Submission
No 3

INQUIRY INTO RAIL INFRASTRUCTURE PROJECT COSTING IN NSW

Name: Dr John Goldberg (Formerly Hon Assoc. University of Sydney)

Date received: 20/09/2011

SUBMISSION TO THE INQUIRY INTO RAIL INFRASTRUCTURE PROJECT COSTING IN NSW

Dr John L Goldberg

Formerly Honorary Associate

The University of Sydney

This submission is the result of 20 years research experience by the author in the road transport sector. It shows how the present problem of rail costings is linked with the past history of road transport in NSW. This work stresses the importance of economic evaluation of projects by proper cost benefit analysis so that correct decisions are made to advance the welfare of society as a whole.

It is presented in the hope that more favourable transport outcomes can be produced than in the past by taking into account the influence of ideology, the conduct of bureaucrats, and the advantage of proper mathematically based financial evaluation techniques. .A failure to learn from the past may compromise the success of vital rail infrastructure in the future.

The compelling nature of the evidence presented here about the misfeasance of state bureaucrats strongly suggests that this problem can only addressed by exposure in a Royal Commission with coercive powers. I suggest that the Attorney-General give serious consideration to such a proposal.

21 September 2011

Summary of main findings and recommendations

1 This submission provides a cost-benefit analysis of the North West Rail Link (NWRL) proposal, and shows that at a cost of approximately of about $4 billion and at a discount rate of 7%pa over 50 years, the project will satisfy the economic requirements of the Environmental Planning and Assessment Act by virtue of the value of the savings in travel time and other benefits. The problem of cost overruns is discussed and a statistical method is proposed to evaluate the integrity of the difference of a pair of cost estimates for a rail proposal.

2 The submission reveals quantitative evidence of the use of false and misleading cost benefit analysis of roads which would have the effect of marginalising rail alternatives on the basis of their cost. It is unlikely that the NSW Treasury would have undertaken any valuation of benefits. This has enabled the RTA to justify uneconomic road proposals such as the M2 and M5 Motorways and their upgrades.

This tendency is illustrated by an in-depth evaluation of the cost benefit analysis made by

The predetermination process has been used to influence the misuse of the ministerial determination powers to favour road projects and upgrade proposals.

3 Transurban's ownership through public private partnerships (PPP) of a significant part of the road network in the Sydney region will be shown to have had a disastrous financial outcome which should serve as a warning to avoid rail funding by this means. The PPP arrangement is the result of a mistaken ideology to privatise roads and was instituted by the former Premier of NSW, N. F. Greiner who has been appointed Head of Infrastructure NSW. He is invited to comment on the following audited results which summarise the aggregate of 12 years of Transurban operations (2000-2011), the essential components of which are shown in Table 1 below.

Table 1

Quantity	Amount ($ billion)	Comment
Toll revenue	4.948	
Profit	0.178	Profit is only 3.7% of the revenue
Distributions paid	1.824	Paid out of borrowings
Accumulated losses	0.741	
Total deficit	2.565	Distributions paid plus accumulated losses
Total debt service costs	3.912	Nearly 81% of the total toll revenue

Total equity	3.922	At financial 2011
Total liabilities	8.401	Includes non-recourse debt of 1.99 billion.
Deferred tax liability	0.830	At financial 2011.
Cash at bank (CB)	0.412	CB is less than 50% of the tax liability(2011)
Market capitalisation	7.546	

Total liabilities clearly exceed total equity plus cash held by about $4 billion. This outcome must raise serious doubts about Transurban's solvency. Paying distributions without supporting profitability further erodes unit holder equity.

But the financial situation is even worse than that shown in Table 1 as there is a serious anomaly in the value of its assets. In 2011, 80% of the total asset value of $10 403.billion has been declared intangible and the value of these intangible assets are said to be based on the concessions granted by the state governments of NSW and Victoria. But these assets can be shown to be worthless by a discounted cash flow process. In any case, no market exists for such assets. In the event of the likely corporate collapse of Transurban, the salvage value probably would at best not exceed about one quarter of the total market capitalisation value, . It is highly likely that superannuation funds and other investors would lose heavily.

In the context of society's needs there can no benefit whatsoever from the existence of a PPP such as Transurban. It is nothing more than a cash collecting agency that exists only for the large amounts of remuneration paid to its executives ($17.595m in 2010; $18.293m in 2011,). Reference to table 1 above shows that in these two years Transurban executives awarded themselves an amount equivalent to over 20% of the total profit of $178m made in the same two years.

.These financial facts provide more than adequate reasons why another Greiner initiative, namely the use of superannuation funds to underwrite transport requirements in NSW must not be implemented under any circumstances.

