User Guide

Estimating the Incremental Cost Impact on Unsealed Local Roads from Additional Freight Tasks

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DISCLAIMER

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1 INTRODUCTION

Western Australian Local Governments face significant costs from road wear as a consequence of unforeseen heavy vehicle traffic triggered by projects, typically in the resources industry. The impacts of additional heavy vehicle traffic on shortening road life and increasing maintenance requirements are greater for roads that were not designed and constructed for this purpose, which is the case for most Local Government roads. In 2015, WALGA published the ***User Guide, Estimating the Incremental Cost Impact on Sealed Roads from Additional Freight Tasks (WALGA & ARRB 2015)***. Subsequently many Local Governments have requested that WALGA develop a similar tool for unsealed roads.

This guide provides Local Governments with a tool to quantify the cost of additional wear and damage to affected unsealed roads for a defined freight task. It can be used as the basis for negotiation of cost recovery from industry, to ensure that the local community does not bear the costs imposed by private businesses, and to adjust long term financial plans. The detailed development of the guide is provided in a separate report, '***Technical Basis for Estimating the Cost of Road Wear on Unsealed Local Government Roads in Western Australia (ARRB 2019)***', available from the WALGA website.

Users of this guide will require a basic understanding of gravel material properties and unsealed road maintenance treatments. Input parameters required to estimate the cost of road wear include the quantity and the type of heavy vehicles that will be used for the task to be assessed, the length of the affected road segment and the quality of the gravel wearing course.

1.1 Background

The guide has been developed using the concept of a marginal cost of road wear. The marginal cost of road wear in this context, is defined as the difference in cost of maintaining a road in a serviceable condition with an increased load of traffic and a base traffic load. The marginal cost is expressed in dollars per axle pass for one kilometre of road. Analysis has shown that the marginal cost for unsealed roads is mostly dependent on the:

- quality of surfacing materials,
- climate,
- the number of axle passes, and
- the cost of road maintenance activities.

Using these critical variables, a catalogue has been developed to represent the spectrum of scenarios that are likely to be encountered on unsealed Local Government roads across the State.

The marginal cost for each scenario was modelled by using a custom-built spreadsheet developed by ARRB. The model generates a life cycle cost analysis of the road based on deterioration curves that predict gravel loss as a function of the time since grading, traffic, precipitation and material properties. The deterioration curves were developed from a long-term monitoring program across Australia and further calibrated to represent the scenarios likely to be encountered in Western Australia. As the defined road deteriorates under specific loading conditions, the model triggers maintenance interventions required to keep the road serviceable. The marginal costs are then calculated by accounting for the difference in costs incurred between the additional load and the normal load cases.

Deterioration is primarily in terms of gravel loss and therefore an annual asset consumption based method of costing has been used. Discounting cost escalation, task duration beyond the first year does not therefore change the annual cost.

The scenarios are represented by bar charts which present the marginal cost for a range of granular surfacing material compliance levels in dollars per axle pass for one kilometre lengths of road. The user needs to define their relevant scenario in terms of the vehicle type undertaking the task, the number of trips and the quality of the gravel wearing course. The guide will then lead the user to the applicable graph. Detailed information on how to use the guide is provided in section 2.

1.2 Limitations

Practitioners need to be aware that the marginal costs presented in this guide have been developed by modelling a synthetic road network designed to represent the majority of scenarios likely to be encountered in Western Australia. There are a multitude of variables that will influence the cost of road wear and the calculated values are only an estimate of the actual cost. Users need to be aware that their scenario may include factors that render the estimate inaccurate.

Some of the limitations are listed below:

1. The marginal cost charts are based on a synthetic network and the user should select the scenario that best fits their circumstances. There may be aspects at a project level that require a review of the calculated cost. Possible examples are:
    - The road is unable to carry the additional traffic from a structural or trafficability view and therefore requires an initial treatment, the choice and cost of which is outside the scope of this manual.
    - Sections of the road are subject to unusual conditions, e.g. flooding or very weak subgrades.
2. The method does not calculate the costs for associated infrastructure, e.g. bridges, culverts and floodways.
3. The actual loading quantities and durations may lie between or outside of the given values. The user will need to interpolate or extrapolate accordingly. The guide may not be valid for scenarios that lie well beyond the modelled limits.
4. The guide has been developed for unsealed local roads only, a separate guide is available for sprayed seal roads.
5. The unit rates are current for 2017. The rates were established from a survey of 28 Local Governments. Users are advised to check if the rates as shown in ***Table 4: Indicative unit cost rate*** are representative of their scenario and if necessary apply an adjustment as described in Section 2 of this Guide. Escalation factors should be considered for future years.
6. The guide has been developed for the WA Local Government road network and the catalogue of solutions (and underlying assumptions) may not be valid in other jurisdictions.
7. ***Table 1: Estimated payloads and axle quantities for typical vehicle types*** gives typical vehicle parameters for a range of commonly used vehicles in WA. These figures have been estimated using typical WA vehicle combinations and tare weights. Actual tare weights and axle configurations may vary across vehicle models resulting in slight differences in payload tonnage and total axles.
8. Intersections may be subject to accelerated gravel loss due to turning movements which may warrant a separate assessment.

2 HOW TO USE THIS GUIDE

The guide is structured around a simple stepped process. Figure 1 presents the nine-step procedure to be followed.

STEP 1:
Determine the total freight tonnage, route, distance and duration of the task

STEP 2:
Determine the vehicle type/s undertaking the freight task

STEP 3:
Calculate the number of one-way trips and the total axle passes for two-way trips per annum

STEP 4:
Select the cost zone for the road network

STEP 5:
Select the category of gravel compliance

STEP 6:
Select the applicable marginal cost chart

STEP 7:
Determine the marginal cost for the additional freight task

STEP 8:
If necessary, adjust the marginal cost based on actual costs

STEP 9:
Calculate the total annual cost attributable to the freight task

Figure 1: Process for calculating the marginal cost estimate and total annual cost

Details for completing each step are given below. This is followed by a series of typical worked examples.

What information is required?

The user will need the following information:

1. The type of vehicles to be used for the task
2. The annual freight tonnage for the task or the quantity of vehicle passes
3. The duration of the task
4. The task routing and distance
5. The quality of the gravel wearing course

The following sections detail the sequential steps to determine the cost impact for a defined loading task.

STEP 1: Determine the annual freight tonnage, distance and duration of the task

The User will need to gain a good appreciation of the freight task that is being assessed. This will usually involve discussions with the freight generator to determine the duration of the freight task, the total freight tonnage and routing. Typically, these tasks are well structured, with the proponent possibly having a lease on a mine or similar to extract a certain amount of product over a defined period of time.

The modelling has been based on the use of an annual asset consumption-based method of costing. Discounting escalation and duration beyond the first year does not affect the annual marginal cost (see Limitations, point 5). Therefore the following steps are all performed based on annual task parameters.

The annual freight tonnage is required to calculate the number of vehicle passes which is the critical input variable.

The distance is defined as the road distance to be traversed on a defined route by the loaded vehicles.

STEP 2: Determine the vehicle type undertaking the task

The next step is to determine the type of vehicle or vehicles that will be used to undertake the task. The vehicle type will typically be supplied by the freight generator. The user must then select the appropriate RAV designation for the vehicle from Appendix A.

STEP 3: Calculate the number of one-way trips and convert into Axle Passes (AP) and determine the total Axle Passes for two-way trips

The total number of one-way trips may be supplied by the freight generator or it can be calculated by dividing the annual freight tonnage by the vehicle payload to calculate the loaded trips. The vehicle payload will typically be supplied by the freight generator or alternatively it can be estimated using ***Table 1: Estimated payloads and axle quantities for typical vehicle types*** that gives typical payload tonnages for a range of vehicles commonly used in Western Australia.

The quantity of axles per vehicle is given in Table 1. For other vehicles, the practitioner must ask the freight generator to supply the number of axles per vehicle. If only the RAV category is known, then the number of axles per vehicle can be determined from the diagrams in Appendix A.

