Hyder

THE IMPORTANCE OF MAKING BEST USE OF EXISTING NETWORKS IN PROMOTING PRODUCTIVITY

A VALUE FOR MONEY APPROACH

THE IMPORTANCE OF NETWORK OPTIMISATION IN PROMOTING PRODUCTIVITY

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Author	Chris Money
Checker	Rachel Baxter
Approver	Chris Money
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1 SUMMARY

Hyder Consulting, as part of its review of the new Government Policy Statement on Land Transport has undertaken some thinking about how making better use out of existing capacities in the transport network (as a complement to enhanced capacity in high growth areas) might contribute to increased economic growth and productivity. Our thinking is underpinned by an approach that will not only reduce travel times and increase trip reliability for all users of the network, but also maximise value for money for the funders of the network, namely drivers who pay fuel taxes and licence fees.

We firstly assess the potential impact network optimisation may have on all users of the transport network. Within this approach we also assess the achievability of an optimised network. Following from this, we use cycling as a case study to demonstrate one potential contributor to network optimisation that benefits all users of the network.

Our conclusions are as follows:

Better use of existing networks is significantly more productive than providing “more of the same”

In a situation where travel demand is not significantly increasing, but networks are nonetheless congested, there is a strong body of research pointing to superior economic outcomes from network optimisation as opposed to additional investment to expand capacity.

Focusing on changing the decisions of a small number of car drivers results in better outcomes all round

Analysis of congested routes clearly shows small nominal changes in vehicle numbers can have significant impacts on congestion. Therefore, in stable traffic demand scenarios a combination of better information to users and small scale infrastructure investment, to encourage more car pooling, or public transport use, or walking, or cycling, would be a considerably more efficient outcome than adding extra capacity for private motor vehicles.

Improved cycling facilities possibly offer the lowest cost suite of infrastructure options for achieving these small nominal shifts.

Cycling investment as part of wider capacity improvements will help with cost-effective network optimisation in the medium to long term

The above two points begin from the fundamental assumption that growth in the medium to long term is not significant and that realistic options other than capacity improvements exist. In the longer term, this seems unlikely — it is likely that increased capacity for private motor vehicles in congested urban environments will be required in the long term.

However, the basic findings are also relevant where infrastructure options require expansion of capacity to ensure that, when expansion is completed, efficient network use is encouraged so that further congestion doesn’t result. The marginal cost of infrastructure improvements that encourage a broader use of the network (e.g. the inclusion of a cycling lane or wide road shoulder), seem to be far outweighed by the potential economic benefits as that extra capacity becomes progressively more congested.

2 GETTING MORE OUT OF NETWORKS: HOW DO THIS PROMOTE EFFICIENCY?

2.1 The existing transport network

New Zealand's urban transport networks are coming under increasing pressure. There are many reasons for this pressure and their relationship to one another is complex, but the most important causes of pressure include:

- Population growth: More people on the network
- Expanding urban limits: More people commuting longer distances, thereby spending more time on the network
- Reducing real costs of private transport, combined with the increasing value of mobility: There is a positive correlation between vehicle ownership rates and travel and for the last 10 years, vehicle growth has been 150% of population growth (Statistics New Zealand and NZTA data).

Despite this pressure, there remains a considerable amount of latent network capacity, even in congested urban networks. Some examples include:

Non arterial roads: These tend to be relatively underutilised at peak times because information is poor on whether non-arterial routes will yield a faster trip on any given day.

Evidence from floating vehicle navigation trials (intelligent GPS-based route direction based on real-time traffic conditions) in Tokyo and Osaka have shown increases in peak time vehicle speeds of 20% for subscribers, and decreases in emissions of 18% (see Honda website). These gains were achieved simply by reallocating existing traffic more efficiently over the available network.

Under-utilisation of congested roadspace: Where congestion exists, and vehicle speeds drop, it becomes possible to safely utilise more of the roadspace. The Highways Agency in the UK has run a number of successful trials of hard-shoulder running on the M25 during congested times as a way of increasing the performance of the network.

A blind eye is turned to such hard shoulder running in New Zealand motorway exits on a daily basis.

Unused capacity on public transport: With a limited number of exceptions, there remains a reasonable amount of space on existing peak-time public transport services in urban areas. The difference between this latent capacity and the two above it is that more fully utilised public transport services lowers the level of service for users, whereas the two measures above increase the level of service for users of the network.

