulk traffic are much closer to those by truck (and may be greater than by truck for shorter-distance movements). While the case studies display considerable variation due to local factors, the marginal train costs are always lower than the corresponding truck costs.

▸ For trains, freight rates are somewhat (around 2¢/NTK) greater than SRMC in all cases, except in the early period of the Napier-Gisborne case study (years 1-5): this reflects that operator marginal costs are significantly (around 30%) lower than operator average costs. Napier-Gisborne freight rates equal only 50% of operator costs in Year 1 (2003) but are 12% higher than operator costs in Year 6 (2008).

▸ On the Napier-Gisborne route, a comparison of road and rail shows that in year 1, the marginal costs for truck (13.9¢/NTK) and train (13.7¢/NTK) are very similar, while from year 6 onwards, the marginal costs for train (7.4¢/NTK) are substantially lower than those for truck (12.6¢/NTK).

▸ On the Auckland-Wellington route, freight rates overall are 40% higher than operator costs. The marginal costs of express trains (which are the services that compete with road) are significantly higher than those of general trains. This is because express trains carry approximately half the maximum load that general trains do, and these services use two locomotives, instead of one. On the Auckland-Wellington route overall, both operator costs and user charges are lower for rail than for road.

▸ On the Kinleith-Tauranga route, the cost of rail is below the national average, probably a reflection of the large volumes of a small number of types of freight being carried and the relatively flat route. Rail costs and charges are noticeably lower than road, and environmental costs are considerably lower than road.

3.3.4.3   Additional Comments on Results and Sensitivity

The following provides additional commentary on, and interpretation of, the results, including their sensitivity relating to uncertainties in key inputs and how this may affect the comparisons between user charges and provider/external costs.

In terms of sensitivity of the results, it should be noted that the figures presented are based on typical train and truck loadings for longer-distance freight movements. In practice, marginal costs depend very much on the specific situation as discussed below and examined further in the separate case studies (as summarised in Annex E).

Heterogeneity in the long-distance freight sector – interpreting the figures

The figures for marginal costs on long-distance freight routes, as shown in Table 3.6, seem at first sight to show a confusing story. It is not possible to generalise the results to show one standard result across the long-distance freight sector.

As discussed below, one very important factor to take into account when interpreting the figures in Table 3.6 is the heterogeneity along routes, between routes and between market structures. This study aims to find overall patterns of costs and charges for the modes, but there is no simple answer and the devil is most definitely in the detail. This heterogeneity for long-distance freight comes from a variety of sources, all of which must be appreciated when interpreting the figures.

- **Market structure**

In understanding the truck and train figures, it is helpful to consider the differing market structures for each mode and therefore the incentive structure in setting prices (freight rates) in light of their costs and competitive environment. Addressing road and rail freight below helps to explain the diversity of cost and charge levels reflected in Table 3.6.

Turning first to the road freight industry, there are a large number of companies of varying sizes so on most routes they will be facing competition with other trucking companies. The trucking market is renowned for being perfectly competitive; being able to go anywhere; with easy entry and exit from the industry; having a large number of competitors; and most costs are variable in the short to medium term. Thus, the road industry sets prices in road freight. Furthermore, our figures have assumed that they tend to make 'normal profits', i.e. long-term profit is just enough to keep the companies viable, without significant 'supernormal profit' which is associated with more monopolistic firms who can extract more consumer surplus from their customers. This is the purely financial position of the operators as reflected in D–(A+B) in Table 3.6, as opposed to the economic position which is represented by the last line showing D-(A+C) which takes into account external costs.

With regard to rail freight there is one supplier of rail services, and given the nature of the road freight industry, rail is a price taker in the long-distance freight market. Given prices arrived at in the road freight market, rail must then treat these prices as a ceiling to what it can charge in the same market, setting prices equal or below these levels. Whether rail is then viable depends on whether these prices are high enough for rail to cover its costs.

As a single entity, the rail company is interested in balancing its overall position over its entire operations over the whole country, and as such may choose to cut freight rates in some areas in order to compete for contracts with the roading industry, if it can balance this against earning a higher level of profit on other routes. Individual routes are less determinant of the company's financial position, it is the whole picture which matters. Low (or possibly negative) contribution to finances on some routes may make economic sense in terms of retaining the operation of the network, rather than having some sections unused, and also making contributions to fixed costs and overheads.

- **Long-run 'normal' profit**

In the short term, a company needs to cover its variable costs in order to remain viable, but in the long term, it needs to cover all costs, i.e. its average total costs, plus a margin to allow for the amount of investment required to keep the company functioning at the current level. This long term profit level is referred to as 'normal profit'. Any profit earned above this level is 'supernormal profit' and tends to be associated with monopolistic organisations. The figures showing this in the table are D-(A+B).

The ability for a company to earn normal or supernormal profits depend on the competitive forces in that market. It is assumed in each of the three long-distance freight case studies, and also nationally (i.e. in the generic case), that the roading sector is competitive within itself and that the rail sector is competing directly with road for the freight business. Therefore, one would expect normal profit to be earned overall in the road/trucking sector. However, within the modes, prices vary according to the various conditions, both competitive and geographical. The figures in Table 3.6 reflect this.

As noted above, looking across the marginal costs and charges on the selected long-distance freight routes, there is great variety between modes and between routes. Assuming a low positive profit for both modes, it would appear that overall each mode is balancing less profitable and more profitable routes and overall are making normal profits as competitive firms would be expected to do in a free market economy. The road/trucking industry is assumed to make normal profits on each of the routes (as reflected by D-[A+B] at around zero), while for rail there is variance from zero in both directions – positive for the Auckland-Wellington route and negative for the Napier-Gisborne and Kinleith-Tauranga routes. For rail, these differences reflect the negotiating strength of the parties, as well as

ensuring that routes are preserved for potential future growth. The differences are interesting to note, and reflect the differing approaches to the long-distance freight market adopted by road versus rail in New Zealand.

- **Differences between routes:**

1. Location/conditions along a route

The costs of transporting goods along a route with steep slopes and/or difficult terrain and with urban and rural sections will impact upon the marginal costs of a freight company, be it road or rail. Therefore, it is to be expected that the operational and maintenance costs of infrastructure and the vehicles themselves should vary according to particular point along the route. Also externalities vary along a route, since the externality costs vary with the receiving environment as discussed below. Thus, the marginal cost figures shown in Table 3.6 are hiding the fluctuations of marginal costs along a route

2. Different markets being served and the scope for backloading

Each of the routes studied serve different markets, so this in itself would lead us to expect to see differences in cost structures between these routes. Different products require appropriate vehicles and transportation conditions, and appropriate frequency of service, and road will be more attractive than rail for some products for specific reasons as well as cost differentials, and vice versa. In addition, the type of commodity being transported will attract differing freight rates.

The other factor arising from the specifics of the market will impact upon whether there is backloading, i.e. whether the rail company carries freight in both directions or predominantly in only one, which will impact upon the cost per tonne km. For example, carrying coal from the West Coast to Lyttleton port tends not to involve backloading, so the costs of this carriage are effectively higher because there is travel in one direction carrying nothing. By contrast, there is significant backloading on the Auckland to Wellington route which carries predominantly containers of general freight, thereby reducing cost per net tonne km, compared to a situation with no backloading because costs are spread over a greater tonnage. This is particularly true for rail which has a high proportion of fixed costs compared to road freight.

3. Location/conditions between routes

As with conditions along a particular route, freight costs will be expected to vary between routes due to geography, population, length of route, and so on. Table 3.6 shows that the marginal costs for operations, vehicle and time costs vary from 9.4¢/ntk along the Auckland-Wellington route compared to 14.3¢/ntk along the Kinleith-Tauranga route which is much rougher terrain by road (but not by rail).

Another contributing factor to the higher net tonne km costs on the Kinleith-Tauranga route is to do with the length of the route. Auckland-Wellington is about 650km, so terminal costs are spread along a longer distance which reduces costs per tonne km. The Kinleith-Tauranga route is much shorter at about 110km which affects its operating costs in this way, and has the added consideration that there is very little or no backloading to dilute the non-variable costs.

4. Market forces

As discussed above, some routes will have a number of operators vying for the business and others will face far less competition, for any number of reasons. As discussed in the previous section though, this has to average out for the whole industry in order that normal profits are achieved so that the companies can all survive in the long term.

- **Environmental costs**

One finding of interest is that the environmental externality marginal cost component tends to be relatively small, and of similar magnitude on the two modes. For long-distance freight this tends to be true because the routes pass through areas which are primarily rural and where minimal LAQ damage occurs due to the population density of the receiving environment. However, it must be borne in mind that the figures in Table 3.6 are the 'averaged' environmental marginal cost over the length of the trip. For example, on the Auckland to Wellington trip, only 76km out of the total trip length of 650km (see Table 6.1 of Case Study) is classed as urban and this is where the vast majority of any environmental costs will have an impact. Therefore, the environmental costs are focused on this 76km and then are averaged out across the 650km for the purposes of this case study. For the people living along the urban sections, these costs are far from insignificant.

For rail, the only provider/external costs that are shown to be significant are from the environmental externality. For trucks, the largest component of the provider/external costs is the accident externality followed by the infrastructure maintenance costs. Environmental and congestion components are considerably smaller. While the accident externality figure is subject to particular uncertainty, plausible variations in it seem unlikely to change the conclusion that the external costs are in most cases significantly below the current charges.

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[34] As explained in the Environmental paper, with environmental costs, one of the main determining factors of the extent of some of these costs is the receiving environment, i.e. who is being affected. Since urban areas are the relatively highly populated areas, environmental costs are therefore higher because of the increased number of people affected by local air pollution, noise, and so on. Greenhouse gases on the other hand are not location specific.

TABLE 3.6: LONG-DISTANCE FREIGHT MARGINAL COSTS AND CHARGES - ¢ per net tonne km								
Mode	**Road/Truck**				**Rail /Train**			
Case	NAP-GIS	NAP-GIS	AKL-WLG	KIN-TAU	NAP-GIS	AKL-WLG		KIN-TAU
	CS1 (year 1)	CS1 (year 6)	CS2	CS4	CS1 (Rail)	CS2	CS2	CS4
Type						Express non-bulk	General non-bulk	
Item								
A. Operator Costs: Resource								
1. Operations, Vehicle and Time Costs	10.1 (6)	8.7	9.4 (6)	14.3	13.5 (13)	7.4 (13)	4.4 (13)	6.3 (13)
2. Accident Costs (internal, not otherwise covered)	0.4	0.3	0.3	0.4	-	-	-	1.5
B. Operator Costs: Charges								
1. RUC	4.1	4.0	1.8	5.5	-	-	-	-
2. MV licensing/registration	0.0 (7)	0.0	0.0 (7)	0.0	-	-	-	-
C. Provider/External (Social) Costs								
1. Infrastructure mtc	1.0 (8)	1.0	0.8 (9)	1.3	-	-	-	-
2. Congestion (external) costs	0.2	0.3	0.4	0.2	-	-	-	-
3. Accident costs (external)	2.0	1.8	1.1	1.3	(assumed zero)	(assumed zero)	(assumed zero)	(assumed zero)
4. Environmental costs	0.2	0.2	0.6	0.4	0.2	0.8	0.8	0.1
D. User Charges								
1. Freight Rates	13.0 (9)	13.0	13.0	19.9 (5)	8.8	10.2 (14)	10.2 (14)	7.0 (15)
Totals								
A. Operator Costs: Resources	10.5	9.3	9.8	14.7	13.5	7.4	4.4	7.8
B. Operator Costs: Charges	4.1	4.0	1.8	5.6	-	-	-	-
C. External Costs	3.4	3.3	2.9	3.2	0.2	0.8	0.8	0.1
A+B = Total Operator Costs	**14.6**	**13.3**	**11.6**	**20.3**	**13.5**	**7.4**	**4.4**	**7.8**
A+C = Economic SRMC	**13.9**	**12.6**	**12.7**	**17.9**	**13.7**	**8.2**	**5.2**	**7.9**
C-B = External Costs - Charges	**-0.7**	**-0.7**	**1.1**	**-2.4**	**0.2**	**0.8**	**0.8**	**0.1**
D – (A+C) = User Charges - SRMC	**-0.9**	**0.4**	**0.3**	**2.0**	**-4.9**	**2.0**	**5.0**	**-0.9**

Notes:

(1)   Operator costs and charges derived in 'Truck Cost Model' Working Paper. Based on weighted average payload of 13 tonnes.

(2)   From Road Infrastructure Costs Paper (adjusted RCAM for rural state highways).

(3)   From Road Congestion Costs Paper. This is a maximum likely value, typical of the more heavily trafficked sections of the inter-urban SH network.

(4)   Based on Napier-Gisborne Case Study analyses.

(5)   Assumed equal to total operator costs.

(6)   Based on average of one-way load of 26T, returning empty.

(7)   From general case analysis.

(8)   Using adjusted RCAM.

(9)   Generic value

(10)   Using adjusted dTIMS.

(11)   From Rail Freight Costs and Charges paper. Figures represent average MC and charges for TRL's bulk and non-bulk freight traffics. Costs relate to **line-haul task only**. For traffic requiring separate handling and pick-up/delivery, typical additional costs/charges would be $7/tonne for containers and $16/tonne for smaller consignments. For typical line-haul trip distances (300km), these equate to about 2.3¢/NTK and 5.3¢/NTK respectively.

(12)   From Rail Freight Costs and Charges paper (Table 14): represents average existing line haul revenues for bulk/non-bulk rail freight.

