REPORT 6
(1215/48/IM)

ROADING, TRAFFIC & TRANSPORTATION ASSET MANAGEMENT PLAN ROADING NETWORK ROUGHNESS LEVELS SUPPLEMENTARY INFORMATION

1 Purpose of Report

To provide additional information to the Committee on roading network roughness levels as a supplement to the Roading, Traffic & Transportation Asset Management Plan (AMP). This further report was requested by the Committee when it approved the AMP in October 2003.

2 Executive Summary

The Council has adopted the 2003 Roading Traffic and Transportation Asset Management Plan subject to receipt of supplementary information on a number of issues. This report considers the following:

- Roading network roughness levels and its impacts.
- AMP performance levels relating to road roughness.
- Transfund NZ guidelines.
- Modelling to determine future trends.
- Budgetary requirements.

Road roughness is one of the key indicators of the performance of the roading network. There is a close relationship between road roughness and ride quality. Various studies, particularly overseas have shown that roughness also has a direct bearing on vehicle maintenance costs, fuel consumption, safety and future maintenance costs of the network. The unit for roughness measure is NAASRA (National Association of Australian State Roading Authorities) counts per kilometre. The Wellington City network has higher roughness levels than other major cities in New Zealand.

Vehicle operating costs increase with increasing road roughness. Methods have been developed to quantify these costs and are used to calculate benefit to cost ratios for individual projects.

As part of the Strategic Review carried out by Council, the Levels of Service were set at maintaining the current roughness levels of the roading network with some variations within the various network categories. The AMP sets out the roughness performance measures and these are shown in Table 3.

The dTIMS (Deighton Total Infrastructure Management System) is used by the Council to model the effects of roughness progression and optimise expenditure for road smoothing. This model is used by most other local authorities and Transit NZ.

The existing budget is predicted to maintain the roughness condition of the highest trafficked pavements (46% of the network) at present levels. However modelling predicts a decline in smoothness for the rest of the network over the 20-year analysis period. An increase of $0.5m in the budget is predicted to maintain the current levels except for those streets with less than 200 vehicles a day (22%) which would continue to decline. A further $0.2m will be necessary to maintain the whole network at current levels.

Transfund New Zealand also has a set of guide lines for network roughness levels which is applied nationally. Although we do not have to comply with Transfund's guidelines they will fund to these levels if requested.

The network presently does not comply with any of Transfund's suggested guidelines. It is estimated that an extra $1.5m above the existing budget will be required to be within 10 NAASRA counts of Transfund's target mean roughness. To meet Transfund's guidelines is probably unrealistic considering our local conditions particularly topography and narrow winding roads.

The budget for road smoothing works is mainly in Project CX092 (Shape and Camber Correction). We are requesting an additional $480,000 for the 2004/05 year. $80,000 of which is for price escalations over a two year period and the remainder for additional works. This is less than is predicted by our modelling but we are confident that by better targeting of works we should be able to maintain the overall roughness levels over the medium term. The increased budget is already included in the Draft Annual Plan and attracts a subsidy at a rate of 53% from Transfund which is up 5% from this year.

3 Recommendations

It is recommended that the Committee:

1. *Receive the information.*

2. *Confirm the AMP recommendation for additional expenditure requirements of $480,000 (net $225,600 after subsidy) for Shape and Camber Correction; Project CX092.*

4 Background

This report has been prepared in response to a request for follow up reports by the City Infrastructure Committee following their adoption of the 2003/04 Roading Traffic and Transportation Asset Management Plan at the meeting on 21 October 2003. The AMP proposes an increase of $480,000 for shape and camber correction works on the city's roading network. These works are mainly done to improve the road roughness. The sum includes an allowance for contract escalations for a period of two years and amounts to $80,000.

This report covers the following

- Roading network roughness levels and its impacts.
- AMP performance levels relating to road roughness.
- Transfund NZ guidelines.
- Modelling to determine future trends.
- Budgetary requirements for smoothing works.

5 Discussion

5.1 Road Roughness

To define the riding qualities of pavement surfaces quantitatively road controlling authorities throughout the world developed methods to measure roughness. About fifteen years ago, The National Association of Australian State Road Authorities (NAASRA) developed a roughness meter for such a purpose. The meter, which is fitted to a vehicle, measures the separation between the body of the vehicle and its rear axle. This separation is measured on a cumulative basis over a kilometre and is defined as roughness and the unit of measure is NAASRA counts per kilometre. These days the mechanical methods have been replaced by laser meters which are faster and more accurate.