This paper explores the potential to unlock some of this latent network capacity and attempts to assess the possible impact of unlocking this latent capacity. We refer to this as network optimisation.

2.2 Economic benefits from efficient use of the existing transport network

It is generally agreed that transport can and does contribute to economic and productivity growth. However, the relationship is complex and difficult to quantify and the direction of causality has not been proved. As a result, the importance of transport to growth is widely debated. The exact contribution is likely to depend on a number of factors, such as the maturity and efficiency of the economy and transport network.

The United Kingdom Government commissioned a detailed study — The Eddington Transport Study — to examine the long-term links between transport investment and economic productivity, growth and stability. For developed economies it was suggested that productivity benefits from transport may be more closely related to the efficiency of the existing transport system, rather than to the total amount of investment. This relationship was particularly likely to be the case where the existing transport system was stretched, as demonstrated through congestion or unreliability, for example.

A number of empirical studies have been undertaken to consider the economic benefits from more efficient use of existing infrastructure. Research by Hulten (1996)[1] showed that effectiveness has a strong impact on growth, with an analysis of data from low to middle income countries showing that a 1% increase in infrastructure effectiveness generates an impact on growth seven times greater than the impact of a 1% increase in the rate of public investment. The implication Hulten gives is that programmes aimed at only at new construction may have a limited effect on economic growth, or may have a perverse effect if they divert resources away from the maintenance and operation of existing infrastructure.

Chang (2002) analysed data from seven East Asian economies over the period of 1979–1998, which showed that how efficiently the government manages the existing stock of infrastructure is an important issue — with additional infrastructure investment potentially being of little help in stimulating growth if existing infrastructure is not being used effectively.[2]

Rioja (2003) developed a general equilibrium model and analysed data from seven Latin American countries, showing that the long-run penalty of ineffective infrastructure for those countries is about 40% of steady-state real GDP per capita. Raising the effectiveness of the infrastructure was shown to have positive economic growth effects, and new infrastructure investment could negatively impact on per-capita incomes if effectiveness in the existing network was low.

Details of additional empirical studies considering the impact of efficient use of infrastructure are summarised in The Eddington Transport Study (2006)[3] and in Ministry of Economic Development (2005).[4]

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1 Hulten, C. (1996). “Infrastructure capital and economic growth: how well you use it may be more important that how much more you have”. NBER Working Paper Series, Working Paper 5847.

2 Wang, E. (2002). “Public infrastructure and economic growth: a new approach applied to East Asian economies”. Journal of Policy Modeling 24 411–435.

3 Department for Transport (2006). “The Eddington Transport Study: Transport’s role in sustaining the UK’s productivity and competitiveness. Available at http://www.dft.gov.uk/about/strategy/transportstrategy/eddingtonstudy/

4 Ministry of Economic Development (2005). “Linkages between infrastructure and economic development”. Available at http://www.med.govt.nz/templates/MultipageDocumentPage____9189.aspx.

2.3 Increasing network efficiency through small decreases in traffic volume

There is a basic transport proposition between transport density and vehicle velocity — the more vehicles that there are on a road, the slower their velocity will be. The fundamental diagram of traffic flow diagrammatically details the relationship between the traffic flow (vehicles per hour) and traffic density (cars per kilometre). The fundamental diagram of traffic flow is therefore of importance in conducting an analysis of the efficiency of particular road sections. Congestion occurs where increased vehicle density causes decreases in traffic volume or flow. The point at which congestion occurs on the fundamental diagram is known as the 'critical density' point.

Sugiyama et al (2008)[5] conducted analysis of Japan Highway data and provide the following fundamental diagram, where *q* indicates traffic flow or velocity (vehicle per 5 minute interval) and *p* indicates traffic density (vehicles per kilometre):

