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st(VT) = Delay(VI) \*  
5 TotalTTC\_B 8 # - 318.81  
TVFHR(VT) CrashCost = MVK 60 A TR X AACC

FOR REFERENCE PURPOSES

## Appendices



# 5

## Appendix A: Case study input data

## Maintenance

Screen	Inputs	Base case	Project case
Create new evaluation	Road class	State strategic	State strategic
	Region	Darling Downs	Darling Downs
	Zone	Dry non-reactive	Dry non-reactive
	Evaluation period	30	30
	Discount rate	6%	6%
	Speed environment	Rural	Rural
Road details	MRS	8	8
	Section length	2 km	2 km
	Initial roughness	80 NRM	80 NRM
	Safe operating speed	80 km/h	80 km/h
	Pavement type	Flexible	Flexible
	Surface type	Sprayed surface seal	Sprayed surface seal
	Horizontal alignment	Straight	Straight
	Vertical alignment	Rolling or undulating	Rolling or undulating
Road traffic data	AADT year 1	2500	2500
	Traffic growth rate	2% linear	2% linear
	Cars – private	73%	73%
	Cars – commercial	5%	5%
	Non-articulated	5%	5%
	Buses	0%	0%
	Articulated	5%	5%
	B-double	8%	8%
	Road train 1	3%	3%
	Road train 2	1%	1%
Capital and maintenance costs	Capital	0	0
	Routine maintenance costs	\$10 000 yearly	\$10 000 yearly
	Periodic maintenance costs	\$500 000 in years 5, 10, 15, 20, 25 and 29	\$500 000 in years 6 and 28
	Reduction in roughness from periodic maintenance	5 NRM each time	5 NRM each time
	Rehabilitation	0	\$2 000 000 in year 12
	Roughness after rehabilitation	NA	50 NRM
	Residual value	0	0

## Road widening without shoulder seal

Screen	Inputs	Base case	Project case
Create new evaluation	Road class	Regional	Regional
	Region	North Coast	North Coast
	Zone	Wet non-reactive	Wet non-reactive
	Evaluation period	31	31
	Discount rate	6%	6%
	Speed environment	Rural	Rural
Road details	MRS	7	10
	Section length	2 km	2 km
	Initial roughness	100 NRM	50 NRM
	Safe operating speed	80 km/h	80 km/h
	Pavement type	Flexible	Flexible
	Surface type	Sprayed surface seal	Sprayed surface seal
	Horizontal alignment	Curvy	Curvy
	Vertical alignment	Rolling or undulating	Rolling or undulating
Road traffic data	AADT year 1	3000	3000
	Traffic growth rate	3% linear	3% linear
	Cars – private	84%	84%
	Cars – commercial	10%	10%
	Non-articulated	2%	2%
	Buses	0%	0%
	Articulated	2%	2%
	B-double	2%	2%
	Road train 1	0%	0%
	Road train 2	0%	0%
Capital and maintenance costs	Capital	0	\$2 500 000
	Routine maintenance costs	\$10 000 yearly	\$10 000 yearly excluding year 1
	Periodic maintenance costs	\$500 000 in years 7, 21 and 28	\$500 000 in years 10, 17 and 24
	Reduction in toughness from periodic maintenance	5 NRM each time	5 NRM each time
	Rehabilitation	\$1 000 000 in year 14	0
	Roughness after rehabilitation	80 NRM	NA
	Residual value	0	0

## Road widening with shoulder seal

Screen	Inputs	Base case	Project case
Create new evaluation	Road class	Regional	Regional
	Region	North Coast	North Coast
	Zone	Wet non-reactive	Wet non-reactive
	Evaluation period	31	31
	Discount rate	6%	6%
	Speed environment	Rural	Rural
Road details	MRS	7	11
	Section length	2 km	2 km
	Initial roughness	100 NRM	50 NRM
	Safe operating speed	80 km/h	80 km/h
	Pavement type	Flexible	Flexible
	Surface type	Sprayed surface seal	Sprayed surface seal
	Horizontal alignment	Curvy	Curvy
	Vertical alignment	Rolling or undulating	Rolling or undulating
Road traffic data	AADT year 1	3000	3000
	Traffic growth rate	3% linear	3% linear
	Cars – private	84%	84%
	Cars – commercial	10%	10%
	Non-articulated	2%	2%
	Buses	0%	0%
	Articulated	2%	2%
	B-double	2%	2%
	Road train 1	0%	0%
	Road train 2	0%	0%
Capital and maintenance costs	Capital	0	\$2 800 000
	Routine maintenance costs	\$10 000 yearly	\$10 000 yearly excluding year 1
	Periodic maintenance costs	\$500 000 in years 7, 21 and 28	\$500 000 in years 10, 17 and 24
	Reduction in roughness from periodic maintenance	5 NRM each time	5 NRM each time
	Rehabilitation	\$1 000 000 in year 14	0
	Roughness after rehabilitation	80 NRM	NA
	Residual value	0	0

## Realignment

Screen	Inputs	Base case	Project case
Create new evaluation	Road class	Regional	Regional
	Region	Central West	Central West
	Zone	Dry reactive	Dry reactive
	Evaluation period	32	32
	Discount rate	6%	6%
	Speed environment	Rural	Rural
Road details	MRS	12	12
	Section length	2.5 km	2.3 km
	Initial roughness	100 NRM	60 NRM
	Safe operating speed	80 km/h	100 km/h
	Pavement type	Flexible	Flexible
	Surface type	Sprayed surface seal	Sprayed surface seal
	Horizontal alignment	Curvy	Straight
	Vertical alignment	Level or flat	Level or flat
Road traffic data	AADT Year 1	5000	5000
	Traffic growth rate	4% compound	4% compound
	Cars – private	85%	85%
	Cars – commercial	5%	5%
	Non-articulated	4%	4%
	Buses	2%	2%
	Articulated	2%	2%
	B-double	2%	2%
	Road train 1	0%	0%
	Road train 2	0%	0%
Capital and maintenance costs	Capital	0	\$2 000 000 year 1 and \$6 000 000 year 2
	Routine maintenance costs	\$50 000 yearly	\$45 000 yearly
	Periodic maintenance costs	\$550 000 in years 7, 21 and 28	\$545 000 in years 9, 23 and 30
	Reduction in roughness from periodic maintenance	5 NRM each time	5 NRM each time
	Rehabilitation	\$2 000 000 in year 14	\$1 950 000 in year 16
	Roughness after rehabilitation	50 NRM	50 NRM
	Residual value	0	0

## Single overtaking lane

Screen	Inputs	Base case	Project case
Create new evaluation	Road class	National network	National network
	Region	Northern	Northern
	Zone	Wet non-reactive	Wet non-reactive
	Evaluation period	31	31
	Discount rate	7%	7%
	Speed environment	Rural	Rural
	Advanced option selected	Overtaking lane (single)	Overtaking lane (single)
Road details	MRS	12	16
	Section length	2 km	2 km
	Initial roughness	80 NRM	60 NRM
	Safe operating speed	100 km/h	100 km/h
	Pavement type	Flexible	Flexible
	Surface type	Sprayed surface seal	Sprayed surface seal
	Horizontal alignment	Straight	Straight
	Vertical alignment	Rolling or undulating	Rolling or undulating
Road traffic data	AADT year 1	4545	4545
	Traffic growth rate	2% compound	2% compound
	Cars – private	80%	80%
	Cars – commercial	5%	5%
	Non-articulated	4%	4%
	Buses	2%	2%
	Articulated	2%	2%
	B-double	7%	7%
	Road train 1	0%	0%
Road train 2	0%	0%	
Capital and maintenance costs	Capital		\$3 000 000
	Routine maintenance costs	\$2000 yearly	\$3000 yearly
	Periodic maintenance costs	\$20 000 in years 7, 12, 17, 22 and 27	\$30 000 in years 7, 12, 17, 22 and 27
	Reduction in roughness from periodic maintenance	5 NRM each time	5 NRM each time
	Rehabilitation	0	0
	Roughness after rehabilitation	NA	NA
	Residual value	0	0

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Screen	Inputs	Base case	Project case
Downstream area details	MRS	12	12
	Section length	5 km	5 km
	Initial roughness	80 NRM	80 NRM
	Safe operating speed	100 km/h	100 km/h
	Pavement type	Flexible	Flexible
	Surface type	Sprayed surface seal	Sprayed surface seal
	Horizontal alignment	Straight	Straight
	Vertical alignment	Rolling or undulating	Rolling or undulating

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## Head-to-head overtaking lanes