Road roughness is one of the key indicators of the performance of the roading network. There is a close relationship between road roughness and ride quality. Various studies, particularly overseas have shown that roughness also has a direct bearing on vehicle maintenance costs, fuel consumption, safety and future maintenance costs of the network.

Vehicle operating costs increase with increasing road roughness. Methods have been developed to quantify these costs and are used to calculate benefit to cost ratios for individual projects. Most of the research was done by the World Bank and adopted by Transfund and New Zealand road controlling authorities. Table 1 shows the range of roughness in the City and the expected condition of the road.

NAASRA Count	% of WCC Network	Description of Expected Defects
370 - 420	1%	Erosion Gulleys and Deep Depressions
260 -370	5%	Frequent Shallow Depressions. Some Deep
160 - 260	22%	Frequent Minor Depressions
50 - 160	66%	Surface Imperfections
0 – 50	5%	Smooth

Table 1: Range of roughness and expected condition

5.2 Wellington City Network

The Wellington City network has a higher roughness than other major cities in New Zealand. The average roughness for the network is 138 NAASRA counts. Table 1 below shows comparisons with some of the other roading networks. The higher average roughness value reflects to some extent the steep topography, narrow windy roads and frequent trenching in our streets. It also reflects an acceptance of higher roughness values in the past and Council not choosing to make additional investments in this area.

City	Average Roughness
Wellington	138
Auckland	132
Christchurch	124
Hutt City	120
Hamilton	110
State Highways	70

Table 2: Comparison of average roughness values

5.3 Historic Expenditure and Roughness Trends

Figure 1 below shows an historical correlation between level of spending and resultant average road roughness. The level of expenditure was reduced in 1996 which appears to have led to an increase in roughness level over the next 2 years. Increased expenditure levels have since decreased the roughness level again.

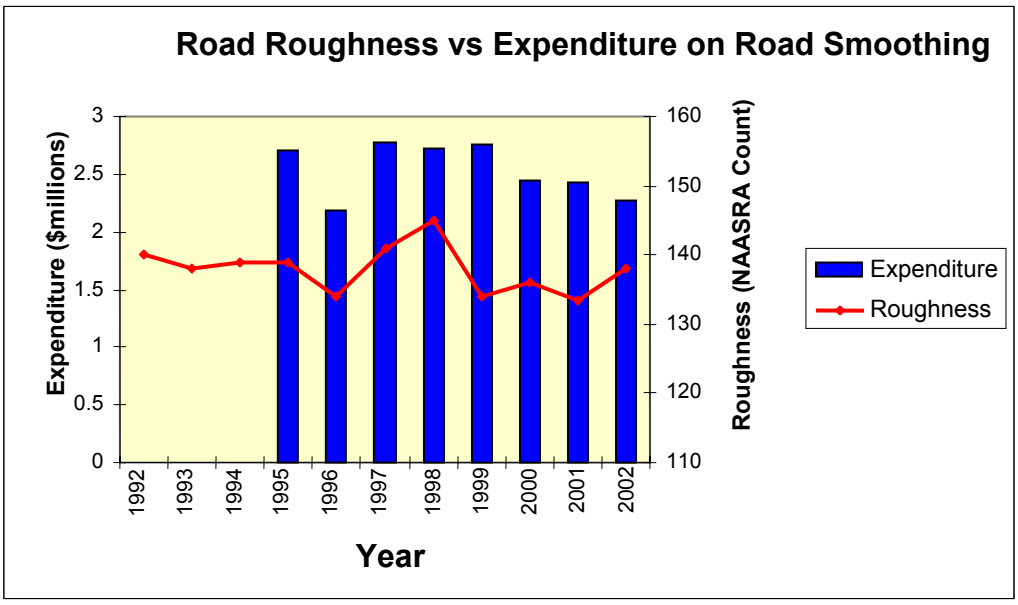

Figure: 1 Road roughness and Expenditure

5.4 AMP Performance Measures

The AMP sets out various vehicle network standards and performance measures. Those relating to road pavement roughness and current levels are shown in Table 3 below. The overall performance objective when setting these measures was to ensure that the roads are comfortable with the higher use pavements having lower roughness thresholds.