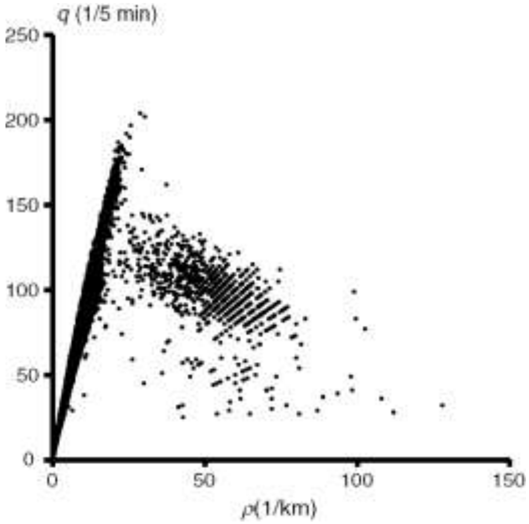

Figure 2-1 'Fundamental diagram' of traffic flow versus traffic density

The critical density is nearly 25 (vehicles per km). Before the critical density value, increasing volumes of traffic can be accommodated in a free-flowing environment, however after the critical point increasing traffic volumes dramatically decrease traffic flow. Sugiyama et al (2008) also states that "fundamental diagrams show similar shapes at any point on any highway, and the critical density is almost the same value". Out of interest, Davis (2004)[6] and Mahnke et al (2008)[7] both outline similar critical density values. Davis (2004) provides analysis of traffic flow data on a German autobahn which illustrates a critical density of 30 vehicles per kilometre. Mahnke et al (2008) study traffic data in Atlanta city in Georgia, USA and illustrate critical density values of 25 vehicles per kilometre for both multi-laned highway sections and on single-laned on ramps.

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5 Yuki Sugiyama, Minoru Fukui, Macoto Kikuchi, Katsuya Hasebe, Akihiro Nakayama, Katsuhiro Nishinari, Shin-ichi Tadaki and Satoshi Yukawa (2008), "Traffic jams without bottlenecks—experimental evidence for the physical mechanism of the formation of a jam", *New Journal of Physics*, Volume 10, 2008

6 Craig Davis (2004), "Physicists and Traffic Flow", *APS News: A publication of the American Physical Society*, Volume 13, No 4, April 2004.

7 Reinhard Mahnke, Christof Liebey, Reinhart Kuhne, Haizhong Wang (2008) "Traffic Flow Prospectives: From Fundamental Diagram to Energy Balance" retrieved from http://www.tft.pdx.edu/greenshields/papers/A2_Mahnke_Kuehne_paper.pdf on 27 April 2009.

2.4 Optimised networks – some conclusions

Network efficiency is fundamentally determined by the available capacity of the network. Where capacity is plentiful, travel times are short and trip time reliability is high. Where this condition exists, productivity of users of the network is maximised, with resulting positive impacts on economic growth.

In New Zealand, this abundance of capacity exists for most hours of the day, for almost all of the transport network[8]. Network efficiency drops almost exclusively at peak times, and only has a tangible impact on productivity and economic efficiency in urban areas, where commuting times tend to be longer and the number of congested links greater.

Given urban network capacity usually only presents tangible efficiency and productivity losses during peak periods, there is a strong case for considering short to medium term approaches that:

- improve private vehicle capacity at only peak times (e.g. clearways, or recent experiments in the UK with hard shoulder running on motorways when network speeds drop significantly)
- provide marginal extra capacity on alternative modes (e.g. extra train cars)
- regulate or incentivise private travel choices (for example road pricing or reallocating roadspace to high occupancy vehicle lanes); or
- provide better facilities that encourage some private car users to cycle or walk in peak times

These approaches represent potential value for money improvements because they:

- tend to be cheaper, on average, than adding the private motor vehicle capacity necessary to achieve an increase in network flow that removes the productivity reducing conditions;
- potentially improve economic efficiency beyond “first order” travel choices. This is because the network optimisation approach does little to discourage high economic value trips off the network, but, in providing more choices for lower value trips (e.g. “time rich” travellers), it can improve the efficiency of these high-value trips through faster, more reliable travel times; and
- do not provide capacity that has little or no economic value outside of peak times.

In support of this value for money argument, the fundamental flow diagrams clearly demonstrate that network optimisation can be achieved by small nominal reductions in private motor vehicle use. By way of example, the congested Petone to Nauranga link represents about 5km of congested double lane motorway. Its usual peak-time flows[9] are only just at “break down” suggesting that there are 26-28 vehicles per km per lane. On this stretch of road, this suggests that the efficiency and productivity costs of a sub optimal network are caused by between 10 and 30 vehicles out of the 250-280 vehicles occupying that space at congested times.