Screen	Inputs	Base case	Project case
Create new evaluation	Road class	National network	National network
	Region	Northern	Northern
	Zone	Wet non-reactive	Wet non-reactive
	Evaluation period	31	31
	Discount rate	7%	7%
	Speed environment	Rural	Rural
	Advanced option selected	Overtaking lane (head to head)	Overtaking lane (head to head)
Road details	MRS	12	16
	Section length	4 km	4 km
	Initial roughness	80 NRM	60 NRM
	Safe operating speed	100 km/h	100 km/h
	Pavement type	Flexible	Flexible
	Surface type	Sprayed surface seal	Sprayed surface seal
	Horizontal alignment	Straight	Straight
	Vertical alignment	Rolling or undulating	Rolling or undulating
Road traffic data	AADT year 1	4545	4545
	Traffic growth rate	2% compound	2% compound
	Cars – private	80%	80%
	Cars – commercial	5%	5%
	Non-articulated	4%	4%
	Buses	2%	2%
	Articulated	2%	2%
	B-double	7%	7%
	Road train 1	0%	0%
Road train 2	0%	0%	
Capital and maintenance costs	Capital		\$6 000 000
	Routine maintenance costs	\$4000 yearly	\$6000 yearly excluding year 1
	Periodic maintenance costs	\$40 000 in years 7, 12, 17, 22 and 27	\$60 000 in years 7, 12, 17, 22 and 27
	Reduction in roughness from periodic maintenance	5 NRM each time	5 NRM each time
	Rehabilitation	0	0
	Roughness after rehabilitation	NA	NA
	Residual value	0	0

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Screen	Inputs	Base case	Project case
Downstream area details	MRS	12	12
	Section length	10 km	10 km
	Initial roughness	80 NRM	80 NRM
	Safe operating speed	100 km/h	100 km/h
	Pavement type	Flexible	Flexible
	Surface type	Sprayed surface seal	Sprayed surface seal
	Horizontal alignment	Straight	Straight
	Vertical alignment	Rolling or undulating	Rolling or undulating

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## Side-by-side overtaking lanes

Screen	Inputs	Base case	Project case
Create new evaluation	Road class	National network	National network
	Region	Northern	Northern
	Zone	Wet non-reactive	Wet non-reactive
	Evaluation period	31	31
	Discount rate	7%	7%
	Speed environment	Rural	Rural
	Advanced option selected	Overtaking lane (side by side)	Overtaking lane (side by side)
Road details	MRS	12	17
	Section length	2 km	2 km
	Initial roughness	80 NRM	60 NRM
	Safe operating speed	100 km/h	100 km/h
	Pavement type	Flexible	Flexible
	Surface type	Sprayed surface seal	Sprayed surface seal
	Horizontal alignment	Straight	Straight
	Vertical alignment	Rolling or undulating	Rolling or undulating
Road traffic data	AADT year 1	4545	4545
	Traffic growth rate	2% compound	2% compound
	Cars – private	80%	80%
	Cars – commercial	5%	5%
	Non-articulated	4%	4%
	Buses	2%	2%
	Articulated	2%	2%
	B-double	7%	7%
	Road train 1	0%	0%
Road train 2	0%	0%	
Capital and maintenance costs	Capital		\$5 500 000
	Routine maintenance costs	\$4000 yearly	\$6000 yearly excluding year 1
	Periodic maintenance costs	\$40 000 in years 7, 12, 17, 22 and 27	\$60 000 in years 7, 12, 17, 22 and 27
	Reduction in roughness from periodic maintenance	5 NRM each time	5 NRM each time
	Rehabilitation	0	0
	Roughness after rehabilitation	NA	NA
	Residual value	0	0

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Screen	Inputs	Base case	Project case
Downstream area details	MRS	12	12
	Section length	10 km	10 km
	Initial roughness	80 NRM	80 NRM
	Safe operating speed	100 km/h	100 km/h
	Pavement type	Flexible	Flexible
	Surface type	Sprayed surface seal	Sprayed surface seal
	Horizontal alignment	Straight	Straight
	Vertical alignment	Rolling or undulating	Rolling or undulating

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## Flood immunity

Screen	Inputs	Base case	Project case
Create new evaluation	Road class	State strategic	State strategic
	Region	Fitzroy	Fitzroy
	Zone	Wet non-reactive	Wet non-reactive
	Evaluation period	33	33
	Discount rate	6%	6%
	Speed environment	Rural	Rural
	Advanced option selected	Road closure and diverting route	Road closure and diverting route
Road details	MRS	10	15
	Section length	1 km	1 km
	Initial roughness	80 NRM	50 NRM
	Safe operating speed	80 km/h	80 km/h
	Pavement type	Flexible	Flexible
	Surface type	Sprayed surface seal	Sprayed surface seal
	Horizontal alignment	Very curvy	Straight
	Vertical alignment	Rolling or undulating	Rolling or undulating
Road traffic data	AADT year 1	8000	8000
	Traffic growth rate	3% linear	3% linear
	Cars – private	67%	67%
	Cars – commercial	20%	20%
	Non-articulated	0%	0%
	Buses	1%	1%
	Articulated	3%	3%
	B-double	9%	9%
	Road train 1	0%	0%
	Road train 2	0%	0%
	Average annual time of closure (AATOC)	14 hours	0 hours
Road closure details	Average duration of closure (ADC)	56 hours	10
	% of traffic not travelling	0%	0%
	% of traffic waiting	10%	20%
	% of traffic diverting	90%	80%

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Screen	Inputs	Base case	Project case
Capital and maintenance costs	Capital		\$3 000 000 in year 1 and \$7 000 000 in year 2
	Routine maintenance costs	\$13 000 yearly	\$15 000 yearly excluding years 1 and 2
	Periodic maintenance costs	\$300 000 in years 7, 21 and 28	\$320 000 in years 10, 15, 20 and 30
	Reduction in roughness from periodic maintenance	10 NRM each time	10 NRM each time
	Rehabilitation	\$5 000 000 in year 14	\$0
	Roughness after rehabilitation	60 NRM	NA
	Residual value		\$7 000 000
		<b>Diverting route details</b>	<b>Base case</b>
	MRS	9	9
	Road class	Regional	Regional
	Roughness	60 NRM	60 NRM
	Safe operating speed	60 km/h	60 km/h
	Pavement type	Flexible	Flexible
	Surface type	Sprayed surface seal	Sprayed surface seal
	Horizontal alignment	Curvy	Curvy
	Vertical alignment	Rolling or undulating	Rolling or undulating
	Existing traffic on route	1200	1200
	Length of alternate route (C)	15 km	15 km

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Screen	Inputs	Base case	Project case	
Road traffic data	AADT year 1	8400	8400	
	Traffic growth rate	3% linear	3% linear	
	Cars – private	67%	67%	
	Cars – commercial	20%	20%	
	Non-articulated	0%	0%	
	Buses	1%	1%	
	Articulated	3%	3%	
	B-double	9%	9%	
	Road train type 1	0%	0%	
	Road train type 2	0%	0%	
	Improved route case			
	Improved route details			
	MRS		10	10
	Road class		State strategic	State strategic
	Roughness		60 NRM	60 NRM
	Safe operating speed		80 km/h	80 km/h
	Pavement type		Flexible	Flexible
	Surface type		Sprayed surface seal	Sprayed surface seal
	Horizontal alignment		Curvy	Curvy
	Vertical alignment		Level or flat	Level or flat
	Length of improved route (B)		10 km	10 km

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## Road closure

Screen	Inputs	Base case	Project case	
Create new evaluation	Road class	Regional	Regional	
	Region	Central West	Central West	
	Zone	Dry non-reactive	Dry non-reactive	
	Evaluation period	31	31	
	Discount rate	6%	6%	
	Speed environment	Rural	Rural	
	Advance option selected	Road closure	Road closure	
	Road details	MRS	10	10
Section length		1	1	
Initial roughness		110 NRM	60 NRM	
Safe operating speed		100 km/h	100 km/h	
Pavement type		Flexible	Flexible	
Surface type		Sprayed surface seal	Sprayed surface seal	
Horizontal alignment		Straight	Straight	
Vertical alignment		Level or flat	Level or flat	
Road traffic data	AADT year 1	500	500	
	Traffic growth rate	3% linear	3% linear	
	Cars – private	42%	42%	
	Cars – commercial	10%	10%	
	Non-articulated	5%	5%	
	Buses	0%	0%	
	Articulated	3%	3%	
	B-double	12%	12%	
	Road train 1	8%	8%	
	Road train 2	20%	20%	
	Road closure details			
	Average annual time of closure (AATOC)	12	0	
	Average duration of closure (ADC)	12	0	
	% of traffic not travelling	0%	0%	
	% of traffic waiting	100%	0%	



Screen	Inputs	Base case	Project case
Capital and maintenance costs	Capital		\$800 000
	Routine maintenance costs		
	Periodic maintenance costs		
	Reduction in roughness from periodic maintenance		
	Rehabilitation	\$1000 yearly excluding years 1 and 31	\$1000 yearly excluding years 1 and 31
	Roughness after rehabilitation	110 NRM	60 NRM
	Residual value	0	0

