Prioritising Road-Rail Level Crossings for Grade Separation Using a Multi-Criteria Approach

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ABSTRACT

There are 177 at-grade rail road level crossings within Melbourne's metropolitan rail network. Each crossing represents a conflict point between trains and road traffic including cars, buses, trams, cyclists and pedestrians. Whilst the desire to eliminate level crossings is often based on safety needs, in the Melbourne context congestion is a major driver for grade separation. In particular it is the interaction between the crossings and neighbouring signalled junctions that is a significant contributor to congestion and a barrier to the efficient performance of the transport network. This conflict will be exacerbated by increasing train volumes: some crossings are forecast to carry nearly 40 trains per hour at peak times by 2021.

This paper considers the assessment criteria available to prioritise metropolitan level crossings for grade separation. These include conventional economic, social and environmental measures as well as Melbourne specific 'strategic fit' criteria that reflect the relative importance of different roads to the transport network overall. In particular the paper discusses the challenges of data constraints, the weighting of quantitative versus qualitative indicators and the difficulties of accurately estimating the potential delay benefits from grade separations for a large range of sites.

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1. INTRODUCTION

There are 177 at-grade rail road level crossings within Melbourne's metropolitan rail network[1]. Each crossing represents a conflict point between trains and road traffic including cars, buses, trams, cyclists and pedestrians. With average crossing closure times well in excess of one minute, these conflicts represent a constraint to road capacity and hence are contributing to traffic congestion in Melbourne.

The current cost of congestion in Melbourne is estimated to be around $3 billion per year with forecasts indicating this will double by 2020 (Bureau of Transport and Regional Economics, 2007). One measure aimed at addressing the increasing congestion in is the elimination of road and rail at-grade crossings. Accordingly the Victorian Transport Plan (State of Victoria, 2008) contains a commitment of $440 million to eliminate level crossings at critical locations in the metro area, out of a total program of $38 billion.

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[1] Includes all crossings on public roads within the electrified metropolitan rail network. Light rail and private crossings not included.

A four stage assessment program was established by the the Victorian Department of Transport (DOT) to identify a prioritised short list of level crossings for grade separation. All 177 level crossings on the metropolitan rail network were considered in the assessment process. Sinclair Knight Merz (SKM) was engaged by the DOT to undertake Stages 3 and 4 of the Metropolitan Rail Road Grade Separation (MRRGS) program which was primarily based on the development and application of a multi-criteria assessment (MCA) tool.

This paper includes full details of the MCA used to inform the prioritisation process. In particular the paper discusses the challenges of data constraints, the weighting of quantitative versus qualitative indicators and the difficulties of accurately estimating the potential delay benefits from grade separations for a large range of sites. It should be noted however that the MRRGS program is on-going and as such this paper cannot report on the specific outcomes of the prioritisation process.

While the focus of this paper is the MCA, for completeness the paper also provides an overview of the complete four stage process. The paper continues as follows:

- Section 2 describes the four stage prioritisation process adopted by the DOT;
- Section 3 provides an overview of the appraisal framework;
- Sections 4 to 7 detail the economic, social, environmental and strategic fit appraisal criteria included in the framework;
- Section 8 discusses some sensitivity tests applied in the MCA;
- Section 9 explains the attempts to refine the MCA methodology as part of the Stage 4 assessment; and
- Section 10 provides some concluding remarks.

2. The Four Stage Approach

The prioritisation study included the following four stages:

- Stage 1 – Closure Assessment;
- Stage 2 – Congestion and Safety Assessment;
- Stage 3 – Initial Prioritisation; and
- Stage 4 – Short List Prioritisation.

The Stage 1 closure assessment (GTA Consultants, 2007) identified those sites that have the potential to be permanently closed and therefore are considered to be the lowest priority for grade separation. The criteria applied to identify such sites were:

1. Have a local road functional classification;
2. Carry an existing two-way daily traffic volume of less than 5000 vehicles per day;
3. Do not have on-road public transport routes; and
4. Have a nearby suitable alternative route to deal with the displaced traffic without causing significant detriment to the surrounding network.