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[8] Examples where “interpeak” congestion exists are limited but include Central Motorway Junction in Auckland

[9] There are clearly issues with the current works and the Horokiwi turnoff causing a breakdown in flow. We have assumed this away.

If 3 vehicles per lane per km at peak time is the extent of the current congestion problem for this 5km stretch of road, then it is clear that the costs of adding extra permanent vehicle capacity would be greater than the benefits in addressing short to medium term congestion. However, the extent of the productivity losses associated with less than optimal flows still represent a tangible annual cost to the economy, which can be significantly addressed through a small number of car drivers making a different travel choice during peak flows.

3 NETWORK OPTIMISATION IN THE CONTEXT OF GOVERNMENT TRANSPORT TARGETS

3.1 The Government Policy Statement (GPS)

The new GPS has a strong focus on economic development and productivity. In fact, it is the first point made in the Minister's Foreword. A critical underpinning of the GPS is that it "closely reflects the transport choices that are realistically available to New Zealanders." In this respect it has a strong focus on roadspace devoted to private motor vehicles.

3.1.1 Core Goals

The core economic and productivity goals from transport are as follows:

- Improvements in the provision of infrastructure and services that enhance transport efficiency and lower the cost of transportation through:
  - improvements in journey time reliability
  - easing of severe congestion
  - more efficient freight supply chains
  - better use of existing transport capacity.
- Better access to markets, employment and areas that contribute to economic growth.
- A secure and resilient transport network.

3.1.2 Planning and evaluation requirements

The NZTA and other road controlling authorities will be required to consider the following factors

- The government's priority to support national economic growth and productivity, which includes the national roading priorities set out in the list of Roads of National Significance.
- Considering networks from a national perspective.
- Achieving value for money.
- Encouraging integrated planning.
- Making best use of existing networks and infrastructure.

- Implementing and fostering a co-ordinated approach.
- Considering the impact of volatile fuel prices.

Regional Transport Committees are also required to give priority to initiatives that:

- improve the provision of infrastructure and services that enhance transport efficiency and
- lower the cost of transportation to New Zealanders through
    - improvements to journey time reliability
    - easing severe congestion
    - more efficient freight supply chains
    - provide better access to markets, employment and areas that contribute to economic growth

3.1.3 Network optimisation and the GPS

While the GPS is considered by many to be a move towards supporting the private motor vehicle through roading infrastructure, our analysis suggests that a network optimisation approach to address short and medium term network flow and efficiency issues takes significant steps to addressing the goals of the GPS in an urban environment. In fact, if done correctly, getting better use out of existing networks probably contributes more to each of the goals above per dollar spent than providing additional infrastructure.

3.2 Overall government goals

The government has clearly signalled an approach to infrastructure investment that is, above all else, aimed at improving the position of the New Zealand economy. The Minister of Finance has signalled an intention that infrastructure investment achieve two key objectives.

Firstly, infrastructure spending is being brought forward as a partial response to short term economic conditions. Spending on construction of roads, schools and state housing stock is clearly intended to reduce the impact of the economic downturn on the domestic construction sector.

Secondly, and more importantly, the government is seeking long-term productivity gains from much of its infrastructure programme. OECD estimates suggest that distance from markets reduces New Zealand's GDP per capita by 10%[10]. The government has clearly signalled a focus on improving the efficiency of our networks (roading, telecommunications etc) as one of the most important ways that New Zealand can improve its long-term economic wellbeing.

3.3 New Zealand Transport Strategy

The New Zealand Transport Strategy 2008 (NZTS) is a statement of the government’s long-term (2040) outcomes it seeks from transport. While it is a statement of policy from the previous government, it still remains in force.

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[10] 2009 Budget Policy Statement

The overarching strategy in the NZTS is delivering on New Zealand's economic, social and environmental goals through a balanced approach to additional infrastructure investment, tied with a greater emphasis on utilising a wider range of transport modes.

Reducing single occupancy private motor vehicle use is a key feature of the NZTS. In this respect, many of the NZTS goals can be achieved through optimised networks.