Table 1: Estimated payloads and axle quantities for typical vehicle types

Vehicle Type	GCM (Max permitted mass tonnes)	RAV	Approximate Payload[1] (tonnes)		Total[3] Axles
			Regulation mass limit	AMMS L3[2]	
3 Axle Rigid Truck (12.5m)	22.5	N/A	13	14	3
6 Axle Articulated (19m)	42.5	2 (B)	24	29	6
B Double (27.5m)	67.5	2 (C)	45	53	10
PM + Semi + 5 axle DT (27.5m)	84.0	3 (A)	54	63	12
PM + Semi + 6 axle DT (27.5m)	87.5	4 (A) / 6(A)	56	68	13
Truck + 2 x 6axle DT (36.5m)	107.5	7 (A)	72	87	16
PM + Semi + 2 x 6axle DT (53.5m)	127.5	10(A)	84	102	19

[1] *These figures have been estimated using typical WA vehicle combinations and tare weights. Actual tare weights may vary across vehicle models resulting in slight differences in payload tonnage.*

[2] *The Accredited Mass Management Scheme (AMMS) allows up to an additional 3.5 tonnes per tri-axle combination and 1.0 tonne per tandem axle combination. The AMMS has three loading levels. If a lower level is applicable then use a proportionate value between RML and AMML L3.*

[3] *Assumes a twin-drive configuration. Adjust total axles for tri-drive and single drive configurations.*

Since research indicates that material loss is similar for both loaded and unloaded trips (ARRB 2019) we therefore calculate the AP for the total two-way trips.

An example is as follows:

Proponent supplies the following information:

Total payload = 300,000 tonnes per annum

Vehicle Type = Prime Mover +semi-trailer + 6 axle dog trailer operating at AMMSL3

From Appendix A the vehicle type is a RAV4(A)

From Table 1, the payload is 68 tonnes and there are 13 axles per vehicle

Therefore, the number of annual loaded one way trips is 300,000/68 = 4412

The AP for one-way trips = 4412x13 = 57,356 AP

The total AP for two-way trips = 57,356x2 = 114,712 AP

STEP 4: Select the cost zone

The appropriate cost zone must be selected from Figure 2.

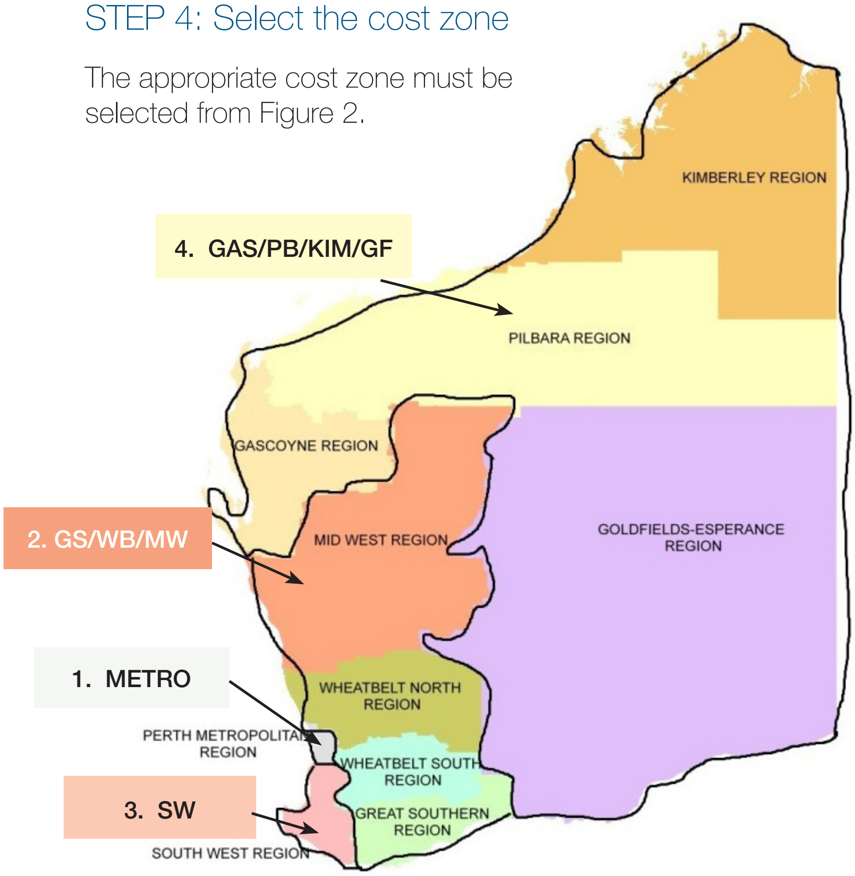


Figure 2: Western Australian cost zones

STEP 5: Select the gravel compliance level

Gravel compliance refers to the materials characteristics relative to a gravel that has optimum characteristics that minimise gravel loss and deformation under traffic. The material grading and plasticity are the two most important performance criteria.

Select the appropriate gravel compliance level from Table 2. If there are sections of the road with distinctly different gravel quality characteristics, then it may be appropriate to assess these sections independently. In most cases an experienced practitioner will be able to select the appropriate level from a visual inspection. However if grading and linear shrinkage testing results can be obtained then Table 2 can be used together with Figure 3 to assist in selecting the most appropriate level.

Table 2: Indicative compliance level and performance of unsealed road granular surfacing materials

Indicative compliance level	Materials and performance attributes
Non-compliant below	High rate of material loss (> 20 – 40 mm per year per 100 AADT) with surface ravelling and corrugations under traffic. Shrinkage Product (SP) below 100, whereas the Grading Coefficient (GC) may vary widely. Uniformly graded fine materials with a low GC display low resistance to erosion and coarsely graded higher GC materials tend to ravel badly and are generally unsuitable.
Borderline below	Moderate rate of material loss (10 – 20 mm per year per 100 AADT), with the surface tending to loosen and corrugate under the action of traffic but may remain tolerable to heavy traffic at low to moderate speeds. SP below 200, whereas GC may vary widely. Performance can improve with regular grading/cushioning operations.
Compliant	Low rate of material loss, typically less than 5 – 10 mm per year per 100 AADT, with a well-knit surface resulting from a mechanically stable particle size distribution with few weak particles and containing a sufficient quantity of plastic fines. Ideal materials typically have a SP greater than 200 with an upper limit of 600 depending on the proportion of heavy traffic and tolerance for dust, and a GC of between 20 and 30. Arm-chair type (or gap) gradings are acceptable with concretionary materials, such as calcretes and laterites.
Borderline above	Moderate rate of material loss (10 – 20 mm per year per 100 AADT), with the surface tending to rut and become slippery in the wet but may remain tolerable to heavy traffic under wet conditions. SP above 600, whereas GC may vary widely. Performance can improve with regular grading/cushioning operations.
Non-compliant above	Moderate to high rate of material loss (> 20 mm per year per 100 AADT) with risk of severe rutting and slipperiness in the wet. SP above 700, whereas GC may vary widely. Uniformly graded fine materials with lower GC display low resistance to erosion and are generally unsuitable, whereas high GC materials tend to be ravel badly leading to extensive potholes.