If Mr Greiner needs additional evidence of the failure of his privatisation ideology, I refer him to the financial collapse of the Cross City Tunnel, the Lane Cove Tunnel and the River City Motorway in Brisbane; I correctly forecast these failures years ahead of the events (Goldberg, 2006). In the not too distant future he will be able to observe the forecast financial collapse of another PPP, the Brisconnections Airport Link which I described to the Super System Review in 2009.

4 The RTA have claimed [1]that it carried out "due diligence" on Transurban which enabled it to grant permission for Transurban to borrow $275m from a consortium of six banks to finance

[1] Response of the Minister for Roads and Ports to question 0324 (Cate Faehrmann).

the M2 Upgrade and for refinancing existing debt. As shown above in this submission I have detailed knowledge of Transurban's disastrous financial position (Goldberg, 2009) and therefore have good reason not to believe this claim. The material on which this claim is based should be submitted to the NSW Auditor-General for examination. As already indicated, in view of the highly adverse experience with road funding, it is vital in the public interest that the following lessons be learned and clearly understood.

i. Rail financing must on no account use the PPP process which allows financial manipulation to occur.
ii. Ownership of transport infrastructure must always remain in the complete control of government to avoid conflicts of interest.

5 In the post GFC environment as governments worldwide struggle with the problems of debt, wastage of resources cannot be tolerated. Projects must be properly evaluated for their outcomes to deliver welfare and productivity gains. In this context the RTA has totally disqualified itself from having any input into transportation planning in an urban environment.

6 Table 2 below is a list of consultants

. High fees are paid to these so-called experts to provide reports endorsing predetermination. A sample of these experts is listed in Table 2. I participated in these projects as an expert witness at hearings or gave expert advice to law firms and other parties..

Table 2

Consultant	Project	Nature of misfeasance	Outcome for society
Manidis Roberts	M2 Motorway		Delay and prevention of rail alternative
Maunsell AECOM	M2 upgrade		Economically worthless project designed to generate revenue for Transurban
Hyder Consulting	Cross City Tunnel		Financial collapse
Parsons Brinkerhoff	Lane Cove Tunnel		Financial collapse
Maunsell AECOM	River City Motorway (Brisbane)		Financial collapse
Sinclair Knight Merz	Albury Bypass		Proper solution of Albury's problems with heavy vehicles prevented
Gutteridge Haskins and Davey	M2 Motorway		Failure to properly forecast the onset of congestion has

			led to the financial waste in upgrading the M2 Motorway
Ove Arup	Airport link (Brisbane)		Almost certain financial collapse
Renzo Tonin and Associates	F3 Freeway	Endorsed totally inadequate RTA traffic noise guidelines	Protection of residents along the M2 Motorway will be compromised'
Sinclair Knight Merz	Proposed M2-F3 connection		There would be no solution to the traffic problems on Pennant Hills Road

Recommendations

1. That the statistical method proposed for examining the integrity of cost proposals for rail be implemented and that financing arrangements for rail should be overviewed by a committee to dilute the influence of the NSW Treasury. This recommendation has been brought about as the result of the highly adverse influence of the RTA on road funding decisions.

4. That the "due diligence" asserted by the RTA in relation to the granting of permission to borrow funds for roads and refinancing of existing loans be examined for its integrity by the NSW Auditor-General.

5. That the prerogative of the RTA to grant permission for raising funds for roads be completely removed and made the responsibility of the NSW Auditor-General.

6. That the influence of the RTA to initiate any transport planning decision be completely removed and its activities be confined to road maintenance and traffic management.

7. In conclusion, I believe that I have shown that misfeasance and corruption in the NSW road transport sector is widespread. Proper transport solutions such as rail have been compromised by this conduct, involving the road bureaucracy and its connections with the private sector. There is thus a compelling case for investigation by a Royal Commission with its coercive powers.

Dr. John L Goldberg

Formerly Honorary Associate

The University of Sydney

21 September 2011

Contents

6. Cost benefit analysis of the 23 km North West Rail Link (NWRL)

   6.1 Value of productive work during the rail journey.

   Appendix A

   A1.

   A2. A test of the integrity of the Transurban traffic modelling program (TUSTM) and the validation of its results.

   A3. The Transurban cost benefit analysis of the M2 Upgrade

   A4. Detailed examination of the Transurban CBA.

   Appendix B

1. Cost-benefit analysis applied to transport systems- The disutility of road transport compared with rail in a metropolitan setting.

Disutility is an economic term which expresses the dissatisfaction that an individual suffers as a result of using the road system. In land transport and air transport time saved in travel provides a measurable scale of satisfaction. Society expects that its expenditure on a mode of transport will deliver benefits that can be measurable in monetary terms and will at least equal or exceed the costs measured according to the same monetary scale. These ideas form the basis of cost benefit analysis which is widely used in making a decision as to whether a particular project is justified or whether one project should be preferred to another project. As will be canvassed in this submission there has been widespread abuse of cost benefit analysis in a number of ways particularly in dealing with transport proposals. As already mentioned (Flyvbjerg et al, 2003) these range from inflating the benefits, particularly common in road proposals, or inflating the costs such as rail proposals in order to obtain economic leverage for opposing road transport modes.