Performance Objective	Performance Measure			Target	Current
The higher use pavements are smoother than the lower use pavements	% of road surfaces that meet the following roughness levels				
		Roughness	length		
	Arterial	120	7.5	90%	97%
	Principal	130	68.1	90%	83%
	Collector	140	114.8	75%	65%
	Sub Collector	150	29.1	62%	53%
	Local	170	244.8	61%	64%
	Residential	180	121.1	65%	74%
	Rural 1	140	23.1	62%	53%
	Rural 2	170	44.3	74%	64%
	Suburban Shopping	130	9.0	62%	69%
	Central City	130	3.7	54%	75%
	Central City Shopping	130	1.5	40%	51%
	Central City Business	130	5.0	35%	39%
	Service Lane	170	3.8	35%	43%

Table 3: AMP Performance Measures

5.5 Transfund New Zealand Roughness Guidelines

Transfund New Zealand's "Maintenance Guidelines for Local Roads" sets out various standards for road controlling authorities. Those relating to roughness are shown below in Table 4. As these have been derived from inter-network comparisons of average roughness levels, Transfund acknowledges that while these guideline values of acceptable roughness align with current industry standards, they may not be optimal because of local conditions. In our case this is particularly so because of our topography, narrow and windy roads and frequent trenching. In addition, these guideline values of roughness are independent of vehicle speed, yet overseas and New Zealand research has shown that ride quality of vehicles is a function of both travel speed and roughness, not roughness alone. Our methods of modelling include both vehicle speed and roughness.

Transfund NZ provides roughness performance guidelines for local sealed roads, both in terms of mean and maximum roughness levels and 95percentile threshold levels, based on 6 traffic bands and two speed environments. We do not presently meet any of the Transfund New Zealand roughness targets for either mean or upper bound values, apart from those roads that have a daily traffic count of less than 50 vehicles. These roads comprise less than 0.1% of the WCC network.

If we were to accept Transfund's mean roughness levels guidelines the present road maintenance budget would need to be increased by $1.5M per annum.

Table 4 summarises the WCC network's compliance to the Transfund New Zealand roughness targets based on the 2003 values.

Environment	Daily Traffic Count (ADT)	Length (km)	Mean Roughness (NAASRA counts/km)		Transfund Target 95th Percentile Roughness (NAASRA)	Proportion of WCC Network Exceeding the 95th Percentile Roughness Target as at 2003
			Transfund NZ Target	WCC Network (2003)		
Urban	>10000	60.276	90	97	120	19%
Urban	5000-10000	50.608	100	109	130	16%
Urban	1000-5000	188.087	110	127	140	29%
Urban	200-1000	192.669	120	143	150	45%
Urban	<200	115.854	140	153	170	36%
Rural	1000-5000	3.879	100	149	120	53%
Rural	200-1000	27.437	110	142	130	49%
Rural	50-200	24.103	120	145	150	44%
Rural	<50	0.667	140	172	180	0%

Table 4: WCC compliance with Transfund New Zealand roughness targets

5.6 Modelling to Assess Future Roughness/Condition Trends

The dTIMS (DeightonTotal Infrastructure Management System) is the model used to analyse the effects of roughness and condition progression with time and to optimise expenditure. The model originates from Canada and is widely used by other road controlling authorities in New Zealand. The model has been used for several years and has been customised for the city. Opus Consultants have made a significant contribution to the development of our model and were engaged to test various budget scenarios over a 20-year period. A summary of the results of the modelling is outlined below.

5.6.1 Roughness Levels

The mean roughness condition for roads carrying 500 or more vehicles per day (vpd), as forecast for the next 20 years, is plotted in Figure 2 for three maintenance budgets: 2004/05 budget, and plus and minus $0.5m. It can be seen that for the existing (03/04) budget which is $0.5m less than the 04/05 budget, there is a continual decline in the condition of the network, with the mean roughness level being about 6% higher at the end of the analysis period. The 04/05 budget will generally maintain the network at its present condition over this period. However, according to the model the very poor roads will only get minimal treatment. An increase of $1.0m over the existing budget will deliver significant improvements from year 8 onwards.