The study found that eight sites could potentially be permanently closed. These sites were therefore filtered from the list of level crossings to consider during later stages of the program.

Stage 2 of the assessment (GTA Consultants, 2007) was to remove those sites that are not likely to be considered to have high safety or congestion issues in the future. A measure identified as suitable for assessing both was 'Exposure' defined as:

$$E = V_{2021} + T_{2021}$$

Where: E = Exposure
V_{2021} = Forecast Daily Traffic Volume in 2021
T_{2021} = Forecast Daily Train Services in 2021

This method was applied to all sites with the assumption made that the top priority crossings would be in the top third. Consequently the top 50 sites identified by the Exposure ranking were taken forward to Stage 3. However, to ensure that strategically important or unsafe crossings were not discounted by this methodology, consultations were conducted with VicRoads, Public Transport Safety Victoria (PTSV) and other key stakeholders. This resulted in further six sites being nominated and therefore taking the total sites to be assessed in Stage 3 to 56.

Stage 3 involved the creation and application of an appraisal framework (Sinclair Knight Merz (SKM), 2008) that took a triple-bottom line approach to the prioritisation assessment, incorporating a broad range of project impacts. This required concepts plans and a cost estimate to be developed for each crossing (Connell Wagner, 2007). A triple-bottom line approach ensured that full consideration was given to the broader project impacts such as; community severance, development opportunities, transport connectivity, visual and noise impacts, air quality and green house gas emissions. In addition to the traditional economic, social and environment objectives, the assessment framework also incorporates a criterion that considers the road's position within the wider transport network (the 'strategic fit' objective). This objective considers the road's use including freight and on-road public transport.

The purpose of Stage 4 was to derive a short list of sites to be recommended for business case development. This was done through the application of refined data and enhanced methodologies applied in the MCA (SKM, 2009). A total of 15 sites were included in the Stage 4 assessment.

3. APPRAISAL FRAMEWORK

The overall approach to the MCA was to develop an appraisal framework (tool) that could perform a relative appraisal of each level crossing site for each performance indicator, on a normalised scale where the higher the score, the better the project (compared with the others). The overall appraisal score for each site is then calculated by weighting each performance indicator by the weights shown in Table 1.

Table 1 Overview of Appraisal Framework

Area	Objective	Weights 1	Weights 2	Weights Overall	Indicator used	Type	Normalised score range				
Economic	Minimise project implementation cost Maximise transport economic benefits	37%	100%	36.7%	Benefit-cost ratio (BCR)	Calculated	0	Maximum	10	Minimum	Full-scale
Social	Reduce risk of death or injury	30%	31%	9.3%	Weighted PTSV incident history	Calculated	0	Minimum	10	Maximum	Full-scale
	Reduce community severance		14%	4.1%	Accessibility across railway and/or road	Qualitative	-5	Worsen	+5	Improve	Full-scale
	Improve visual amenity		7%	2.1%	Visual appearance of crossing site	Qualitative	-5	Worsen	+5	Improve	Full-scale
	Improve noise amenity		7%	2.1%	Noise levels on adjacent occupied areas	Qualitative	-5	Worsen	+5	Improve	Full-scale
	Create suitable development opportunities		10%	3.1%	Development opportunities with grade separation	Qualitative	0	Minimum	5	Maximum	Half-scale
	Improve transport connectivity and accessibility		21%	6.2%	Transport connectivity and accessibility rating	Qualitative	0	Minimum	5	Maximum	Half-scale
	Avoid impact on sites of social significance		10%	3.1%	Local impact rating (property, heritage etc)	Qualitative	-5	Worsen	0	No effect	Half-scale
Environmental	Reduce energy consumption Reduce GHG emissions Improve air quality	12%	83%	9.7%	Vehicle-hours saved used as a proxy measure	Calculated	0	Minimum	10	Maximum	Full-scale
	Improve local natural environment		17%	1.9%	Effect on natural areas, flora and fauna, watercourses etc	Qualitative	-5	Worsen	0	No effect	Half-scale
Strategic fit	Align with road network operating objectives	22%	100%	21.7%	Road use priorities and overall performance framework	Calculated	0	Minimum	10	Maximum	Full-scale