(13)   Includes infrastructure capital

(14)   Average for all business units and train types

(15)   May be as high as 9.7

Figure 3.6A Napier to Gisborne Freight – Marginal Costs and Charges
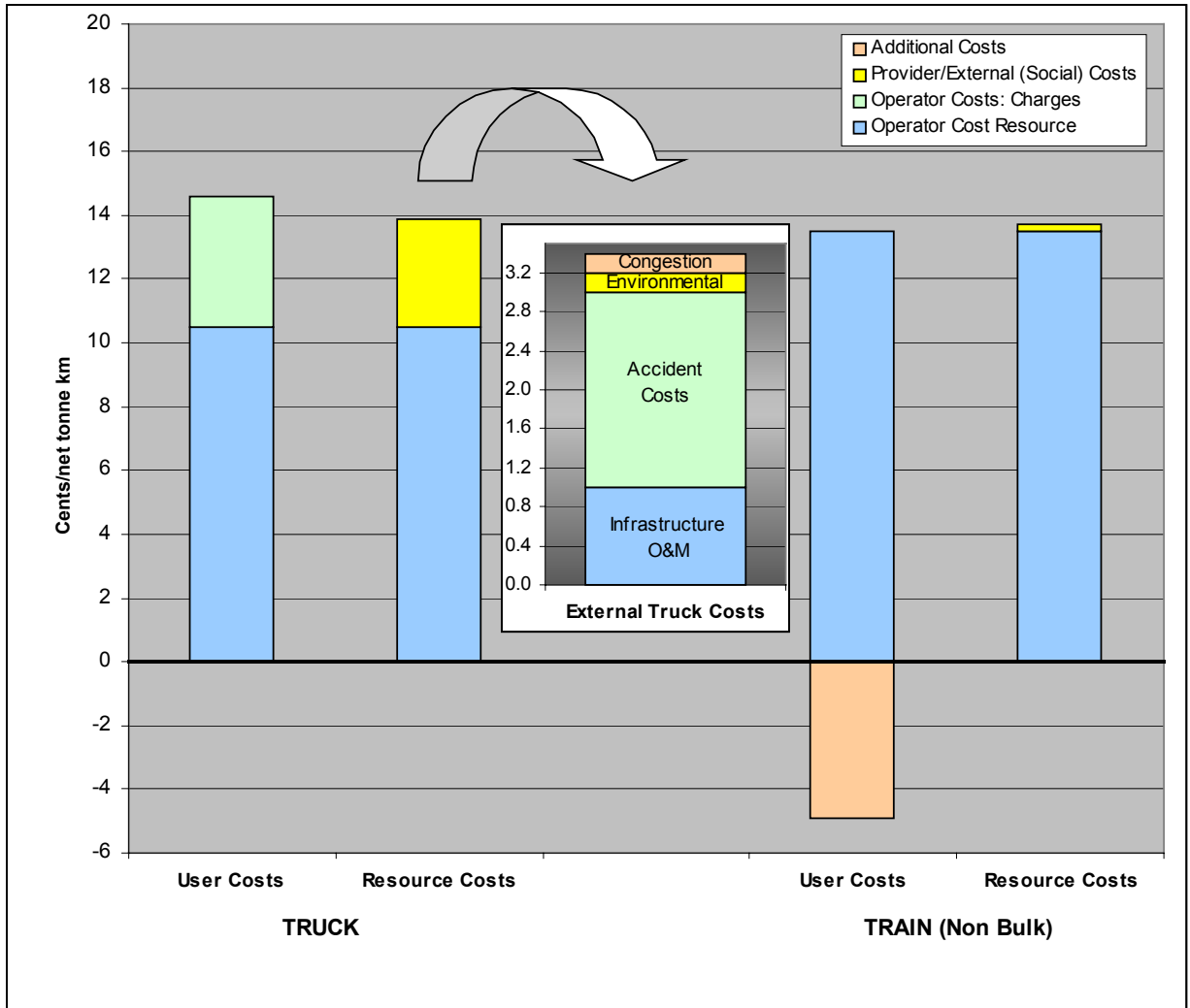
Figure 3.6B: Auckland to Wellington Freight – Marginal Costs and Charges
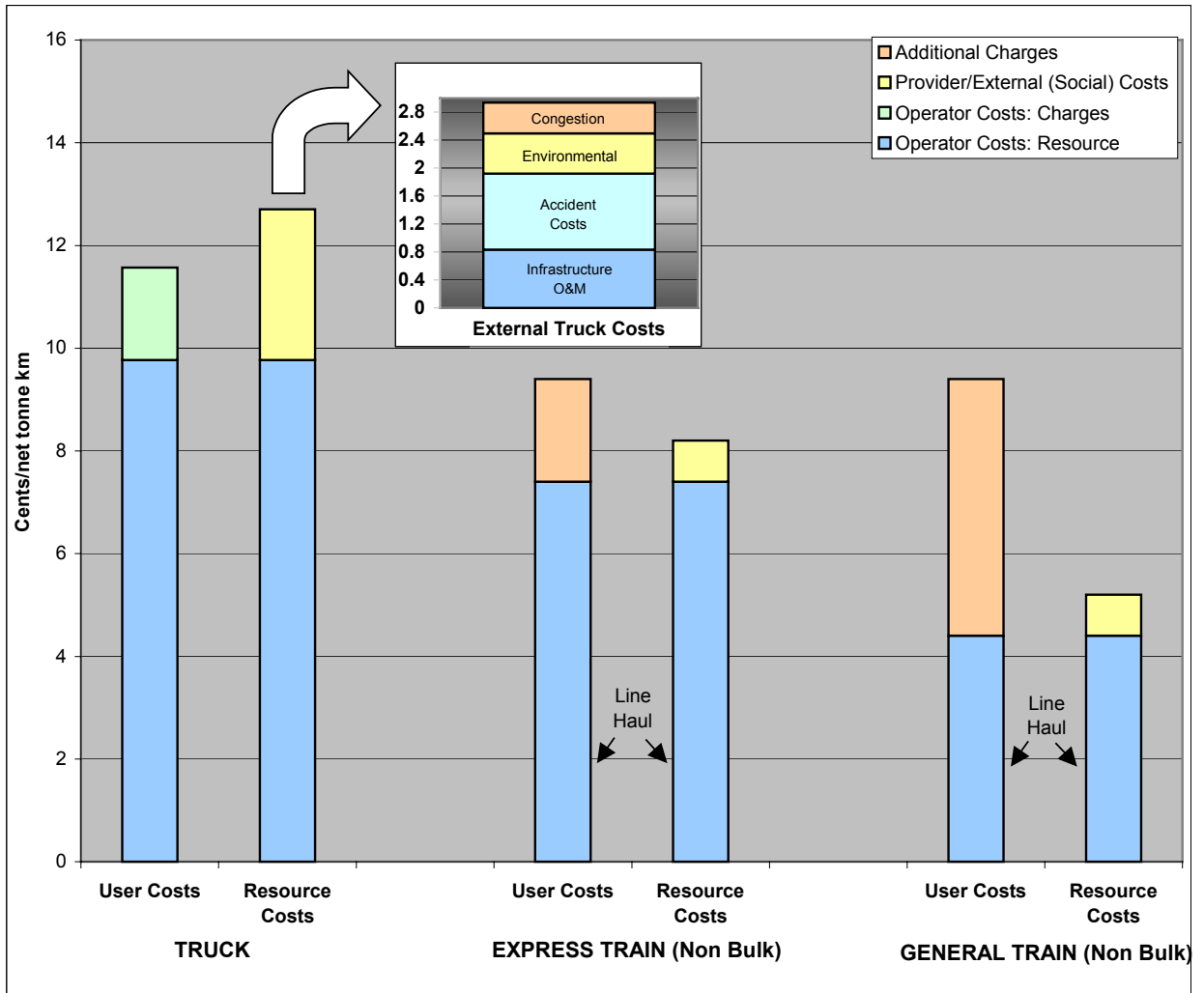
Figure 3.6C: – Kinleith to Tauranga Freight - Marginal Costs and Charges
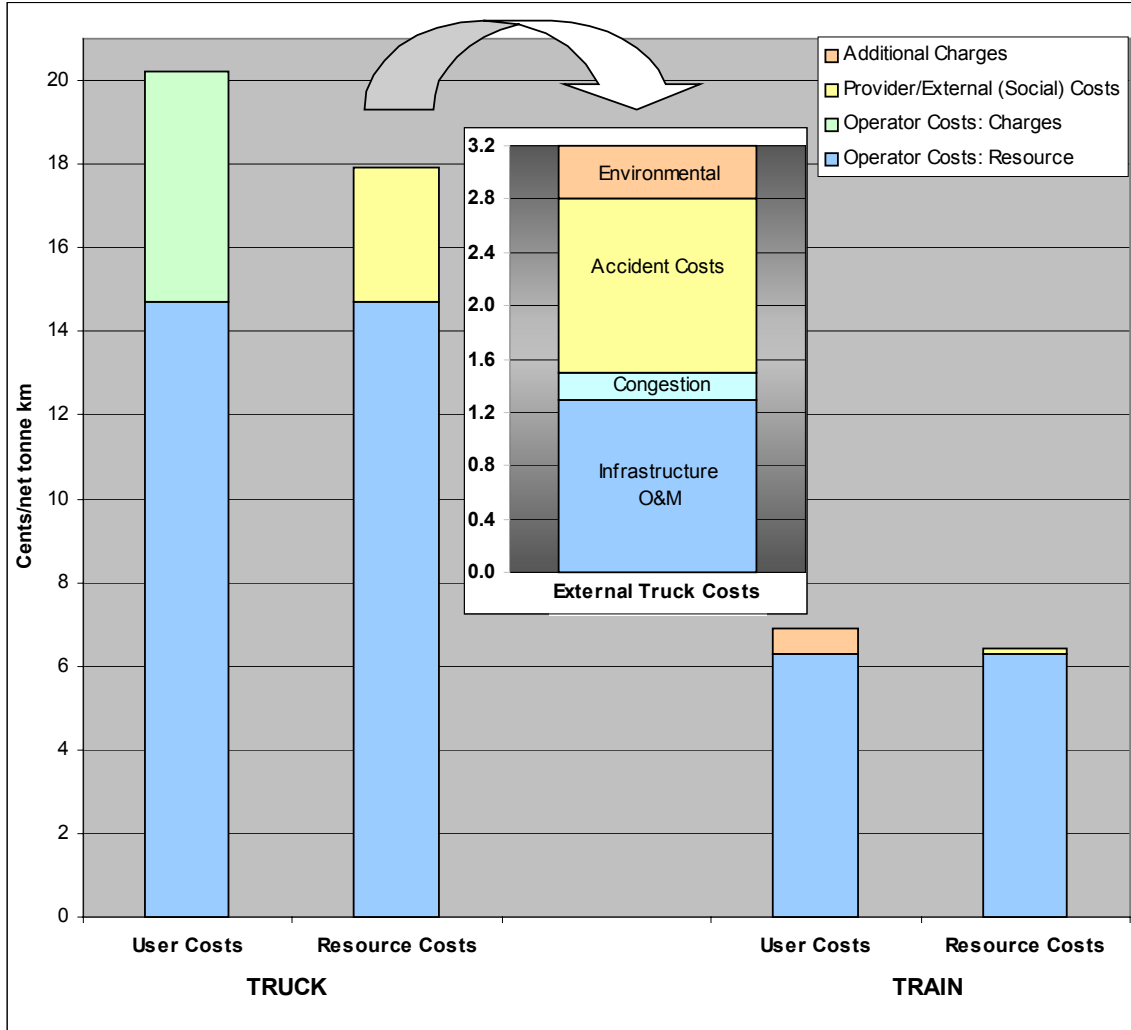
3.4 Summary and Conclusions

This section presents a summary and highlights the key conclusions from the appraisals in this chapter. As earlier in the chapter, it covers the Total Cost/Fully Allocated Costs results first, followed by the Marginal Costs results. Its main emphasis is on comparisons between the provider/external costs in each sector and the charges currently levied on that sector.

3.4.1 Total Cost/Fully Allocated Cost Appraisal

3.4.1.1 Road System – Total Costs and Charges

Table 3.7 presents a summary for the total road system of the provider/external costs and the corresponding current charges. Key findings may be summarised as:

▸ Current charges total some $2.63 billion p.a., or $2.34 billion if roading rates are excluded as not being a user charge.

▸ The best estimate of total provider/external costs is $5.59 billion p.a., i.e. just over double the current charges.

▸ However, almost half these costs relate to the target return on road infrastructure assets. The majority of these assets have no viable alternative use (opportunity cost) and it is arguable whether a return should be charged on these.

▸ The likely minimum estimate for provider/external costs, assuming no charge on the non-recoverable assets, is $2.36 billion p.a. This is slightly less than the current level of charges.

▸ The likely maximum estimate for provider/external costs, including a charge on the non-recoverable assets, is $8.37 billion. This is over three times the current level of charges.

3.4.1.2 Road System – Fully Allocated Costs

Fully allocated cost analyses have been undertaken, to analyse the total road system user costs, user charges and provider/external costs by:
▸ Vehicle type – principally cars and trucks
▸ Road type   – state highways and local roads
                  - urban areas and rural areas.

Such analyses involve a multitude of assumptions in allocating costs (many of which are not separable) and should be regarded as giving broad indications only.

The main findings in terms of comparing user charges with provider/external costs are:

Vehicle type

▸ The 'social cost recovery' (charges: external costs ratio) is significantly greater for cars than for trucks (whether or not a return on non-recoverable assets is included in the costs).

TABLE 3.7: TOTAL ROAD SYSTEM PROVIDER/EXTERNAL COSTS AND CHARGES SUMMARY			
Item	Annual Figures - $ Billion (2001/02)		
	Best Estimate[1]	**Likely Range**[2]	
		Minimum	**Maximum**
Provider/External Costs			
Road System Operation and Maintenance:			
Maintenance	0.77	0.75	0.85
Operations and Administration	0.38	0.38	0.38
Accident Externalities	0.67	0.33	1.34
Environmental Impacts	1.17	0.60	2.40
Road System Infrastructure Capital Return:			
Recoverable Assets (Land)	0.75	0.30	0.98
Non-recoverable Assets	1.86	0[3]	2.42
Totals	**5.59**	**2.36**	**8.37**
Current Charges			
Fuel Excise	1.09		
Road User Charges	0.58		
Motor Vehicle Fees	0.57		
Other	0.10		
Roading Rates	0.29		
Total	**2.63**		

Notes: [1] Taken from Table 3.1
[2] Drawn from Section 3.2.2.3
[3] Put at zero on basis that arguably not expected to recover this item from user charges.

Road and area type

‣ On total costs (including a return on non-recoverable assets), the 'social cost recovery' ratios are substantially higher for state highways than for local roads, and substantially higher for urban than rural roads. The highest ratio applies to urban state highways (78%) and the lowest ratio to rural local roads (37%).

‣ If a return on non-recoverable assets is excluded, all these ratios increase, but the picture is less clear-cut. The ratios range from 89% for urban state highways to 57% for urban local roads.

3.4.1.3 Rail System

The rail system is different in nature from the road system, inasmuch as the infrastructure and operations occur within a single organisation (Tranz Rail) and thus issues of charging for infrastructure are internalised. For this reason, the comparison between external costs and charges on the rail system is different in nature, and less important, than for the road system. In regard to this comparison, the main findings are as follows:

‣ The main external costs imposed by the rail system relate to environmental impacts. These are estimated as in the order of $11 million p.a.

‣ Charges levied on the railway are relatively trivial, at about $0.2 million p.a. (relating to a local authority diesel tax).

‣ In addition, the railway system receives some public subsidies. These amount to some $26 million p.a. for public funding to the urban passenger services (Auckland and Wellington); plus arguably an amount representing any difference between the opportunity cost of the land leased (for a nominal sum) by Tranz Rail from Government and the amount that rights to land represented in the original sale price.

Other significant findings in relation to the rail system relate to its overall financial viability. Taking all sectors together, it was found that:

▸ Total system revenue is some $432 million p.a. (including $26 million public funding for the urban passenger services).

▸ Total recurrent costs are $331 million p.a. An appropriate capital charge to refurbish/ replace rolling stock to maintain broadly its present age and condition would add some $64 million, giving total costs of $395 million p.a.

▸ In the medium/long term, it will also be necessary to renew/replace selected infrastructure assets (e.g. track, signalling etc.). An appropriate capital charge on these assets (excluding land) is around $100 million p.a. This would increase total costs to $493 million p.a.

▸ It is evident that total railway system revenues are currently insufficient to allow for replacement/renewal of assets at a sufficient rate to keep the railway in a steady-state condition.

3.4.2   Marginal Cost Appraisal

Table 3.8 presents a summary of results comparing marginal provider/external costs and charges for urban passenger travel, long-distance passenger travel and long-distance freight transport. Further comments are given in the following sub-sections.

3.4.2.1   Urban Passenger Transport

Our appraisal has analysed typical trips by car, bus and train in Auckland (general), and between Waitakere and Auckland CBD, Wellington (general), based on:

▸ Travel between suburban areas and CBD
▸ Peak (commuter) trips and off-peak trips
▸ User pays full costs for parking
▸ Range of car occupancy levels (1-2 people/car).

The main findings in terms of comparisons between provider/external costs and current charges are, as summarised in Table 3.8:

Car

▸ Charges (fuel duty) are only a small proportion of provider/external costs (principally congestion externality costs). This is true in both peak and off-peak periods.

▸ If charges were to be set to cover marginal external costs, current charges would need to increase to ten-fold, (20-30¢/pkm) in the peak, up to five-fold (5-10¢/[km) in the off-peak.

TABLE 3.8: SUMMARY OF MARGINAL EXTERNALITY COSTS AND CHARGES COMPARISONS. All figures in ¢/pass km or ¢/net tonne km									
	Car/Truck			Bus/Coach			Train		
	Charge	Ext Cost	Charge: Cost %	Charge	Ext Cost	Charge: Cost %	Charge	Ext Cost	Charge: Cost %
Passenger Urban [1]									
Peak	2-3	20-40	c 10%	17-20	44-54	c 40%	9-15	12-24	50-75%
Off-peak	2-3	4-12	20%-50%	17-21	7-11	c 200%	9-15	0	1000% +
Passenger – Long Distance [2]	1-2	1-2	c 65%	8-11	10-12	c 80%-90%	12-171	6-8	c 150% - 240%
Freight – Long Distance	2-6	2-3	c 60%-200%				-	0.1-0.8	-

Notes: [1] *Relates to Auckland (general), Wellington (general) and Waitakere – Auckland CBD. Car figures focus on average car occupancies. – Covers car occupancies in range 1.0-2.0 persons/car*
(2) *Based on Auckland-Wellington and Picton-Christchurch travel. Car figures focus on average car occupancy (1-7)*
(3) *Assuming prices were to be set based on SRMC (and assuming no changes in costs if prices are varied).*

Marginal costs show the costs imposed by extra use of the service.
They do not reflect what charges would be necessary to recover the costs involved in the system.

Public Transport

▸ In peak periods, current user charges (fares) are around 40% of marginal provider/external costs for bus services, but a rather higher proportion (50% - 75%) for train services.

▸ In off-peak periods, current charges are substantially greater than marginal provider/external costs (these are close to zero for off-peak train services).

▸ If charges were to be set to cover only the marginal costs in both periods, then peak charges (fares) would broadly double, while off-peak fares would reduce by half or more.

3.4.2.2   Long-distance Passenger Transport

Our appraisal has been based on trips by car, coach and train between Auckland and Wellington and between Picton and Christchurch: these results could be applied broadly to other longer-distance passenger trips/minibus. Car travel has been considered at a range of occupancy levels (1 to 3 people/car).

The main findings in terms of comparisons between provider/external costs and current charges are (refer Table 3.8):

Car

▸ Charges (fuel duty) are somewhat less than (on average about two-thirds) the marginal provider/external costs. However, both provider/external costs and charges are small, typically around 5% of total travel costs.

▸ If charges were to be set to approximate to marginal external costs, current charges would need to increase by in the order of 50%, or around 1¢/passenger kilometre.