Further, the existing budget is predicted to maintain the roughness condition of the highest trafficked pavements (46% of the network) at present levels. However modelling predicts a decline in smoothness for the rest of the network over the 20-year analysis period. An increase of $0.5m in the budget is predicted to maintain the current levels except for those streets with less than 200 vehicles a day (22%) which would continue to decline. A further $0.2m will be necessary to maintain the whole network at current levels. We believe with optimal targeting we should be able to retain current levels with an increase of $0.48m. This amount is the increase requested in the draft annual plan.

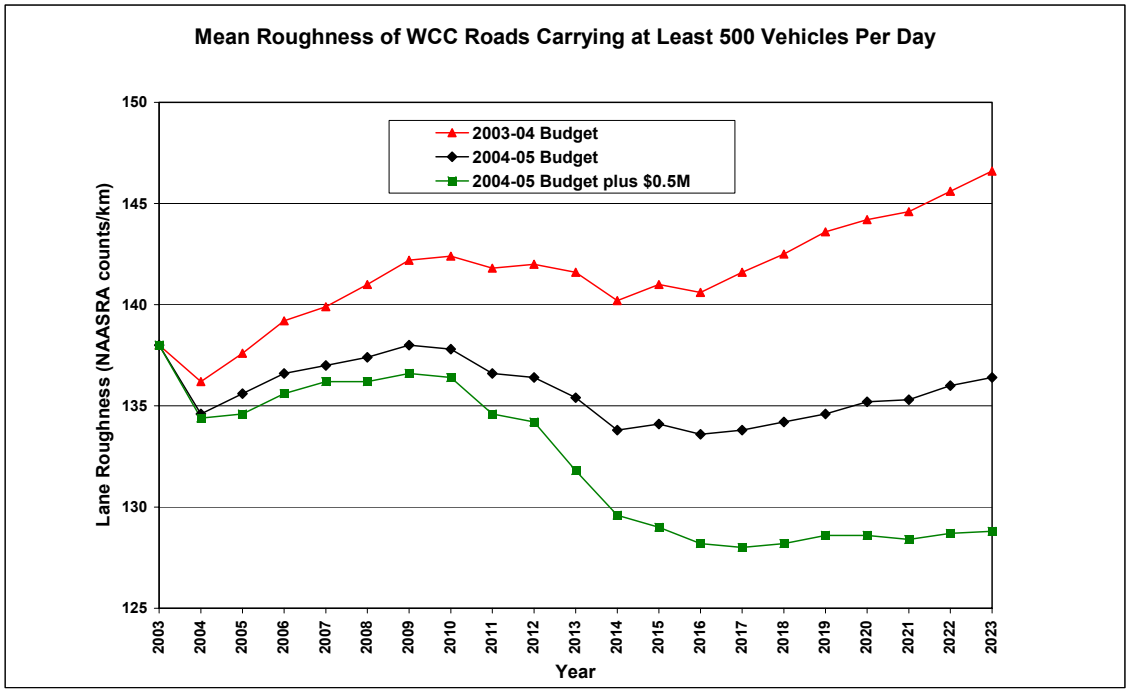

Figure 2: Modelled Mean Roughness Levels of WCC Roads Carrying over 500 vpd

5.6.2 Ride Index

The ride quality of a road is not only dependent on the roughness but also on the vehicle speed. To account for this, a new index (RIDE) was developed. The RIDE index relates vertical accelerations of the floor of the vehicle's passenger compartment to the product

of vehicle speed and lane roughness. This optimisation scheme attempts to provide the same level of vehicle ride quality throughout the entire network, irrespective of the speed environment. The Opus-WCC-dTIMS models were optimised using this new condition index.

The RIDE index has been calibrated to a range of 0-100 in such a way that condition ranges below correspond to performance levels of very poor to excellent as shown below:

RIDE Range	Condition
0-40	Very Poor
40-50	Poor
50-55	Fair
55-65	Good
65-100	Excellent

The Appendix graphically demonstrates the relative decrease and increase of the percentages of the various condition grades of the network measured by the RIDE index for three budget scenarios. The trend is consistent with the roughness outputs in that the length of very poor roads increase as the budget is decreased in a linear relationship of about 0.25% per year with a reduction of $0.5m per year. The $0.5m difference in expenditure per annum also relates to a difference in roads receiving smoothing treatment by about 3.0km per year and the change in very poor roads by 1.7 km per year.