Indicators which are 'Calculated' are calculated from available data. 'Qualitative' indicators are based on an objective rating of the relevant effect. All calculated indicators are 'normalised' to a score on a scale of 0-10 before being weighted as shown. Some indicators were rated qualitatively from general knowledge about the sites in question, and from the concept plans for each site. It is stressed that this qualitative rating is approximate as the specifics of grade separation at each site were only developed to a preliminary level. They are also open to a fair degree of subjectivity.

The appraisal framework was established through a consultative process that involved representatives from the DOT, VicRoads as well as various consultants engaged by the DOT. The framework, including inputs, indicators and weightings was agreed at a workshop. In order to form a consensus on the weights applied to both the appraisal 'areas' and individual 'objectives', the workshop participants were divided into three groups and asked to assign weightings to each 'area' and then to each 'objective'. The final weightings used represent an average of each of the three group's assessment (as shown by Table 2).

Table 2 Deriving MCA Weights

Area	Weights 1	2	3	Av	Objective	Weights 1	2	3	Av
Economic	40	35	35	37	Minimise project implementation cost	40	60	60	53
					Maximise transport economic benefits	60	40	40	47
Social	25	30	35	30	Reduce risk of death or injury	33	40	20	31
					Reduce community severance	11	10	20	14
					Improve visual amenity	6	10	5	7
					Improve noise amenity	6	10	5	7
					Create suitable development opportunities	11	10	10	10
					Improve transport connectivity and accessibility	22	10	30	21
					Avoid impact on sites of social significance	11	10	10	10
Environmental	10	15	10	12	Reduce energy consumption	30	30	30	30
					Reduce GHG emissions	30	30	30	30
					Improve air quality	20	20	30	23
					Improve local biodiversity	20	20	10	17
Strategic Fit	25	20	20	22	Align with network operating objectives	100	100	100	100

4. ECONOMIC OBJECTIVES

There are two economic objectives included in the appraisal framework namely:

a) Minimise project implementation costs; and
b) Maximize transport economic benefits.

Performance of each project against the economic objectives is measured using the benefit-cost ratio (BCR), calculated using the assumptions described below. The BCR accounts for 37% of the overall appraisal score. It should be noted that at this program level of assessment, the BCRs calculated by the MCA were considered to be preliminary and suitable only for comparability between sites. The short listed sites that are recommended to progress to business case will be subject to more rigorous assessment and modelling whereby the BCRs will be refined.

From the concept plans high level cost estimates were derived. The choice of the grade separation method and the preliminary layout was developed based on an overview of the following factors:

- Topography/ terrain;
- Gradient and configuration of existing rail and road;
- Impact to existing facilities (e.g. train stabling area and depot, rail junction etc.)
- Impact to major road traffic;
- Possible integration with adjacent level crossings if rail grade is changed;
- Environmental and noise concerns;
- Nearby land usage (residential/commercial/industrial);
- Impact to community (e.g. resume shopping area, accesses etc.); and
- Impact during construction (minimise disruption of train/tram service and traffic during construction).

Economic benefits were calculated for four elements:

1. travel time savings for travellers (car, train, bus and tram occupants);
2. vehicle operating costs savings;
3. tram/train crossing operating cost savings; and
4. accident savings.

Benefit parameter values to feed into the BCR calculation were sourced from Ausroads Guide to Project Evaluation, Part 4 Project Evaluation Data (Austroads, 2008). The total economic value of benefits was calculated as the sum of the above four elements, which are calculated as described in the following paragraphs.