4 CASE STUDY: THE ROLE OF CYCLING IN OPTIMISING NETWORKS

We consider it useful to look in detail at how optimised networks might be achieved under the Government Policy Statement. We have chosen cycling as a case study because it is comparatively underdeveloped as a peak time mode choice in New Zealand and therefore offers a good base for analysis of the opportunities available. A similar analysis could be undertaken for other measures including public transport, better traveller information (e.g. floating vehicle navigation)

4.1 WHAT CONSTITUTES INFRASTRUCTURE INVESTMENT IN CYCLING

In this paper we take a very broad view of what constitutes and investment in infrastructure that improves cycling amenity. Essentially we consider that there are four broad areas of infrastructure investment:

Infrastructure Investment	Description
Traditional cycling infrastructure projects	Projects that are exclusively or predominantly focussed on improving cycling Examples include dedicated cycle paths
Integrated construction, renewal or maintenance investment	Projects where cycling is explicitly catered for when a road controlling authority undertakes a project that is primarily focussed on motor vehicles. Examples may include levelling and widening of shoulders and potentially some reallocation of roadspace.
Investment in network infrastructure management	Capital investment in roadside facilities not directly part of the roadspace. Examples include variable message signs
Investment in "infrastructure cleanup"	Separate from improving the physical infrastructure through maintenance, the asset can be made to work more efficiently for cyclists and motorists alike through paint, signage and better management of the kerbside. Examples may include the creation of a shoulder through paint on wider roads that are not wide enough to accommodate a separate cycle lane.

A broad view of what constitutes investment is critical for the purposes of this report as it allows an open approach to what investment might potentially improve economic growth or productivity.

5 HOW CAN CYCLING CONTRIBUTE TO PRODUCTIVITY GROWTH?

The benefits of cycling are widely agreed, with the main benefits typically given as:

- Reducing congestion
- Faster travel times in urban centres
- Improved local economies and land values
- Reductions in household expenditure on travel
- Reduced requirement for car parking space (including the ability to relocate and improve commercial activity)
- Reducing emissions and noise pollution
- Improved health outcomes
- Reduced reliance on imported fuel

5.1 The economic benefits of cycling

While the benefits might be generally agreed, the exact magnitude of the benefits, and the relationship between cycling and productivity, is difficult to quantify. A potential framework to use when evaluating the contribution of cycling facilities to productivity is to consider the benefits of the facilities associated with:[11]

- Reduced use of private cars
- Improved travel conditions for existing cyclists
- Increases in the number of cyclists

The contribution of cycling facilities to productivity is discussed below within this framework.

5.1.1 Reduced use of private cars

Cycling competes with other transport modes. If cycling improvements lead to people substituting away from private cars towards cycles, the following economic benefits are likely to result:

- Reduced travel times for other (non-cyclist) road users
- Reduced congestion, leading to improved journey reliability times for other (non-cyclist) road users
- Reduced emissions and noise pollution.

5.1.2 Improved travel conditions for existing cyclists

Improved travel conditions for existing cyclists are likely to contribute to productivity and economic growth by resulting in:

- Faster journey times
- More reliable journeys (although given that one of the major benefits of cycling is reliability, the incremental impact is likely to be minimal)
- Safer trips due to slower travel speeds and the safety in numbers effect (reducing the chances of cyclists being involved in accidents)

These three factors are incorporated into the Government Policy Statement on Land Transport Funding (GPS).

5.1.3 Increases in the number of cyclists

Improved cycling facilities have the potential to increase the number of people cycling, which may have productivity improvements through:

- Improved health outcomes
- Affecting labour market decisions
- Increasing access to markets and connecting areas with economic growth potential.

[11] The framework has been adopted from the 2004 Victoria Transport Policy Institute paper "Quantifying the Benefits of Non-motorized Transportation for Achieving Mobility Management Objectives". The paper is available at http://www.vtpi.org/nmt-tdm.pdf

Improved health outcomes

One of the main benefits of greater numbers of cyclists is the productivity improvements associated with improved health outcomes. There is a significant body of quantitative evidence which shows that the economic costs associated with poor health are high, and cycling is one way to reduce these costs and improve labour productivity.

Affecting labour market decisions

Transport policy, affecting factors such as transport speeds, reliability and safety, influence people's decisions to work, where to do so and how far to travel. Improved cycling facilities therefore have the potential to alter people's labour market decisions. For example, difficulties with transport have been shown to limit employment opportunities. A United Kingdom Department for Transport survey found that 13 percent of respondents of working age said that they had decided not to apply for a particular job in the last 12 months because of transport problems.[12] Improved cycling facilities could be one way to break down such barriers, particularly in areas where people may not have access to a car and are not well served by public transport.