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## Intersection

Screen	Inputs	Base int case		Project int case		
Create new evaluation	Road class	Regional		Regional		
	Region	South Coast		South Coast		
	Zone	Wet non-reactive		Wet non-reactive		
	Evaluation period	11		11		
	Discount rate	6%		6%		
	Speed environment	Urban		Urban		
	Advance option selected	New intersection evaluation		New intersection evaluation		
Intersection data (include at least 2 years data for each case)	Morning peak	Year 1	Year 11	Year 1	Year 11	
	Duration of period (hours)	1	1	1	1	
	Number of vehicles (per hour)	2203	2646	2203	2646	
	Average delay (in seconds/period)	28.2	181.1	4.4	56.9	
	Fuel consumption (litres/hour)	152.7	335.3	122.5	235.5	
	Afternoon peak	Year 1	Year 11	Year 1	Year 11	
	Duration of period (hours)	1	1	1	1	
	Number of vehicles (per hour)	2361	2835	2361	2835	
	Average delay (in seconds/period)	36.3	327	3.7	6.7	
	Fuel consumption (litres/hour)	161.8	503.4	126.7	172.2	
	Cars – private	93%	93%	93%	93%	
	Cars – commercial	5%	5%	5%	5%	
	Non-articulated	1%	1%	1%	1%	
	Buses	1%	1%	1%	1%	
	Articulated	0%	0%	0%	0%	
	B-double	0%	0%	0%	0%	
	Road train 1	0%	0%	0%	0%	
	Road train 2	0%	0%	0%	0%	
	Intersection capital and maintenance costs	Capital	\$1 500 000			
		Maintenance and operations	\$2000 yearly	\$15 000 yearly excluding year 1		
Residual value						
Accident and other costs	Accident costs	\$50 000 yearly	\$25 000 yearly			

## Duplication

Screen	Inputs	Base case	Project case
Create new evaluation	Road class	National network	National network
	Region	Far North	Far North
	Zone	Wet reactive	Wet reactive
	Evaluation period	32	32
	Discount rate	7%	7%
	Speed environment	Rural	Rural
Road details	MRS	13	19
	Section length	3 km	3 km
	Initial roughness	75 NRM	50 NRM
	Safe operating speed	100 km/h	100 km/h
	Pavement type	Flexible	Rigid
	Surface type	Sprayed surface seal	Asphaltic concrete
	Horizontal alignment	Straight	Straight
	Vertical alignment	Level or flat	Level or flat
Road traffic data	AADT year 1	12 000	12 000
	Traffic growth rate	5% linear	5% linear
	Cars – private	77%	77%
	Cars – commercial	12%	12%
	Non-articulated	5%	5%
	Buses	1%	1%
	Articulated	3%	3%
	B-double	2%	2%
	Road train 1	0%	0%
	Road train 2	0%	0%
Capital and maintenance costs	Capital	0	\$2 000 000 year 1 and \$49 000 000 year 2
	Routine maintenance costs	\$30 000 yearly	\$75 000 yearly excluding years 1 and 2
	Periodic maintenance costs	\$500 000 in years 5, 10, 20, 25 and 30	\$1 200 000 in years 10, 17, 24 and 31
	Reduction in roughness from periodic maintenance	5 NRM each time	5 NRM each time
	Rehabilitation	\$2 000 000 in year 15	0
	Roughness after rehabilitation	75 NRM	NA
	Residual value	0	0

## Bypass

Screen	Inputs	Base case	Project case
Create new evaluation	Road class	State strategic	State strategic
	Region	Fitzroy	Fitzroy
	Zone	Dry non-reactive	Dry non-reactive
	Evaluation period	32	32
	Discount rate	6%	6%
	Speed environment	Rural	Rural
	Advance option selected	Bypass	Bypass
Road details	MRS	1	15
	Section length	7 km	7 km
	Initial roughness	200 NRM	50 NRM
	Safe operating speed	0 km/h	100 km/h
	Pavement type	Unpaved	Flexible
	Surface type	Unsurfaced	Sprayed surface seal
	Horizontal alignment	Straight	Straight
Road traffic data	Vertical alignment	Level or flat	Level or flat
	AADT year 1	0	2000
	Traffic growth rate	3% linear	3% linear
	Cars – private	100%	76%
	Cars – commercial	0%	13%
	Non-articulated	0%	5%
	Buses	0%	1%
	Articulated	0%	2%
	B-double	0%	3%
	Road train 1	0%	0%
Road train 2	0%	0%	
Capital and maintenance costs	Capital	0	\$10 000 000 year 1 and \$50 000 000 year 2
	Routine maintenance costs	\$50 000 yearly	\$20 000 yearly excluding years 1 and 2
	Periodic maintenance costs	\$0	\$1 000 000 in years 8, 15 and 29
	Reduction in roughness from periodic maintenance	NA	5 NRM each time
	Rehabilitation	\$0	\$3 000 000 in year 22
	Roughness after rehabilitation	NA	50 NRM
	Residual value	0	0

## Existing section 1

Screen	Inputs	Base case	Project case
Road details	MRS	9	9
	Section length	1 km	1 km
	Initial roughness	75 NRM	75 NRM
	Safe operating speed	40 km/h	40 km/h
	Pavement type	Flexible	Flexible
	Surface type	Sprayed surface seal	Sprayed surface seal
	Horizontal alignment	Straight	Straight
	Vertical alignment	Level or flat	Level or flat
Road traffic data	AADT year 1	4000	2000
	Traffic growth rate	3% linear	3% linear
	Cars – private	82.0%	88.0%
	Cars – commercial	11.0%	9.0%
	Non-articulated	3.3%	1.6%
	Buses	1.0%	1.0%
	Articulated	1.1%	0.2%
	B-double	1.6%	0.2%
	Road train 1	0%	0%
	Road train 2	0%	0%

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## Existing section 2

Screen	Inputs	Base case	Project case
Road details	MRS	9	9
	Section length	4 km	4 km
	Initial roughness	75 NRM	75 NRM
	Safe operating speed	40 km/h	40 km/h
	Pavement type	Flexible	Flexible
	Surface type	Sprayed surface seal	Sprayed surface seal
	Horizontal alignment	Straight	Straight
	Vertical alignment	Level or flat	Level or flat
Road traffic data	AADT year 1	8000	6000
	Traffic growth rate	3% linear	3% linear
	Cars – private	82.0%	84.1%
	Cars – commercial	11.0%	10.3%
	Non-articulated	3.3%	2.7%
	Buses	1.0%	1.0%
	Articulated	1.1%	0.8%
	B-double	1.6%	1.1%
	Road train 1	0%	0%
	Road train 2	0%	0%

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### Existing section 3

Screen	Inputs	Base case	Project case
Road details	MRS	9	9
	Section length	4 km	4 km
	Initial roughness	75 NRM	75 NRM
	Safe operating speed	40 km/h	40 km/h
	Pavement type	Flexible	Flexible
	Surface type	Sprayed surface seal	Sprayed surface seal
	Horizontal alignment	Straight	Straight
	Vertical alignment	Level or flat	Level or flat
Road traffic data	AADT year 1	8000	6000
	Traffic growth rate	3% linear	3% linear
	Cars – private	82.0%	84.1%
	Cars – commercial	11.0%	10.3%
	Non-articulated	3.3%	2.7%
	Buses	1.0%	1.0%
	Articulated	1.1%	0.8%
	B-double	1.6%	1.1%
	Road train 1	0%	0%
	Road train 2	0%	0%

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## Existing section 4

Screen	Inputs	Base case	Project case
Road details	MRS	9	9
	Section length	1 km	1 km
	Initial roughness	75 NRM	75 NRM
	Safe operating speed	40 km/h	40 km/h
	Pavement type	Flexible	Flexible
	Surface type	Sprayed surface seal	Sprayed surface seal
	Horizontal alignment	Straight	Straight
	Vertical alignment	Level or flat	Level or flat
Road traffic data	AADT year 1	4000	2000
	Traffic growth rate	3% linear	3% linear
	Cars – private	82.0%	88.0%
	Cars – commercial	11.0%	9.0%
	Non-articulated	3.3%	1.6%
	Buses	1.0%	1.0%
	Articulated	1.1%	0.2%
	B-double	1.6%	0.2%
	Road train 1	0%	0%
	Road train 2	0%	0%

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## Unsealed road

Screen	Inputs	Base case		Project case	
Create new evaluation	Road class	District		District	
	Region	Far North		Far North	
	Zone	Dry non-reactive		Dry non-reactive	
	Evaluation period	31		31	
	Discount rate	6%		6%	
	Speed environment	Rural		Rural	
	Advance option selected	Livestock		Livestock	
Road details	MRS	1		7	
	Section length	12 km		12 km	
	Initial roughness	200 NRM		75 NRM	
	Safe operating speed	70 km/h		100 km/h	
	Pavement type	Unpaved		Flexible	
	Surface type	Unsurfaced		Sprayed surface seal	
	Horizontal alignment	Straight		Straight	
Road traffic data	Vertical alignment	Level or flat		Level or flat	
	AADT year 1	125		125	
	Traffic growth rate	1% linear		1% linear	
	Cars – private	55%		55%	
	Cars – commercial	5%		5%	
	Non-articulated	3%		3%	
	Buses	0%		0%	
	Articulated/ livestock	6%	50%	6%	50%
	B-double/livestock	14%	50%	14%	50%
	Road train 1/ livestock	0%	0%	0%	0%
Road train 2/ livestock	17%	100%	17%	100%	

Screen	Inputs	Base case	Project case
Capital and maintenance costs	Capital		\$6 000 000
	Routine maintenance costs	\$20 000 yearly	\$25 000 yearly excluding year 1
	Periodic maintenance costs	0	\$250 000 in years 7, 14, 21 and 28
	Reduction in roughness from periodic maintenance	NA	5 NRM each time
	Rehabilitation	0	0
	Roughness after rehabilitation	NA	NA
	Residual value	0	0