5.7 Budget Requirements and Outputs

The budget allocated to road smoothing works is in Annual Plan Project CX092, Shape and Camber Correction. The 2003/04 year budget is $2.089m. We are seeking a budget of $2.569m which is similar to the expenditure for previous years up to 2001. This is an increase of $480,000 for the 2004/05 year which includes an allowance of $80,000 for contract cost escalations over the past two years (2% per year). The remainder will be allocated to an additional 3km of smoothing works to bring the total annual output to 20km. This is similar to the amount done in the years previous to the 03/04 year and will allow us to maintain the current levels of roughness for the roading network. All the works that are undertaken under this category are required to meet Transfund's benefit to cost ratio criteria and attract a subsidy at a rate of 53%. This is in line with the Strategic Review undertaken by Council when the levels of service were set at maintaining the overall current roughness levels.

6 Conclusion

- Road roughness levels are one of the key indicators of the performance of the roading network. In addition to affecting the ride quality, roughness impacts on vehicle operating costs, safety and future road maintenance costs. Wellington City has one of the roughest roading networks in the country mainly due to its topography, narrow and windy roads and frequent trenching. An acceptance of this lower standard and a lower level of investment in the past have also had a bearing on the current situation.
- Transfund's "Maintenance Guidelines" sets out national roading network roughness guidelines. We can choose to have a lower standard than those stated in the guidelines. To meet the guidelines will require additional funding of $1.5m.
- Council in conjunction with Opus International Consultants have utilised the nationally accepted modelling tool (dDtims) to forecast roughness regression and optimise smoothing expenditure for up to twenty years.
- To maintain the current roughness levels the model suggests an increase of about $0.5m per annum is required over the 03/04 budget. We have requested an increase of $0.48m including escalation costs for the 04/05 year. This amount has been included in the DAP. This is in line with the Strategic Review which opted to maintain the current levels of service for road roughness.