Increasing access to markets and connecting areas with economic growth potential

Increasing access to markets and connecting areas with economic growth potential are two of the proposed GPS impacts. Essentially these are indirect economic growth benefits resulting from transport projects. Cycling facilities have the ability to provide these wider economic benefits, particularly for dedicated recreational cycle ways, and also through the reduction in congestion for higher value vehicle trips.

As noted above, reduced travel times and improved reliability are two of the proposed GPS impacts, as is reduced congestion.

5.2 Productivity and agglomeration impacts

The wider impacts of transport projects are conceived as the impact that a particular mode has on peoples' travel to work choices and therefore the potential to influence productivity growth and other effects, such as agglomeration impacts. Overall, direct productivity and agglomeration impacts from cycling are likely to be small, given the relative numbers of people choosing to cycle to work compared to other modes (according to the 2006 Census, cycling is 2% of the market). However, there are two critical issues to examine which potentially make cycling as a mode choice an important, albeit indirect, contributor to the efficient running of the transport network:

- The network impact of cycling as a mode choice in the overall transport market
- The spatial distribution of cycling as a travel to work option
- The potential densities and spatial interactions that could be achieved if cycling's contribution to transport were fully expressed through optimised networks

Both of these factors working individually and in tandem imply that cycling can have a positive role to play in helping the government achieve the new set of GPS objectives aimed at assisting with productivity increases and economic growth.

[12] Department for Transport (2002). Accessibility of local services and facilities. Department for Transport. A Department of Labour literature review, while specific to the settlement of refugees but still applicable more generally, also found that living away from transport limits employment opportunities.

5.2.1 Network and market effects

Markets work best when there are lots of choices and very few barriers to consumers being able to make the choice that best suits them. High barriers to consumer choice go hand in hand with high transactions costs faced by consumers in making those choices, rendering markets less efficient at delivering services. The market for transport is no different in this regard, with mode and route choice across the transport network being critical for internal efficiencies within the network to be maximised. In this regard the new GPS objectives revolve around solving issues related to the removal of transactions costs within the system, as illustrated in Table 5-1 below.

GPS Objective	Promoting choice to the travelling public	Reducing transactions costs
Improving transport efficiency	✓	✓
Improvements in journey reliability time	✓	✓
Easing severe congestion		✓
Improvements in road safety	✓	
More efficient freight supply chains		✓
Providing better access to markets, employment and areas that contribute to economic growth	✓	

Table 5-1 Cycling's potential impact on the new GPS targets

The presence of cycling facilities within the transport market helps to create choices for consumers over their daily travel needs.

5.2.2 Spatial distribution of cycling

Cycling as a travel to work activity is not evenly distributed across the country, with some places showing far more uptake than others. Table 5-2 illustrates the skewed distribution of cycling activities as a travel to work option by analysing the 2006 Census data for the locations where most people choose cycling as their preferred travel to work option. Several interesting facts arise from examining the data:

- The top 20 of the 76 territorial authorities comprise just over 76% of the total number of people choosing to cycle.
- Further indications of the skewed nature of the cycling choice are shown by just over 50% of all people who choose cycling are located in the top seven ranked locations for cycling
- Urban density and topography would appear to have some influence on the number of people, with all the top 20 featuring significant urban concentrations within the New Zealand context.

These facts are further influenced by other demographic, business / organisation and employment location factors.

Top 20 locations for people who bike to work (as % of total)			
Territorial Authority	**Bike % NZ**	**Rank**	**Cumulative**
Christchurch City	23.9%	1	23.9%
Auckland City	6.5%	2	30.4%
Wellington City	5.7%	3	36.1%
Palmerston North City	4.8%	4	40.8%
Hamilton City	4.5%	5	45.3%
Nelson City	3.2%	6	48.5%
Tauranga City	2.6%	7	51.2%
Hastings District	2.4%	8	53.6%
Tasman District	2.4%	9	56.0%
Napier City	2.2%	10	58.2%
Dunedin City	2.2%	11	60.4%
Marlborough District	2.2%	12	62.6%
North Shore City	2.0%	13	64.6%
Manukau City	1.8%	14	66.4%
New Plymouth District	1.8%	15	68.2%
Waitakere City	1.8%	16	70.0%
Wanganui District	1.6%	17	71.6%
Lower Hutt City	1.6%	18	73.3%
Timaru District	1.5%	19	74.7%
Rotorua District	1.4%	20	76.2%