FOR REFERENCE PURPOSES ONLY

## Generated traffic

Screen	Inputs	Base case	Project case
Create new evaluation	Road class	Regional	Regional
	Region	Mackay/Whitsunday	Mackay/Whitsunday
	Zone	Wet reactive	Wet reactive
	Evaluation period	31	31
	Discount rate	6%	6%
	Speed environment	Rural	Rural
Road details	Advanced option selected	Generated traffic	Generated traffic
	MRS	6	15
	Section length	25 km	20 km
	Initial roughness	100 NRM	65 NRM
	Safe operating speed	60 km/h	100 km/h
	Pavement type	Flexible	Flexible
	Surface type	Sprayed surface seal	Sprayed surface seal
	Horizontal alignment	Curvy	Straight
Vertical alignment	Mountainous	Rolling or undulating	
Road traffic data	AADT year 1	1750	1750
	Traffic growth rate	3% linear	3% linear
	Cars – private	95%	95%
	Cars – commercial	0%	0%
	Non-articulated	5%	5%
	Buses	0%	0%
	Articulated	0%	0%
	B-double	0%	0%
	Road train 1	0%	0%
Road train 2	0%	0%	
Capital and maintenance costs	Capital	0	\$120 000 000
	Routine maintenance costs	\$50 000 yearly	\$40 000 yearly
	Periodic maintenance costs	\$600 000 in years 5, 10, 20, 25 and 30	\$400 000 in years 7 and 14 and \$500 000 in year 27
	Reduction in roughness from periodic maintenance	5 NRM each time	5 NRM each time
	Rehabilitation	\$7 000 000 in year 15	\$5 000 000 in year 21
	Roughness after rehabilitation	70 NRM	70 NRM
	Residual value	0	0

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Screen	Inputs	Base case	Project case
Generated traffic – road traffic data	AADT year 2	150	150
	Traffic growth rate	6% compound	6% compound
	Cars – private	100%	100%
	Cars – commercial	0%	0%
	Non-articulated	0%	0%
	Buses	0%	0%
	Articulated	0%	0%
	B-double	0%	0%
	Road train 1	0%	0%
	Road train 2	0%	0%

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## Changes in multi-combination vehicle

Screen	Inputs	Base case	Project case
Create new evaluation	Road class	Regional	Regional
	Region	Wide Bay/Burnett	Wide Bay/Burnett
	Zone	Wet reactive	Wet reactive
	Evaluation period	31	31
	Discount rate	6%	6%
	Speed environment	Rural	Rural
Road details	MRS	8	13
	Section length	2 km	2 km
	Initial roughness	110 NRM	60 NRM
	Safe operating speed	100 km/h	100 km/h
	Pavement type	Flexible	Flexible
	Surface type	Sprayed surface seal	Sprayed surface seal
	Horizontal alignment	Straight	Straight
	Vertical alignment	Level or flat	Level or flat
Road traffic data	AADT year 1	515	491
	Traffic growth rate	3% linear	3% linear
	Cars – private	48.9%	51.4%
	Cars – commercial	21.0%	22.0%
	Non-articulated	6.0%	6.3%
	Buses	1.0%	1.0%
	Articulated	10.1%	5.6%
	B-double	1.0%	1.2%
	Road train 1	12.0%	7.5%
	Road train 2	0.0%	5.0%
Capital and maintenance costs	Capital	0	\$1 000 000
	Routine maintenance costs	\$5000 yearly	\$10 000 yearly
	Periodic maintenance costs	\$100 000 in years 7, 21 and 28	\$110 000 in years 7, 14 and 28
	Reduction in roughness from periodic maintenance	5 NRM each time	5 NRM each time
	Rehabilitation	\$700 000 in year 14	\$500 000 in year 21
	Roughness after rehabilitation	80 NRM	60 NRM
	Residual value	0	0

## Multiple project cases

Screen	Inputs	Base case	Project case 1	Project case 2	Project case 3
Create new evaluation	Road class	State strategic	State strategic	State strategic	State strategic
	Region	Metropolitan	Metropolitan	Metropolitan	Metropolitan
	Zone	Wet non-reactive	Wet non-reactive	Wet non-reactive	Wet non-reactive
	Evaluation period	32	32	32	32
	Discount rate	6%	6%	6%	6%
	Speed environment	Rural	Rural	Rural	Rural
	Advanced option selected	Multiple project case	Multiple project case	Multiple project case	Multiple project case
Road details	MRS	7	10	15	17
	Section length	5 km	5 km	5 km	5 km
	Initial roughness	120 NRM	60 NRM	60 NRM	60 NRM
	Safe operating speed	80 km/h	80 km/h	80 km/h	100 km/h
	Pavement type	Flexible	Flexible	Flexible	Rigid
	Surface type	Sprayed surface seal	Sprayed surface seal	Sprayed surface seal	Asphaltic concrete
	Horizontal alignment	Straight	Straight	Straight	Straight
	Vertical alignment	Rolling undulating	Rolling undulating	Rolling undulating	Rolling undulating
Road traffic data	AADT year 1	10 000	10 000	10 000	10 000
	Traffic growth rate	3% linear	3% linear	3% linear	3% linear
	Cars – private	81%	81%	81%	81%
	Cars – commercial	8%	8%	8%	8%
	Non-articulated	5%	5%	5%	5%
	Buses	1%	1%	1%	1%
	Articulated	3%	3%	3%	3%
	B-double	2%	2%	2%	2%
	Road train 1	0%	0%	0%	0%
	Road train 2	0%	0%	0%	0%
Capital and maintenance costs	Capital		\$2 000 000 year 1 \$3 000 000 year 2	\$4 000 000 year 1 \$6 000 000 year 2	\$8 000 000 year 1 \$10 000 000 year 2
	Routine maintenance costs	\$20 000 yearly	\$22 000 yearly	\$27 000 yearly	\$35 000 yearly
	Periodic maintenance costs	\$100 000 years 14, 21 and 28	\$125 000 years 9, 16 and 30	\$130 000 years 9, 16 and 30	\$200 000 years 9, 16 and 30
	Reduction in Roughness	5 NRM	5 NRM	5 NRM	5 NRM
	Rehabilitation	\$1 000 000 year 7	\$1 200 000 year 23	\$1 300 000 year 23	\$5 000 000 year 23
	Roughness after rehabilitation	80 NRM	60 NRM	60 NRM	60 NRM
	Residual value	0	0	0	0

## Incremental analysis (town bypass 2)

Screen	Inputs	Base case	Project case
Create new evaluation	Road class	State strategic	State strategic
	Region	Fitzroy	Fitzroy
	Zone	Dry non-reactive	Dry non-reactive
	Evaluation period	32	32
	Discount rate	6%	6%
	Speed environment	Rural	Rural
	Advance option selected	Bypass	Bypass
Road details	MRS	1	17
	Section length	7 km	7 km
	Initial roughness	200 NRM	50 NRM
	Safe operating speed	0 km/h	100 km/h
	Pavement type	Unpaved	Rigid
	Surface type	Unsurfaced	Asphaltic concrete
	Horizontal alignment	Straight	Straight
Vertical alignment	Level or flat	Level or flat	
Road traffic data	AADT year 1	0	2000
	Traffic growth rate	3% linear	3% linear
	Cars – private	100%	76%
	Cars – commercial	0%	13%
	Non-articulated	0%	5%
	Buses	0%	1%
	Articulated	0%	2%
	B-double	0%	3%
	Road train 1	0%	0%
Road train 2	0%	0%	
Capital and maintenance costs	Capital	0	\$10 000 000 year 1 and \$70 000 000 year 2
	Routine maintenance costs	\$50 000 yearly	\$20 000 yearly excluding years 1 and 2
	Periodic maintenance costs	\$0	\$1 000 000 in years 8, 15 and 29
	Reduction in roughness from periodic maintenance	NA	5 NRM each time
	Rehabilitation	\$0	\$3 000 000 in year 22
	Roughness after rehabilitation	NA	50 NRM
	Residual value	0	0

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## Existing section 1

Screen	Inputs	Base case	Project case
Road details	MRS	9	9
	Section length	1 km	1 km
	Initial roughness	75 NRM	75 NRM
	Safe operating speed	40 km/h	40 km/h
	Pavement type	Flexible	Flexible
	Surface type	Sprayed surface seal	Sprayed surface seal
	Horizontal alignment	Straight	Straight
	Vertical alignment	Level or flat	Level or flat
Road traffic data	AADT year 1	4000	2000
	Traffic growth rate	3% linear	3% linear
	Cars – private	82.0%	88.0%
	Cars – commercial	11.0%	9.0%
	Non-articulated	3.3%	1.6%
	Buses	1.0%	1.0%
	Articulated	1.1%	0.2%
	B-double	1.6%	0.2%
	Road train 1	0%	0%
	Road train 2	0%	0%