Bent Flyvbjerg[2] in his influential study of land transport in Europe states that:

> *"not only are cost estimates 'highly, systematically and significantly deceptive', but so are the cost-benefit analyses into which cost estimates are routinely fed to calculate the viability and ranking of projects"*

[2] Professor of Planning at Oxford University, UK

He goes on to say that

> *"an important policy implication for the public, politicians, administrators, bankers and media is not to trust the cost estimates presented by infrastructure promoters and forecasters".*

and

> *"another important implication is that institutional checks and balances-including financial, professional or even criminal penalties for consistent or foreseeable estimation errors-should be developed to ensure the production of less deceptive cost estimates".*

1.1 Cost overruns for various transport modes

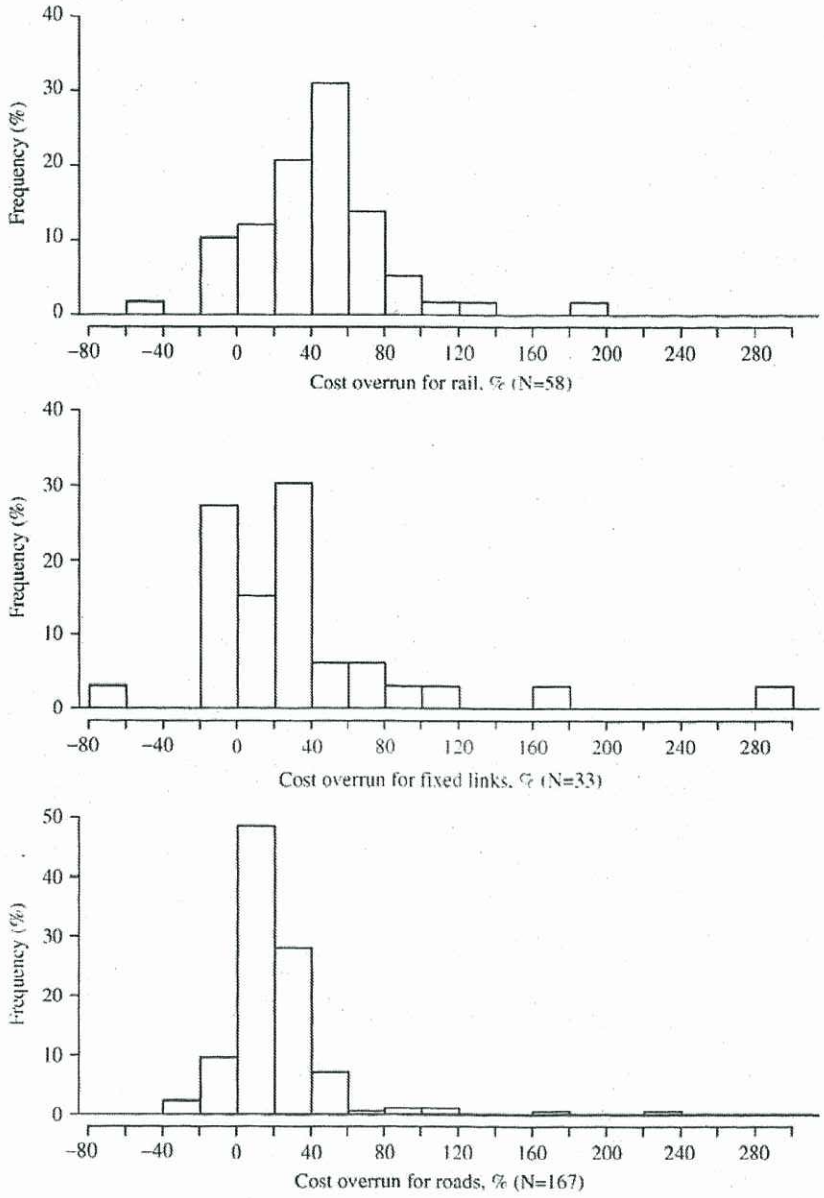

Figure 2.3 Inaccuracies of cost estimates for rail, fixed links and roads in 258 projects. The figure shows the percentage distribution of projects with respect to cost overrun (constant prices)

Figure 1. Cost overruns for three different transport modes (After Flyvbjerg, Bruzelius and Rothengatter (2003). The histograms show statistical frequencies of the percentage of projects with cost overruns were based on a sample size of 258 projects of the three main types. The key result is that the average cost overruns for rail are likely to be about 40% higher than for roads.

2. A proposed statistical method for testing whether the difference between two cost estimates for the same rail proposal is significant or can be justified.