Public transport

▸ For coach travel, current user charges (fares) are rather less than marginal provider/external costs; whereas for train travel charges are significantly greater than the marginal costs (this reflects that, for trains, marginal costs are significantly below average costs).

▸ Setting charges to approximate to marginal costs would thus involve a small increase in coach charges, a more substantial reduction in train charges.

3.4.2.3   Long-distance Freight Transport

Our appraisal has focused on two main types of medium-long-distance freight movements, for which road/truck and rail/train are competitive modes: general freight movements (as in the Auckland-Wellington analysis), and bulk logging/forestry product movements (as in Napier-Gisborne and Kinleith-Tauranga). In part, our conclusions need to distinguish between these two types of movements.

In terms of comparisons between marginal provider/external costs and current charges, the main findings are (refer Table 3.8):

Truck

▸ Current charges (mainly RUC) are in most cases greater than the level of marginal provider/external costs (principally accident externalities and marginal road wear).

▸ If charges were to be set based on marginal costs, this would imply some reduction overall in current charges.

Train

▸ The main marginal external cost associated with rail freight transport is environmental impacts, although these are small relative to other cost items (most other costs are internalised within the rail business).

Two other findings from the freight appraisal are also worth noting:

▸ For the primarily rural movements analysed, the environmental impact costs are similar in magnitude by the two modes.

▸ For typical longer-distance general freight movements, which can be served by the rail network, both the operator cost rates and the marginal economic rates are quite similar for the two modes. This indicates that the choice of mode will often be finely balanced where it is dictated by either user cost considerations or economic considerations.

ANNEX A:

STUDY WORKING PAPERS

The following lists the current Working Papers prepared as part of the study, that are still relevant. (A number of earlier papers, not listed here, have now been superseded by or incorporated in the papers listed.)

Topic Areas

Infrastructure Valuation and Capital Charges

Valuation of NZ Road and Rail Infrastructure

Vehicle Ownership and Use Charges

Public Sector Transport Expenditure and Funding Flows

Review of Road Cost Allocation Model

Marginal Road Infrastructure Costs

Car Operating Cost Model

Truck Cost Model

Rail Freight Costs and Charges

Long-Distance Rail Passenger Services

Long Distance Coach Services

Costs of Urban Public Transport Operations

Road Congestion Costs

Social Costs of Road Crashes

Parking Costs and Charges

Environmental Costs

Case Studies

CS1:   Napier – Gisborne Freight

CS2:   Auckland – Wellington Freight

CS3:   Waitakere – Auckland Urban Passenger

CS4:   Kinleith – Tauranga Freight

CS5:   Picton – Christchurch Long-distance Passenger

ANNEX B:

SUMMARY OF ANALYTICAL FINDINGS

B1   Road and Rail Infrastructure Valuation and Capital Charges

B2   Public Sector Transport Expenditure and Funding Flows

B3   Road Infrastructure Maintenance and Operation

B4   Car and Truck Cost Models

B5   Rail Freight Costs and Charges

B6   Long-Distance Rail Passenger Services

B7   Long-Distance Coach Services

B8   Urban Public Transport

B9   Road Congestion

B10   Road Accident Costs

B11   Parking Costs and Charges

B12   Environmental Impact Costs

B13   Vehicle Ownership and Use Charges

ANNEX B1:

ROAD AND RAIL INFRASTRUCTURE VALUATION AND CAPITAL CHARGES

B1.1   Scope

This Annex summarises work on:

- approach to the valuation of infrastructure assets
- estimation of an appropriate rate of return on these assets
- valuation of NZ road and rail infrastructure assets
- derivation of the corresponding target return on the assets.

This work is relevant only to the Total Cost/Average Cost analyses, not to the SRMC analyses (which ignore past costs).

B1.2   Valuation Approach – Methodology and Findings

Our main findings on the appropriate approach to valuation of infrastructure assets for study purposes are as follows:

- The optimised depreciated replacement cost (ODRC) methodology is recommended as the basic approach to infrastructure valuation for study purposes. (Methods such as NPV are inappropriate in this case as they suffer from the 'circularity' problem.)

- Asset values should include land, valued at opportunity cost based on adjacent uses.

- Issues re optimisation and estimation of replacement costs ('greenfields' v 'brownfields') may warrant more detailed consideration subsequently.

- Depreciation profiles should be based on the economic depreciation of the infrastructure. (For some applications, average whole-of-life values may be more appropriate than depreciated values at any point in time.)

- These recommendations are generally consistent with those adopted by the NZ Commerce Commission in its determinations on the valuation of infrastructure assets in the electricity lines and telecommunications sectors.

- In the study context, there may be a strong case for expecting a return on infrastructure assets that have a significant opportunity cost in alternative use ('recoverable' assets); but the case for expecting a return on 'sunk' (non-recoverable) assets with no significant value in alternative use, is much more arguable. (This issue is discussed in more detail in Section 2.5 of this report.)

B1.3   Cost of Capital - Methodology and Findings

Our work reviewed evidence from a range of sources and studies in NZ and Australia, by regulatory authorities and others, on the weighted average cost of capital (WACC) appropriate for estimating a target return on NZ road and rail infrastructure assets in the study context. Sources reviewed included:

- The 'standard' rate applying to all NZ Government Departments and several Commercial Enterprises (Treasury Circular 2001/16, as updated).

- Recent NZ Commerce Commission determinations relating to airfield activities, electricity lines businesses and gas pipeline businesses.

▸ NZ Land Transport Pricing Study (1995)

▸ Reviews and determinations by various Australian regulatory authorities.

All the sources reviewed apply a Capital Asset Pricing Model (CAPM) approach in the estimation of WACC values (although different model variants are used in different cases). For study purpose, our focus is on WACC rates expressed in real, pre-tax terms.

The main findings from this review are as follows:

▸ The 'standard' NZ Government rate (nominal pre-tax) was 9.0% for 2001/02, 8.5% for 2002/03 and 2003/04. (Allowing for inflation of about 2% p.a., these convert to real rates of 6.9% and 6.4% approximately.)

▸ Studies by the Commerce Commission derived the following rates:

    –   International airports (2002)   :   range 8.4% to 9.3% nominal post-tax (about 10.3% to 11.6% in real pre-tax terms).

    –   Electricity lines (2003)   :   range 5.8% to 8.0% nominal post-tax (about 6.5% to 9.7% in real pre-tax terms).

    –   Gas pipelines (2004)   :   range 6.1% to 8.5% nominal post-tax (about 7.0% to 10.5% in real pre-tax terms).

▸ The NZ Land Transport Pricing Study (1994/95) derived a real (mid-point) rate of 6.4% appropriate to the NZ roading network.

▸ An Australian review (2002) of WACC values from recent decisions by regulators (10 cases) found all were within the range 6.1% to 8.2%, with a mean of 7.4% (real terms).

We also note that the British Surface Transport Costs and Charges Study simply applied the standard UK public sector discount rate of 6% (real) as its WACC rate. (The equivalent NZ discount rate is 10% real, as applied in the Transfund evaluation procedures.)

Based on our review findings, we have adopted the following WACC rates (pre-tax, real terms) as the basis for estimating the target return on NZ road and rail infrastructure assets in the study context:

▸ Central (point) estimate   :   7.0%

▸ Range (sensitivity testing)   :   6.0% to 8.0%.

B1.4   Road and Rail Infrastructure Asset Valuation – Methodology and Findings

Estimates were derived of infrastructure replacement costs and depreciated replacement costs for:

▸ State Highway network. These were based directly on information provided by Transit NZ from its annual SH valuation update at June 2002 (Opus Consultants).

▸ Local Road network. Depreciated replacement values were based on analyses of data from TLA Annual Reports for year 2001/02. Total (as new) replacement costs were then estimated approximately by applying the ratio (replacement cost: DRC) for local roads estimated in the Land Transport Pricing Study.

▸ Rail network. Estimates were based directly on two principal sources:

    –   Land – TRL estimates based on valuation of adjacent uses taken from recent roll/rating valuations

– Other infrastructure – based on a comprehensive appraisal undertaken for NZ Railways in 1988, updated to reflect subsequent asset acquisitions and the current estimated remaining proportion of asset life for each asset group, and then adjusted up to June 2002 prices (using CPI).

Table B1.1 provides our current estimates for replacement cost and depreciated replacement cost. Totals for road are $46.2 billion (replacement cost) and $37.3 billion (DRC); and for rail are $11.2 billion (replacement) and $7.7 billion (DRC).

Recognising the case for different treatment of different types of assets in applying an appropriate return (refer Section 2.5 and Section B1.2 above), we have separated these assets into three groups:

▸ **Recoverable, depreciating assets.** These comprise assets that depreciate and need to be periodically replaced, and have a significant opportunity cost in alternative use. These are principally rail track, signalling and telecommunications equipment.

▸ **Recoverable, non-depreciating assets.** These comprise assets that do not depreciate and do not need periodic replacement, but have a significant opportunity cost in alternative use. The only item in this category is land.

▸ **Non-recoverable assets**. These are specialised ('sunk') assets that have no opportunity cost in alternative use, and generally do not need to be replaced (or only over a very extended timescale). These include formation, tunnels and bridges (both road and rail).

The lower section of Table B1.1 provides estimates of DRC for assets (road/rail) in each of these three categories. For road, the recoverable assets account for 28% of the total assets; while for rail the corresponding proportion is 24%.

B1.5   Road and Rail Target Returns – Findings

As noted above, it was determined that the economic rates of return on road and rail infrastructure assets should be based on the estimation of a weighted average cost of capital (WACC) within a Capital Asset Pricing Model (CAPM) framework. The appropriate WACC rates were a central estimate of 7.0%, with a range between 6.0% and 8.0%.

Table B1.1 also shows the target returns on road/rail infrastructure on this basis:

▸ For the road system, the target return on total assets is $2.6 billion p.a. (range $2.2 billion - $3.0 billion). Of this amount $0.75 billion p.a. (range $0.64 billion - $0.86 billion) relates to the 'recoverable' assets.

▸ For the rail system, the target return on total assets is $0.54 billion p.a. (range $0.46 billion - $0.62 billion). Of this amount, $0.13 billion p.a. (range $0.11 - $0.15 billion) relates to the 'recoverable' assets, of which slightly under $0.10 billion p.a. relates to depreciating assets.

B1.6   Comments on Areas of Uncertainty

Given the relative importance of the return on asset figures in the overall assessment of Total Costs, we note several areas of uncertainty in these estimates, as follows:

▸ **Precision of replacement cost figures**. We note that the State Highway estimates are the subject of detailed valuation studies; but that the estimates for local roads and rail are likely to be subject to somewhat lower precision.

‣ **Depreciation assumptions**. We note that a considerable degree of professional judgement is involved in the assessment of the proportion of asset life expended, and the resultant estimates will be subject to significant uncertainty (with possibly different biases in the three sectors). We note in particular that the rail evaluation assumes depreciation of 'formation' costs, while that for state highways assumes no depreciation: if state highway formation was assumed depreciated in the same proportion as for rail, this would reduce its DRC value by about $0.9 billion.

‣ We also note that depreciation has generally been calculated on a straight-line basis over estimated asset lives. In practice (considering 'recoverable' assets), economic depreciation typically follows more closely to a diminishing value curve (i.e. the annual depreciation is a constant proportion of the value at the start of the year). If this is the case, then all the DRC estimates derived are likely to significantly over-state the true (economic) values.

‣ **WACC values**. As is evident from Table B1.1, the range of WACC rates account for a range of some $900 million p.a. in the appropriate total return on infrastructure assets.

‣ **Opportunity costs**.   If closure of parts of the rail or road system were being contemplated, then the relevant valuation concept is opportunity cost, being the value of the asset in its best alternative use. This would typically be significantly less than the DRC values presented here, as it has to allow for the costs of conversion to the alternative use (e.g. to convert road or rail tracks to farming use).

Chapter 3 of the report includes sensitivity tests on the target returns on assets, which attempt to cover the various factors above.

TABLE B1.1: SUMMARY VALUATION AND RETURN ESTIMATES							
	Replacement Cost		Depreciated Repl Cost		Return on DRC at:		
Item	Total $B	Per Route Km $M	Total $B	Per Route Km $M	6% $M	7% $M	8% $M
Roads:							
State Highways	14.78	1.37	11.95	1.11	717	837	956
Local Roads	31.37 [1]	0.38 [2]	25.36	0.31 [2]	1522	1775	2029
Sub total	**46.15**		**37.31**		**2239**	**2612**	**2985**
Rail	**11.18**	2.87[3]	**7.73**	1.98	**464**	**541**	**618**
Grand Total	**57.33**		**45.04**		**2703**	**3153**	**3603**
Analysis by Asset Category:							
Recoverable, depreciating							
Road			-		-	-	-
Rail			1.40		84	98	112
Recoverable, non-depreciating (land)							
Road			10.71		643	750	857
Rail			0.46		28	32	37
Non-recoverable							
Road			26.60		1596	1862	2128
Rail			5.87		352	411	470

Notes: [1] *Derived from DRC estimate, based on estimated ratio RC: DRC of 1.237 for local roads, derived in LTPS analyses.*

(2) *Based on 81,598 LR km (Tfd Draft Roading Statistics at June 2002).*

(3) *This is because a higher proportion is bridges and tunnels.*

ANNEX B2:

PUBLIC SECTOR TRANSPORT EXPENDITURE AND FUNDING FLOWS

B2.1   Scope

This Annex summarises public sector transport expenditures, sources of funds and funding flows for 2001/02. Figures have been derived from a variety of sources, principally:

‣ Ministry of Transport
‣ Transfund NZ
‣ Accident Compensation Corporation.

All figures are provided on an accrual basis, GST exclusive.

B2.2   Sources of Funds – Findings

Table B2.1 summarises the main sources of funds raised:

‣ Total funds raised were $2.71 billion.

‣ Almost 83% of this amount comes from direct charges on motorists, through fuel duties, road user charges and motor vehicle licences/registration.

‣ A further 13% comes from local authority rates (TLAs and RCs), levied on all ratepayers.

Table B2.1: Main Sources of Transport Funds		
Funding Sources	**$Million**	**%**
Fuel Duties	1,092.606	40.2%
Road User Charges	583.711	21.5%
Motor Vehicle Licensing and Registration	567.605	20.9%
Local Authority (Transport) Rates	290.595	10.7%
Regional Council Rates	60.884	2.2%
Police Fines	81.6	3.0%
Government Funding for Fire Services	20.0	0.7%
Motor Vehicle Insurance Charge Fire Levy	17.9	0.7%
Total	**2714.9**	

Note: All figures relate to 2001/02, accrual basis and GST exclusive.

B2.3   Categories of Expenditure – Findings

Table B2.2 summarises the main categories of expenditure for the funds raised:

‣ The total of $2.7 billion may be split into transport 'capital' items (14.1%), transport re-current items (55.9%), other transport non-recurrent items (5.9%) and non-transport items (24.2%).

‣ The main transport 'capital' items are improvements to state highways and local roads (14.0%).

‣ The main transport recurrent items include road infrastructure maintenance and operations (27.8%), accident compensation relating to current year claims (9.7%), police traffic/safety duties (6.4%) and public transport operating support (5%).

- The 'other transport non-recurrent' item comprises 'catch-up' funding of accident claims from prior years (4.6%).

- The main non-transport item is the contribution to the Crown Account from fuel duties (some $547 million, 20.1% of the total) and police fines ($82 million, 3.0% of the total).

Table B2.2 Main Sources of Transport Expenditure		
Expenditure Category	**$Million**	**%**
Transport Capital		
State Highways	267.628	
Local Roads	101.324	
Alternatives to Roading	8.792	
Public Transport Capital	3.813	
Sub-Total	**381.556**	**14.1%**
Transport Recurrent		
State Highways (O&M)	265.106	
Local Roads (O&M)	489.861	
Public Transport (O&M)	124.243	
ACC - Current Claims	263.757	
LTSA - Safety and Admin	36.262	
Police Safety Enforcement	173.400	
Fire Services	37.900	
MoT Admin	53.067	
Transfund Roading Program Admin & Misc	72.810	
Sub-Total	**1,516.429**	**55.9%**
Other Transport Non-Recurrent		
ACC - Prior Claims	160.496	
Sub-Total	**160.496**	**5.9%**
Non Transport Items		
Crown Account – Fuel Excise	546.659	
Crown Account – Police Fines	81.600	
Crown Minerals (Energy Resource Levy)	1.049	
Local Authorities General Use (Petroleum Tax)	25.747	
Energy Markets Information and Services (Petroleum Fuels Monitoring Levy)	1.196	
Sub-Total	**656.251**	**24.2%**
Grand Total	**2,714.7**	**100%**

Note: All figures relate to 2001/02, accrual basis and GST exclusive.