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## Existing section 2

Screen	Inputs	Base case	Project case
Road details	MRS	9	9
	Section length	4 km	4 km
	Initial roughness	75 NRM	75 NRM
	Safe operating speed	40 km/h	40 km/h
	Pavement type	Flexible	Flexible
	Surface type	Sprayed surface seal	Sprayed surface seal
	Horizontal alignment	Straight	Straight
	Vertical alignment	Level or flat	Level or flat
Road traffic data	AADT year 1	8000	6000
	Traffic growth rate	3% linear	3% linear
	Cars – private	82.0%	84.1%
	Cars – commercial	11.0%	10.3%
	Non-articulated	3.3%	2.7%
	Buses	1.0%	1.0%
	Articulated	1.1%	0.8%
	B-double	1.6%	1.1%
	Road train 1	0%	0%
	Road train 2	0%	0%

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### Existing section 3

Screen	Inputs	Base case	Project case
Road details	MRS	9	9
	Section length	4 km	4 km
	Initial roughness	75 NRM	75 NRM
	Safe operating speed	40 km/h	40 km/h
	Pavement type	Flexible	Flexible
	Surface type	Sprayed surface seal	Sprayed surface seal
	Horizontal alignment	Straight	Straight
	Vertical alignment	Level or flat	Level or flat
Road traffic data	AADT year 1	8000	6000
	Traffic growth rate	3% linear	3% linear
	Cars – private	82.0%	84.1%
	Cars – commercial	11.0%	10.3%
	Non-articulated	3.3%	2.7%
	Buses	1.0%	1.0%
	Articulated	1.1%	0.8%
	B-double	1.6%	1.1%
	Road train 1	0%	0%
	Road train 2	0%	0%

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## Existing section 4

Screen	Inputs	Base case	Project case
Road details	MRS	9	9
	Section length	1 km	1 km
	Initial roughness	75 NRM	75 NRM
	Safe operating speed	40 km/h	40 km/h
	Pavement type	Flexible	Flexible
	Surface type	Sprayed surface seal	Sprayed surface seal
	Horizontal alignment	Straight	Straight
	Vertical alignment	Level or flat	Level or flat
Road traffic data	AADT year 1	4000	2000
	Traffic growth rate	3% linear	3% linear
	Cars – private	82.0%	88.0%
	Cars – commercial	11.0%	9.0%
	Non-articulated	3.3%	1.6%
	Buses	1.0%	1.0%
	Articulated	1.1%	0.2%
	B-double	1.6%	0.2%
	Road train 1	0%	0%
	Road train 2	0%	0%

FOR REFERENCE PURPOSES ONLY

## Linking analysis (arterial road)

Screen	Inputs	Base case	Project case
Create new evaluation	Road class	Regional	Regional
	Region	South Coast	South Coast
	Zone	Wet non-reactive	Wet non-reactive
	Evaluation period	11	11
	Discount rate	6%	6%
	Speed environment	Rural	Rural
Road details	MRS	10	13
	Section length	1 km	1 km
	Initial roughness	100 NRM	50 NRM
	Safe operating speed	60 km/h	60 km/h
	Pavement type	Flexible	Flexible
	Surface type	Sprayed surface seal	Sprayed surface seal
	Horizontal alignment	Straight	Straight
	Vertical alignment	Level or flat	Level or flat
Road traffic data	AADT year 1	10 000	10 000
	Traffic growth rate	3% linear	3% linear
	Cars – private	93%	93%
	Cars – commercial	5%	5%
	Non-articulated	1%	1%
	Buses	1%	1%
	Articulated	0%	0%
	B-double	0%	0%
	Road train 1	0%	0%
	Road train 2	0%	0%
Capital and maintenance costs	Capital	0	\$2 500 000
	Routine maintenance costs	\$10 000 yearly	\$20 000 yearly
	Periodic maintenance costs	0	\$500 000 in year 8
	Reduction in roughness from periodic maintenance	NA	5 NRM each time
	Rehabilitation	\$500 000 in year 7	0
	Roughness after rehabilitation	80 NRM	NA
	Residual value	0	\$1 600 000



# 5

## Appendix B: CBA6 lookup tables

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## Free speed array

Table 1: Free speed array

Vehicle type	Road type*	Straight gradient 0–2%	Straight gradient 4%	Straight gradient 6%	Straight gradient 8%	Straight gradient 10%	Curvy gradient 0–2%	Curvy gradient 4%	Curvy gradient 6%	Curvy gradient 8%	Curvy gradient 10%	Very curvy gradient 0–2%	Very curvy gradient 4%	Very curvy gradient 6%	Very curvy gradient 8%	Very curvy gradient 10%
Cars – private	≤ 4.5 m	83.0	82.0	76.0	66.0	56.0	77.0	76.0	72.0	64.0	55.0	69.0	68.0	66.0	60.0	53.0
Cars – commercial	≤ 4.5 m	82.0	79.3	72.0	61.7	52.0	75.0	73.0	68.0	59.7	51.0	67.0	65.3	62.3	56.3	49.3
Non-articulated	≤ 4.5 m	82.4	68.8	55.6	44.6	36.0	73.0	63.4	53.2	43.4	35.8	64.2	57.6	49.8	42.2	35.6
Buses	≤ 4.5 m	86.0	72.0	57.0	45.0	37.0	77.0	67.0	55.0	45.0	37.0	67.0	61.0	53.0	44.0	36.0
Articulated	≤ 4.5 m	86.0	49.0	39.0	32.0	24.0	71.0	45.0	38.0	32.0	24.0	59.0	41.0	36.0	31.0	24.0
B-double	≤ 4.5 m	88.0	38.0	27.0	20.0	16.0	72.0	35.0	27.0	19.0	16.0	59.0	32.0	26.0	19.0	16.0
Road train 1	≤ 4.5 m	88.0	38.0	27.0	20.0	16.0	72.0	35.0	27.0	19.0	16.0	59.0	32.0	26.0	19.0	16.0
Road train 2	≤ 4.5 m	88.0	38.0	27.0	20.0	16.0	72.0	35.0	27.0	19.0	16.0	59.0	32.0	26.0	19.0	16.0
Cars – private	> 4.5 m	105.0	102.0	88.0	72.0	59.0	90.0	89.0	81.0	68.0	57.0	75.0	74.0	71.0	63.0	55.0
Cars – commercial	> 4.5 m	99.7	95.0	81.3	66.3	54.3	85.7	83.3	75.0	63.0	52.7	72.0	70.3	66.3	58.7	51.0
Non-articulated	> 4.5 m	93.8	74.2	58.0	45.4	36.2	79.8	67.2	55.0	44.2	36.0	67.2	60.2	51.4	42.8	35.8
Buses	> 4.5 m	100.0	78.0	59.0	46.0	37.0	85.0	71.0	57.0	45.0	37.0	70.0	63.0	54.0	44.0	36.0
Articulated	> 4.5 m	100.0	52.0	40.0	32.0	24.0	75.0	47.0	39.0	32.0	24.0	60.0	42.0	36.0	31.0	24.0
B-double	> 4.5 m	100.0	40.0	28.0	20.0	16.0	75.0	36.0	27.0	19.0	16.0	60.0	33.0	26.0	19.0	16.0
Road train 1	> 4.5 m	100.0	40.0	28.0	20.0	16.0	75.0	36.0	27.0	19.0	16.0	60.0	33.0	26.0	19.0	16.0
Road train 2	> 4.5 m	100.0	40.0	28.0	20.0	16.0	75.0	36.0	27.0	19.0	16.0	60.0	33.0	26.0	19.0	16.0
Cars – private	Freeway	110.0	106.0	90.0	72.0	59.0	93.0	90.0	82.0	69.0	58.0	76.0	75.0	71.0	63.0	55.0
Cars – commercial	Freeway	105.0	99.3	83.3	66.3	54.3	88.7	84.7	76.0	63.7	53.3	73.0	71.3	66.7	58.7	51.0
Non-articulated	Freeway	99.0	77.2	58.8	45.4	36.2	82.0	68.4	55.6	44.2	36.0	68.6	60.8	51.6	42.8	35.8
Buses	Freeway	110.0	82.0	60.0	46.0	37.0	89.0	73.0	58.0	46.0	37.0	72.0	64.0	54.0	44.0	37.0
Articulated	Freeway	106.0	53.0	40.0	32.0	24.0	77.0	47.0	39.0	32.0	24.0	60.0	42.0	36.0	31.0	24.0
B-double	Freeway	105.0	41.0	28.0	20.0	16.0	76.0	36.0	27.0	19.0	16.0	60.0	33.0	26.0	19.0	16.0
Road train 1	Freeway	105.0	41.0	28.0	20.0	16.0	76.0	36.0	27.0	19.0	16.0	60.0	33.0	26.0	19.0	16.0
Road train 2	Freeway	105.0	41.0	28.0	20.0	16.0	76.0	36.0	27.0	19.0	16.0	60.0	33.0	26.0	19.0	16.0

Source: Austroads report bs.e.n.548 n.bs.9903 part 1, p. 12, Table 6.

\* Corresponds with model road states detailed at Appendix 6:

- < 4.5 m – model road state 1–5
- > 4.5 m – model road state 6–14, 16, 18
- Freeway – model road state 15, 17, 19.