Appendix: Ride Index Condition Graphs

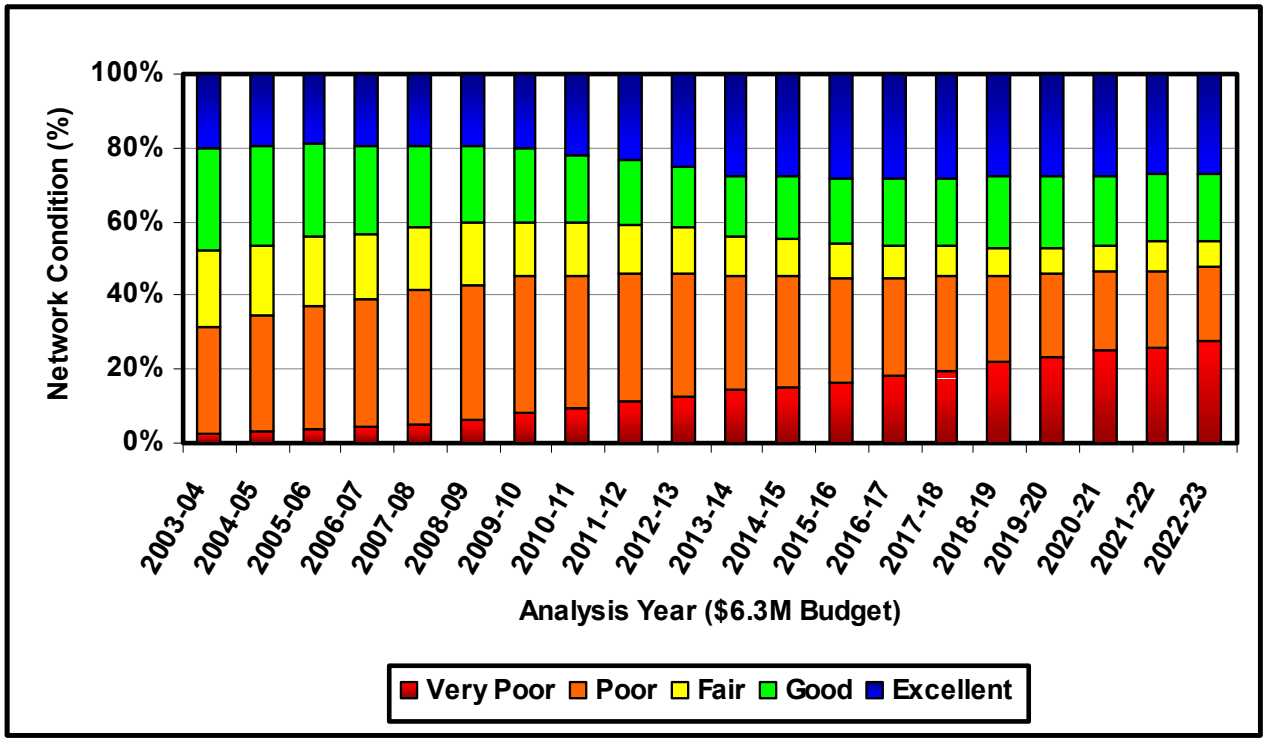

Figure A: RIDE, network condition distribution for 2003/04 budget (04/05 - $0.5m)