Table 5-2 Top 20 concentrations in New Zealand for people cycling to work

Source: Statistics New Zealand Census 2006

For instance, productivity growth and agglomeration impacts (from increasing cycling amenities) are more likely to occur in areas that:

- Have the necessary concentration of populations and therefore are more likely to have a higher degree of division of labour – also where population is concentrated, there is more likely to be road congestion, therefore cycling becomes more attractive
- Have significant concentrations of businesses in industries that have been shown in overseas studies to possess positive agglomeration elasticities

The Economic Evaluation Manual defines these industries with significant positive elasticities along similar lines (currently) to the UK and rates these as:

- Manufacturing
- Construction
- Distribution, hotels and catering
- Transport, storage and communications
- Real estate
- IT
- Banking, finance and insurance
- Business services
- Public services

The top five cycling locations all contain one or more universities and in general have other strong research based institutions. These locations are also centres for value-added manufacturing and also feature strong concentrations of the service based industries listed above. These industries are also likely to attract a greater diversity of workers with specialised occupations (professions and trades) into these areas, resulting in higher than national average incomes. Hyder's work on the Waikato Expressway illustrates and supports this through its identification of nationally significant concentrations of professional, technical and trades workers within the city.

Conclusion

The potential for cycling to have an impact (i.e. bang for buck) on productivity and agglomeration should be considered where the two factors of network / market effects and spatial distribution overlap. By prioritising and focussing the development of cycling activities in these areas implies that cycling initiatives are more likely to support transport network development that is aligned with the new GPS targets.

5.3 IMPROVING STRATEGIC INFRASTRUCTURE INVESTMENT

Because our focus has been on economic impacts, we have focussed on the most productive users of the non-freight transport network, namely commuters. Transport has a critical productivity impact for all commuters in terms of travel times, trip reliability. These factors impact not only on choice of transport mode, but are also proved to impact on employment and residential location.[13] Productivity benefits are therefore likely to be greatest where investment is focussed on urban centres, and targeted at the most congested routes

Empirical evidence clearly shows that making better use of existing networks has a significantly greater impact on economic growth than allocating additional investment into new lane capacity. In this respect any increase in the number of people choosing commuting options other than single occupancy vehicles on congested routes is likely to have significantly greater macroeconomic impacts than investing to provide extra capacity.

It follows that smaller scale infrastructure investment focussed on better managing an existing network is likely to have a stronger net impact on productivity as opposed to adding significant capacity. Such investment may be in intelligent transport systems, bus priority measures or better cycling conditions.

Evidence based on traffic flow information suggests that our most congested networks can deliver considerable improvements in travel times, and therefore productivity, with reasonably small nominal reductions in single occupancy vehicles. The most cost effective means of achieving that result would undoubtedly be non-infrastructure measures such as improved information. However, if it got to the point where investment in infrastructure is warranted, the marginal reduction in the number of motor vehicles required to make the congested network more productive is comparatively small in the short to medium term. Improved cycling amenity is significantly cheaper than the addition of extra capacity for motor vehicles, or grade separation, as shown in Appendix 1.

With the majority of our urban networks facing increased congestion through vehicle and population growth, it would seem that additional capacity would be unavoidable in the medium to long term. Our research suggests that projects that incorporate comparatively low cost options to increase network effectiveness beyond simply adding capacity will, over the life of the project lead to net reductions in commuting times for all users of that project.

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[13] For example, the Auckland Road Pricing Evaluation Study showed congestion in Auckland has reduced labour shortages in suburban retail as lower skilled workers gravitated to employment options closer to home, rather than work in the CBD.

Analysis suggests that inclusion of complementary cycling investment has a benefit to all users of the network. Cyclists get better facilities and marginal reductions in private motor vehicles provide noticeable improvements in traffic flow for car drivers. In this respect a project that includes cycling investment may have a notable impact on the viability of the project and may also affect priorities across the network.

6 Appendix 1: Illustrative example of urban cycling economics

The table below shows a reasonably simple equation around a congested urban route. In selecting the example, we have focused on a high volume commuting route with good potential in terms of commuter origins and destinations to get more efficient use of the network as the route is already a key cycling and public transport corridor, in addition to being a major arterial for private motor vehicles. This is only an illustration. We wish to demonstrate the principle benefits of cost-effective network management practices. The figures used in this example are unlikely to be exact and will vary from place to place/case to case. However, the principles will remain relatively stable across NZ State Highways and local road.