## Pavement speed condition factor

Table 2: FSRG1 pavement speed condition factor at 110 NRM

Vehicle type	Road type	Straight flat	Straight gradient 4%	Straight gradient 6%	Straight gradient 8%	Straight gradient 10%	Curvy flat	Curvy gradient 4%	Curvy gradient 6%	Curvy gradient 8%	Curvy gradient 10%	Very curvy flat	Very curvy gradient 4%	Very curvy gradient 6%	Very curvy gradient 8%	Very curvy gradient 10%
Cars – private	< 4.5 m	0.98	0.98	0.99	1.00	1.00	0.99	0.99	0.99	1.00	1.00	0.99	0.99	0.99	1.00	1.00
Cars – commercial	< 4.5 m	0.97	0.98	0.99	1.00	1.00	0.98	0.99	0.99	1.00	1.00	0.99	0.99	0.99	1.00	1.00
Non-articulated	< 4.5 m	0.95	0.97	0.98	0.99	1.00	0.97	0.98	0.99	0.99	1.00	0.98	0.98	0.99	0.99	1.00
Buses	< 4.5 m	0.97	0.98	0.99	1.00	1.00	0.98	0.99	0.99	1.00	1.00	0.99	0.99	0.99	1.00	1.00
Articulated	< 4.5 m	0.95	0.97	0.99	0.99	1.00	0.97	0.98	0.99	0.99	1.00	0.99	0.99	0.99	0.99	1.00
B-double	< 4.5 m	0.94	0.97	0.99	0.99	1.00	0.97	0.98	0.99	0.99	1.00	0.99	0.99	0.99	0.99	1.00
Road train 1	< 4.5 m	0.94	0.97	0.99	0.99	1.00	0.97	0.98	0.99	0.99	1.00	0.99	0.99	0.99	0.99	1.00
Road train 2	< 4.5 m	0.94	0.97	0.99	0.99	1.00	0.97	0.98	0.99	0.99	1.00	0.99	0.99	0.99	0.99	1.00
Cars – private	> 4.5 m	0.96	0.96	0.98	0.99	1.00	0.97	0.98	0.99	1.00	1.00	0.99	0.99	0.99	1.00	1.00
Cars – commercial	> 4.5 m	0.96	0.96	0.98	0.99	1.00	0.97	0.98	0.99	1.00	1.00	0.99	0.99	0.99	1.00	1.00
Non-articulated	> 4.5 m	0.93	0.96	0.98	0.99	1.00	0.96	0.97	0.98	0.99	1.00	0.97	0.98	0.99	0.99	1.00
Buses	> 4.5 m	0.95	0.98	0.99	1.00	1.00	0.97	0.98	0.99	1.00	1.00	0.99	0.99	0.99	1.00	1.00
Articulated	> 4.5 m	0.91	0.96	0.99	0.99	1.00	0.97	0.98	0.99	0.99	1.00	0.99	0.99	0.99	0.99	1.00
B-double	> 4.5 m	0.91	0.96	0.99	0.99	1.00	0.97	0.98	0.99	0.99	1.00	0.99	0.99	0.99	0.99	1.00
Road train 1	> 4.5 m	0.91	0.96	0.99	0.99	1.00	0.97	0.98	0.99	0.99	1.00	0.99	0.99	0.99	0.99	1.00
Road train 2	> 4.5 m	0.91	0.96	0.99	0.99	1.00	0.97	0.98	0.99	0.99	1.00	0.99	0.99	0.99	0.99	1.00

Source: Adopted from Table 8, Austroads Publication AP-R264/05.

Table 3: FSRG22 pavement speed condition factor (PCSPDF) at 250 NRM

Vehicle type	Road type	Straight flat	Straight gradient 4%	Straight gradient 6%	Straight gradient 8%	Straight gradient 10%	Curvy flat	Curvy gradient 4%	Curvy gradient 6%	Curvy gradient 8%	Curvy gradient 10%	Very curvy flat	Very curvy gradient 4%	Very curvy gradient 6%	Very curvy gradient 8%	Very curvy gradient 10%
Cars – private	< 4.5 m	0.76	0.77	0.80	0.87	0.92	0.79	0.80	0.83	0.88	0.92	0.84	0.85	0.87	0.90	0.94
Cars – commercial	< 4.5 m	0.75	0.77	0.81	0.88	0.93	0.79	0.80	0.83	0.89	0.93	0.84	0.85	0.87	0.90	0.94
Non-articulated	< 4.5 m	0.68	0.76	0.84	0.91	0.95	0.74	0.79	0.86	0.91	0.95	0.79	0.83	0.87	0.92	0.95
Buses	< 4.5 m	0.74	0.81	0.89	0.95	0.97	0.79	0.84	0.90	0.95	0.97	0.85	0.87	0.91	0.95	0.97
Articulated	< 4.5 m	0.61	0.78	0.87	0.93	0.97	0.71	0.82	0.89	0.94	0.97	0.81	0.87	0.91	0.94	0.97
B-double	< 4.5 m	0.60	0.79	0.88	0.94	0.97	0.71	0.83	0.89	0.94	0.97	0.81	0.88	0.91	0.95	0.97
Road train 1	< 4.5 m	0.60	0.79	0.88	0.94	0.97	0.71	0.83	0.89	0.94	0.97	0.81	0.88	0.91	0.95	0.97
Road train 2	< 4.5 m	0.60	0.79	0.88	0.94	0.97	0.71	0.83	0.89	0.94	0.97	0.81	0.88	0.91	0.95	0.97
Cars – private	> 4.5 m	0.63	0.65	0.73	0.83	0.90	0.71	0.72	0.77	0.85	0.91	0.81	0.81	0.84	0.88	0.93
Cars – commercial	> 4.5 m	0.64	0.67	0.75	0.85	0.91	0.72	0.74	0.79	0.86	0.92	0.81	0.82	0.85	0.89	0.93
Non-articulated	> 4.5 m	0.62	0.71	0.83	0.90	0.95	0.70	0.77	0.85	0.91	0.95	0.77	0.82	0.87	0.92	0.95
Buses	> 4.5 m	0.65	0.76	0.88	0.94	0.97	0.75	0.81	0.89	0.95	0.97	0.83	0.86	0.91	0.95	0.97
Articulated	> 4.5 m	0.53	0.74	0.86	0.93	0.97	0.68	0.81	0.88	0.94	0.97	0.80	0.86	0.91	0.94	0.97
B-double	> 4.5 m	0.54	0.75	0.87	0.94	0.97	0.68	0.82	0.89	0.94	0.97	0.80	0.87	0.91	0.95	0.97
Road train 1	> 4.5 m	0.54	0.75	0.87	0.94	0.97	0.68	0.82	0.89	0.94	0.97	0.80	0.87	0.91	0.95	0.97
Road train 2	> 4.5 m	0.54	0.75	0.87	0.94	0.97	0.68	0.82	0.89	0.94	0.97	0.80	0.87	0.91	0.95	0.97

Source: Adopted from Table 8, Austroads Publication AP-R264/05.



## Fuel consumption gradient correction factors

Table 4: Fuel consumption gradient correction factors

Vehicle type	Gradient	Speed description												
		Spd_01	Spd_02	Spd_03	Spd_04	Spd_05	Spd_06	Spd_07	Spd_08	Spd_09	Spd_10	Spd_11	Spd_12	Spd_13
		8–15 km/h	16–23 km/h	24–31 km/h	32–39 km/h	40–47 km/h	48–55 km/h	56–63 km/h	64–71 km/h	72–79 km/h	80–87 km/h	88–95 km/h	96–103 km/h	104–112 km/h
Cars – private	4%	0.03	0.07	0.07	0.07	0.08	0.09	0.09	0.10	0.08	0.05	0.04	0.04	0.03
Cars – commercial	4%	0.02	0.06	0.06	0.05	0.06	0.06	0.07	0.07	0.05	0.04	0.04	0.03	0.03
Non-articulated	4%	0.06	0.09	0.08	0.08	0.11	0.16	0.25	0.22	0.18	0.17	0.17	0.17	0.17
Buses	4%	0.08	0.11	0.10	0.13	0.20	0.26	0.39	0.52	0.42	0.29	0.19	0.10	0.00
Articulated	4%	0.06	0.14	0.13	0.19	0.28	0.37	0.46	0.46	0.46	0.46	0.46	0.46	0.46
B-double	4%	0.06	0.15	0.15	0.22	0.31	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43
Road train 1	4%	0.07	0.16	0.15	0.19	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29
Road train 2	4%	0.16	0.17	0.13	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Cars – private	6%	0.04	0.11	0.10	0.11	0.12	0.14	0.17	0.19	0.16	0.12	0.11	0.10	0.08
Cars – commercial	6%	0.04	0.09	0.09	0.09	0.10	0.11	0.12	0.14	0.11	0.09	0.08	0.08	0.07
Non-articulated	6%	0.10	0.18	0.22	0.28	0.34	0.43	0.52	0.47	0.46	0.46	0.46	0.46	0.46
Buses	6%	0.15	0.24	0.32	0.42	0.54	0.65	0.83	0.98	0.84	0.70	0.57	0.45	0.32
Articulated	6%	0.18	0.29	0.40	0.52	0.66	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70
B-double	6%	0.10	0.30	0.42	0.54	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63
Road train 1	6%	0.11	0.29	0.39	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
Road train 2	6%	0.39	0.29	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34
Cars – private	8%	0.05	0.19	0.17	0.17	0.18	0.21	0.26	0.30	0.25	0.21	0.18	0.15	0.12
Cars – commercial	8%	0.05	0.17	0.16	0.16	0.17	0.18	0.19	0.22	0.18	0.15	0.13	0.12	0.10
Non-articulated	8%	0.19	0.39	0.47	0.55	0.62	0.68	0.70	0.65	0.65	0.65	0.65	0.65	0.65
Buses	8%	0.26	0.50	0.62	0.76	0.91	1.05	1.25	1.42	1.25	1.08	0.92	0.78	0.62
Articulated	8%	0.33	0.60	0.75	0.90	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
B-double	8%	0.18	0.62	0.76	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
Road train 1	8%	0.21	0.61	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
Road train 2	8%	0.60	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61
Cars – private	10%	0.06	0.28	0.27	0.28	0.30	0.35	0.42	0.47	0.42	0.34	0.28	0.25	0.21
Cars – commercial	10%	0.07	0.27	0.27	0.28	0.30	0.32	0.35	0.39	0.35	0.30	0.26	0.24	0.21
Non-articulated	10%	0.30	0.61	0.72	0.83	0.89	0.93	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Buses	10%	0.39	0.76	0.93	1.11	1.28	1.45	1.69	1.90	1.69	1.49	1.31	1.13	0.95
Articulated	10%	0.47	0.90	1.08	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13
B-double	10%	0.27	0.93	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12