B2.4. Funding Flows – Findings

The diagram following summarises the flow of funds through the system, from funding sources to final expenditure

NOT GOVERNMENT POLICY

(1) Motor Vehicle Licensing & Registration $567.6

(1) Road User Charges $583.7

(1) Fuel Duties $1092.6

(1) Police Fines $81.6

(2) Motor Vehicle Insurance Charge (Fire service levy) $17.9

$202.6 — $8.3 — $583.7 — $456.8 — $160.5 — $196.2 — $61.2 — $546.7 — $1.2 — $81.6 — $1.0 — $25.7 — $17.9

(5) LTSA $8.3 - Safety Standards Levy and Audit and Standards Levy

(6) National Roads Fund $1248.6 (includes $11.9 unspent)

(7) ACC $160.5 - Prior Claims

(7) ACC $263.8 - New Claims

(8) Crown Account $628.3

(9) Energy Markets Info and Services Group Petroleum Fuels Monitoring Levy $1.2

(9)Crown Minerals Group Energy Resource Levy $1.0 -consolidated fund

(9) Local Authorities $25.7 - for local council general use

$27.9 — $53.2 — $982.1 — $173.5 — $20.7

(10) LTSA $27.9 - Land Transport Auditing, Policy Advice, - Safety Info and Promotion, Community Road Safety project

(11) MoT $53.2 - MVR and RUC Admin

(11) Transfund National Roading Program $982.1

(11) Police $173.5 - Safety enforcement

(12) ACC MVA Transported by Ambulance $6.5 ACC Administration $14.2

(13) Fire Services Costs $37.9

$72.8 — $65.7 — $302.5 — $532.7 — $8.4

(14) Administration $72.8 (includes $15.9 of unspent funds)

(15) Regional Council - Passenger Transport Capital $2.4 Recurrent $63.4

(15) Local Authorities - Local roads Capital $53.0 Recurrent $249.5

(15) Transit -SH program Capital $267.6 Recurrent $265.1

(16) Alternatives to Roading $8.8

$65.7 — $302.5

(17) PT Program Capital $3.8 Recurrent $124.2

(18) LA Roading Program Capital $101.3 Recurrent $489.9

$0.4

$60.9 — $1.4 — $288.7 — $20.0

(4) Regional Council Rates $60.9

(3) Local Authorities Transport Rates $290.5

(2) Government Funding - Fire Services $20.0

NOT GOVERNMENT POLICY

NOT GOVERNMENT POLICY

ANNEX B3:

ROAD INFRASTRUCTURE MAINTENANCE AND OPERATION

B3.1   Scope and Approach

This Annex summarises work on the SRMC associated with the maintenance and operation of road infrastructure, i.e. the marginal road system maintenance/operation costs associated with an additional trip (vehicle kilometre) at the current road system capacity and level of service.

Total costs of road maintenance and operation in NZ are approximately $800 million p.a.

Three main approaches were investigated to estimate the SRMC for road infrastructure operation and maintenance, by road type and vehicle type:

‣ **Augmented RCAM** approach. This approach essentially uses the MoT Road Cost Allocation Model (RCAM) use-related cost allocations to derive variable cost rates (per vehicle km, gross tonne km and ESA km). For this approach, the inputs costs to the model were refined through a more detailed breakdown by road type than is used in the original model.

‣ **Adjusted RCAM/dTIMS Variable Cost** approach. This approach involves:

  – Applying the NZ-dTIMS predictive pavement model to synthesise the level and type of optimum maintenance expenditure over time, for roads in defined traffic volume classes

  – Derive therefrom the variable cost rates with traffic volume for different types of maintenance expenditure

  – Use these rates to adjust relevant cost rates in the Augmented RCAM approach.

‣ **dTIMS Marginal Analysis** approach. This approach involves applying the dTIMS model for a given 'base' traffic loading (ESAs), as above; and then re-applying the model with a marginal (10%) increase in traffic volumes, to derive incremental maintenance costs.

B3.2   Results and Appraisal

Table B3.1 summarises the key results from the three approaches, in terms of their averaged use-related variable costs (structural maintenance only) for state highways: these results have been translated into equivalent rates per ESA kilometre (EKT).

Key features of these results include:

‣ The **Augmented RCAM** variable cost rate averages 4.9¢/EKT: this represents a 4.6% increase in structural maintenance expenditure for a 10% increase in EKT. This rate is essentially consistent with the variable cost rates in the original RCAM model.

‣ The **Adjusted RCAM** cost rate (3.6¢/EKT) is not far removed from the Augmented RCAM figure for structural maintenance (4.9¢/EKT). The Adjusted RCAM figure reflects an improved allocation of structural maintenance expenditures between variable and residual components, in the light of the dTIMS variable analyses.

‣ The **dTIMS Marginal** cost rate (0.8¢/EKT) is very low relative to the RCAM-based figures, whereas it would have been expected that the different approaches would give

broadly similar results. Further appraisal identified a number of reasons why the dTIMS Marginal figures are likely to understate the true marginal costs.

B3.3   Conclusions and Recommendations

In the light of these results and appraisals, we recommend that the **Adjusted RCAM** approach and outputs be adopted as providing the best estimates of SRMC for study purposes. These outputs are based on a combination of average use-related allocations derived from dTIMS for structural maintenance expenditure categories and engineering judgement on the remaining categories (e.g. Traffic Services).

Table B3.2 presents the Adjusted RCAM figures (per VKT) by vehicle type and road type, and also shows the Augmented RCAM figures for comparison.

Given the range of results found under the three approaches, some further appraisal may be desirable of the reasons for the differences. However, it might be noted that, under all three of the approaches, the SRMC estimates are only a small proportion (under 50% in each case) of the current road user charges for heavy vehicles.

TABLE B3.1 SUMMARY OF RESULTS, USE-RELATED VARIABLE COSTS		
Approach	**Average Use-related Variable Costs - Structural Maintenance, State Highways ¢/EKT**	**Notes**
Augmented RCAM	4.9	Represents 4.6% increase in structural maintenance expenditure for 10% increase in EKT
Adjusted RCAM/dTIMS Variable	3.6	Reduces with traffic volume: lowest volume bands 4.0 to 4.5, highest volume bands 2.9.
dTIMS Marginal	0.8	Reduces with traffic volume: lowest volume band 1.3, highest volume band 0.6. Increases for larger changes in traffic volume. Represents 0.9% increase in structural maintenance expenditure for 10% increase in EKT.

TABLE B3.2: MARGINAL ROAD INFRASTRUCTURE COSTS							
Method	**Road Type**	**Marginal Cost by Vehicle Type (¢/VKT)**					
		Car	**Lcv**	**Mcv**	**Hcvl**	**Hcvll**	**Bus**
Adjusted RCAM (Recommended)	Urban SH	0.1	0.4	1.4	3.3	6.9	3.7
	Rural SH	0.2	0.4	1.6	3.7	7.4	4.0
	Motorway	0.1	0.4	1.4	3.2	6.7	3.6
	Urban Local	0.1	0.6	2.4	5.6	11.7	6.3
	Rural Local	0.4	1.2	4.4	10.3	20.8	11.2
	Unsealed	0.4	1.0	3.3	7.5	15.6	8.5
Augmented RCAM	Urban SH	0.2	0.7	2.2	5.1	10.6	5.7
	Rural SH	0.5	0.9	2.8	6.1	12.0	6.6
	Motorway	0.3	0.8	2.5	5.6	11.6	6.3
	Urban Local	0.3	0.9	3.5	8.2	17.1	9.2
	Rural Local	0.5	1.6	5.4	12.3	25.9	14.0
	Unsealed	2.1	3.1	6.7	13.3	26.4	15.1

ANNEX B4:

CAR AND TRUCK COST MODELS

B4.1   Scope

This Annex summarises work on the development of cost models of car and truck operation in NZ. The work focussed on:

‣ A car cost model for the average private car (petrol-powered)
‣ A truck cost model for 'heavier' (HCVII) trucks, which provide the main longer-distance road freight haulage in situations competitive with rail.

In each case the work:

‣ separated resource costs from Government charges
‣ included vehicle capital costs (on an average annualised basis)
‣ addressed both average costs and marginal costs.

B4.2   Findings – Cars

Table B4.1 summarises the car cost model: this was based on the AA cost model with some adjustments (particularly for vehicle lives).

Costs have been shown in fixed (per year) and variable (per kilometre) components. (In general for private modal choice the variable component only is relevant.)

Note that no time costs have been included in the model formulation: these are added in separately where required for analysis purposes.

The basic model has been developed in terms of GST-inclusive costs. Costs are also shown separately (in brackets in the table) on a GST-exclusive basis.

B4.3   Findings – Trucks

Table B4.2 summarises the truck cost model: this is based on work undertaken for the Transit 'Heavy Vehicle Limits' project, suitably adjusted and updated. The model is based on costs for heavier trucks (average payload exceeding 10 tonnes), which would be typical of trucks competitive with the rail alternative.

Costs are shown on two alternative bases:
‣ Per vehicle kilometre (including both 'fixed' and 'variable' components).
‣ Per net tonne kilometre (derived using average payload estimates).

These costs are average (or total) costs, including time costs and an operator profit margin (and generally corresponding to average charges, given the competitive incentive of the industry). However, given the nature of the trucking industry and for the purposes of this study, they may be also be taken as a reasonable estimate for marginal costs.

TABLE B4.1: CAR COST MODEL – SUMMARY[1]			
Cost Item	**Fixed Cost - $/veh p.a.**		**Variable Cost[4]** **- ¢/veh km**
	Capital	**Operating**	
Resource Cost [2]	3196 (2841)	429 (381)	15.8 (14.0)
Charges [3]	-	-	195 (173)	3.4 (3.0)
Total Financial Cost	3196 (2841)	994 (884)	19.2 (17.0)

Notes: [1] Costs are shown including GST (unbracketed) and excluding GST (bracketed)
[2] Based on 20 year life, including average annualised capital charge (6.6% rate of interest)
[3] Covers vehicle licensing/registration and petrol duties (39.2¢/litre).
[4] Variable costs relate to urban operation in 'interrupted' traffic conditions (traffic level of service C/D), based on a petrol price of $1.05/litre (GST inclusive). Different costs will apply in other conditions (refer Car Operating Cost Model working paper for more details).

TABLE B4.2: TRUCK COST MODEL – SUMMARY [1]		
Cost Item	**Cost per Veh km (¢)**	**Costs per Net Tonne Km (¢)** [2]
Resource Cost [2]	126.2	9.7
Charges [3]	42.6	3.3
Total Financial Cost	168.7	12.9

Notes: [1] Model relates to 'HCVII' category, i.e. heavy trucks with average payload exceeding 10 tonnes – which account for the majority of long-distance truck haulage in NZ. Costs exclude GST.
[2] Based on estimated average payload of 13.1 tonnes.
[3] Covers road user charges and vehicle licensing/registration.

NOT GOVERNMENT POLICY

ANNEX B5:

RAIL FREIGHT COSTS AND CHARGES

B5.1   Scope and Approach

Tranz Rail has a highly sophisticated traffic and cost database, but uses a cost allocation model for product costing and pricing that allocates all costs over all products. It therefore effectively assumes all costs are variable with traffic (in the long term). While this may be appropriate for its purposes, it does not provide the long-run variable or short-run marginal costs required by this study.

We therefore developed a more sophisticated line-haul costing model that takes specific cognisance of the way the costs are built up. The model is in three parts:

▸ An operational model that takes the freight demand and allocates it to trains. The output of this model is train and wagon movements by route (service) and tonnage by track section.

▸ A train costing ('above rail') model that calculates the running costs for a particular traffic pattern.

▸ An infrastructure costing ('below rail') model that calculates the track maintenance and capital costs.

The operational model has been calibrated to provide a reasonably accurate fit to operational data provided by Tranz Rail. The model shows that bulk trains operate at around 80% of their capacity, while overall, non-bulk trains operate at an average of about 50% of their capacity. We have assumed that these ratios are the result of operational constraints (unpredictability/ variability of loads offering, traffic imbalances, allowances to ensure reliability, etc.) and that the same ratios would hold at higher tonnages. This assumption may be varied in some cases if appropriate.

'Above rail' costs are basically all volume-variable, but some costs only increase in reasonably large increments, reducing the impact of changes at low volumes. The number of trains per week is usually constrained for marketing and operational reasons to ensure the same number of trains per day, with a lesser number operating on Saturdays and Sundays. For low volume lines, the first effect of increased volumes is to increase train sizes. For bulk traffic, the schedule is also on a fixed number of trains per day, although there may be a limited degree of flexibility if demand is reduced. However, in general, above rail costs are not very variable in the short term unless resources can be profitably used elsewhere at short notice.

Below rail costs are ultimately variable: as tonnages increase, the standard of track (rail weight, sleeper spacing, etc.) is raised accordingly. However for any given standard of track, much of the maintenance cost is dependent on the length of track to be maintained. As a result, the short run marginal cost is relatively low.

The cost estimates derived include, for all replaceable assets (i.e. those having an opportunity cost through an alternative use), appropriate capital charges based on unit replacement costs, estimated economic life and a weighted average cost of capital (WACC) of 7% p.a. (real). These capital charges have been included in both the 'above rail' cost (locomotives and wagons) and the 'below rail' costs (track, signals, telecommunications). No charges have been included in these analyses for land, formation, bridges and tunnels (although they are included in the overall Total Costs appraisal presented in Chapter 3).

The line-haul model includes the shunting task, but not any pick up/delivery task or any handling (loading/unloading) task. The costs and revenues associated with these tasks have been assessed separately, to derive rates (per tonne, per container etc.) applying where appropriate. (Tranz Rail allocates a portion of traffic revenues to each of these functions where appropriate, based on either external costs paid or internal charges. We have adopted the same assumptions to derive pick up/delivery and handling revenues: the remaining revenues are then allocated against the line-haul task.)

B5.2   Findings – Line Haul Task

Table B5.1 shows, for the line-haul task only, the overall average costs for the existing traffics, the marginal costs for bulk and non-bulk traffics (on average) and the average revenues for each of Tranz Rail's business groups. All figures relate to 2001/02 and are given per net tonne kilometre (our analyses indicated that line-haul cost and revenue rates are relatively insensitive to distance).

Key conclusions in terms of **total costs and average costs** include:

▸ Average costs are a system-average of 10.88¢/NTK, equivalent to $30.00/net tonne.

▸ Average costs may be split between operating costs (58% of total, about one-quarter of which is 'below rail') and capital charges (42%, more than half 'below rail').

▸ Average revenues of 8.83¢/NTK are significantly lower than average costs (but are sufficient to cover all cost categories other than 'below rail' capital charges). This indicates that the business is failing to earn an economic return on the replacement cost of track and other replaceable assets: however, it should be noted that the price Tranz Rail paid for these assets was heavily discounted relative to their replacement values.

Key conclusions in terms of **marginal costs** include:

▸ Marginal cost rates overall are about 65% of average cost rates. The principal differences between marginal and average cost rates relate to the 'below rail' components, for both operating costs and capital charges.

▸ Marginal cost rates for bulk traffics (4.5¢/NTK) average around 52% of the costs for non-bulk traffics overall (8.7¢/NTK). (We have not attempted to split average costs between bulk and non-bulk traffic, given the significant element of jointness in many cases.)

B5.3   Findings – Pick up/Delivery and Handling Tasks

As noted above, Tranz Rail allocates revenues to the pick up/delivery and handling tasks based on either external (contract) charges or internal costs of these functions.

For those traffics requiring pick up/delivery and handling, the effective average costs/charges average about $16/tonne for less-than-container-load (LCL) goods and about $7/tonne for goods in containers. (These rates are relevant when comparing costs for freight transport between rail and road.)

TABLE B5.1: RAIL FREIGHT LINE-HAUL AVERAGE COST AND REVENUE SUMMARY					
Item	**Rates - ¢ net tonne km** [1]				
	Operating Costs		**Capital Charges**		**Total**
	Above rail	**Below rail**	**Above rail**	**Below rail**	
Average Costs	4.80	1.49	2.04	2.56	10.88
Overall Revenue					8.83

Notes: [1] All figures relate to line-haul task only (see text), based on 2001/02 statistics.

ANNEX B6:

LONG-DISTANCE RAIL PASSENGER SERVICES

B6.1 Scope

This annex presents our appraisal of the remaining long-distance rail passenger services in New Zealand. Since 2001, these have been operated by Tranz Scenic (2001) Ltd. The business comprises 5 distinct services and our appraisal has considered each of these separately:

- The Overlander — Auckland – Wellington daylight
- The Northerner — Auckland – Wellington night
- The Tranz Coastal — Picton – Christchurch (connecting with Interislander)
- The Tranz Alpine — Christchurch – Greymouth
- The Capital Connection — Palmerston North – Wellington (commuter service).

Our appraisal of the existing business has been based heavily on statistics provided by Tranz Scenic in general relating to calendar year 2002. We have also estimated marginal costs based on our own assessment as to how service would be varied (through running longer trains) in response to increasing demand.