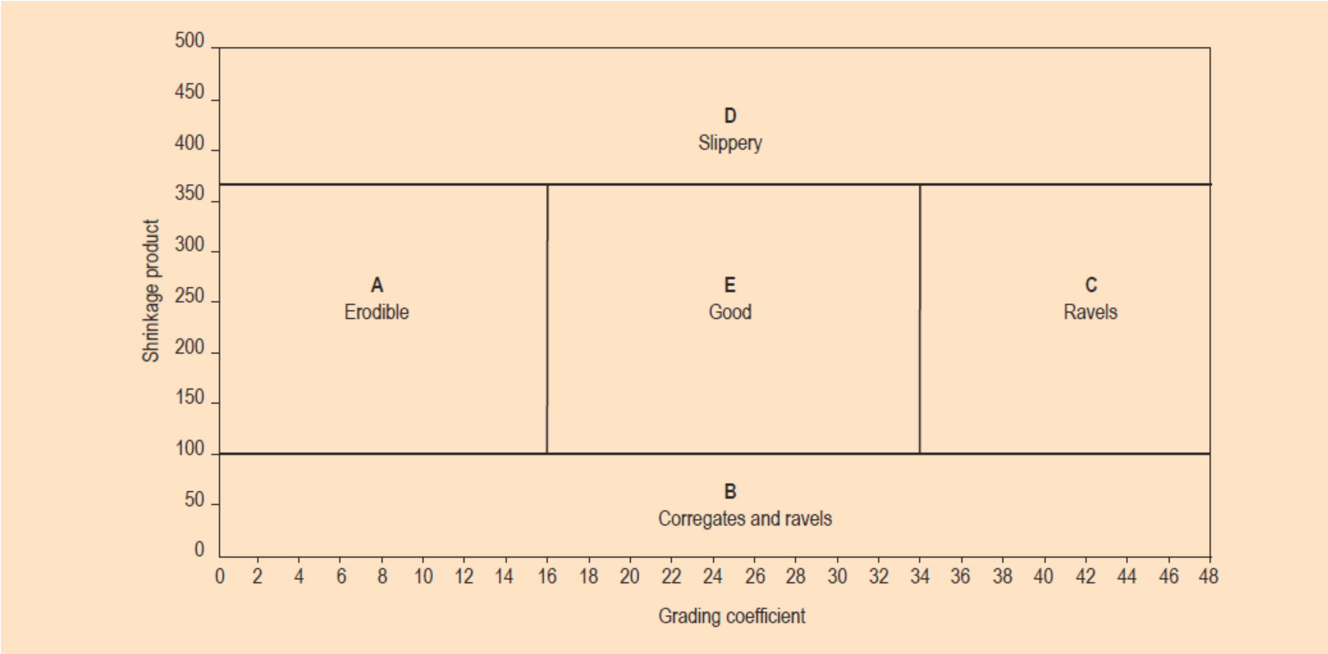


Figure 3: Relationship between gravel wearing surface properties and performance

Notes:

1. *Shrinkage product = linear shrinkage x % passing the 0.425 mm sieve*
2. *Grading coefficient = (% passing the 26.5 mm sieve - % passing the 2 mm sieve) x per cent passing the 4.75 mm sieve/100*

Source: P Paige-Green 1987

STEP 6: Select the applicable marginal cost chart

Using Table 3, input the Cost Zone and the closest AP total for two-way trips and then select the applicable chart.

For example:

Given Cost Zone 2 and 114,712 AP (therefore use 100,000AP)

Select Chart B4

Table 3: List of marginal cost charts

Cost Zone	Additional AP/ per (two-way)	Chart
2	10,000	Figure B1
	20,000	Figure B2
	40,000	Figure B3
	100,000	Figure B4
	200,000	Figure B5
3	10,000	Figure B6
	20,000	Figure B7
	40,000	Figure B8
	100,000	Figure B9
	200,000	Figure B10
4	10,000	Figure B11
	20,000	Figure B12
	40,000	Figure B13
	100,000	Figure B14
	200,000	Figure B15

STEP 7: Determine the marginal cost for the additional freight task

Using the Chart selected in STEP 6 with the gravel compliance category from STEP 5, the marginal cost for the defined scenario can be determined. An example of how the chart is to be used is presented in Figure 4.

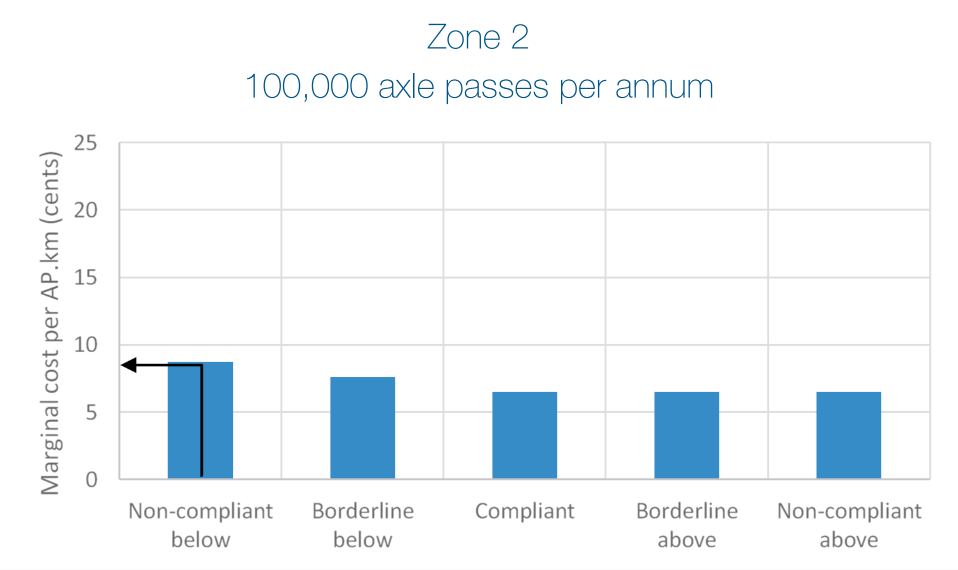


Figure 4: Marginal cost per additional axle pass (cents per km) for Zone 2 and 100,000 AP per annum

For a "non-compliant below material" the marginal cost = 9c per AP.km

STEP 8: Adjust the marginal cost based on actual costs

The marginal cost charts have been developed using unit rates that were determined from a Local Government survey in 2017 which are represented in Table 4.

Table 4: Indicative unit cost rate for resheeting used in the development of the user guide

Cost Zone	Average cost rate per Cost Zone ($/km 2017)
2	43,747
3	35,656
4	78,133

If the actual cost of resheeting is known and is different to the indicative costs, then the marginal cost can be adjusted using the equation below:

AMC = MC x a/b

where

AMC	=	Adjusted Marginal Cost for specific case study
MC	=	Marginal Cost
a	=	Actual cost of resheeting ($/km)
b	=	Indicative cost of resheeeting per Cost Zone ($/km) (see Table 4)

For example:

The calculated marginal cost = 9c per AP.km

The cost of resheeting for this project is known to be $49,500 per km

AMC = 9 X 49,500/43,747

AMC = 10 c per AP.km

STEP 9: Calculate the total annual cost attributable to the freight task

The total annual cost is determined by multiplying the marginal cost by the total AP and the route distance.

For example:

Marginal Cost = 10c per AP.km
Route distance = 21 km
Total AP = 114,712

Total annual cost = 0.1 x 21 x 114,712 = $240,895

3 EXAMPLE CALCULATIONS

3.1 Worked Example #1

A mining company is developing a mine site in the Mid-West and proposes to transport 300,000 tonnes of iron ore per annum over a five year period along an unsealed Local Government road to access the State road network. They will be using a prime mover towing a semi-trailer and a B double with a concessional loading permit (AMMS Level 3). The road is 58 km long. The Works Manager has reported that the gravel wearing course is coarsely graded and susceptible to ravelling and corrugations, but an acceptable performance can be maintained with regular grading. The cost of resheeting is $45,500 per km.

Calculate the annual cost of road wear resulting from this additional freight task.

Solution:

1. **Determine the annual freight tonnage, distance and duration of the task:**

   The annual freight tonnage is given as 300,000t

   The route distance is 58 km

   The duration of the task is 5 years

2. **Determine the vehicle type undertaking the task:**

   Go to Appendix A and select the applicable RAV Category.

   A prime mover towing a semi-trailer and a B double is a RAV 7 (A).