A typical example of a cost discrepancy is provided by the Chatswood-Epping 13 km rail link. Two cost estimates of this same project produced $78.72m/km (Thiess) and $177.6m (Eddington). However, if we had the appropriate data as specified below, we can apply probability theory to these estimates as follows. Each total cost estimate will involve the costs of many individual parts. The cost of each separate part will have an uncertainty attached to it and the total uncertainty can be calculated[3].Statistical theory enables to test whether each individual estimate of the cost is significant or in other words whether the value is real or whether it has arisen by chance alone or even by deliberate misrepresentation.

The measures of uncertainty are then combined and it is calculated whether the difference in costs exceeds this combined uncertainty. If this is the case then it is probable that the difference is significant; if the difference in costs is less than the combined uncertainty then the difference can be declared not significant. The test enables one to determine also whether or not the components of the cost structure arose from the same material source or were the result of deliberate misrepresentation. The method should be applied to the costing of the North West Rail Link (NWRL).

3. Comments on competing transport systems in the North West Sector

In the M2 Prospectus (1994), page 26 "Competing Transport Systems" it is stated that:

> *"The traffic projections for the M2 Motorway assume that it will be the primary transport link to North West Sydney. If the New South Wales Government discriminates against the Company in the running of the M2 Motorway or which prejudices the M2 Motorway's operational results....then the parties are* ***required*** *(sic) to negotiate in good faith etc."*

The negotiations had as there aim the repayment of the project debt in some manner to be negotiated and to ensure that investor returns were not compromised.

The M2 development must represent one of the most extraordinary episodes in the history of transport in NSW. In summary, an uneconomical facility is built, congestion defeats it yet an economical rail proposal which could have been the prime transport facility in the sector is delayed for years because the Treasury refuses to recognise anything but costs, not benefits

Then, later in 2009 an economically worthless widening project is proposed, branded "critical" infrastructure to be paid by borrowed funds, consisting of both debt and equity, which were obtained for the Transurban Group

[3] In statistical language the uncertainty is specified by its variance or standard error.

. Proper risk assessment for borrowing the debt component needed for the upgrade were supposed to be obtained as a result of due diligence, the outcome of which was probably predetermined in the traditional RTA manner. The equity has been raised by misleading investors who do not really understand the value of what they are investing in[5].

4. How policy decisions to prefer road over rail were influenced by false cost-benefit analyses.

As confirmed by Flyvbjerg et al (2003) and the author (Goldberg, 2010) there has been widespread abuse of cost benefit analysis in a number of ways particularly in dealing with transport proposals. These range from inflating the benefits, particularly common in road proposals, or inflating the costs such as rail proposals in order to obtain economic leverage for opposing road transport modes.

In the Sydney metropolitan region, the introduction of so-called expressways has been justified by cost benefit analysis. Two examples are the M5 South Western Expressway and the M2 North West Transport Link. Both these projects have failed to deliver the travel time savings expected from the cost benefit analysis.

We shall now examine in detail the case of the economic fraud which underwrote the justification for the M2 Motorway.

5. The cost benefit analysis used by the RTA and its consultant in 1992 to justify the M2 Motorway

We now show specifically how the economic justification for the M2 Motorway was based on a false and misleading cost benefit analysis. The consultant Manidis Roberts (1992) examined the economic performance of 11 different options for the M2 road. On page 6 of the report it is stated that

> *"our view is similar to that presented in the New South Wales Treasury guidelines".*[6]

The analysis resulted in 11 different values of benefit-to-cost ratio (BCR) ranging from 0.99 to 1.81 (using a central case discount rate of 7%pa). The variation is substantially due to the different costs involved in the various options

As a participant in the EIS process in 1992 I fortunately had retained a copy of their analysis including all their spread sheets. These provided critical information in this investigation.

---

[5] I have decided to name this particular lack of objectivity by investors "The Transurban Effect"

[6] These treasury guidelines were the work of the RTA.
The reference is NSW Treasury (1997) NSW Government Guidelines for Economic Appraisal. Policy and Guidelines Paper. Office of Financial Management.