B6.2 Findings

Our main findings are summarised in Table B6.1. Key features include:

- The current business carries some 516,000 passengers (128 million passenger km) per year on scheduled services, with corresponding revenue of $22.3 million. A further $1.05 million is earned from charter services. (Net total revenue was $22.7 million, after allowing for adjustments relating to catering, commissions and rentals.)

- Overall average fares (net of GST) were 17.4¢/pass km.

- Net revenues overall for the five services averaged 16.2¢/pass km, slightly greater than the total cost (including capital replacement) of 15.9¢/pass km.

- Marginal costs (including capital replacement) are typically around 55% of average cost on each of the service (range 51% to 60%).

ANNEX B7:

LONG-DISTANCE COACH SERVICES

B7.1   Scope

▸ This Annex presents our appraisal of long-distance (inter-urban) scheduled coach services in New Zealand. It attempts to cover all the main scheduled services, but excludes tour services.

The appraisal is based on:

▸ Analyses of timetables and fare scales
▸ Detailed data on patronage and revenues for year 2002 from InterCity Group (InterCity and Newmans Coaches), the dominant operator in New Zealand.
▸ Various other BAH sources (for unit costs, etc.).

B7.2   Findings

Table B7.1 provides a summary of the appraisal results for the existing operations. Key findings include:

▸ Total 1.4 million passenger trips, with average trip length of 230km and (weighted) average load of 16.4 passenger km/vehicle km (large coaches).

▸ Total passenger revenue of about $38 million, equivalent to $27 per passenger trip or abut 12¢/passenger km.

▸ Total operating costs of about $37 million, including economic capital charges for vehicle replacement (i.e. slightly less than total revenue).

In general, we consider marginal costs (for additional passengers) will approximate to existing average costs, taking a medium-run view. While there will be many instances where additional passengers can be accommodated on existing services at close to zero marginal cost, a 10% (say) increase in overall demand is likely to result in a broadly 10% increase in services (coach km) and costs in the medium run.

TABLE B7.1: SUMMARY OF FINDINGS (Approximate)		
Item		**Total Coach Operations** [1]
Total Coach Km	(mill)	24.0
Total Operating Costs	($ mill) [2]	37
Passengers	(mill)	1.4
Passenger Km	(mill)	320
Passenger Revenue	($ mill)	38
Average Trip Length	(km)	230
Ave Rev/Passenger	($)	27.2
Ave Rev/Passenger Km	(¢)	12.1
Passenger Km: Coach Km (average load) [3]		16.4

Notes [1]   All figures relate to calendar year 2002 and exclude GST.
[2]   Includes economic capital charge for vehicle replacement
[3]   Based on typical large coaches (c. 53 seater).

ANNEX B8:

URBAN PUBLIC TRANSPORT

B8.1 Scope

This Annex summarises work on the economic costs of urban public transport (bus and rail) operations in New Zealand. It covers average operator costs, marginal operator costs and marginal user costs (economies of scale).

The main analyses are based around the Auckland bus system (which may be taken as broadly representative of bus services in the other main centres) and the Auckland and Wellington rail systems.

B8.2 Findings

The main findings are summarised in Table B8.1. Points of note include the following:

Total Costs and Average Costs and Charges

‣ Overall cost recovery (i.e. fare revenue: total costs) is about 55% for both the Auckland bus and Wellington rail systems, about 35% for the Auckland rail system.

‣ Average passenger trip lengths are very different in the three cases – about 7km for Auckland bus, 15km for Auckland rail and 24km for Wellington rail: these differences influence many of the results.

‣ Average fares for both the rail systems are around 65% greater than for Auckland bus on a per passenger basis. On a per passenger km basis, the rail fares are in the order of half the Auckland bus fares.

‣ Gross costs for the rail service are around 65% greater (Wellington) and 140% greater (Auckland) than for Auckland bus, on a per passenger basis. On a per passenger km basis, costs for Auckland rail and Auckland bus are similar, but Wellington rail costs are under half this figure.

Marginal Costs and Charges

‣ In peak periods, additional passengers would require pro rata increases in services for both rail and bus systems: for the rail services, it is assumed these would be achieved by running longer trains rather than more trains, and acquiring refurbished or second-hand rolling stock. The resultant marginal operator costs are $3.15 per passenger for Auckland bus, $2.50 for Wellington rail and $3.45 for Auckland rail. On a per passenger km basis, the Wellington rail rate is about half the Auckland rail rate, which in turn is about half the Auckland bus rate.

‣ In off-peak periods, for Auckland bus, estimated marginal operator costs are about one-third of average (off-peak) costs. For Wellington and Auckland rail, marginal operator costs are close to zero as ample spare capacity exists on the existing services.

‣ Marginal user costs (user economies of scale) apply in the case of Auckland bus. These vary over a range, largely reflecting different service frequencies. Marginal user costs are zero for Wellington rail and Auckland rail, as service frequency is assumed not to vary at the margin.

‣ Overall for Auckland bus, in the peak periods net marginal cost (operator plus user) is in the range 27-40 ¢/pass km, compared with the average fare of 20¢/pass km. In the off-

peak, net marginal costs are 2-7¢/pass km, compared with the average fare of 21¢/pass km.

▸ For Auckland rail, in the peak periods marginal costs of 23¢/pass km are approaching twice the average fare (13¢/pass km). For Wellington rail, in the peak periods marginal costs of 10¢/pass km are only slightly greater than the average fare (9¢/pass km). In both cases, off-peak marginal costs are close to zero.

TABLE B8.1: SUMMARY OF FINDINGS – ALL STATISTICS 2001/02									
Item	**Auckland Bus**			**Auckland Rail**			**Wellington Rail**		
	Total	**Peak**	**Off-peak**	**Total**	**Peak**	**Off-peak**	**Total**	**Peak**	**Off-peak**
Total Costs ($M) [1]	96.5			12.8			39.2		
Total Fare Revenue ($M)	54.1			4.5			21.7		
Total Public Funding ($M)	42.3			8.3			17.5		
Cost Recovery (%)	56%			35%			55%		
Average Fares ($)									
Per Passenger	1.38	1.41	1.36	2.00			2.14		
Per Passenger km	0.21	0.20	0.21	0.13			0.09		
Average Costs ($)									
Per Passenger	2.34	3.15	1.82	5.69			3.86		
Per Passenger km	0.35	0.45	0.28	0.37			0.16		
Marginal Operator Costs ($)									
Per Passenger		3.15	0.60		3.45	zero		2.50	zero
Per Passenger km		0.45	0.09		0.23	zero		0.10	zero
Marginal User Costs ($)									
Per Passenger		(-) 0.32 to (-) 1.28	(-) 0.12 to (-) 0.48		zero	zero		zero	zero
Per Passenger km		(-) 0.05 to (-) 0.18	(-) 0.02 to (-) 0.07		zero	zero		zero	zero

Notes: [1] Calculated as fare revenue plus public funding.

ANNEX B9:

ROAD CONGESTION

B9.1   Scope

This Annex summarises work on the total, average and marginal (externality) costs of road traffic congestion in NZ. For this purpose, 'congestion' has been defined in terms of the excess travel time relative to time in 'free-flow' conditions.

The costs of congestion have been estimated in four types of situations:

‣ Three main centres (Auckland, Wellington, Christchurch) – recurrent congestion. Estimates were derived mainly using the regional/district transport models in each case. These were also compared against the recent Auckland/Wellington work by Transit NZ to assess congestion indices (CGI), and adjustments made where the model results seemed implausible. The fixed trip matrix modelling results were then factored down to allow for 'secondary' effects (e.g. trip redistribution, retiming etc.), based on previous work undertaken: reduction factors of up to 50% (depending on the level of congestion) were applied.

‣ Other urban centres – recurrent congestion. Indicative estimates were made.

‣ Inter-urban (state highway) network – recurrent congestion. Estimates were based on the Transit NZ passing lanes model (PEM Appendix A10).

‣ Non-recurrent congestion, due to incidents such as accidents, breakdowns and road-works. Indicative estimates were made based on previous work on the effects of incidents on traffic flows.

In each case, congestion was valued by applying standard values of time savings (Transfund PEM), including allowance for the increases in values with increased levels of congestion. In urban situations an allowance has also been included for increases in vehicle operating costs in congested conditions.

B9.2   Findings – Total/Average Costs

The main findings are summarised in Table B9.1. Key points include:

‣ The total cost of congestion in NZ is in the order of $1.0 billion ($1000 million) per year.

‣ Over 90% of this congestion occurs in the three main centres, and over 70% of it in Auckland.

‣ Average costs of congestion in the three main centres are in the range 18¢/VKT (Auckland) to 9¢/VKT (Christchurch) in the peaks, and 8¢/VKT (Auckland) to 2¢/VKT (Wellington, Christchurch) in the off-peak.

‣ On the inter-urban network, average congestion costs average about 0.3¢/VKT, and only exceed 1¢/VKT in a small minority of situations.

B9.3 Findings – Marginal Externality Costs

The main findings relating to the marginal externality costs of congestion are set out on the RHS of Table B9.1. Key findings include:

‣ Marginal externality congestion costs in the three centres range between 36¢/VKT (Auckland) and 23¢/VKT (Christchurch) in the peak periods, between 16¢/VKT (Auckland) and 6¢/VKT (Wellington, Christchurch) in other periods.

‣ By comparison, congestion costs are relatively low on the inter-urban (state highway) network. Even on the more heavily trafficked portions, marginal externality costs are only in the order of 1¢/VKT on average, but up to about 10¢/VKT for trucks on the most congested sections.

B9.4 Comments on Sensitivity of Results

Given the magnitude of the congestion costs (both total and marginal) relative to values in other components of the study, and given the difficulties in estimating the congestion costs, we note the following points in particular relating to the potential uncertainty in the results:

‣ The regional transport model total/average and marginal congestion cost estimates for Wellington in the off-peak period were multiplied by 2.0, to better reflect professional judgements on relative congestion levels. Similarly, the Christchurch off-peak model results were multiplied by 0.5.

‣ The resulting (adjusted model) average cost estimates for Auckland and Wellington were checked against the Transit CGI (observed) average cost estimates, for peak and off-peak periods. These comparisons appear reasonable, noting that the CGI estimates themselves are subject to significant uncertainty.

‣ The total national congestion cost estimates are dominated by Auckland's congestion, and hence are not sensitive to the above adjustments of the Wellington and Christchurch model results.

‣ The marginal congestion cost rates in all three centres (which are a key component in the overall study marginal cost analyses) are sensitive both to the initial estimates (adjusted model figures) and the reduction factors for 'secondary' effects: these factors are in the range 21% to 50% in the peaks, 2% to 13% in the off-peak. Reliable estimation of these secondary effects is a difficult technical area. Uncertainties in these effects will have the greatest impact on the marginal rates for the peak periods.

TABLE B9.1: SUMMARY OF CONGESTION COST FINDINGS									
Situation	**Total Cost - $m p.a.**			**Average Costs - ¢/VKT**			**Marginal Externality Costs - ¢/VKT [1]**		
	Total	**Peak**	**Off-pk**	**Total**	**Peak**	**Off-pk**	**Total**	**Peak**	**Off-pk**
Main Urban Centres									
Auckland	701	320	381	11	18	8		36	16
Wellington	101	80	21	6	12	2		28	5
Christchurch [2]	77	57	20	4	10	2		23	6
Other Urban Centres									
Other centres with population >50,000	36				5 [4]				
Inter-urban SH network									
Sections analysed [3]	28			0.7 [3]			1.4 truck, 0.9 car		
Remaining rural SH	5								
Total rural SH network [3]	33			0.3			0.7 truck, 0.4 car		
Incidents	20								
Total	961								

Notes:
[1] These figures for the main urban centres have been adjusted to allow for 'secondary' effects from changes in the level of congestion (e.g. peak spreading, modal change, trip suppression etc.).
[2] Christchurch and Wellington interpeak modelled figures have been adjusted (downwards and upwards respectively) to better reflect the observed situation.
[3] Sections analysed were the busiest sections of the rural SH network, accounting for 18% of route km and 40% of VKT on rural SH network. Figures given represent averages over sections analysed/total rural SH network. This maximum MC found on any one section was 10.3¢/VKT for trucks, 3.5¢/VKT for cars.
[4] Indicative only.

ANNEX B10:

ROAD ACCIDENT COSTS

B10.1 Scope

This Annex summarises the study work undertaken on road accident (crash) costs, using LTSA's database for calendar year 2001 (social costs of accidents expressed in June 2002 prices).

The main analyses undertaken relate to:

‣ **Average costs**. Total and unit social costs of accidents by vehicle type involved (with results pro-rated back to sum to total costs over all vehicle types).

‣ **Marginal costs**. Unit marginal costs of accidents by vehicle type, based on average costs with allowances for the estimated variation of costs at the margin in both congested urban conditions and other conditions. The externality component of these costs is then separately identified.

‣ **Comparison of ACC charges with costs suffered**. Comparison between ACC charges by vehicle type and total accident costs suffered by that type: this gives useful information on the equity of ACC charges across different vehicle types.

‣ **Cost comparison by vehicle at fault and vehicle suffered**. An analysis to compare the costs each vehicle type causes (according to 'at fault' accident records) with the costs suffered by each type.

All analyses have been undertaken by main vehicle types. Where possible they have been split further by vehicle sub-types (e.g. four categories of trucks) and by road types: further analyses may be possible in this regard. Most of the analyses have included cyclists and pedestrians, although these results are not reported fully here.

It should be noted that, in general, the results given for trucks and buses may not be reliable: there are inconsistencies in vehicle classifications used for accident costs (based on police reports) and those used for traffic volume estimates (based on the National Traffic Database, etc.), and it is not possible to completely reconcile these.

B10.2 Findings – Average Costs

Table B10.1 summarises the findings in relation to total costs and average costs.

Major features include:

‣ The lower rates for urban than rural travel: urban rates are typically around 50% of rural rates.
‣ The very high rates for motorcycles.

(The rates for trucks and for buses may not be reliable, due to the difficulties noted above.)

B10.3 Findings – Marginal Costs

Table B10.2 summarises the findings in relation to marginal costs and their externality component. Major features include:

- For cars and motorcycles, MC for rural situations are around twice those for urban off-peak situations.

- MC for urban peak situations are generally negative, reflecting the effects of congested conditions: additional vehicles result in reduced total accident costs as a result of the reduction in travel speeds (which affects both the number and severity of accidents).

- Marginal externality costs are generally lower than the overall marginal costs.

- For cars, marginal externality costs are around 2¢/VKT in rural and urban off-peak situations, but around –3¢/VKT in urban peak situations.

B10.4 Findings – ACC Charges versus Relevant Accident Costs

Table B10.3 compares ACC charges (excluding prior levy) by vehicle type with the accident cost components suffered by each vehicle type that are relevant to ACC (i.e. medical, loss of output, a proportion of permanent disability/loss of life).

The key finding is the 'cross-subsidy' to motorcycles from all other vehicle types.

Again, the absolute rates for trucks and buses should be treated with caution.

B10.5 Findings – Costs Suffered versus Costs at Fault

Table B10.4 summarises an analysis of total costs and average costs by vehicle type primarily at fault versus vehicle type suffering the costs.

This illustrates clearly that:

- The most 'vulnerable' road user groups (motorcycles, cycles, pedestrians) suffer substantially greater costs than they cause.

- The converse is true of the least 'vulnerable' groups, particularly trucks.

(Note that the anomalies in vehicle classification may mean that the absolute results for each vehicle category are incorrect, but the comparisons of costs suffered versus costs at fault are likely to be valid.)