3. **Calculate the number of one-way trips and convert into axle passes and determine the total AP for two-way trips per annum:**

   The annual tonnage is 300,000t

   From Table 1, the payload for a RAV 7(A) at AMMSL3 = 87 tonnes

   The number of one-way trips = 300,000/87 = 3449 per annum

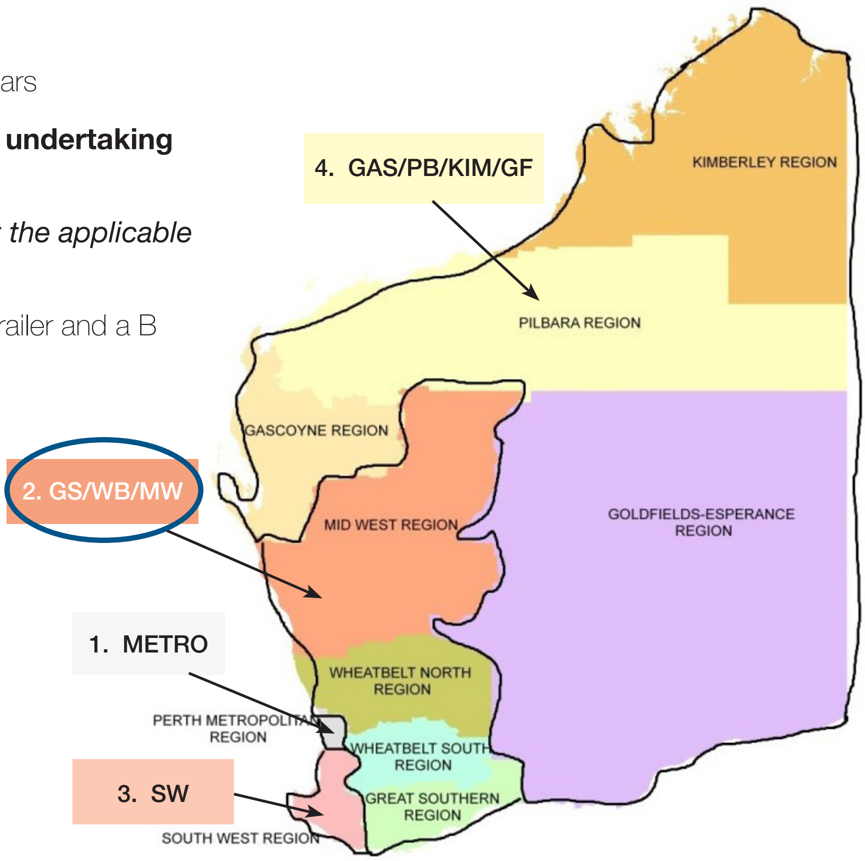
   From Table 1, the number of axles for a RAV 7(A) = 16

   Total AP per annum = 3449 x 16 = 55,184 one way

   Therefore two way AP = 110,368 AP per annum.

4. **Select the cost zone:**

   Go to Figure 2 and select cost zone 2 for the Mid West.



The Mid West falls in Cost Zone 2.

5. **Select the gravel compliance level:**

The gravel wearing course is described as "coarsely graded and susceptible to ravelling and corrugations but an acceptable performance can be maintained with regular grading".

From Table 2; the most appropriate gravel compliance level is "Border Line Below".

6. **Select the applicable marginal cost chart:**

Table 3 is used to select the marginal cost chart.

elect Cost Zone 2 and 100,000 AP (the closest value to the actual calculated AP of 110,368).

Select chart B4.

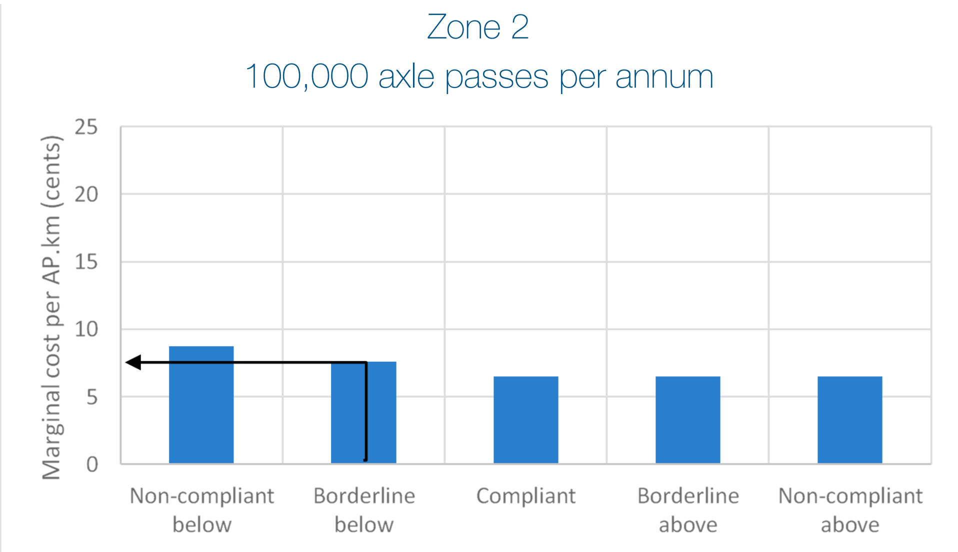
7. **Determine the marginal cost:**

With the appropriate marginal cost chart selected in Step 6, read off the marginal cost for the gravel compliance level of borderline below.

Table 3: List of marginal cost charts

Cost Zone	Additional AP/ per (two-way)	Chart
2	10,000	Figure B1
	20,000	Figure B2
	40,000	Figure B3
	100,000	Figure B4
	200,000	Figure B5
3	10,000	Figure B6
	20,000	Figure B7
	40,000	Figure B8
	100,000	Figure B9
	200,000	Figure B10
4	10,000	Figure B11
	20,000	Figure B12
	40,000	Figure B13
	100,000	Figure B14
	200,000	Figure B15

The applicable marginal cost chart is Figure B4.



Therefore, from the chart, the marginal cost is 7.5 cents per AP.km

8. **Adjust the marginal cost based on actual costs:**

The cost of resheeting is $45,500 per km

Adjusted Marginal Cost = Marginal Cost x Actual cost of resheeting / indicative cost (Table 4)

AMC = 7.5 X 45,500/43,747

AMC = 7.8 c

9. **Calculate the total annual cost attributable to the freight task:**

The annual cost can now be calculated from all of the above information.

MC = 7.8 c per AP.km

Route distance = 58 km

Total AP = 110,368

Total annual cost = 0.078 x 58 x 110,368 = $499,305

Note: This is the estimated cost for the first year of the operation. Increases in the annual charge related to escalation should be considered during discussions with the freight generator.

3.2 Worked Example #2

A logging company in the South West is proposing to use a Local Government gravel road to transport an estimated 35,000 tonnes per annum of timber to port for chipping. The gravel road is 18 km long and the gravel wearing course is reported as having a high plasticity and prone to becoming very slippery when wet. The company will be using a prime mover and semi-trailer loaded at the regulation mass limit.

Solution:

1. **Determine the annual freight tonnage, distance and duration of the task:**

   The annual freight tonnage is given as 35,000t

   The route distance is 18 km

   The duration of the task is 1 year

2. **Determine the vehicle type undertaking the task:**

   Go to Appendix A and select the applicable RAV Category.

   A prime mover towing a semi-trailer is a RAV 2 (B).

3. **Calculate the number of one-way trips and convert into axle passes and determine total AP for two-way trips per annum:**

   The annual tonnage is 35,000t

   From Table 1, the payload for a RAV 2(B) at RML = 24 tonnes

   The number of one-way trips = 35,000/24 = 1459 per annum

   From Table 1, the AP for a RAV 2(B) = 6

   Total AP per annum = 1459 x 6 = 8754 one way

   Therefore two way AP = 17,508 AP per annum.

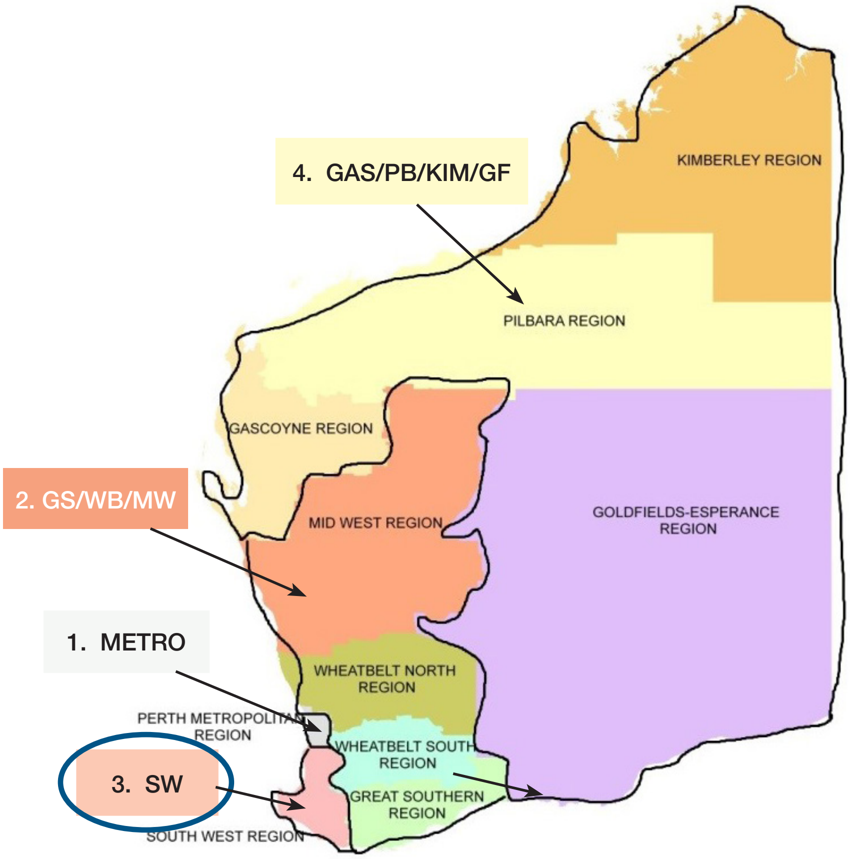
4. **Select the cost zone:**

   Go to Figure 2 and select cost zone 3.