We have selected the Seaview to Nauranga stretch of road in Wellington for a number of reasons:

- The stretch of road is a key congested urban arterial for private motor-vehicle travelers that is at, or slightly above the 25 vehicles per km in density, which is the point at which vehicle levels of service drop dramatically.
- Cycle commuting offers excellent potential benefits with good travel times relative to cars and strong trip reliability. It is already comparatively well used by cyclists (500+ per day).
- Commuters using all or part of the route are also well-serviced by public transport services (both bus and train)
- The wide median along Petone foreshore, and the wide shoulders, rail corridor and existing cycle path along SH2 reduces land purchase costs for securing additional capacity.[14] The width of the corridor means the road cost assumptions are conservative relative to cycleway/wider shoulder costs (i.e. we have not picked a central city project, say, for example, Adelaide Road, where land purchase cost is considerably higher, making the costs of additional vehicle capacity much higher).

While we have selected a Wellington road some of the core characteristics of the example are shared with other possible congested commuter routes including:

- Improved cycling amenity on the major arterials within the Auckland Isthmus.
- Access to central Tauranga from both Highway 29 (East) and SH 2 (West).
- Commuter movement in Hamilton, especially the case for the Wairere Drive/E1 project.
- Dunedin South and Southeastern suburb access through to the main cycle routes.

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[14] It is important to note, however that the landward side of the rail line is probably still not wide enough to accommodate a fully specified six lane road. That said, costs of earthworks and even potentially movement of rail line may be marginally cheaper than urban property purchase, and in this respect it means this illustrative example can still use a conservative roading cost.

	1 extra vehicle lane each way	1 dedicated cycle lane each way
Distance	10km	10 km
Construction cost range per km for two lanes	$20 million[15] Possible cost range: $8 million to $64 million[16]	$1 million[17] (but could be far less if existing road shoulders were used)
Total construction cost	$200 million	$10 million
Potential benefit to car users in terms of time savings.	The car lane represents a significant potential increase in the level of service. However, the “bottleneck” at Ngauranga means there is unlikely to be a significant marginal difference between the travel times associated with increased flows from an additional lane of vehicles (about 2.5 minutes if traffic moves from 60km/h to 80km/h) and the increased flows from a marginal reduction in the number of private motor vehicles using the route	
Maintenance	Cost per KM/lane of reseal: $65,000[18]	Cost per KM/lane of reseal: $32,500[19]

15 We have used an adjusted per km construction cost (excluding interchanges and stations) of the Northern Busway in Auckland as a comparator. Our reasons for choosing this is that the Busway:

- represented a widening of an existing State Highway rather than a new project such as Mt Roskill or Wellington’s inner city bypass.
- Is approximately the same distance as Gracefield to Nauranga, which controls for average marginal cost comparisons for construction project distance.
- Did not involve land acquisition, which would have inflated the construction cost.

We have rounded the roading cost <u>down</u> to the nearest $10 million per km to account for the traffic separation works on the Busway, which are not relevant in our example. We have therefore assumed 10km of 2 additional lanes with very little additional engineering work. We have not included a cost for dealing with the Petone interchange and as such have almost certainly underestimated the cost per KM using the Northern Busway comparator.

16 Source: Auckland Regional Transport Authority: Average per lane per km for urban state highway projects

17 Source: Ministry of Tourism briefing to the Prime Minister dated 17 March 2009 on the average costs per km of widening urban State Highways for the National Cycleway. This probably overstates the infrastructure cost of improving cycling facilities due to the higher specification a National Cycleway would entail, but we consider this reasonable in this example.

18 Source NZTA

19 Conservative assumption that cycle lane is ½ width of vehicle lane

	Period of resealing	4-9 years	40+ years
	Reseal cost of road over 40 year period	$5.2 million	$650,000
	Total construction and maintenance cost[20]	$205.2 million	$10.65 million

[20] Note we have not done a NPV calculation, firstly to keep things simple, and secondly because the costs of cycle capacity relative to roading capacity would be reduced still further because the maintenance/reseal costs fall beyond the standard Project Evaluation Manual analysis period