Travel time savings

In Stage 3 of the program the MCA adopted a simplistic approach to estimate the delay benefits whereby travel time savings were estimated based on the expected delays to road traffic resulting from level crossing closures. It was assumed that every vehicle that arrives at a level crossing when it is closed experiences a delay equal to the level crossing closure time. The calculations to estimate this from the data available are thus:

$$D = \sum_i V_i p_{\cdot i} t_{close} \text{ where } p_i = \frac{n_i t_{close}}{T_i}$$

Where: D = Total Vehicle Delay

V_i = Traffic Volume in time period i

p_i = Probability of being delayed at a level crossing in time period i

t_{close} = Average level crossing closure time

n_i = Number of level crossing closures in time period i

T_i = Total duration of period i

The model considers two time periods (i): peak and off-peak.

It was accepted that in many cases this methodology would under-estimate the true cost of congestion as it does not take account of 'network effects' such as:

a) those caused by the interaction of crossing closures with neighbouring traffic signals (that is, traffic only being able to proceed when the traffic signals are green **and** the booms are up); and
b) time delays (and vehicle operating costs) caused by people diverting to avoid the level crossing.

An attempt to generate a better estimate of the delay experienced by vehicles at an array of level crossings was included in the Stage 4 assessment and described later in this paper.

Vehicle operating cost savings

Only vehicle-hours are assumed to change due to time savings from eliminating a level crossing. The study did not attempt to identify any vehicle-kilometre changes; it was assumed that there would be no significant changes to horizontal alignments of road or rail as part of a grade separation project, or any significant redirection of traffic from other routes when a level crossing is removed. Furthermore it was assumed that a grade separation will not lead to changes in public transport vehicle fleet needs to operate the services affected.

Tram/Train crossing operating cost savings

At level crossings where a tram line crosses the railway, there is currently the requirement for a crossing attendant to be present to switch the voltage of the overhead power lines, control check points that would derail a tram if it were to approach the crossing when unsafe, and operate tram signals which advise tram drivers when it is safe to enter the crossing. These crossings currently have one person in attendance for operation of the train and tram switches at all times that trains and trams are in operation – about 20 hours per day.

Accident savings

Accident savings were calculated using incident history data supplied by PTSV, which included reported near misses and gate or boom strikes as well as incidents involving actual train/vehicle or train/pedestrian accidents. The analysis assumed that all accidents at the crossing, and 25% of accidents adjacent to it, would be saved if a site were to be grade separated. This assumption was applied to the accident data to give an estimated annual accident saving, which is then adjusted for future years in proportion to forecast traffic growth.

In utilising the PTSV data it was further assumed that a near miss is equivalent to 50% of an actual incident, whilst a boom strike is equivalent to 25% (of the economic cost of an accident). Near misses are an indicator of risk and also a source of trauma, especially to train drivers. Boom strikes result in significant costs as, in addition to the damage, they cause the crossing to be closed causing delays to train travellers and road users. In addition if trains queue up they can cause adjacent level crossings to remain closed, compounding the impact on road users. Thus a total weighted incident rating for each site is calculated by taking 100% of actual incidents, 50% of near misses and 25% of boom strikes.

These assumed weightings were considered suitable for comparison of sites through the appraisal framework. However it is accepted that the number of adjacent accidents saved through grade separation will vary considerably from site to site, depending on the details of road layout changes surrounding the rail crossing. Furthermore, with a road underpass or overpass solution (in which the rail track vertical alignment is unchanged) it is possible that pedestrian crossings of the rail track would still occur, with the attendant risk of continued incidents.

Delays to train services due to incidents

Published economic costs of accidents (Austroads, 2008) cover the community costs but do not account for disruption in rail operations and delays to train passengers that may result from incidents at level crossings. Therefore in addition to this a notional allowance for train operating cost and passenger delays was made.

The economic cost of a delay per train-hour was applied to the trains that would present themselves at the crossing over the two hours that it is assumed to be closed for each (weighted PTSV) incident. A two hour period was chosen somewhat arbitrarily to represent the average disruption caused by an incident at a level crossing. Of course in many instances the disruption can be much greater, sometimes necessitating use of supplementary bus services or other measures.

It was noted that the congestion cost incorporated in accident cost rates is likely to underestimate the congestion at level crossing incidents as traffic will often have less alternative routes when a crossing is closed.