5. **Select the gravel compliance level Select the road class:**

   The gravel wearing course is described as “having a high plasticity and prone to become very slippery when wet”

   From Table 2; the most appropriate gravel compliance level is “Non-compliant above.”



The South West falls in Cost Zone 3.

6. **Select the applicable marginal cost chart:**

   Table 2 is used to select the marginal cost chart.

   Select Cost Zone 3 and 20,000 AP (the closest value to the actual calculated AP of 17,508).

The applicable marginal cost chart is Figure B7.

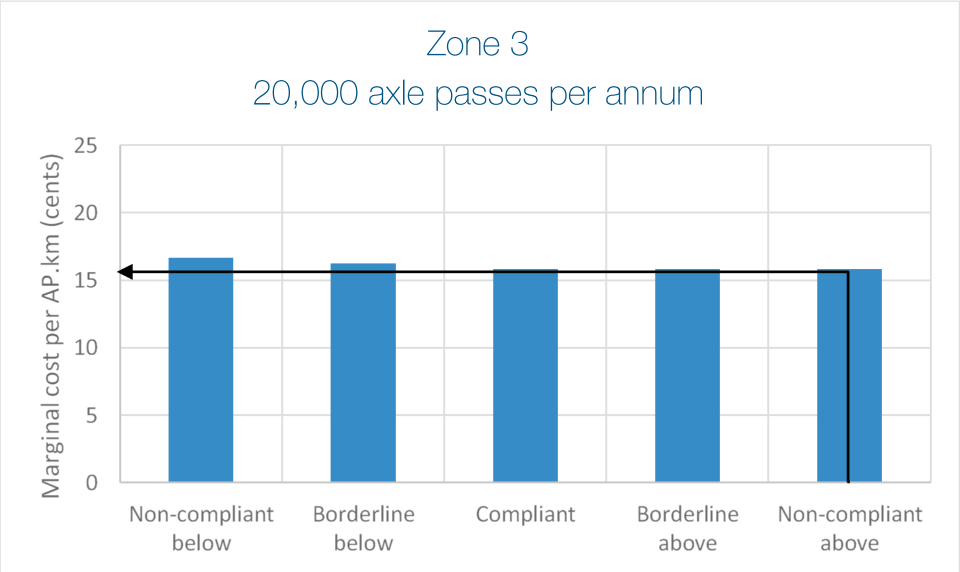
7. **Determine the marginal cost:**

   With the appropriate marginal cost chart selected in Step 6, read off the marginal cost for the gravel compliance level of "non-compliant above".

Table 3: List of marginal cost charts

Cost Zone	Additional AP/ per (two-way)	Chart
2	10,000	Figure B1
	20,000	Figure B2
	40,000	Figure B3
	100,000	Figure B4
	200,000	Figure B5
3	10,000	Figure B6
	20,000	Figure B7
	40,000	Figure B8
	100,000	Figure B9
	200,000	Figure B10
4	10,000	Figure B11
	20,000	Figure B12
	40,000	Figure B13
	100,000	Figure B14
	200,000	Figure B15

Therefore, from the chart, the marginal cost is 16 cents per AP.km



8. **Adjust the marginal cost based on actual costs:**

   If no information is available regarding the actual costs of resheeting then no adjustment is applied.

9. **Calculate the total annual cost attributable to the freight task:**

   The annual cost can now be calculated from all of the above information.

   MC = 16 c per AP.km

   Route distance = 18 km

   Total AP = 17,508

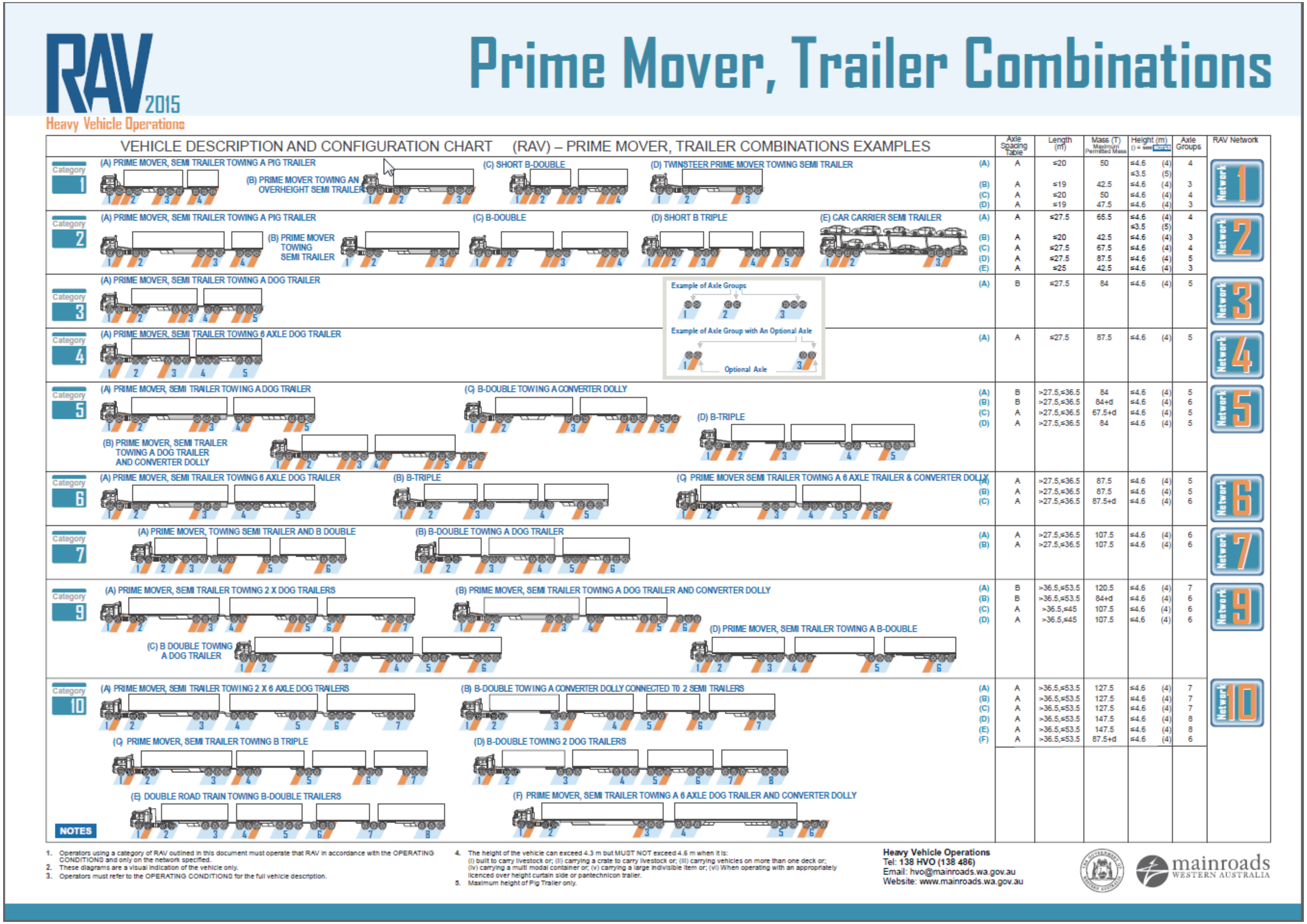
   Total annual cost = 0.16 x 18 x 17,508 = $50,423

   Note: This is the estimated cost for the first year of the operation. Increases in the annual charge related to escalation should be considered during discussions with the freight generator.