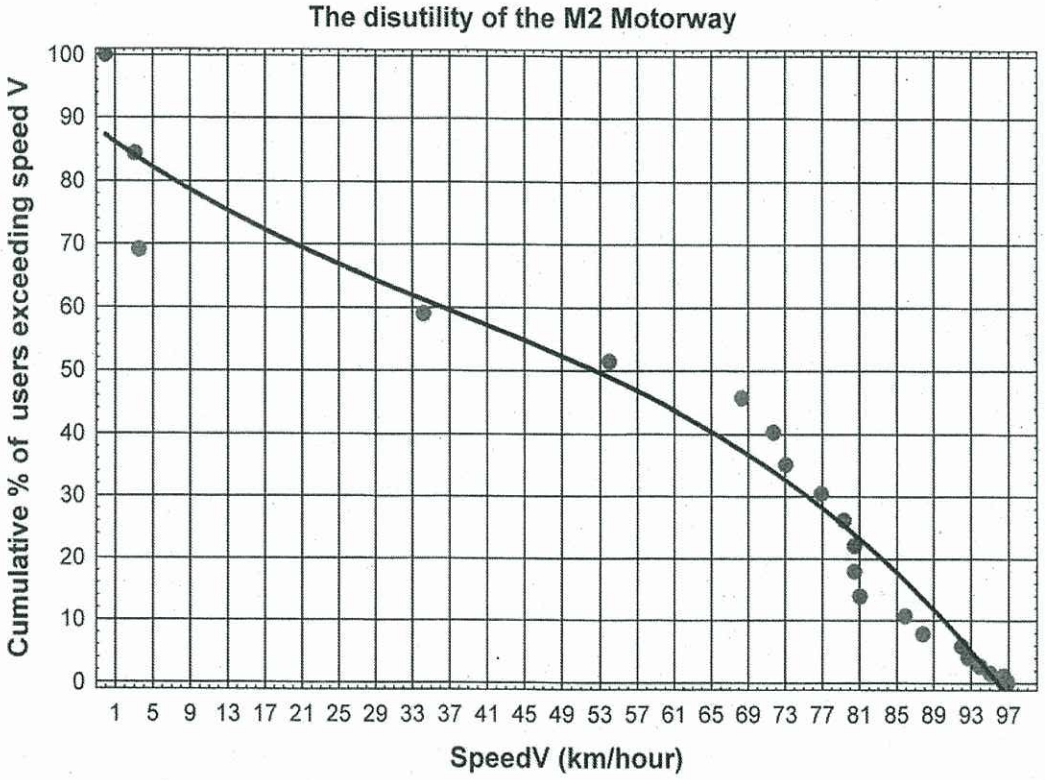

Figure 2. This graph was derived from actual traffic density distributions measured on the M2 Motorway. It shows that only a small percentage of the total traffic can travel at the same time at the high speeds for which the roadway was designed. This is the meaning of the term "disutility". Cost benefit frauds usually involve the spurious claim that all traffic can travel at the same speed all the time.

There are a number of factors involved in economic evaluation. The most significant factor is the valuation of travel time savings. Savings in accident costs and vehicle operating costs play a relatively minor role in the overall evaluation. The Manidis Roberts document gave 28 values of travel time savings for the years 1996 to 2025 for the option expressway (W) plus expressway (E). Critical information such as the travel time savings and speeds were understandably omitted from the spread sheet, but these were obtained by me using mathematical induction as described below.

The main benefit that of travel time savings was calculated by comparing the travel time gained by a road user if he were to use the M2 Motorway instead of the surrounding arterial road network. The travel speed for the user of the arterial road system cannot exceed 60 km/h .

Working back from the spread sheet details and calculating the time differences revealed that the average speeds on the motorway would have corresponded to a value of 96 km/h in

1998 to 68 km/h in 2025. We show that it is impossible for the entire average daily traffic (AADT) to sustain such speeds because speed is a function of the traffic densities which are highly variable over a 24 hour period. We show for example using actual measured traffic density data that only about 2% of the total traffic can travel at 96 km/h and only 38% can travel at 68km/h. These results are derived from **Figure 2** above and are based on Goldberg (2010).

During the peak two hour AM period it will be shown that traffic densities which correspond to these speeds would imply that the traffic flow in vehicles per lane per hour would exceed lane capacity of 2000 v/l/h. throughout the entire period 1998-2025. Exceeding lane capacity causes queuing, delays and breakdown in the traffic flow (Austroads, 1988)

The traffic forecasts themselves on which the Manidis-Roberts CBA is based were derived in such a way as to satisfy financial criteria and therefore have no real connection to the fundamental criteria demanded by land use-transport interaction. One of the unfortunate legacies of these forecasts is that motorists are now paying excessive charges for usage of the M2 for which they are receiving little or no return in terms of time savings.

According to the Manidis Roberts cost benefit analysis (CBA) very large travel time savings were generated from this impossible speed regime. The idea was to ensure that these non-existent benefits of travel time savings would exceed the cost of construction ($435.77m) or if the bus way was included the total cost was $577m.

The spread sheet gave only the monetary values of the travel time savings for the years 1998 to 2025. These were in the form of present values, calculated at the social discount rate (Pearce, 1983) of 7% pa. It did not give the traffic forecasts for these years which were fortunately independently available from the Base Case financial model prepared by the Macquarie Bank in collaboration with other parties for the benefit of investors. These so-called traffic forecasts were derived by work back from the returns promised to equity investors. The forecasts therefore had little to do with those derived by proper consideration of land use and transport interaction-the mechanism that generates traffic.