5. SOCIAL OBJECTIVES

There are seven social objectives included in the appraisal framework which in total account for **30%** of the overall appraisal scores. They include:

a) Reduce risk of death or injury (9.3%);
b) Reduce community severance (4.1%);
c) Improve visual amenity (2.1%);
d) Improve noise amenity (2.1%);
e) Create suitable development opportunities (3.1%);
f) Improve transport connectivity and accessibility (6.2%); and
g) Avoid impact on sites of social significance (3.1%).

Many of these objectives were assessed subjectively for each site by the project team based on known existing conditions and the preliminary designs. However where it was feasible to remove subjectivity from the assessment this has been done. For instance, the score applied to visual and noise amenity is based purely on the nature of the scheme i.e. road underpass etc.

Reduce risk of death or injury

Accident data from a number of sources were all considered as indicators of the incidents that could be avoided through grade separation, thus reducing risk of death or injury. These included incident histories supplied to the Project Team by PTSV, VicRoads (Crashstats database) as well as results from the Australian Level crossing Assessment Model (ALCAM, 2007) study. For the purpose of the appraisal it was decided that the weighted PTSV incidents/year (using the weights described on the preceding page for near misses and boom strikes) should be used.

The resulting range of safety ratings is normalised by scaling pro rata between 0 (for the least number of incidents) and 10 (for the greatest).

Reduce community severance

Community severance is the term for the 'dividing' effect that a road or railway can have on surrounding local communities, by forming a barrier to movement and social interaction. When a grade separation occurs the change can affect community severance positively or negatively. For example, at the recently grade separated Middleborough Road (Box Hill, Melbourne) lowering the railway has tangibly reduced community severance by making surface movement easier for pedestrians, cyclists and drivers. In locations where a road overpass has been built such as Warrigal Road (Oakleigh, Melbourne) however, community severance may be worsened due to the intrusion of the elevated structure and its approaches.

Given the concept plans for the grade separation projects, a rating by considering the local conditions (service roads/laneways, parking, rail station access and general pedestrian access) and the type of grade separation (rail or road underpass or overpass) has been devised. The assessment is made on a scale of -5 to +5 as shown in Table 3. This is a subjective score based on general consideration of the type of project and the degree of activity in the surrounding area.

Table 3 Rating for community severance

Rating	Guideline	Score
Substantial improvement	Where it is clear that strong existing barriers to local movement can be removed (likely to apply to rail or road underpasses only)	5
Significant improvement	Some key barriers can be removed (most likely to apply to rail underpass projects in areas with established local movement activity)	3
Slight improvement	Minor reduction in existing barriers to movement (most likely to apply to rail underpass projects that are not in areas of focussed local activity)	1
No effect	No essential change to existing conditions in an area that does not have significant local movement activity	0
Slight worsening	A road or rail overpass in areas without strong local movement activity	-1
Significant worsening	A road or rail overpass in an area with significant local movement activity	-3
Substantial worsening	A road or rail overpass in an area with substantial established local movement activity (no examples exist amongst the candidate sites)	-5

Improve visual amenity

Lowering the railway or road can often ‘hide’ elements of transport infrastructure and improve visual amenity. Raising them on elevated structures can give rise to a considerable, negative effect by worsening visual amenity.

Without detailed design solutions a simple rating based on the type of project, assuming that the worst visual intrusion is likely to arise with a road overpass, and the greatest potential for improvement is with a rail underpass was adopted. The project types have been positioned on a scale of -5 to +5 as shown in Table 4.

Table 4 Rating for visual intrusion

Project type	Score
Rail underpass	5
Road underpass	3
No reasonable solution	0
Rail overpass	-3
Road overpass	-5

As with community severance, the resulting scores are kept on a scale of -5 to +5 in the overall appraisal.

Improve noise amenity

Similar comments to those above apply to noise amenity. An assessment was made for each site based on the nature of the project from a transport noise perspective. It is assumed that the worst noise impact is likely to be associated with a rail overpass (noise from trains on an elevated structure is likely to be spread over a wider area, and/or require greater noise mitigation works). The greatest potential for noise reduction is with a rail underpass. The project types have been positioned on a scale of -5 to +5 as shown in Table 5.