TABLE B10.1: TOTAL AND AVERAGE ACCIDENT COSTS BY VEHICLE TYPE

Item	Vehicle Type					
	Car	Truck [1]	M/Cycle	Bus [1]	Other	Total
Total Costs ($M)						
Urban	1222	141	85	3	48	1498
Rural	1699	195	118	4	50	2067
Total	2921	336	203	7	98	3565
Average Costs (¢/km)						
Urban	6.6	8.6	81.0	9.2		
Rural	12.9	8.7	157.3	9.1		
Total	9.2	8.7	112.8	9.1		

Note [1] *Doubt as to reliability of these results due to inconsistencies in classification of vehicle types.*

TABLE B10.2: MARGINAL ACCIDENT COSTS AND EXTERNALITY COSTS BY VEHICLE TYPE

Item	Vehicle Type			
	Car	Truck [1]	M/Cycle	Bus [1]
Marginal Costs (¢/VKT)				
Rural	14.9	15.9	221	19.3
Urban Off-peak	7.9	16.3	118	19.3
Urban Peak	-6.0	-12.4	-90	-18.1
Marginal Externality Costs (¢/VKT)				
Rural	1.8	9.9	19.6	14.7
Urban Off-peak	2.3	13.2	-15.8	5.9
Urban Peak	-3.0	-12.6	1.5	-12.2

Note [1] *Doubt as to reliability of these results due to inconsistencies in classification of vehicle types.*

TABLE B10.3: COMPARISON ACC CHARGES WITH RELEVANT ACCIDENT COSTS

Item	Vehicle Type					
	Car	Truck	M/Cycle	Bus	Other	Total
ACC Charges 2001/02						
Total paid - $M	215.8	40.5	4.0	1.5	1.9	263.8
- %	81.8	15.4	1.5	0.6	0.7	
Average rate - ¢/VKT	0.68	1.05	2.24	1.96		
Relevant Accident Costs						
Total cost $M	192.6	6.9	22.5	0.4	41.4 [1]	263.8
- %	73.0	2.6	8.6	0.2		
Average rate - ¢/VKT	0.61	0.18	12.48	0.57		
Total Paid : Total Costs - %	112%	587%	18%	345%		100%

Note: [1] *Mainly pedestrians and cyclists (no ACC charges).*

TABLE B10.4: COMPARISON COSTS SUFFERED WITH COSTS AT FAULT								
Item	**Vehicle Type**							
	Car/van	**Truck**[1]	**M/Cycle**	**Bus**[1]	**Cycle**	**Pedn**	**Other**	**Total**
Total Costs - $M								
Vehicle at Fault	2893	198	227	7	57	174	10	3565
Vehicle Suffering	2641	93	284	6	160	369	12	3565
Average Costs ¢/veh km								
Vehicle at Fault	9.1	5.1	126.1	9.7				
Vehicle Suffering	8.3	2.4	157.8	7.9				
Average Costs ¢/person km [2]								
Vehicle at Fault	5.6	4.2	118.9	0.5	19.7	20.2		
Vehicle Suffering	5.1	2.0	148.9	0.4	55.2	42.9		

Notes: [1] *Doubt as to reliability of these results due to inconsistencies in classification of vehicle types.*
[2] *For cars/vans, trucks and motorcycles, estimated from costs/VKT based on average occupancy estimates from National Travel Survey 1997/98. For buses, cycles, pedestrians derived direct from total costs using NTS person km estimates.*

ANNEX B11:

PARKING COSTS AND CHARGES

B11.1 Scope

This Annex summarises the study's assessment of:

‣ Car parking unit costs (average and marginal) and user charges in typical situations, focusing on travel to CBDs in urban areas.

‣ Total (annual) car parking costs and charges relating to CBDs in all major NZ urban areas.

B11.2 Findings – Unit Costs

Indicative parking resource costs were estimated for a range of parking types and trip types in NZ urban areas, focussing on regional and suburban CBD areas (elsewhere most parking is either on-street, and costs have been accounted for under road infrastructure; or is on private properties, where substantial externalities do not arise). In practice, resource costs were approximated by typical levels of charges in situations where car parking is provided on a fully commercial basis (e.g. in privately-owned parking buildings).

The main findings in relation to unit parking costs in CBD areas are:

‣ Typical resource costs (and commercial charges) for parking spaces in regional CBDs are in the order of $10/day, but varying in particular with land values (e.g. they are higher in CBD heart areas than in fringe areas, and higher in larger cities than smaller cities). These costs include both recurrent costs (operations and maintenance) and annualised capital costs.

‣ In the heart of the larger cities, costs may be up to $15/day or even higher; whereas in the fringes of smaller cities they may be $5/day (ground level sites) or even lower.

B11.3 Findings – Charges

In most cases, charges to car park users approximate to the resource costs of the parking spaces. However, particularly for commuters, a wide range of charging arrangements may be found:

‣ Payment by the commuter on a daily basis (e.g. for casual off-street parking). This may be regarded as a true short-term marginal cost to the user.

‣ Payment by the commuter on a periodic basis. One example is the leasing of parking space on a monthly basis. Another example is when car parking is negotiated with the employer through a 'salary sacrifice' arrangement, typically on an annual basis. In such cases, parking charges are not relevant to modal decisions on a daily basis (they are 'sunk'), but only relevant to periodic decisions as to whether to continue the arrangement.

‣ Payment by the employer, with no effective charge to the employee (i.e. no effective salary sacrifice). This type of arrangement is probably the least common of the three (although there is very limited evidence on this).

For the various study analyses, it has generally been assumed that car users pay the full resource costs of their parking (even though for commuters this payment may not be variable

on a daily basis). However, there are also discussions on the implications (for mode choice and externalities) of situations where the user pays no charge or less than the full cost.

Based on the typical parking resource cost of around $10/day and typical trip lengths in the larger cities (6 to 10km), commercial parking charges for commuters equate to around 50¢ - 80¢/VKT for commuter trips. For average commuter car occupancies (1.3-1.4 person/car), this equates to 35¢-60¢/person km. For shorter-duration trips (2-3 hours at destination), typical charges would be about one-third to one-half of these levels.

B11.4 Findings – Total Costs and Charges

Indicative estimates have been made of aggregate annual CBD parking resource costs for the 12 largest urban centres (population of at least 50,000) in New Zealand. The total resource costs are estimated at around $360 million p.a., for around 150,000 spaces.

As a first estimate, we assume that total charges paid by car users are equal to these costs. However, as discussed above, there may be a proportion of this cost which is not paid (directly or indirectly) by users, e.g. may be subsidised by employers.

ANNEX B12:

ENVIRONMENTAL IMPACT COSTS

B12.1   Scope

This Annex provides estimates of environmental impact costs (total, average and marginal) for road and rail systems, at a 'first pass' national level, and summarises the analysis prepared for this report. These figures may be further refined:

‣ in disaggregation as allocated costs, by vehicle type, road type, as required; and

‣ through sensitivity analysis, to demonstrate the main variables and degree of effect, and thus the significance of these first estimates.

It should be noted that environmental impacts, therefore costs, are generally highly variable, and specific to the nature of the locality, including the type, proximity and sensitivity of the receiving environment exposed to the emissions from transport operations. National level averages will provide only a very general indicator of average costs in particular situations.

Once environmental cost assessments for the defined case study corridors have been completed, some modifications to the national estimates given here may be warranted.

The environmental impacts subject to the initial analyses are:

‣ Local air pollution
‣ Water quality
‣ Water quantity (hydrology)
‣ Noise
‣ Climate change (greenhouse gas - GHG).

It is noted that there are other externalities affecting people's health resulting from the decision to choose a motorised mode of transport versus walking or cycling which have positive benefits on people's health. Conversely, the choice to drive or catch public transport may have negative health effects on people's health if their level of physical activity is reduced. This externality is acknowledged but is not assessed in this report.

B12.2   Methodology – Road System

Aside from GHG, the nature and magnitude of each impact, and therefore the relative cost, will be specific to the locality. A first assumption is that the urban environment is the most sensitive to impacts: the analysis has been based on the densities of road activity and population factors profiled by the defined Urban Areas, primary (25), secondary (15) and others (100), a total of 140. Then VKT totals for urban vs. national are used to estimate average and marginal costs.

For roads, fleet profiling and emissions performance by vehicle type have been drawn from the MoT Vehicle Fleet Model, for a base year of 2001. This develops a total VKT of 38.6 billion for that year. The VKT and road length distributions, by UA and by vehicle type, have been correlated with the dataset developed by MWH for the corresponding base year in the Working Paper 'Marginal Road Infrastructure Costs'.

The methodology/sources for each type of impact are summarised briefly as follows:

‣ **Local air quality**

The analysis uses damage cost relationships determined by the ExternE process (as applied in the recent Fuel Taxation - Air Pollution Costs study, for the Australian Government), expressing $per tonne of transport emissions in each UA as a function of urban population density. A cross-check has also been made using the premature mortality estimates derived in the recent MoT study 'Health Effects due to Motor Vehicle Air Pollution in NZ', based on PM emission exposure. The initial results are of the same order, and also compare well with those from overseas studies.

‣ **Water quantity**

A mitigation cost approach has been applied, using micro-level, annualised cost indices for provision of stormwater system infrastructure (road run-off), drawn from the MoT's Waitakere City ECA demonstration model. This has then been applied to other UAs on the basis of local road length km: VKT ratios.

‣ **Water quality**

A mitigation cost approach has been applied, assuming the installation and maintenance of road-side barriers (swales or porous pavement), and estimating annualised costs, for the complete 17,400km of urban roads.

‣ **Noise**

For road transport, total costs are taken from the 1996 LTPS-EE analysis, as no further work has been done since in attempting to refine national level costs. No data is available on the noise impacts from the rail sector. Noise impact assessment is an area that particularly needs local level analysis, as the level of impact, and particularly marginal costs, is very sensitive to existing traffic levels and noise thresholds.

‣ **GHG**

This uses 2001 annual transport sector emissions as reported by the Ministry of Economic Development and NZ Climate Change Office, including CH_4, N_2O and CO in the CO_2 equivalent total. A \$25 /tonne CO_2 indicator is then applied, which is the government's cap for a carbon charge under the Kyoto Protocol. This figure is used in the absence of an estimate of the actual or likely environmental cost of increasing CO_2. Although the cap has been set at \$25/tonne the international price of carbon is likely to vary.

The level of the carbon charge does not equate to the cost on the environment of greenhouse gas emissions. Rather, the level recognises the cost of the government of complying with the first commitment period of the Kyoto Protocol - i.e. it is intended to internalise the cost of Kyoto.

B12.3 Findings – Road System

The estimated environmental cost impacts associated with the road system are summarised in the following tables:

‣ Table B12.1: summary of Total Costs (\$m p.a.), average and marginal costs (¢/VKT) at aggregate and averaged levels.

‣ Table B12.2: allocation of Total Costs by road type.

‣ Table B12.3: allocation of Total Costs by vehicle type.

▶ Table B12.4: marginal cost estimates by vehicle type and by area type (urban/rural) and level of service (urban areas).

In terms of the **total costs** (and **average costs**) results, key findings are as follows:

▶ Total national environmental impact costs are in the order of $1.2 billion p.a.

▶ About 85% of these costs relate to impacts in urban areas.

▶ About 57% of these costs relate to cars, the remainder largely to commercial vehicles.

▶ The largest of the five separate impacts is local air quality in all cases, followed (on a national basis) by GHG emissions.

▶ Average costs (over all vehicle types) are around 6.0¢/VKT in urban areas, 0.8¢/VKT in rural areas, and about 3.0¢/VKT as a national average.

In terms of the **marginal cost** results (Table B12.4), key findings are as follows:

▶ For **rural situations**, the only significant effect is from GHG emissions. These are proportional to fuel consumption: rates vary from about 0.4¢/VKT for cars up to 2.8¢/VKT for HCVII (rates assume free-flow rural travel).

▶ For **urban situations**, unit cost rates vary with the fuel type used (diesel v petrol) and the traffic level of service. For petrol vehicles, cost impacts relating to local air quality, noise and GHG emissions are of similar magnitude; while for diesel vehicles, local air cost impacts dominate.

▶ For **petrol cars** (urban travel), marginal cost rates total between 1.2¢/VKT (Level of Service (LoS) A/B) and 1.8¢/VKT (LoS E/F).

▶ For **diesel trucks**, marginal cost rates for MCV total between 18.0¢/VKT (LoS A/B) and 25.5¢/VKT (LoS E/F); for HCVII rates vary between 41.4¢/VKT (LoS A/B) and 47.9¢/VKT (LoS E/F)

The figures given in Table B12.4 in particular should be treated as indicative only. Noise and local air quality impacts are very dependent on the layout and population distribution of the areas affected: noise impacts are strongly influenced by the population adjacent to the road and the corridor topography; while local air quality impacts are strongly influenced by the population (or population density) in the affected 'air-shed'.

B12.4 Findings – Rail System

The estimated environmental cost impacts for the rail system are summarised in Table B12.5. No noise cost assessments for the rail sector have been included here, but this aspect has been further investigated in the case studies undertaken for selected corridors.

It is notable that:

▶ Overall, total rail system environmental costs (that are included in the analyses) are in the order of 1% of total road system environmental costs.

▸ For each of the two largest environmental impacts, for which comparable data are available (local air quality, GHG), total rail system costs are around 1.5% of the corresponding road system costs.

TABLE B12.1:	SUMMARY OF ENVIRONMENTAL TOTAL, AVERAGE AND MARGINAL COSTS – ROAD SYSTEM						
Cost Item	Area	Local Air Quality[2]	Water Quality [6]	Water Quantity [6]	Noise[3]	GHG [7]	Totals
Total Costs	Urban	442	28	98	289	145	1002
($m p.a.)	Rural [1]	-	-	-	-	172	172
	National Total	**442**	**28**	**98**	**289**	**317**	**1174**
Average Costs [2]	Urban	2.67[3][5]	0.17	0.59	1.77[5]	0.82[5]	5.96
(¢/VKT)	Rural	-	-	-	-	0.82	0.82
	National Average [4]	1.14	0.07	0.25	0.75	0.82	3.03
Marginal Costs [2]	Urban	2.67[3][5]	-	-	0.61[5]	0.82[5]	4.10
(¢/VKT)	Rural	-	-	-	-	0.82	0.82
	National Average [4]	1.14	-	-	0.26	0.82	2.22

Notes/Sources:
[1] Impacts from local air, water quality/quantity and noise close to zero outside urban areas.
[2] Taken from Local Air pollution spreadsheet. Relate to 'averaged' vehicle type, except where noted.
[3] Taken from Summary spreadsheet. Values for 4 different urban population density bands are 6.07 (Central Auckland only), 1.88, 1.82, 0.02.
[4] National average figures would not normally be used (comprise weighted average of urban and rural figures, weighted in proportion to urban/rural VKT).
[5] Indicative figures by vehicle type given in Table B12.4
[6] Taken from Water spreadsheet
[7] Taken from Summary spreadsheet

TABLE B12.2: TOTAL ENVIRONMENTAL COSTS – BY AREA/ROAD TYPE ($m p.a.) [1]					
Cost Category	Urban		Rural		Total
	SH	LR	SH	LR	
Local Air Quality	98	344	-	-	442
Water Quality	6	22	-	-	28
Water Quantity	22	76	-	-	98
Noise	64	225	-	-	289
GHG	32	113	124	47	317
Total	223	780	124	47	1174

Notes/Sources: [1] Taken from Environmental Summary spreadsheet.

TABLE B12.3: TOTAL ENVIRONMENTAL COSTS – BY VEHICLE TYPE ($m p.a.)[1]							
Cost Category	Car	LCV	MCV	HCVI	HCVII	Bus	Total
Local Air Quality	149	96	89	32	69	7	442
Water Quality	22.5	4.3	0.6	0.2	0.3	0.1	28
Water Quantity	78.9	15.0	2.3	0.7	0.9	0.2	98
Noise	200	38	29	9	11	2	289
GHG	220	42	25	8	19	2	317
Total	671	195	146	51	100	11	1174

Notes/Sources:
[1] Taken from Environmental Summary spreadsheet. These are allocated costs, not necessarily corresponding to incremental costs.

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TABLE B12.4: MARGINAL ENVIRONMENTAL EXTERNALITY COST RATES COSTS IN ¢/VKT			
Vehicle Type	Local Air [1] (Urban)	Noise [2] (Urban)	GHG [3] (All)
Car (petrol)	0.2/0.4/0.7	0.5	0.46/0.55/0.63/0.36
LCV (petrol)	0.4/0.6/0.9	0.8	0.57/0.68/0.78/0.45
MCV (Diesel)	14.9/19.3/21.6	1.8	1.31/1.66/2.06/1.45
HCVI/Bus (Diesel)[4]	18.9/22.2/27.6	2.6	1.66/1.87/2.62/1.79
HCVII (Diesel)	34.7/37.4/40.3	3.2	3.52/3.66/4.42/2.83
Fleet Average[5]	2.67	0.61	0.82

Notes:
[1] Three sets of figures correspond to Level of Service A/B, (free/flow), C/D (interrupted), E/F (congested). From WP Table 11.3, Bus taken as equal to HCVI.
[2] Typical truck figures (assumed HCVI) taken as 5 ⬆ car figure (WP Section 9). Other figures estimated by interpolation.
[3] Based on cost rates of 5.75¢/litre for petrol, 6.50¢/litre for diesel. Fuel consumption rates taken from corridor fuel consumption analyses for four situations: urban Level of Service A/B, C/D, C/F and rural free-flow. Refer WP Chapter 8.
[4] Buses taken as same as HCVI category
[5] Fleet average estimated on a top-down basis, may not be fully consistent with bottom-up fleet data.