The mathematical problem that had to be solved was this:

What were the speeds (**VM2**) on the M2 Motorway that would have given rise to the values of travel time savings (**VTTS**) specified on the spread sheet?

Once these speeds (**VM2**) were obtained, the travel time savings (**TTS**) themselves could be examined as to whether they were realistic in traffic engineering terms .The two key variables **VM2** and **TTS** are missing from the Manidis Roberts spread sheet apparently to conceal their origin.

5.1 The mathematical analysis

Let **AADT** = average daily traffic on the M2, then the number of traffic movements in one year = **AADT** x 365.

Suppose each vehicle on the M2 gains a travel time reduction of **TTDIFF** (minutes) by using the M2 rather than the contiguous arterial road system with a speed limit of 60 km/h. Then the total reduction in travel time is **AADT** x 365 X **TTDIFF** (minutes).

If each road user values his travel time at 23.3 cents per minute as commonly accepted (Goldberg, 2010). Then the total value of travel time (VTTS) saved in one year is

$$\mathbf{VTTS} = \mathbf{AADT} \times 365 \times \mathbf{TTDIFF} \times 0.233,$$

from which

$$\mathbf{TTDIFF = VTTS / (AADT \times 365. \times 0.233)} \qquad (1)$$

The quantity VTTS as given on the spread sheet has to be modified by calculating its present value (PV). Then the 28 values of TTDIFF can be readily calculated from equation (1).

A second equation is formed as follows. Over a 21 km transit of the M2, the time taken at 60 km/ is 21/60 hours. In minutes this is 21 x 60 /60. Similarly, the time taken at speed **VM2** is 21 x60/**VM2** minutes.

Thus **TTDIFF** = 21 – 21 x 60/ **VM2**, from which.

$$\mathbf{VM2 = 21 \times 60/ (21. - TTDIFF)} \qquad (2)$$

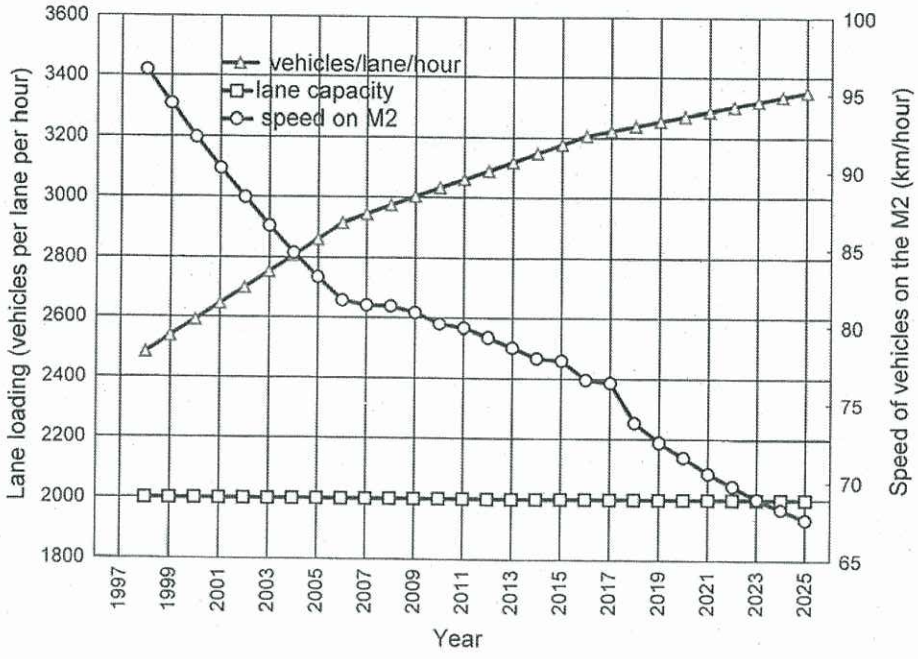

Figure 3. The solution to the equation for speeds on the M2 Motorway (1997-2025). The results defy accepted principles of traffic engineering (Austroads, 1988). Traffic in the peak AM period would be

essentially gridlocked. This is actually occurring now and has been occurring for years on the M2. There are no road user benefits as would be anticipated from the CBA.

5.2. The deductions from this analysis shown graphically.

The analysis predicts an average speed range from 68 km/hour to 96 km/hour over the entire time from 1998 to 2025.

But calculations of the lane loadings in vehicles/lane/hour during the AM peak period show an impossible situation which defies the accepted principles of traffic engineering.

The maximum capacity of a lane is 2000 vehicles/lane/hour. Therefore in the two hour peak period AM according to Austroads (1988) the values correspond to level of service F, that is, queuing, delays and unstable traffic flow, not the free flowing traffic which would be the result of the speed regime derived by examining the cost benefit analysis from 1998 to 2025.