Table 5 Rating for noise amenity

Project type	Score
Rail underpass	5
Road underpass	3
No reasonable solution	0
Road overpass	-3
Rail overpass	-5

Create suitable development opportunities

Some grade separations create opportunities for significant redevelopment of the areas around them, especially (in most situations) where the railway is lowered. A subjective assessment was made on a scale of 0 to 5 (Table 6), based on the notional scale of redevelopment or urban regeneration that can be conceived at the site, considering the nature of the grade separation project. This is clearly a very subjective rating; it is based on local knowledge and the potential for redevelopment that may or may not exist. There was no specialist land use planning used in the assessment.

Table 6 Rating for development opportunity

Opportunity	Comments	Score
No opportunity	Isolated location of crossing site, or lack of available land for redevelopment	0
Limited ($1M)	Opportunity appears limited to minor development only (eg rail overpass with little or no additional land take)	1
Significant ($2-3M)	Minor road or local land reconfiguration associated with underpass or overpass project	2
Moderate ($5M)	Station reconstruction and associated minor development (say one small redevelopment site)	3
Substantial ($10-15M)	Station relocation and/or significant redevelopment opportunities (say 1-2 commercial or retail buildings)	4
Major ($20M+)	Substantial redevelopment opportunity associated with an activity centre	5

Improve transport connectivity and accessibility

Appraisal of the grade separation effect on affected transport linkages is similar to the appraisal of community severance described above, and was made on the same scale (-5 to +5), using the guidelines in

Table 7. The distinction between the two is that community severance is regarded as a localised effect, whilst transport connectivity and accessibility is more regional in nature. In this respect, consideration is given to public transport access/use and the degree of improved connectivity between local, collector and arterial roads in the general vicinity of each crossing site. The appraisal was subjective and open to interpretation; it correlates to some extent with the 'strategic fit' appraisal, but it also considers not just the road crossing the railway at each site, but the surrounding roads in the network as well.

Table 7 Rating for transport connectivity and accessibility

Rating	Guideline	Score
Substantial improvement	Grade separation of important routes that will substantially improve regional accessibility and/or provide opportunity	5
Significant improvement	Grade separation of second-order routes that will significantly improve regional accessibility	3
Slight improvement	Minor reduction in existing barriers to movement (most likely to apply to rail underpass projects that are not in areas of focussed local activity)	1
No effect	No essential change to existing conditions in an area that does not have significant local movement activity	0
Slight worsening	A road or rail overpass in areas without strong local movement activity	-1
Significant worsening	A road or rail overpass in an area with significant local movement activity	-3
Substantial worsening	A road or rail overpass in an area with substantial established local movement activity	-5

Avoid impact on sites of social significance

Sites of known cultural and/or historical significance affected by the grade separation are appraised based on local knowledge and inspection of mapping and aerial photography. These include heritage listed signal boxes, Churches and community centres. Since all the effects were expected to be negative, the appraisal was made on a scale of -5 to 0, using the guidelines given in Table 8. Consideration was given to the presence of residential, commercial and community facilities, and on heritage overlays in the vicinity of each crossing site.

Table 8 Rating for impact on sites of social significance

Rating	Guideline	Score
None	No notable effect on sites of social significance	0
Limited	Limited effect on one or two localised sites or features	-1
Significant	Significant impact on a number of sites or on the general vicinity	-2
Moderate	Moderate impact on an area with overall social significance such as a shopping strip or activity centre	-3
Substantial	Serious impact on sites of heritage significance or community importance	-4
Major	Removal of important sites such as churches, community facilities, likely to give rise to community concern	-5

6. ENVIRONMENTAL OBJECTIVES

There are four environmental objectives included in the appraisal framework which in total account for 12% of the overall appraisal scores. They include:

a) Reduce energy consumption;

b) Reduce GHG emissions;

c) Improve air quality; and

d) Improve local natural environment.