Road train 1	10%	0.30	0.91	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01
Road train 2	10%	0.75	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96

Source: Adopted from Table 13, Austroads Publication AP-R264/05.

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## Fuel consumption roughness correction factors

Table 5: Fuel consumption roughness correction factors

Vehicle type	Speed description												
	Spd_01	Spd_02	Spd_03	Spd_04	Spd_05	Spd_06	Spd_07	Spd_08	Spd_09	Spd_10	Spd_11	Spd_12	Spd_13
	8–15 km/h	16–23 km/h	24–31 km/h	32–39 km/h	40–47 km/h	48–55 km/h	56–63 km/h	64–71 km/h	72–79 km/h	80–87 km/h	88–95 km/h	96–103 km/h	104–112 km/h
Cars – private	0.02	0.06	0.07	0.07	0.08	0.09	0.10	0.10	0.09	0.09	0.09	0.09	0.09
Cars – commercial	0.03	0.06	0.07	0.07	0.08	0.08	0.09	0.09	0.08	0.08	0.08	0.08	0.07
Non-articulated	0.04	0.08	0.09	0.10	0.11	0.12	0.13	0.11	0.10	0.10	0.09	0.08	0.07
Buses	0.05	0.08	0.09	0.10	0.11	0.12	0.14	0.15	0.13	0.12	0.12	0.11	0.10
Articulated	0.03	0.10	0.11	0.13	0.14	0.16	0.18	0.19	0.19	0.17	0.16	0.15	0.13
B-double	0.05	0.10	0.12	0.14	0.16	0.17	0.19	0.20	0.20	0.22	0.19	0.18	0.17
Road train 1	0.06	0.11	0.13	0.15	0.17	0.19	0.21	0.22	0.24	0.24	0.20	0.20	0.20
Road train 2	0.06	0.12	0.14	0.15	0.17	0.20	0.23	0.27	0.22	0.26	0.23	0.23	0.21

Source: Adopted from Austroads Publication AP-R264/05.

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## Appendix C: Improved route calculation

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## Improved Route Calculation – CBA6

VOC and TTC are given as negative values for the improved route. This is intuitively incorrect, however the differences in values derived (benefits) are the same.

The formula used in CBA6 to derive VOC is shown in Equation 96.

*Equation 96: Total VOC*

$$TOTVOC_{VT} = SectionLength_{IR} \times (-AATOC \times \%D) \times AADT_i \times \frac{VOC_i}{100}$$

This formula is applied to both the base and project cases and can be written as in Equation 97 for the base case and Equation 98 for the project case.

*Equation 97: Total VOC base case*

$$TOTVOC_{VT} = SectionLength_{IR} \times (-AATOC_{BC} \times \%D_{BC}) \times AADT_i \times \frac{VOC_{BC}}{100}$$

*Equation 98: Total VOC project case*

$$TOTVOC_{VT} = SectionLength_{IR} \times (-AATOC_{PC} \times \%D_{PC}) \times AADT_i \times \frac{VOC_{PC}}{100}$$

If Equation 98 is subtracted from Equation 97, the benefits to the improved route can be derived by Equation 99.

*Equation 99: VOC benefits to improved route*

$$Ben_{imp} = \frac{[(VOC_{BC} \times (-AATOC_{BC} \times (\%D_{BC}))) - (VOC_{PC} \times (-AATOC_{PC} \times (\%D_{PC})))] \times (AADT_i \times SectionLength_{IR})}{100}$$

The correct formulae to derive VOC for the base case (improved) and project case (improved) for the improved route are stated in Equation 100 and Equation 101 respectively. Benefits are derived when Equation 101 is subtracted from Equation 100. This derivation can be found in Equation 102.

*Equation 100: Correct formulae for total VOC base case*

$$TOTVOC_{VT} = SectionLength_{IR} \times (365.25 - AATOC_{BC} \times \%D_{BC}) \times AADT_i \times \frac{VOC_{BC}}{100}$$

*Equation 101: Correct formulae for total VOC project case*

$$TOTVOC_{VT} = SectionLength_{IR} \times (365.25 - AATOC_{PC} \times \%D_{PC}) \times AADT_i \times \frac{VOC_{PC}}{100}$$

*Equation 102: VOC benefits to improved route (correct)*

$$Ben_{imp} = \frac{[(VOC_{BC} \times (365.25 - AATOC_{BC} \times (\%D_{BC}))) - (VOC_{PC} \times (365.25 - AATOC_{PC} \times (\%D_{PC})))] \times (AADT_i \times SectionLength_{IR})}{100}$$

Equation 102 can be rearranged as shown in Equation 103.

*Equation 103: Re-arranged VOC benefits to improved route*

$$Ben_{imp} = \frac{[(VOC_{BC} - VOC_{PC}) - ((365.25 - AATOC_{BC} \times (\%D_{BC})) - (365.25 - AATOC_{PC} \times (\%D_{PC})))] \times (AADT_i \times SectionLength_{IR})}{100}$$

365.25 can be eliminated from the equation, hence Equation 104 is derived which is equal to Equation 99.

*Equation 104: Second re-arrangement of VOC benefits to improved route*

$$Ben_{imp} = \frac{[(VOC_{BC} \times (-AATOC_{BC} \times (\%D_{BC})) - (VOC_{PC} \times (-AATOC_{PC} \times (\%D_{PC})))] \times (AADT_i \times SectionLength_{IR})}{100}$$

The same mathematical manipulation of TTC as VOC can be done. The benefits derived in CBA6 are correct even though the VOC and TTC for the improved route have been stated as negative values in the reports.

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# 5

## Appendix D: Casualty crash rates for major urban intersections

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Table 6 shows major urban intersection casualty crash rates suitable for use within eastern Australia.

*Table 6: Estimated Crash Rates – Major Urban Intersections*

	Major rural intersection casualty crash rates	Crashes per 106 vehicles entering
<b>Intersection stereotype</b>	Signalised	0.16
	Roundabout	0.13
<b>Freeway-arterial interchange</b>	Signalised	0.1
	Unsignalised	0.11

Source: Austroads AP-R184

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# 5

## Appendix E: Heavy vehicle types

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Table 7: Austroads standard vehicle types

Vehicle types	Configuration	Maximum length (m)	Gcm (t)	Hml (t)
Semi-trailer		19	42.5	45.5
Quad-axle semi-trailer		19	46.5	50
B-double		26	62.5	68
Type 1 road train (A-double)		36.5	79	85
B-triple		36.5	82.5	90.5
AB-triple		36.5	99	107.5
Type 2 road train (A-triple)		53.5	115.5	124.5
AAB-quad		53.5	142.5	By special assessment
BAB-quad		53.5	119	By special assessment
ABB-quad		53.5	119	By special assessment

Mandy Haldane 2009, Comparison of Queensland freight vehicles.

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**Appendix F: Roughness conversion**

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Equation 10 is the standard roughness conversion between two measures of road roughness, the NAASRA roughness measure (NRM) and the international roughness index (IRI). In CBA6, all IRI values should be converted to NRM for input.

*Equation 10: NRM to IRI conversion*

$$NRM = 26.49 \times IRI - 1.27$$

Where:

- *NRM = NAASRA roughness level*
- *IRA = International Roughness Index*

This conversion is also illustrated in Table 48.