Put again in more simple terms, in 2011 the average speed of vehicles on the M2 would be approximately 80 km/h. But in the peak period the lane capacity is exceeded by about 50%. How then can gridlocked traffic be moving at an average speed of 80 km/hour? One does not need mathematics to realise something is profoundly wrong. Simply observe the traffic flow on the M2 and instead of 80 km/hour a motorist would be fortunate to achieve 5 km/hour.

The value of BCR calculated by the author from the Manidis Roberts spread sheet is 1.97 (Manidis Roberts gave 1.81). The discrepancy of 8% between these two values may have arisen from an audit of the M2 traffic forecasts by a group of consultants[7] which recommended a 7% reduction in the original forecasts

The author has shown that three other projects collapsed due to the same approach.[8]

The probability is high that every major road in the Sydney Region has had its economic performance in the same way.

. The widespread congestion and the consequent demands for the M2 and M5 roads to be widened in the misguided expectation of congestion relief, suggest a degree of misunderstanding of both traffic engineering and economic evaluation fully exploited by the RTA and its toll road acolyte Transurban against the public interest. It is of interest to note the RTA has been at some pains to the

[8] Cross City Tunnel, Lane Cove Tunnel, and River City Motorway in Brisbane. There will be others.

public that uncontrollable traffic induction, responsible for the existing congestion problems plays a minor role in the problems.

The M2 Motorway has comprehensively failed to operate as a free flowing roadway and this failure has given rise to the supposed need to widen it. To justify this expansion another cost-benefit analysis was carried out by the M2 toll road owners Transurban.

in the full knowledge that widening would create traffic induction leading to rapid erosion of any relief from congestion. At the same time widening would increase toll revenue for the Transurban Group.

This case illustrates the extraordinary effect on transport planning that has arisen from the introduction of toll roads in the Sydney region. None deliver travel time savings except at low traffic densities. But roads users are paying exorbitant fees for the use of road space to satisfy an investment outcome for the road investors and promoters. The situation reminds one of a shopkeeper that continues to give short weight. The analogy here is that the road user expects that payment of a toll will guarantee travel time saved which it does not.

We thus have two examples of evasion of responsibility under the E P & A Act generating an implicit bias in favour of roads as against rail. This is a travesty of welfare economics. Moreover, there was no case whatever on economic grounds for not proceeding much earlier with the Epping Chatswood rail link and the NWRL.

As already stated, the CBA analysis for roads as developed by the RTA and its consultants has been adopted by the NSW Treasury and would have had a powerful influence on selection of transport modes.

The author's work in this field (Goldberg, 2010) has shown that unless proper recognition is given to factors such as the variable speeds on motorways, entirely erroneous results will be obtained resulting in economic valuations that are largely worthless.

6. Cost benefit analysis of the 23 km North West Rail Link (NWRL)

This cost benefit analysis of the North West Rail Link was undertaken to quantify the order of cost that would be appropriate to ensure the project was economic. In other words, the value of the travel time savings for rail commuters is calculated and compared with likely cost estimates of the NWRL. In the north west demographic catchment area as can be observed, the NWRL will compete with the demonstrably uneconomic M2 Motorway (whether widened or not). The economic gain for rail users is compared with the economic gain for the M2 Motorway users and the difference in economic performance in terms of the value of travel time savings is calculated. It is shown that the economic gain for rail is very

large. It is augmented by the economic advantage of the likelihood of productive work being carried out by rail commuters during their trips, a situation which is impossible for M2 users.

The results of this analysis provide indicative results only strictly in accordance with the assumptions made. The model for the NWRL analysis is based on the existing Epping to Chatswood rail line. The relevant properties of the Epping-Chatswood line are as follows.

Length of rail link: 13 km.

Average speed taking account of stops: 43.33 km/hour, based on timetable information from City Rail.

Number of passengers assuming Millenium trains: 904 per eight carriage set.

Number of Movements in a 24 hour day during a 5 day week in both directions = 140.

Number of work day passenger movements in a year = 140 x 5 x 904 x 52 = 32.905E+6

Number of weekend passengers = 124 x2 x904 x52 = 11.657E+6.

Total annual passengers = 44.562E+6.

The analysis will initially determine the reduction in travel time obtained by using the train rather than the same commuter using the M2 Motorway over the 24 hour period.

Firstly, we need to determine the percentage of users of the M2 Motorway that actually would be able to travel at the same speed as the NRWL train, namely 43.33 km/h. The graph in Figure 2 shows this percentage as 56%.

The number of commuters involved is 96000 vehicles per day. Assuming each car is carrying one passenger on average, the number of movements per year is 96000 x 365 = 35.04E+6.

But as already indicated only 56% of these commuters move at a speed in excess of the train speed of 43.33km/h.