The first three objectives were combined into a single (calculable) measure under the banner of ‘reduced energy consumption and emissions’ accounting for 9.7% of the overall appraisal.

Reduce energy consumption and emissions

In the appraisal, grade separation projects were assumed to result in savings in vehicle-hours, but not in vehicle-kilometres or the number of vehicles required for the transport task. It was assumed that small savings in energy consumption and emissions would be generated by savings in vehicle hours (generally because vehicles will spend less time queuing with their engines idling), so the estimated change in vehicle hours was used as a proxy for this indicator. The indicator is an amalgamation of the three original indicators (energy consumption, GHG emissions and air quality emissions) agreed with stakeholders.

The vehicle-hour savings are normalised pro rata between 0 (for the least change in vehicle-hours) and 10 (for the greatest change).

Improve local natural environment

Most of the level crossing candidate sites are in areas where the urban fabric is well-established, so effects on the natural environment will be limited. The primary consideration at most sites was whether any established vegetation, especially trees and areas of open space, was likely to be affected by the grade separation. Flora and fauna effects at each site were assessed subjectively from local knowledge, using a scale of 0 to -5 to rate the impacts to the guidelines in Table 9.

Table 9 Rating for impact on local natural environment

Rating	Guideline	Score
None	No effect on sites of environmental significance	0
Limited	Limited effect on one or two localised sites or features	-1
Significant	Significant impact on a number of sites or on the general vicinity	-2
Moderate	Moderate impact such as removal of a few trees	-3
Substantial	Serious impact such as removal of a significant number of trees (especially tree groupings) and open space	-4
Major	Removal of important sites and/or impact on natural watercourses, vegetation and other important items	-5

7. STRATEGIC FIT OBJECTIVES

Appraisal of the 'strategic fit' objective went through a number of iterations during the Stage 3 study:

1. In the first draft of the framework, a subjective rating (score out of ten) was given to the road at each site to reflect its judged significance in the road network.
2. At the second workshop (and through subsequent discussions), a more objective method was devised, to reflect the relative strategic importance of the road at each level crossing site more precisely.
3. Subsequently, VicRoads provided the Project Team with a further scoring system of the strategic importance of roads at the crossing sites.

The second method was adopted by the final Stage 3 appraisal and was also the chosen method for Stage 4. The VicRoads method was also used as a sensitivity test.

Second workshop method

The method devised at the second workshop is summarised in Table 10, to reflect a road's role in terms of public transport, freight and general traffic respectively, and combining these to arrive at a rating on a scale of 1 to 10:

1. For public transport, the road is scored as a SmartBus route – a high standard usually orbital bus route - if it is part of the Principal Public Transport Network, and by the relative number of bus/tram services (the PPTN includes all tram routes).
2. For freight, the road is scored as a B-double route or an over-dimensioned vehicle route.
3. For general traffic the rating reflects whether it is a 'preferred traffic route' (identified by VicRoads as having strategic importance), an arterial road, and by the relative traffic volume.

Table 10 Road network operating objectives – second workshop method

Role of road	Consideration	Score
Public transport	Orbital bus route?	Yes = 1, No = 0
	PPTN?	Yes = 1, No = 0
	Number of bus/tram services/day	0 to 1 (pro rata to number of services)
	Overall rating	**0 to 3**
Freight	B-double route?	Yes = 1, No = 0
	OD route?	Yes = 1, No = 0
	Overall rating	**0 to 2**
General traffic	Preferred traffic route?	Yes = 1, No = 0
	Arterial road?	Yes = 1, No = 0
	2021 traffic volume	0 to 1 (pro rata to daily volume)
	Overall rating	**0 to 3**
Overall rating	Score out of 8, adjusted to a score out of 10 for consistency with other indicators	

8. STAGE 3 SENSITIVITY TESTS

In order to form recommendations of sites to be progressed to the next stage of analysis (Stage 3 to Stage 4), two sensitivity tests were performed:

1. Doubling the weight applied to the economic criteria; and
2. Applying alternative strategic fit scores based on criteria supplied by VicRoads.