4 REFERENCES

ARRB Group 2019, Technical Basis for Estimating the Cost of Road Wear on Unsealed Local Government Roads in Western Australia, Project No PRA16029-2 for Western Australia Local Government Association, Perth, Western Australia. The document can be accessed electronically here.

Paige-Green, P 1987, 'The influence of geotechnical properties on the performance of gravel wearing course materials', PhD thesis, University of Pretoria, South Africa.



Prime Mover, Trailer Combinations

RAV 2015
Heavy Vehicle Operations

VEHICLE DESCRIPTION AND CONFIGURATION CHART (RAV) – PRIME MOVER, TRAILER COMBINATIONS EXAMPLES

Category	Vehicle	Axle Spacing Table	Length (m)	Mass (T) Maximum Permitted Mass	Height (m) () = see NOTES	Axle Groups	RAV Network
Category 1	(A) PRIME MOVER, SEMI TRAILER TOWING A PIG TRAILER	A	≤20	50	≤4.6 (4) ≤3.5 (5)	4	Network 1
	(B) PRIME MOVER TOWING AN OVERHEIGHT SEMI TRAILER	A	≤19	42.5	≤4.6 (4)	3	
	(C) SHORT B-DOUBLE	A	≤20	50	≤4.6 (4)	4	
	(D) TWINSTEER PRIME MOVER TOWING SEMI TRAILER	A	≤19	47.5	≤4.6 (4)	3	
Category 2	(A) PRIME MOVER, SEMI TRAILER TOWING A PIG TRAILER	A	≤27.5	65.5	≤4.6 (4) ≤3.5 (5)	4	Network 2
	(B) PRIME MOVER TOWING SEMI TRAILER	A	≤20	42.5	≤4.6 (4)	3	
	(C) B-DOUBLE	A	≤27.5	67.5	≤4.6 (4)	4	
	(D) SHORT B TRIPLE	A	≤27.5	87.5	≤4.6 (4)	5	
	(E) CAR CARRIER SEMI TRAILER	A	≤25	42.5	≤4.6 (4)	3	
Category 3	(A) PRIME MOVER, SEMI TRAILER TOWING A DOG TRAILER	B	≤27.5	84	≤4.6 (4)	5	Network 3
Category 4	(A) PRIME MOVER, SEMI TRAILER TOWING 6 AXLE DOG TRAILER	A	≤27.5	87.5	≤4.6 (4)	5	Network 4
Category 5	(A) PRIME MOVER, SEMI TRAILER TOWING A DOG TRAILER	B	>27.5,≤36.5	84	≤4.6 (4)	5	Network 5
	(B) PRIME MOVER, SEMI TRAILER TOWING A DOG TRAILER AND CONVERTER DOLLY	B	>27.5,≤36.5	84+d	≤4.6 (4)	6	
	(C) B-DOUBLE TOWING A CONVERTER DOLLY	A	>27.5,≤36.5	67.5+d	≤4.6 (4)	5	
	(D) B-TRIPLE	A	>27.5,≤36.5	84	≤4.6 (4)	5	
Category 6	(A) PRIME MOVER, SEMI TRAILER TOWING 6 AXLE DOG TRAILER	A	>27.5,≤36.5	87.5	≤4.6 (4)	5	Network 6
	(B) B-TRIPLE	A	>27.5,≤36.5	87.5	≤4.6 (4)	5	
	(C) PRIME MOVER SEMI TRAILER TOWING A 6 AXLE TRAILER & CONVERTER DOLLY	A	>27.5,≤36.5	87.5+d	≤4.6 (4)	6	
Category 7	(A) PRIME MOVER, TOWING SEMI TRAILER AND B DOUBLE	A	>27.5,≤36.5	107.5	≤4.6 (4)	6	Network 7
	(B) B-DOUBLE TOWING A DOG TRAILER	A	>27.5,≤36.5	107.5	≤4.6 (4)	6	
Category 9	(A) PRIME MOVER, SEMI TRAILER TOWING 2 X DOG TRAILERS	B	>36.5,≤53.5	120.5	≤4.6 (4)	7	Network 9
	(B) PRIME MOVER, SEMI TRAILER TOWING A DOG TRAILER AND CONVERTER DOLLY	B	>36.5,≤53.5	84+d	≤4.6 (4)	6	
	(C) B DOUBLE TOWING A DOG TRAILER	A	>36.5,≤45	107.5	≤4.6 (4)	6	
	(D) PRIME MOVER, SEMI TRAILER TOWING A B-DOUBLE	A	>36.5,≤45	107.5	≤4.6 (4)	6	
Category 10	(A) PRIME MOVER, SEMI TRAILER TOWING 2 X 6 AXLE DOG TRAILERS	A	>36.5,≤53.5	127.5	≤4.6 (4)	7	Network 10
	(B) B-DOUBLE TOWING A CONVERTER DOLLY CONNECTED TO 2 SEMI TRAILERS	A	>36.5,≤53.5	127.5	≤4.6 (4)	7	
	(C) PRIME MOVER, SEMI TRAILER TOWING B TRIPLE	A	>36.5,≤53.5	127.5	≤4.6 (4)	7	
	(D) B-DOUBLE TOWING 2 DOG TRAILERS	A	>36.5,≤53.5	147.5	≤4.6 (4)	8	
	(E) DOUBLE ROAD TRAIN TOWING B-DOUBLE TRAILERS	A	>36.5,≤53.5	147.5	≤4.6 (4)	8	
	(F) PRIME MOVER, SEMI TRAILER TOWING A 6 AXLE DOG TRAILER AND CONVERTER DOLLY	A	>36.5,≤53.5	87.5+d	≤4.6 (4)	6	

Example of Axle Groups
Example of Axle Group with An Optional Axle
Optional Axle

NOTES

1. Operators using a category of RAV outlined in this document must operate that RAV in accordance with the OPERATING CONDITIONS and only on the network specified.
2. These diagrams are a visual indication of the vehicle only.
3. Operators must refer to the OPERATING CONDITIONS for the full vehicle description.
4. The height of the vehicle can exceed 4.3 m but MUST NOT exceed 4.6 m when it is: (i) built to carry livestock or; (ii) carrying a crate to carry livestock or; (iii) carrying vehicles on more than one deck or; (iv) carrying a multi modal container or; (v) carrying a large indivisible item or; (vi) When operating with an appropriately licenced over height curtain side or pantechnicon trailer.
5. Maximum height of Pig Trailer only.

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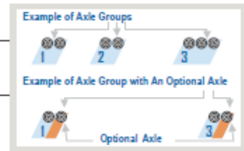
Truck, Trailer Combinations

RAV 2015 Heavy Vehicle Operations

VEHICLE DESCRIPTION AND CONFIGURATION CHART (RAV) – TRUCK, TRAILER COMBINATIONS EXAMPLES

Category	Description		Axle Spacing Table	Length (m)	Mass (T) Maximum Permitted Mass	Height (m) () = see NOTES	Axle Groups	RAV Network
Category 1	(A) TRUCK LIVESTOCK OR VEHICLE CARRIER	(A)	A	<12.5	27.5	≤4.6 (4)	2	Network 1
	(B) TRUCK TOWING A PIG TRAILER	(B)	B	≤20	45.5	≤4.6 (4)	3	
	(C) TRUCK TOWING A DOG TRAILER	(C)	B	≤20	50	≤4.6 (4)	4	
	(D) TRUCK TOWING A CAR CARRIER TRAILER	(D)	A	≤20	42.5	≤4.6 (4)	3	
Category 2	(A) TRUCK TOWING A 6 AXLE DOG TRAILER	(A)	A	≤25	67.5	≤4.6 (4)	4	Network 2
	(B) TRUCK TOWING A CAR CARRIER TRAILER	(B)	A	≤25	42.5	≤4.6 (4)	3	
	(C) TRUCK TOWING A 2,3,4 OR 5 AXLE DOG TRAILER	(C)	B	≤25	64.0	≤4.6 (4)	4	
Category 7	(A) TRUCK TOWING 2 X 5 OR 6 AXLE DOG TRAILERS	(A)	A	>27.5,≤36.5	107.5	≤4.3	6	Network 7
Category 8	(A) TRUCK TOWING 2 DOG TRAILERS	(A)	A	>27.5,≤36.5	107.5	≤4.3	6	Network 8