TABLE B12.5:	SUMMARY OF ENVIRONMENTAL TOTAL, AVERAGE AND MARGINAL COSTS – RAIL SYSTEM						
Cost Item	Area	Local Air Quality[2]	Water Quality	Water Quantity	Noise[3]	GHG	Totals
Total Costs ($m p.a.)	Urban	6.3	-	-	N/A	0.4	6.7
	Rural [1]	-	-	-	-	4.6	4.6
	National Total	6.3	-	-	N/A	5.0	11.3
Average and Marginal Costs [4] (¢/GTK)[5]	Urban	-	-	-	N/A	0.06	0.06
	Rural	-	-	-	-	0.06	0.06
	National Average [4]	0.08	-	-	N/A	0.06	0.14

Notes:
[1] Impacts from local air, water quality/quantity and noise close to zero outside urban areas – hence national figures (in brackets) derived directly from urban figures.
[2] Taken from Environmental WP, Table 12.3 and Section 11.6. Identified as not a major concern, and any externalities likely to be responsibility of track owner to mitigate.
[3] Further work to be undertaken (case studies etc.).
[4] Average costs and marginal costs equal for the impacts estimated.
[5] GTK = gross tonne kilometres, for all passenger and freight movements.

ANNEX B13:

VEHICLE OWNERSHIP AND USE CHARGES

B13.1   Scope

This Annex summarises the valuation of user charges associated with vehicle ownership and use. The range of charges relevant to this analysis include:

▸ Vehicle Licensing and Registration
▸ Fuel Duties
▸ Road User Charges
▸ Insurance Levies (Fire)
▸ Police Fines
▸ Roading Rates (TLAs).

B13.2   Analysis Methodology

This analysis was conducted using a combination of inputs from both disaggregate and aggregate sources. This has primarily included input from the Ministry of Transport, Transfund NZ and the Accident Compensation Corporation. This analysis also draws on the estimates detailed in the working papers.

Two estimates of each component were derived in Table B13.1:

▸ Total 1: Figures based on disaggregate data detailed in the appendices; and

▸ Total 2: Figures based on aggregate data derived from relevant annual reports and financial statements

As far as practicable, this analysis utilised aggregate Total 2 estimates, although Total 1 estimates have also been applied when more aggregate data was unavailable (i.e. Fuel Duties associated with the Crown Account, the Local Authorities Petroleum Tax and the Energy Resource Levy).

Moreover, the disaggregate Total 1 estimates have been used to determine the relative distribution of charges between modes and road types.

Other key inputs not detailed in the table below include the fire insurance levy ($17.9m), which is payable on all fully insured motor vehicles where the cover includes fire protection, and Local Roading Rates ($288.7m).

Table B13.1: New Zealand Government Transport Sector Funding 2001/2002 ($M, GST Exclusive)

Charge		Total Revenue (GST Exclusive)	National Roads Fund	Accident Compensation Corporation		Crown Account	Land Transport Safety Authority			Local Authorities Petroleum Tax	Energy Resource Levy	Petroleum Fuels Monitoring Levy	Admin Costs	GST - IRD
				Premium	Prior Levy		Safety Standards	Audit and Standard Levy	Transport Licence Fee					
Vehicle Registration and Licensing	Car[1]	436.478	119.620	146.855	139.824		3.660	0.049	0.792				25.677	54.560
	Truck[1]	79.181	21.301	26.505	25.236		0.661	0.110	1.564				3.804	9.898
	Bus[1]	2.824	0.675	0.909	0.865		0.023	0.013	0.212				0.127	0.353
	M/Cycle[1]	8.395	1.386	3.281	3.124		0.078	0.000	0.001				0.524	1.049
	Other[1]	20.124	13.378	1.283	1.221		0.062	0.048	0.574				3.558	2.515
	Total 1[1]	547.003	156.360	178.833	170.272		4.483	0.220	3.143				33.691	68.375
	Total 2	604.862	196.167 [8]	202.602 [9]	160.496 [9][12]		4.408 [10]	0.188 [13]	3.744 [10]				37.257 [15]	75.887
Fuel Duties[6]	Petrol[2]	1054.339	413.413	73.833		546.659				19.689	0.000	0.746		131.792
	Diesel[2]	6.517	0.000	0.000		0.000				6.058	0.000	0.459		0.815
	Other[2]	10.965	9.916	0.000		0.000				0.000	1.049	0.000		1.370
	Total 1[2]	1071.821	423.329	73.833		546.659				25.747	1.049	1.205		133.977
	Total 2	1092.606	456.800 [8]	61.155 [9]		546.659 [14]				25.747 [14]	1.049 [14]	1.196 [11]		136.576
RUC	Total 1[3]	594.863	594.863											74.358
	Total 2	583.711	583.711 [8]											73.000
WoF/CoF[7]	Total 1[4]	4.819											4.819	0.602
	Total 2	7.043											7.043 [10]	0.880
Driver Licensing	Total 1[5]	34.179											34.179	4.228
	Total 2	34.013											34.013 [10]	4.252
Police Fines	Total [16]	81.600				81.600								10.200
Total 1		2334.286	1174.552	252.665	170.272	628.259	4.483	0.220	3.143	25.747	1.049	1.205	72.690	281.541
Total 2		2403.835	1236.678	263.757	160.496	628.259	4.408	0.188	3.744	25.747	1.049	1.196	78.313	290.595

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B13.3 Analysis Findings

Drawing on the above findings, the Table B13.2 highlights the relative contribution of each component to the total user related charges:

‣ Motor vehicle fees (vehicle license and registration charges) (22%)
‣ Fuel Duties (42%)
‣ Road user charges (22%)

Collectively these charges account for almost 85% of total user-related charges.

User and Related Charges	Fund	Mode	Mode Allocation	Total	%
TABLE B13.2: USER AND RELATED CHARGES - SUMMARY $M					
Motor Vehicle Fees	NRF[1]			**196.2**	**7%**
Motor Vehicle Fees	ACC	Car	166.4		
		Truck	30.0		
		Bus	1.0		
		M/Cycle	3.7		
		Other	1.5		
		Sub-Total		**202.6**	**8%**
Motor Vehicle Fees – Residual	ACC			**160.5**	**6%**
Motor Vehicle Fees	LTSA			**8.3**	**0%**
Fuel Excise	NRF[1]			**456.8**	**17%**
Fuel Excise	ACC	Car	54.0		
		Truck	6.0		
		Bus	0.4		
		M/Cycle	0.3		
		Other	0.4		
		Sub-Total		**61.2**	**2%**
Fuel Excise	Crown			**546.7**	**21%**
Fuel Excise	Other			**28.0**	**1%**
RUC	NRF[1]			**583.7**	**22%**
Insurance Levy (Fire Service)				**17.9**	**1%**
Police Fines				**81.6**	**3%**
Sub-Total User Charges				**2,343.4**	
Roading Rates—TLAs				**288.7**	**11%**
Total User/Related Charges				**2,632.1**	**100%**

[1]*now National Land Transport Fund (NLTF)*

ANNEX C:
ABBREVIATIONS

This Annex explains those abbreviations used in this Report which are not in everyday New Zealand usage.

ATR	Alternatives to Roading
CBD	Central Business District
DRC	Depreciated Replacement Cost
ESA	Equivalent Standard Axles
FAC	Fully Allocated Cost
GHG	Greenhouse Gases
GTK	Gross Tonne-kilometres
GVW	Gross Vehicle Weight
HCV	Heavy Commercial Vehicle
LCV	Light Commercial Vehicle
LoS	Level of Service
LR	Local Road
LRMC	Long Run Marginal Cost
MC	Marginal Cost
MCV	Medium Commercial Vehicle
MV	Motor Vehicle
NLTF	National Land Transport Fund
NOS	Not Otherwise Specified
NRF	National Road Fund (replaced by NLTF in November 2003)
NTK	Net Tonne-kilometres
O & M	Operations & Maintenance
ODRC	Optimised DRC
PAYGO	'Pay as you go'
PEM	(Transfund) Project Evaluation Manual
PT	Public Transport
PUD	Pick up & Delivery
RCAM	Road Cost Allocation Model
RUC	Road User Charges
SACTRA	Standing Advisory Committee on Trunk Road Assessment (UK)
SH	State Highway
SRMC	Short Run Marginal Cost
TLA	Territorial Local Authority
UPT	Urban Public Transport
VKT	Vehicle-kilometres travelled
VOC	Vehicle Operating Cost
VTTS	Value of Travel Time Savings
WACC	Weighted Average Cost of Capital
WP	Working Paper

NOTE ON THE CLASSIFICATION OF COMMERCIAL VEHICLES (CVs) AND THE FREIGHT TRANSPORT TASK.

There are at least four systems for classifying CVs which are or have been used in New Zealand; however one of these is largely used in undertaking traffic counts and is not relevant to the STCC study. The other systems are:

‣ That used in the Transfund PEM

‣ That used by LTSA in charging RUC

‣ That used in the Heavy Vehicle Limits (HVL) Project, which is due to Austroads.

In general it is the first of these which has been used in the STCC. The others were devised to take account of the exact vehicle configuration, in particular the number of axles and wheels, and so call for a considerable degree of disaggregation.

The PEM system has four classes of CV, light, medium and two sorts of heavy:

‣ LCV: vans, utilities and light trucks up to 3.5 tonnes gross vehicle weight (GVW)

‣ MCV: two-axle trucks without a trailer, over 3.5 tonnes GVW

‣ HCV-I: rigid trucks, with or without a trailer, or articulated vehicles with a total of either three or four axles

‣ HCV-II: trucks with trailers and articulated vehicles with or without trailers having a total of five or more axles.

Note that for HCVs it is the number of axles which determines whether it is a 'I' or 'II'.

The Austroads system is descriptive: R is rigid, T is trailer and A is articulated and the numbers denote the wheels on each axle. Thus, A112 is an articulated vehicle with three axles having single, single and double wheels; R12T12 is a rigid with trailer, each having a single- and a double-wheeled axle.

Table D1 below is taken from the HVL Project and shows how the three systems are related. It also shows the estimated VKT for each class in 1999 and the respective totals for HCV I and II and M/L CV.

The HVL Project also studied payload in net tonne-km. Using this data an estimate has been made of the breakdown of million NTK carried in NZ in 1999 and this is given in Table 2. As the data relates to 1999, an increase of 10% is appropriate to bring the figure up to date; this has been done elsewhere in the STCC study and is also shown in the Table.

The high figure in the last class is a reflection of both the greater weight carried and the distances covered.

For comparison, rail freight carried in 2001/02 is estimated at 3,714 million net tonne-km (Source: Table 14 of the Rail Freight WP).

TABLE D1: HVL - PEM - RUC CLASSIFICATIONS

HVL-IE Class	PEM Class	RUC Class	1999 VKT (HVL-IE)
R11L	MCV*	2	97,586,793
R11H	MCV*	2	830,289,216
R12	HCVI	6	173,654,205
R21	HCVI	5	13,652,738
R22	HCVI	14	93,850,283
R23	HCVII	19	3,748,879
A111	HCVI	2,24	1,079,641
R11T1	HCVI	2,24	8,640,531
A112	HCVI	2,29	6,499,920
R11T11	HCVI	2,27	5,383,809
A122	HCVII	6,29	123,646,842
R12T11	HCVII	6,27	9,709,387
A123	HCVII	6,33	69,544,347
R12T12	HCVII	6,37	131,686,248
B1222	HCVII	6,29,29	20,989,123
R22T12	HCVII	14,37	22,967,089
R22T22	HCVII	14,43	168,489,752
R12T22	HCVII	6,43	52,462,478
A122T11	HCVII	6,27,29	31,979,355
B1232	HCVII	6,33,29	10,493,613
B1233	HCVII	6,33,33	62,970,145

Note *classifications for ALL weights except:*

* LCV if <=3t

Total for:	MCV*	927,876,009
	HCVI	302,761,127
	HCVII	708,687,258
Grand Total		**1,939,324,394**

TABLE D2: BREAKDOWN OF NTK (MILLION P.A.) BY CV CLASS

Class	Estimate 1999	Estimate 2002
LCV	1142	1256
MCV	1101	1211
HCV-I	1715	1886
HCV-II	8798	9678

Surface Transport Costs and Charges: Case Studies

Five case studies have been prepared to provide more detailed analysis of marginal and average costs, and how they might be estimated, in the context of specific route characteristics. These cover a mix of specialised and general freight routes, one intra-urban passenger route and one long-distance passenger route.

Each case study takes a similar approach in estimating three broad components of transport costs:

‣ A: Operator resource costs are the costs (exclusive of any taxes or other public levies) of operating and maintaining vehicles, and in addition the costs of travel time and accident damage costs covered by the operator. In the case of rail (but not road) transport, this category also includes the cost of providing infrastructure.

‣ B: Charges on operators are the levies and charges imposed by public agencies to recover some cost of providing the transport system. They include taxes on transport fuel, vehicle registration fees, road user charges, and miscellaneous other sources such as fines and parking fees (not all of which can be sensibly attributed to individual route sectors). This category also includes fares for passenger transport.

‣ C: Provider/External (Social) Costs are those costs resulting from transport that are not currently covered by existing cost recovery arrangements. For roads these include infrastructure operations and maintenance (external to drivers, although not to roading authorities), congestion costs on other road users, accident costs on other road users, and environmental costs (principally greenhouse gas emissions, local air quality impacts, noise impacts and impacts on waterways). For rail the principal external costs stem from environmental impacts, and to a lesser extent, accidents.

‣ D: User charges are freight rates offered by the rail company or by road freight companies, in the latter case comprising the operators' resource costs plus public charges imposed on them. In the case of passenger transport, fares are handled differently and included as part of B.

These components are estimated through various methods described in more detail in background working papers to this study. Some items are excluded from the marginal cost compilation (such as fixed charges like vehicle registration fees), and some go through staged calculation from total costs to costs per vehicle kilometre: the end result is an estimate of costs and charges per net tonne kilometre or per passenger kilometre of additional travel. The case studies then define:

‣ Total Operator Costs = A + B

‣ Short Run Marginal Social Cost = A + C

‣ Difference between external costs and charges = C – B

‣ Difference between Operators' charges and SRMC = D – (A + C)

The results of these case studies are referred to in the report, and some of the key sensitivities around the results are described in the separate case study documents. Further details of the models and assumptions used in calculating these figures are found in the background working papers listed in Annex A.

Case Study 1: Napier - Gisborne Freight

The purpose of this case study was to examine the effect on total and marginal social costs of carriage by rail and road of freight movements that are currently carried by rail, and those that are expected to be carried in future provided the line is not closed. The Napier - Gisborne route was chosen to illustrate a rural transport link with specialised freight traffic, in which road and rail follow very similar routes. There are currently questions over the continued maintenance and viability of the rail line, and the route has been the subject of a series of surveys of road traffic and evaluations of the rail line as an alternative to roading for dealing with an increase in logging production expected in the near future.

The study constructs estimates of total and marginal social costs that would be experienced if, in the absence of the rail link, the increased traffic expected to be transported by rail in future were to be moved by road. Currently around 48,000 tonnes a year is transported by rail, principally bulk fertiliser (40,000 tonnes), some general goods and kiln-dried timber. But from 2008 increased logging in the Gisborne district raises the possibility of around 225,000 additional tonnes of specialised log or processed wood being transported by rail to the port at Napier. The total distance (both ways) is 430km.

The components of cost are estimated as follows:

‣ Truck operating costs: figures from a Truck Cost Model are applied to the daily increase in current trucks on State Highway 2 if the rail traffic were to be transferred to 44 tonne (GVW) trucks with 29 tonne payload. The current traffic would increase from little over nine trucks a day to carry current loads, and to 43 trucks a day to carry loads anticipated after 2008. This transport task would involve annual operating costs of $1.65 million (for current loads) and $7.64 million (for anticipated loads).

‣ Accident cost per additional truck-kilometre has been calculated using historical accident data from the Transfund Project Evaluation Manual, adjusted slightly to eliminate double-counting of multiple vehicle accidents and to allow for non-linearity of accident rates with traffic volumes. The combined effect of this is a marginal accident cost associated with additional truck movement of 29.2 cents/truck kilometre. The externality component of this is derived as 85% from ratios for rural conditions, giving an external accident cost rate of 24.8¢/truck-km.

‣ Road User Charges: assuming a proportional split of two truck configurations to replace rail capacity, this new truck traffic would face a weighted average RUC of 51.4¢/km for current traffic, rising to 55.8 ¢/km after year 5 when logging traffic increases. Road maintenance costs in Gisborne district are reported to be 2-2.5 times greater than the national average, because of localised factors such as poor quality materials, difficult terrain, high cost plant and labour due to remoteness, and a history of limited investment due to low usage. The unit marginal costs of road-wear have been estimated with the 'Adjusted RCAM' approach to be around 13.0 ¢/truck-km in 2001 and 14.4 ¢/truck-km in 2006.

‣ Congestion has been estimated by developing a detailed 'following model' that estimates how each additional truck on the route, at assumed speeds, increases the encounters and time delays for other vehicles. The result is a marginal congestion cost of 2.4¢/truck-km now, rising to 4.7¢/truck-km with future loads.