*Table 48: Roughness conversion NRM–IRI and IRI–NRM*

NRM	IRI	IRI	NRM
30	1.18	1.0	25
40	1.56	1.5	38
50	1.94	2.0	52
60	2.31	2.5	65
70	2.69	3.0	78
80	3.07	3.5	91
90	3.45	4.0	105
100	3.82	4.5	118
110	4.20	5.0	131
120	4.58	5.5	144
130	4.96	6.0	158
140	5.33	6.5	171
150	5.71	7.0	184

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# 5

## Appendix G: CBA6 model road state categories

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Table 9: Model Road State

Carriageway	Surface	Model road state	Road width description	
Undivided	Natural surface	1	Unsealed natural surface	
		2	Unsealed formed road	
	Gravel	3	Paved < 4.5 m	
		4	Paved >= 4.5 m	
	Sealed	5	5	Narrow seal <= 4.5 m
			6	Narrow seal 4.6 m–5.2 m
		7	7	2 lane seal 5.3 m–5.8 m
			8	2 lane seal 5.9 m–6.4 m
		9	9	2 lane seal 6.5 m–7.0 m
			10	2 lane seal 7.1 m–7.6 m
		11	11	2 lane plus shoulder seal 7.7 m–8.2 m
			12	2 lane plus shoulder seal 8.3 m–9.0 m
		13	13	2 lane plus shoulder seal 9.1 m–9.4 m
			14	2 lane plus shoulder seal 9.5 m–10 m
	15	15	2 lane plus shoulder seal 10.1 m–11.6 m	
		16	3 lane for overtaking	
	Divided	Sealed	17	4 lane undivided sealed
			18	6 lane undivided sealed
19			4 lane divided sealed	
20			6 lane divided sealed	
21			4 lane divided (limited access)	
22			6 lane divided (limited access)	
23			8 lane divided (limited access)	

Source: Adapted from Austroads 2005, page 22.

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# 5

## Glossary

This glossary defines concepts that are unique to CBA, as well as important or frequently used terms found in the manual.

Definitions have been derived from, and are complementary to, the glossary in Volume 3 of the ATC Guidelines (2006).



**Average annual daily traffic (AADT):** The total number of trips passing a point on a road in a year divided by the number of days in a year.

**ARRB Group Ltd (ARRB):** A national organisation that focuses on addressing transport policy and other related issues through high quality road safety, road construction and maintenance practices.

**Australian Transport Council (ATC):** A ministerial forum represented by commonwealth, state and territory transport ministers that advises government on the issues of coordination and integration of transport and road policies at a national level.

**Austroroads:** An association of Australian and New Zealand road transport authorities that aims to improve road transport outcomes.

**Base case:** Represents the state of the world in absence of the proposed initiative. The base case is the benchmark that the project case is compared to.

**Base year:** Is the year to which all values are discounted when determining a present value. It is usually the year in which the analysis has been undertaken.

**Benefit-cost analysis (BCA):** A technique used to assess the economic efficiency of resource allocation by quantifying the costs and benefits of a proposed initiative. BCA and CBA are used interchangeably.

**Benefit-cost ratio (BCR):** The ratio of the present value of economic benefits to the present value of economic costs of a proposed initiative.

**Benefit:** A quantified positive impact due to the implementation of a project.

**Bypass:** A permanent re-routing of traffic, for instance around a mountain or a town.

**Capacity factor:** The factor which represents the proportion of daily traffic in peak periods.

**Compound growth:** See *Technical Guide*.

**Congestion adjustment:** Is a factor that adjusts the speed of the fleet relative to the effects of the congested road.

**Consumer surplus:** Is the difference between the amount the consumer is willing to pay for a good or service and the amount the consumer actually pays.

**Copy to clipboard:** A CBA6 feature which allows the user to transfer the data on the selected screen to another application such as Microsoft Excel.

**Corrected free speed:** The calculated vehicle speed accounting for various road characteristics including roughness.

**Cross elasticity of demand:** Measures the responsiveness of the quantity of demand of a particular product or service to a change in the price of another product or service.

**Decision criteria:** Decision criteria are the conditions a project is required to meet to be considered viable, and encompass an objective series of rules regarding whether to reject or to proceed with a proposed project.

**Depreciation:** The amount that an asset reduces in value over one year, due to wear and tear or environmental factors.

**Discounting:** The process of converting multiple cash flows that occur in different years to a common year or in present value terms.

**Discounted cash flow:** Present value of future cash flows generated by a project.

**Diversion:** A temporary re-route of traffic onto an alternative existing route, e.g. due to flooding or rock fall.

**Disbenefit:** A negative economic outcome due to the implementation of a project.

**Externality:** An effect that one party has on another that is not transmitted through market transactions. An example is noise pollution from vehicles; those operating the vehicles disturb other parties such as nearby residents, but a market transaction between these parties is absent (Page 219, Volume 5, ATC Guidelines).

**Existing route:** The existing route in a bypass is the section of road which will be bypassed and represents the base case.

**Ex-post evaluation:** (Post Completion Evaluation) A review of a completed set of actions to determine whether the desired forecast ends have been realised, and to explain the reasons for the outcomes.

**Free speed:** Free speed represents the average speed of a vehicle and is related to the vehicle type, MRS, and vertical and horizontal alignment.

**First year rate of return (FYRR):** Represents benefits minus operating costs in the first full year of operation of an initiative, divided by the present value of the investment costs, expressed as a percentage. The first year rate of return is used to determine the optimum timing of initiatives.



**Generated traffic:** Freight or passenger traffic that has been induced by an initiative, that is the new traffic would not exist but for the initiative, e.g. an unsealed track being sealed generating new traffic to a beach village.

**Gradient adjustment:** An adjustment factor added to a value to account for changes in the gradient of the road. The adjustment factor varies by vehicle type and by the road gradient.

**Highway Demand Management (HDM-4):** A road investment analysis tool that was initially developed by the world bank.

**Hourly capacity:** Refers to the maximum amount of vehicles per hour a given road type can accommodate.

**Incremental benefit-cost ratio (IBCR):** The IBCR is the present value of additional costs when going from one size or standard to the next. It is used to select between mutually exclusive options (Page 89, Volume 5, ATC Guidelines).

**Improved route:** Refers to the road which is being upgraded, from the start of the diversion to where the diverting route rejoins the upgraded route.

**Inputs:** Inputs refer to entered information within CBA6 which is used to calculate the final inputs and includes roughness and speed.

**Intermediary output:** Refers to those calculations in CBA6 which are used to calculate the final outputs from the inputs and includes fuel, tyres, oil, repairs, operating speed, travel time and vehicle operating costs.

**Linear growth:** See *Technical Guide*.

**Model road state (MRS):** Refers to the 23 categories of road types.

**Million vehicle kilometres travelled (MVKT):** Refers to distance travelled over a one year period.

**Multi-combination vehicle:** All articulated combinations of vehicles exceeding 19 m in length or 42.5 tonne gross mass, including B-doubles, road trains and truck-trailer combinations.

**NAASRA Improved Model for Project Assessment and Costing (NIMPAC):** NIMPAC is an economic model first developed by NAASRA in the 1980s to determine the effects of changes in vehicle limits on Australian roads.

**National Association of Australian State Road Authorities (NAASRA):** The predecessor of Austroads.

**Network effects:** Effects/impacts that occur on the wider road network as a result of the proposed initiative.

**Network cost-benefit analysis (network CBA):** Is a cost-benefit analysis which identifies and incorporates effects in the wider road network as a result of the impact of the proposed initiative.

**Net present value (NPV):** Net Present Value is the present value of benefits accruing from a project minus the present value of operating costs.

**Operating speed:** A prediction on the average speed each vehicle type will travel on a road when adjustments are made for congestion and the road characteristics.

**Opportunity costs:** The value foregone by society from using a resource in its next best alternative use.

**Outputs:** Outputs of the cost-benefit analysis model including the road user cost results and decision criteria.

**Passenger car equivalents (PCE):** Used to calculate traffic volume. PCE factors exist for each vehicle type.

**Price year:** The year in which prices prevailing are used in a cost-benefit analysis for the valuation of the costs and benefits over the life of a project. This is usually the base year.

**Present value:** The current value of a future cashflow or series of future cashflows, discounted to reflect the time value of money.

**Producer surplus:** The difference between the amount that a producer receives from the sale of goods and the lowest amount that a producer is willing to accept for those goods.

**Real prices:** Prices that have been adjusted to remove the effects of inflation. They apply for a particular base year, e.g. 2004 dollars (Page 221, Volume 5, ATC Guidelines).

**Residual value:** The value of an asset at the end of the evaluation period.

**Roughness:** A measure of the unevenness of a road surface. It is reported as either NAASRA Roughness Measurement (NRM) or International Roughness Index (IRI). NRM can be reliably converted to IRI by a linear equation, and vice versa, where required.

**Road user costs (RUC):** The costs of operating vehicles on roads, including time costs. Crash costs may or may not be included.

**Sensitivity analysis:** Changing a variable, or a number of variables, in a model to discover how it affects the model's outputs.

**SIDRA:** An advanced micro-analytical traffic evaluation tool that employs lane-by-lane and vehicle drive cycle models for intersection simulation. SIDRA output is a key input to CBA6.

**Transport and Main Roads (TMR):** The Queensland Government department incorporating the former departments Queensland Transport and Main Roads.

**Travel time costs (TTC):** Represents the economic value of time taken to travel for road users. Travel time is a key output of a road project evaluation.

**Vehicle volume capacity ratio (VCR):** A measure of the level of congestion on a road given the traffic volume on road capacity.

**Vehicle operating costs (VOC):** The costs of operating a vehicle, including fuel, oil, tyres and repairs and maintenance costs.

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# 5

## References

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FOR REFERENCE PURPOSES ONLY

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FOR REFERENCE PURPOSES ONLY

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