NOTES

1. Operators using a category of RAV outlined in this document must operate that RAV in accordance with the OPERATING CONDITIONS and only on the network specified.
2. These diagrams are a visual indication of the vehicle only.
3. Operators must refer to the OPERATING CONDITIONS for the full vehicle description.
4. The height of the vehicle can exceed 4.3 m but MUST NOT exceed 4.6 m when it is: (i) built to carry livestock or; (ii) carrying a crate to carry livestock or; (iii) carrying vehicles on more than one deck or; (iv) carrying a multi modal container or; (v) carrying a large indivisible item or; (vi) When operating with an appropriately licenced over height curtain side or pantechnicon trailer.
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APPENDIX B – MARGINAL COST CHARTS

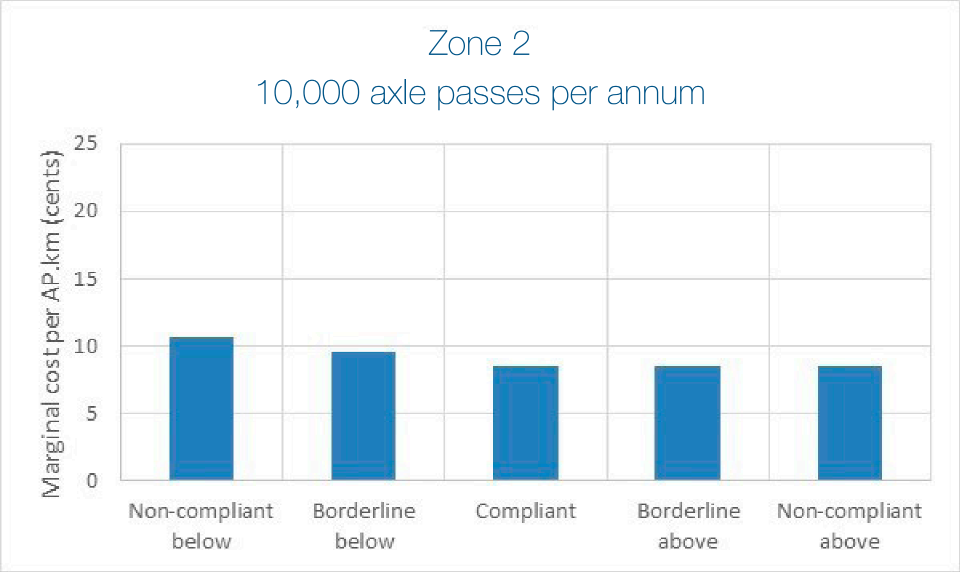

Figure B1: Marginal cost per additional axle pass (cents per km) for Zone 2 and 10,000 AP per annum

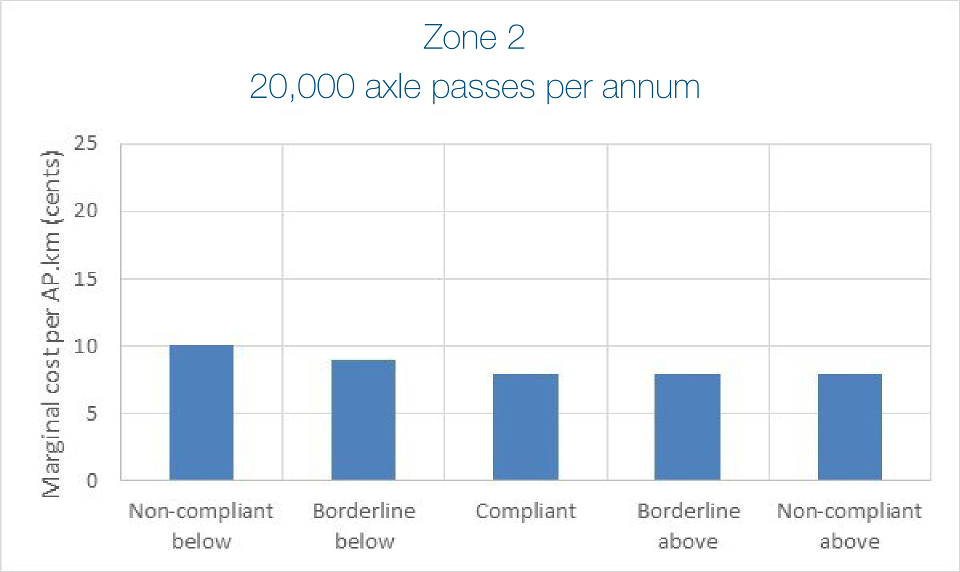

Figure B2: Marginal cost per additional axle pass (cents per km) for Zone 2 and 20,000 AP per annum

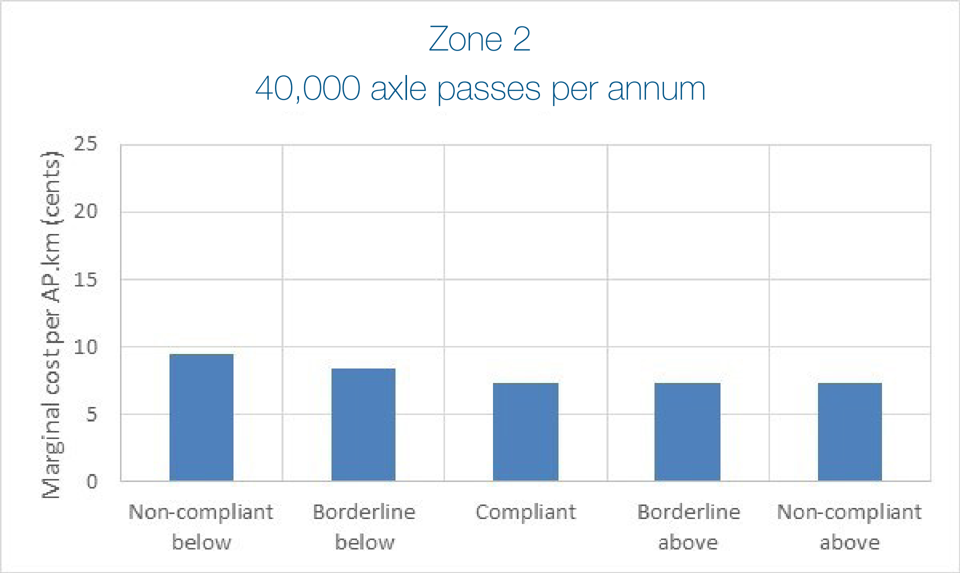

Figure B3: Marginal cost per additional axle pass (cents per km) for Zone 2 and 40,000 AP per annum

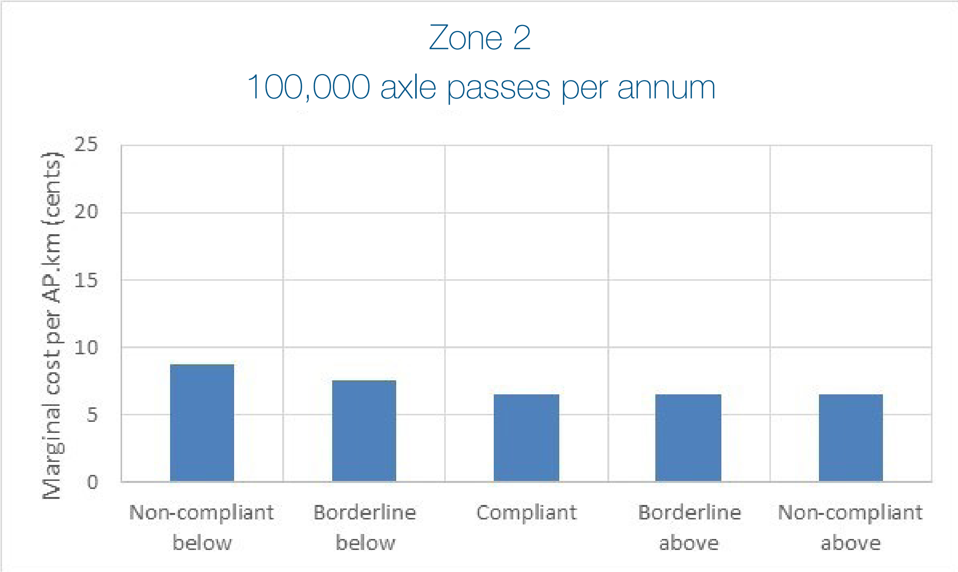

Figure B4: Marginal cost per additional axle pass (cents per km) for Zone 2 and 100,000 AP per annum