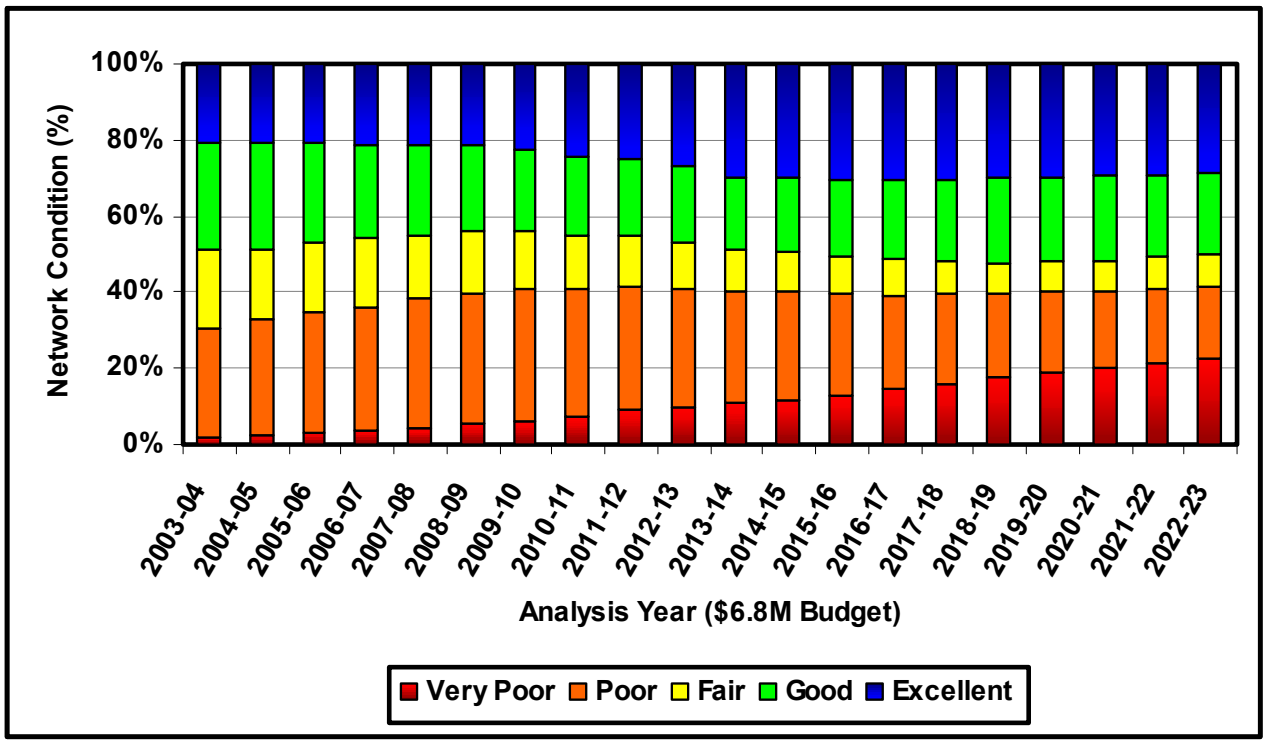

Figure B: RIDE, network condition distribution for 2004/05 budget

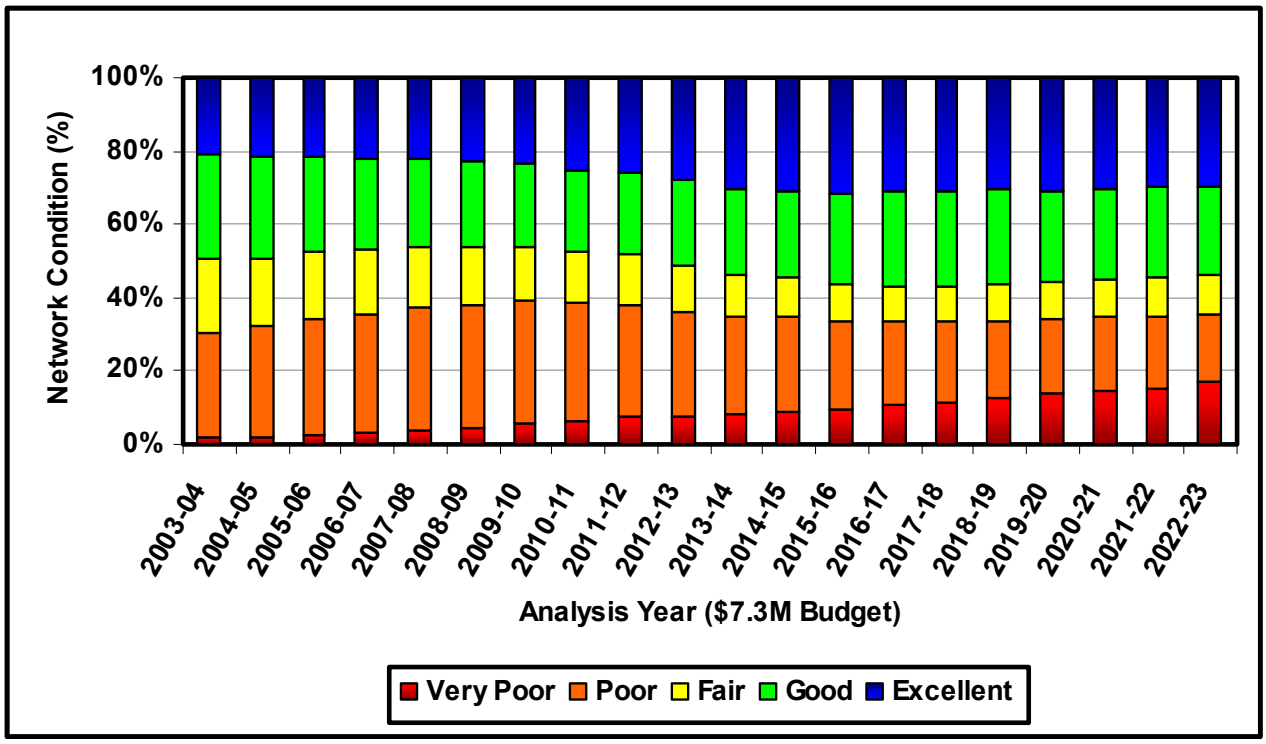

Figure C: RIDE, network condition distribution for 2004/05 budget +0.5m

Contact Officer: Deven Singh, Roading Operations Manager, Infrastructure Group

Supporting Information

1)Strategic Fit / Strategic Outcome

This project supports the following outcomes and objectives of the Strategic Plan:

Outcome 8.1 Transport Effectiveness

A well planned/comprehensive transport network supports a compact and highly liveable city where people move about easily and safely

Outcome 8.2 Transport Accessibility

Transport options allow people to easily fulfil their work and lifestyle requirements

Outcome 8.4 Transport Sustainability

Transport solutions ensure the wise use of resources and cater for long-term needs of the community

2) LTCCP/Annual Plan reference and long term financial impact

The project is contained in CX 092.
These are already included in the Roading Traffic and Transport AMP and 2004/05 Draft LTCCP

3) Treaty of Waitangi considerations

None Identified

4) Decision-Making

The report provides additional information to supplement the Roading Traffic and Transport Asset Management Plan as requested by the City Infrastructure Committee at its meeting on 21 October 2003

5) Consultation

a)General Consultation

This will be carried out via the LTCCP process

b) Consultation with Maori

N/A

6) Legal Implications

None identified

7) Consistency with existing policy

This report is consistent with the asset management plan