The purpose of the sensitivity tests was to understand the stability of the highly ranked sites. One consequence of the MCA method is that some crossings with very poor BCRs (and therefore unlikely to ever receive government funding) were ranking highly due to other factors. Doubling the weighting given to BCRs was tested to increase the ranking of crossings with higher BCRs.

Taking the top 15 crossings from each of the two tests, along with the base case produced a total of 22 crossings. These were then considered by the program Steering Committee.

The MCA is a tool for use in making decisions on priority level crossing, not the tool for prioritisation. The Steering Committee therefore took into account other factors in determining the crossings to proceed to stage 4. These included:

1. The affects of other projects – a commitment was made to the highest priority site Springvale Road, Nunawading, during this stage and therefore further assessment of it was discontinued;
2. Some crossings with very low BCRs were discontinued as it was clear that they did not have the potential to demonstrate an adequate economic performance to attract funding; and
3. Consideration of some crossings with concept plans that would not be acceptable to the public were discontinued, though some of these were returned when more viable concepts were identified

The resulting list of 15 projects then advanced to Stage 4.

9. STAGE 4 ASSESSMENT

In an attempt to generate a better estimate of the delay experienced by vehicles at an array of level crossings in the Stage 4 assessment, a simplified micro simulation tool that models vehicle movements through a small road network, central to which is a level crossing was developed. The software was written in Visual Basic and interfaces with a Microsoft Excel spreadsheet. However due to the complex nature of many of the level crossings in Melbourne, this tool was unable to produce results for all of the stage 4 crossings.

As the spreadsheet tool was unable to estimate traffic delay for all the required sites and given the importance that all sites are fairly compared, it was necessary to revert to the original MCA methodology for calculating vehicle-delays but using the latest data available. However this takes no account of ‘network effects’ which are best estimated through detailed micro-simulation and strategic modelling. This though is a costly exercise more suitable to business case assessment but not viable for the prioritisation process.

Comparison with the micro-simulation conducted for Springvale Road/Whitehorse Road Detailed Improvements Study (Maunsell, 2008) indicated that inclusion of network effects produced delay estimates in excess of three times the simplistic estimate generated by the MCA. Using this result as a benchmark, network effect multipliers were estimated for each of the 15 Stage 4 level crossings.

The network effect multipliers were assigned to each crossing based on a judgement of whether their effect was high, medium, low or nil. Multipliers used varied from four to one, with crossings similar to Springvale Road being assigned a multiplier of three. More extreme cases were assigned four. An extreme case would be a crossing with a signalised intersection on each side and little or no vehicle storage between the crossing and intersections. On the other hand some crossings did not have any other traffic control nearby and the simple model was judged to produce a reasonable estimate. In these cases the multiplier assigned was one.

For stage 4 the remaining sites were also subject to further development of the concept plans and cost estimates (Connell Wagner 2009), updated DOT traffic and train forecasts, rerunning of the MCA and further consideration by the Steering Committee of other factors as per Stage 3. This resulted in a list of crossings that could be categorised into three different groups:

- Crossings that are a current priority for grade separation;
- Crossings that will become priorities during the period to the assessment date of 2021; and
- Of the latter, some of the projects would require significant land acquisition.

Consequently the study produced recommendations of:

1. Crossings to proceed to business case development (to enable a budget submission to be made);
2. Crossings to proceed to have land required protected from development; and
3. Crossings to be further studied with a view to proceeding to business case at a future time.

10. CONCLUDING REMARKS

The MCA ranks level crossings in order of prioritisation based on a broad range of indicators. This is a robust methodology and is a useful tool to support the DOT's MRRGS program. However the MCA should be seen as 'a tool' not 'the tool'. There are site specific factors that the MCA cannot take into account, which may add or subtract to the case for grade separation. At each stage of the program therefore a Steering Committee made up of each of the main project stakeholders was consulted on the program findings.

The sites that are taken to Business Case will be subject to a much higher degree of analysis. The data constraints that limited the prioritisation will need to be overcome.

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