‣ Environmental costs have various components. Greenhouse gas emissions have been estimated from fuel use across the entire route, converted to CO_2 equivalent and valued at $25/tonne CO_2. Local air quality impacts are limited to the 12km or so of road passing through the urban areas of Gisborne, Wairoa and Napier, and valued at $157,000/tonne of particulate matter. Water and noise impacts are considered to be low and hence not estimated. Combined, these aggregate environmental costs imply unit costs of 0.24¢/net tonne

kilometre now, and 0.21¢/net tonne kilometre for future loads on the road. These results are very similar to those calculated for rail.

▸ Rail costs and charges have been estimated using information from TranzRail Ltd comparing costs and revenues with net tonne kilometres travelled over recent years. Marginal costs are estimated as 3.29¢/net tonne-km on current loads and 5.04 ¢/net tonne-km on future increased loads.

The estimates suggest that in the short term (1-5 years ahead) the marginal social cost of carrying current volumes by road is 13.9¢/tkm (where tkm = tonne km), very close to the marginal social cost of carrying them by rail (13.7¢/tkm). End user charges exceed marginal costs on roads (17.9¢/tkm), but not on rail (8.9¢/tkm). But in the longer term (years 6-25), while marginal costs of additional road freight fall slightly to 12.6¢/tkm, the marginal cost of additional rail freight is substantially lower at 7.4¢/tkm.

Case Study 2: Auckland-Wellington Freight

This route was selected for case study because it is the main conduit of general freight traffic in New Zealand, including all surface movements from Auckland to the South Island. Movements to and from intermediate locations such as Hamilton and Palmerston North have been excluded, to simplify calculations and focus on only freight travelling the full distance between Auckland and Wellington.

Currently, around 450,000 tonnes are carried annually by rail in a southbound direction on this route, and 250,000 tonnes carried northbound. Current rail freight is mixed with no dominant products, and current demands are served by around six trains a day in each direction. The case study assesses the effect of a marginal shift of 10% of load from rail to road, i.e. a transfer of 45,000 tonnes in the southbound direction and four fewer trains run each week in each direction. This shift would necessitate around 2,600 extra return trips each year by two-trailer B-train truck configurations.

The components of additional cost have been calculated as follows:

▸ Truck operating costs: figures from a Truck Cost Model have been applied to the daily increase in current trucks on State Highway 1 if the rail traffic were to be transferred to trucks with weighted average payload of 13.05 tonnes.

▸ Accident cost per additional truck-kilometre has been calculated using historical accident data from LTSA on the cost of accidents involving trucks on SH1 over the past 6 years, with total cost converted to a rate per truck-km on the basis of trucks' share of total vehicle kilometres travelled on the route. With adjustments to eliminate double-counting of multiple vehicle accidents and to allow for non-linearity of accident rates with traffic volumes, the combined effect of this is a marginal accident cost associated with additional truck movement of 21.8 cents/truck kilometre. Deducting the externality component of this (derived from national average results) leaves an external accident cost rate of 14.5¢/truck-km, after allowing for accident costs internalised through vehicle operating costs and ACC charges.

▸ Road User Charges: RUC for a B-train of 40 tonnes GVW have been estimated from LTSA information, and amount to 24¢/truck-km, net of GST. This assumes that RUC is purchased for an average load less than the capacity of the truck.

▸ Road maintenance costs have been estimated using the dTIMS model to calculate structural maintenance costs (resurfacing and rejuvenation) on State Highway 1. The marginal cost of road maintenance was estimated to be 11.16¢/truck-km.

- Congestion has been estimated separately for the Auckland and Wellington urban areas, for other urban centres such as Taupo and Hamilton, and the remaining rural section. Trucks were assumed to have a similar congestion effect to three cars. Estimates range from $0.01/vehicle-km in rural areas to $0.611/vkm in Auckland, with an overall value across the route of $0.059/vkm.

- Environmental costs have various components. Greenhouse gas emissions have been estimated from fuel use across the entire route, converted to CO_2 equivalent and valued at $25/tonne CO_2. Local Air Quality impacts are limited to 35 urban centres that the road passes through, and valued on the basis of assumed fuel consumption and emissions of particulate matter. These emission rates are sensitive to truck age and technology. Water and noise impacts are considered to be relatively minor compared to overall traffic flows on this route: additional rail traffic would have more noticeable effect than additional road traffic. Combined, environmental costs imply marginal costs of 0.81¢/net tonne kilometre for additional rail traffic, and 0.58¢/net tonne kilometre for additional road freight (the difference largely being accounted for by an estimated 0.33¢ of noise cost attributed to rail, compared to zero for road). These figures should be viewed with caution as they are sensitive to the assumptions and methodology used.

- Rail costs and charges have been estimated using information from TranzRail Ltd comparing costs and revenues with net tonne kilometres travelled over recent years, and with reference to a BAH rail cost model that estimates costs for 'above rail' and 'below rail' maintenance expenditures.

The results show the national rail network has short run marginal costs of 8.2 ¢/net tonne-kilometre, the only externality being environmental costs of 0.8¢/ntkm (assuming all diesel haulage). By comparison, road freight has external costs of 2.9¢/ntkm across environmental, accident, congestion and infrastructure maintenance categories, with an overall short run marginal cost of 12.7 ¢/ntkm. Charges represent about 60% of the external cost for trucks.

Case Study 3: Waitakere-Auckland Passenger Travel

This case study examines passenger transport costs and charges in the Henderson (Waitakere)-Auckland CBD corridor, by three alternative modes: car, bus and train. It further differentiates examination by two time periods - morning peak and inter-peak periods - and varying car occupancy levels. Marginal costs per increment of travel have initially been derived in terms of the most appropriate unit of travel (e.g. per vehicle trip, per person trip, etc.) and then translated into rates per person kilometre to facilitate comparison within and between modes. Distance is around 22km for rail and 19km by bus, with approximately 7km in West Auckland urban area with a population density of 657/km², and 15km within Auckland Central with population density of 2,326/km².

Estimates of unit variable car operating costs have been taken direct from the Car Operating Cost Model. Traffic levels of service in the peak period are assumed to be congested, and in the off-peak period are assumed to have interrupted flow. The Auckland Regional Transport roading model was used to estimate travel times from Henderson to Auckland CBD in the peak (49.7 minutes) and inter-peak (31.6 minutes) periods, which were combined with a value of time to estimate the resource cost of travelling time. It is assumed that all travellers pay parking charges, a 9 hour period for travellers in the peak and a 2 hour period for travellers in the inter-peak.

Estimates of public transport costs are based on assumptions of access time (from origin to bus stop or rail station), wait times, in-vehicle times (derived from analysis of timetables to give a weighted average of routes and services) and egress times (from disembarkation point to destination). Public transport operating costs have been based on the main study's analyses for

Auckland Rail and Bus. Bus services (but not rail) are also assumed to enjoy 'user economies of scale', based on a methodology also explained in that Working Paper.

The components of additional cost have been estimated as follows:

▸ External accident costs are assumed to be the same as in the main study for urban peak and off-peak conditions, and range between -3¢/vkt (peak) to 2.3¢/vkt (off peak) for cars and -12.2¢/vkt (peak) to 5.9¢/vkt (off-peak) for buses. Peak costs are negative because congestion lowers vehicle speeds and the severity of accident damage.

▸ Road infrastructure cost estimates use the same figures as used in the main report analyses for urban passenger travel.

▸ Congestion externality is estimated by similar methods to those used in the main study assessing the costs of congestion in Auckland. Induced traffic - the release of suppressed demand when congestion is reduced - has been taken into account at different rates in the peak and inter-peak periods by reducing the benefit which accrues each time a vehicle-kilometre travelled is removed.

▸ Environmental costs have been derived for the three modes by assuming a typical vehicle type for each mode and examining the effect of additional passengers, in requiring additional vehicles on the route or changing the operating costs of existing vehicles (for instance, the effect of a 10% diversion of passengers from cars in requiring extra buses on a route, or extra carriages fitted to a train). Greenhouse gases are calculated from additional fuel consumption of new and existing vehicles, local air quality is based on PM emission rate per fuel consumed.

The estimates suggest external costs in the inter-peak period range from 3.5¢/person kilometre in a two occupant car, to 7.9¢/pkm in a bus to 9.3¢/pkm in a train, with environmental costs (particularly train noise) being a major part of the difference. User charges comfortably exceed these costs for bus and train, but not for cars. In the peak period external costs range from 24.1¢/pkm for trains, through 38.8¢/pkm on low occupancy car to 54.3¢/pkm for buses. Congestion is the principal component of this cost for cars, but operating cost is the principal component for trains and buses.

Case Study 4: Kinleith to Tauranga Freight

The purpose of this case study is to illustrate the social costs of relatively specialised transport service supplied by different modes. The goods transported are logs, pulp and paper and sawn timber products, which are taken over a distance of around 110km from Kinleith to the port of Tauranga. Logs and pulp and paper may be transported by either road or rail. The case study assesses the impact of a marginal shift in mode from rail to road by examining the effect of the proportion of Kinleith's total logs, pulp and paper that is transported by rail falling from its current 95% to 85% or 75%. These reductions can be translated to a number of truck-loads and additional traffic on the roads, as in the other freight case studies.

The components of these cost estimates are as follows:

▸ Time and operating costs are derived from the Truck Cost Model. Road User Charges for a B-train and a logging truck have been estimated from information available from LTSA, and allowing for a split between these two vehicle types provides a weighted average RUC of 5.5 ¢/tonne-km excluding GST.

▸ Accident costs were derived from LTSA data of truck accidents on routes in the case study area, and converting the aggregate accident costs from these data to costs per vehicle-kilometre by use of annual vehicle kilometres travelled data from Transit NZ. The marginal

accident cost associated with additional truck movement is 19.1¢/truck-km, the external component of which is 12.3¢/km or 1.3¢/tonne-km.

- Road maintenance costs are derived from dTIMS model data for the specific routes to calculate structural maintenance costs. The marginal rate was estimated to be 12.62¢/km or 1.3¢/tonne-km.

- Road congestion costs are calculated using the same method as in the Main Report. This gives a marginal cost of 2.34¢/truck-km, adjusted down to 1.9¢/truck-km to allow for uncongested parts of the route, or 0.2¢/tonne-km.

- Environmental costs have been derived for each mode under the assumed diversions of load. Greenhouse gases are calculated from additional fuel consumption of new and existing vehicles (differentiating according to traffic free-flow, interrupted flow and congestion on different sections of route). Local air quality is based on PM emission rate per fuel consumed. Noise is calculated in proportion to change in traffic relative to a no change baseline. This results in total environmental marginal cost of 0.107¢/tonne-km for rail and 0.449 ¢/tonne-km for road.

- Rail costs and charges estimates are drawn from information supplied by TranzRail Ltd on costs, revenues and traffic on that line, and use a rail freight model developed for the study. This model suggests the marginal line-haul cost on the line is 6.3¢/net tonne-km.

One of the conclusions of this study were that marginal external costs associated with the Kinleith to Tauranga bulk freight transport amount to 3.2 ¢/net tonne km by road and 0.1¢/net tonne km by rail.

Case Study 5: Picton-Christchurch

This study examines passenger transport costs and charges in the Picton to Christchurch corridor, by four alternative modes: car, minibus (shuttle), coach and train. The distance between Picton ferry terminal and Christchurch city centre represents a distance of around 350km. Traffic peaking through the day is not significant. For each of the road modes two occupancy levels have been used to examine costs per passenger kilometre: 1.7 and 3 passengers in a car, 6 and 8 passengers in a minibus, and 15 or 20 passengers in a typical inter-city coach with 53 seats.

Estimates of unit variable car operating costs have been taken direct from a Car Operating Cost Model, assuming no congestion along the route. The journey time by car was calculated as 4 hours 20 minutes on assumptions of average speed and stopping times.

Estimates of public transport costs are based on assumptions of in-vehicle times (derived from analysis of operators' timetables to give a weighted average of routes and services). Coach and train fares were estimated using functions in respective working papers. Shuttle fares have been estimated from operators' marketing material, adjusted to allow for family discounts and to remove GST.

The components of additional cost have been estimated as follows:

- Accident costs were prepared by combining accident records for the route obtained from LTSA, with the standard cost of accidents given in Transfund's Project Evaluation Manual. After removing truck-only accidents from the analysis, total annual cost of accidents was calculated as almost $55 million, which was then combined with traffic data from Transit NZ to estimate a cost of 8.8¢/vkt. Based on the marginal rates for rural conditions, the marginal accident externality ranged form 1.8¢/vkt for cars, to 8.3¢/vkt for minibuses to 14.7¢/vkt for coaches.

- Road infrastructure costs were derived from dTIMS data to give structural maintenance costs and traffic levels on SH1, while using adjusted RCAM average rates per km for other work categories.

- Congestion costs were estimated with the same processes as in the main report, dividing the route between urban and rural sectors and estimating congestion cost for sectors most likely to suffer congestion. A Christchurch city traffic model was used to derive congestion cost for the 10km of road in the Christchurch urban area, concluding that marginal external cost was 6.4¢/vkt in the inter-peak period, or 64¢/vehicle trip over the limited 10km section of the road.

- Public transport operational costs were based on the analyses in the main report and set out in respective working.

- Environmental costs for each mode were calculated off the increase in vehicles in each mode. Greenhouse gases are calculated off additional fuel consumption of new and existing vehicles. Local air quality is based on PM emission rate per fuel consumed. Noise was assumed to entail very small incremental changes relative to background levels, and not estimated.

The results suggest that marginal external costs of cars are very small on this route, around 1-1.7¢/person-km compared to 10-13¢/pkm for coach, 8.5-11.3¢/pkm for minibus or 6.37¢/person for rail services. The difference is largely due to operations and vehicle costs, which are 'external' from the perspective of a public transport passenger (although internalised by fares) but are 'internal resource costs' from the perspective of car users in these calculations. That aside, cars have higher external costs than most other vehicle types across externality categories other than road operations and maintenance, but minibus shuttles have higher accident and environmental costs than all other modes.

Table E1 Summary of Case Study Results – Marginal Costs and Charges

	Case Study 1				Case Study 2		Case Study 4	
Location	Napier to Gisborne Freight				Auckland to Wellington Freight		Kinleith to Tauranga Freight	
Mode	Road	Rail	Road	Rail	Road	Rail[1]	Road	Rail
Distance (one way) km	215	215	215	215	650	660	110	110
Period	Year 1-5	Year 1-5	Year 6-25	Year 6-25				
Units	cents per net tonne km							
A: User Resource Costs	10.5	13.5	9.3	7.2	9.7	7.4	14.7	7.8
B: Charges on Users	4.1		4.0		1.8		5.5	
C: Provider/External Costs	3.4	0.2	3.3	0.2	2.9	0.8	3.2	0.1
D: User Charges (freight rates	13.0	8.8	13.0	8.1	13.0	10.2	19.9	7.0
A+B = Total User Costs	14.6	13.5	13.3	7.2	11.5	7.4	20.2	7.8
A+C = Economic SRMC	13.9	13.7	12.6	7.4	12.6	8.2	17.9	7.9
C-B = Provider/ External Costs - Charges	-0.7	0.2	-0.7	0.2	1.1	0.8	-2.3	0.1
D-(A+C) = User Charge - SRMC	-0.9	-4.9	0.4	0.7	0.4	2.0	2.0	-0.9

Note: (1) This is Auckland to Wellington express non-bulk rail only. General non-bulk rail is less costly.

	Case Study 3						Case Study 5			
1 Location	2 Henderson to Auckland Passenger						Picton to Christchurch Passenger			
Mode and number of occupants	Car 1.4	Bus	Train	Car 1.4	Bus	Train	Car 1.7	Shuttle 6	Coach 15	Train
Distance (one way) km	22	22	22	22	22	22	350	350	350	350
Period	Peak	Peak	Peak	Inter peak	Inter peak	Inter peak				
Units	cents per passenger km									
A: User Resource Costs	47.9	48.4	46.6	31.4	47.8	51.2	21.4	9.1	8.0	7.9
B: Charges on Users	2.7	16.8	15.1	2.1	16.8	15.1	1.2	6.9	8.1	16.8
C: Provider/External Costs	38.8	54.2	24.2	4.4	7.9	9.3	1.8	11.3	13.4	6.4
A+B = Total User Costs	50.6	65.2	61.7	33.5	64.6	66.3	22.6	16.0	16.1	24.7
A+C = Economic SRMC	86.7	102.6	70.8	35.8	55.7	60.5	23.1	20.5	21.4	14.3
C-B = Provider/ External Costs - Charges	36.1	37.4	9.1	2.3	-8.9	-5.8	0.6	4.5	5.3	-10.4

Note: see 'Health Warning' about marginal costs, section 2.4.2.5

ANNEX F:

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