The annual number is therefore 0.56 x 35.04E+6. = 19.622E+6 as against 44.526E+6.

Therefore 44.526E+6 less 19.622E+6 = 24.904E+6 commuters will gain a speed advantage by not using the M2 Motorway.

The time taken for 23 km is 23/43.33 hours = 0.54 hours.

The value of this time is $44.526E+6 x 13.98 x 0.54 = $336.135million.

The time taken by M2 commuters is 21/43.33 = 0.4846 hours.

The value of this time is $19.622E+6 x 13.98 x 0.4846 = $132.933 million.

The difference in travel time savings (TTS) = $204 million.

This amount however overestimates the advantage of using rail because there are a significant number of commuters that will be able to move in excess of 43.3 km/h. on the M2 as indicated in the following table 1 derived from Figure 2.

TABLE 1

Speed V (km/h)	% commuters on M2 exceeding speed V km/h	Time taken for 21 km	Value ($million)
50	52	0.42 hours	59.9
60	42	0.35 hours	40.32
70	38	0.3 hours	31.27
80	22	0.262 hours	15.81
90	10	0.233 hours	6.39

Total value for M2 commuters from Table 1 = $153.69m'

Grand total for M2 = $153.69 + $132.933 = $286.62m.

Therefore the gain in the value of travel time for users of rail is $336.135m – $286.62m = $50m million. The present value[9] PV of the rail advantage = $50.E+6 x 14.86 = $$0.743E+9. Adjusted for CPI = 1.87, value = $1.39 billion.

Rail has a significant economic advantage over road travel. Productive work can be carried out due to the technological advantages of laptop computers and the internet. This economic advantage is now quantified.

6.1 Value of productive work during the rail journey

The train in one journey covers 23 km at 43.33 km/h.

The duration of the journey = 23/43.33 hours = 0.53 hours.

No of trips per day = 140

No of passengers/day = 140 x 904 = 126.56E+3

Total time/day spent in travel by all passengers = 126.56E+3 x 0.53 = 67.076E+3 hours.

In one working year total time spent = 67.076E+3 x 5 x 52 = 17.43E+6.

[9] The multiplier of 14.86 was obtained using a general formula for calculating present value given the discount rate and number of years. (Goldberg, 2010)

Value of working time = 17.43E+6 x 15.5 at standard wage rates[10] = $270.16E+6

Total present value of working time = $14.86 x 270.16E+6 = $4.0146E+9

Adjusted for mean CPI[11] = 1.87, present value = 7.507E+9 = $7.51 billion.

If only 1 in 3 commuters work productively, value = $2.50 billion.

Total value = 2.50 + 1.39 = $3.89 billion.

NWRL would therefore be economic at a cost of about $3.89 billion.

The 95% confidence interval for the mean is $ [3.56, 3.89, 4.18].billion

These results are indicative only and have been calculated strictly in accordance with the assumptions made.

[10] Standard wage rates are $15.5/hour.
[11] Deduced from extrapolation of Reserve Bank of Australia data.
[12] Goldberg, J.L (2010)..

References

Applied Economics and Manidis Roberts Consultants (1992) North West Transport Link Eastern Section. Economic evaluation.

Alexander, M (2009) Road User Cost Benefit Analysis (Transurban)

Austroads (1988) Guide to traffic Engineering Practice. Part 2 Roadway Capacity.

Flyvbjerg, B; Bruzelius, N; and Rothengatter, W. (2003) Megaprojects and Risk – An anatomy of ambition. (Cambridge).

Glen Lyons et al (2011) Rail passengers travel time use in Great Britain (www.transport.uwe.ac.uk).

Goldberg J.L (2010 Cost-benefit analysis of road widening proposals with special reference to the M2 Motorway in Sydney: a statistical analysis. Proceedings of ATRF2010, 29 September – 1 October, Canberra. (www.patrec.org).

Goldberg, J.L. (2009) The valuation of toll roads and the implications for future solvency with special reference to the Transurban Group. Journal of business valuation and economic loss analysis. Vol.4; iss1; art 2. (Berkeley Electronic Press)

Goldberg, J. L. (2006). The fatal flaw in the financing of private road infrastructure. Proceedings of the Australasian Transport Research Forum (ATRF06) Gold Coast. Queensland (www.patrec.org)

Lapin, L. (1978) Statistics for modern business decisions 2 Ed. (Harcourt, Brace, Jovanovich Inc.)

NSW Treasury (1997) NSW Government for Economic Appraisal. Policy and Guidelines Paper. Office of Financial Management.

Pass, C; Lowes, B and Davies, L. (1988) Dictionary of Economics (Collins, London and Glasgow)

Pearce, D. W. (1983) Cost-Benefit Analysis. 2 Ed. (Macmillan)

Transurban Group (2000-2011). Annual Reports.