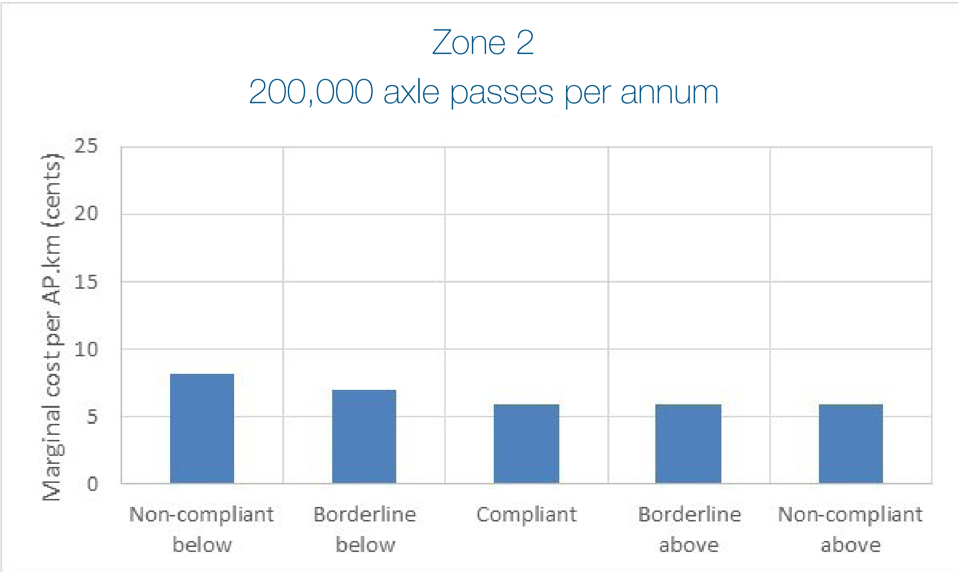

Figure B5: Marginal cost per additional axle pass (cents per km) for Zone 2 and 200,000 AP per annum

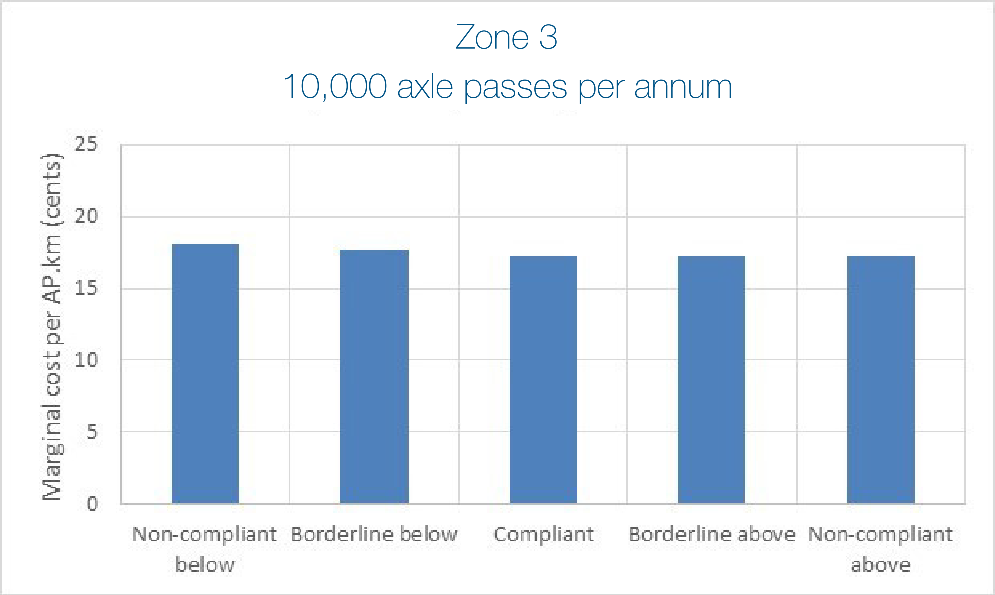

Figure B6: Marginal cost per additional axle pass (cents per km) for Zone 3 and 10,000 AP per annum

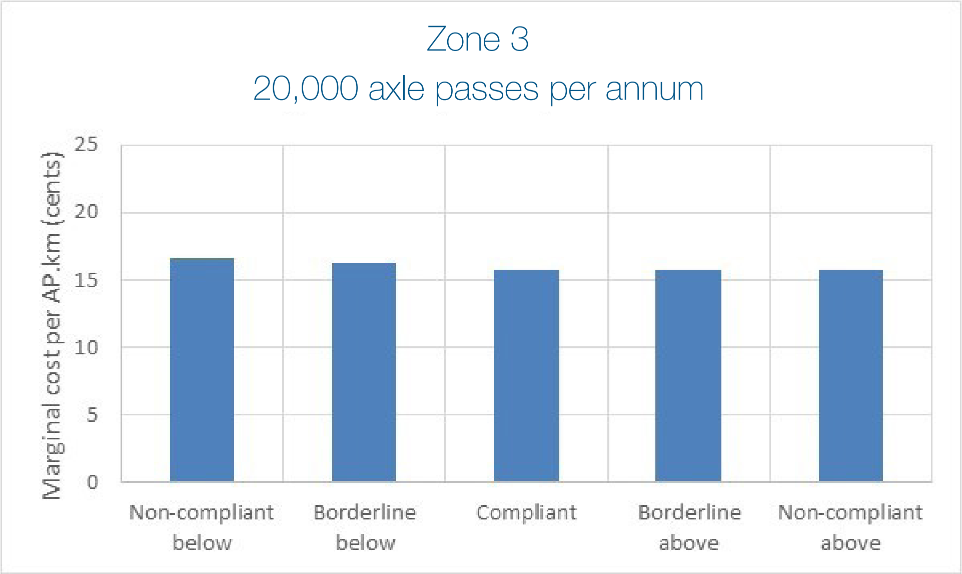

Figure B7: Marginal cost per additional axle pass (cents per km) for Zone 3 and 20,000 AP per annum

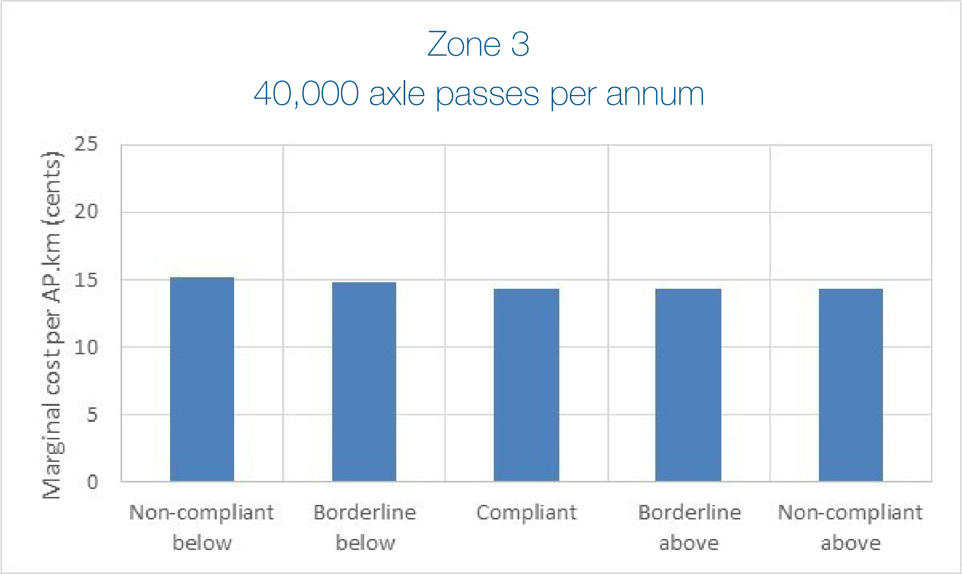

Figure B8: Marginal cost per additional axle pass (cents per km) for Zone 3 and 40,000 AP per annum

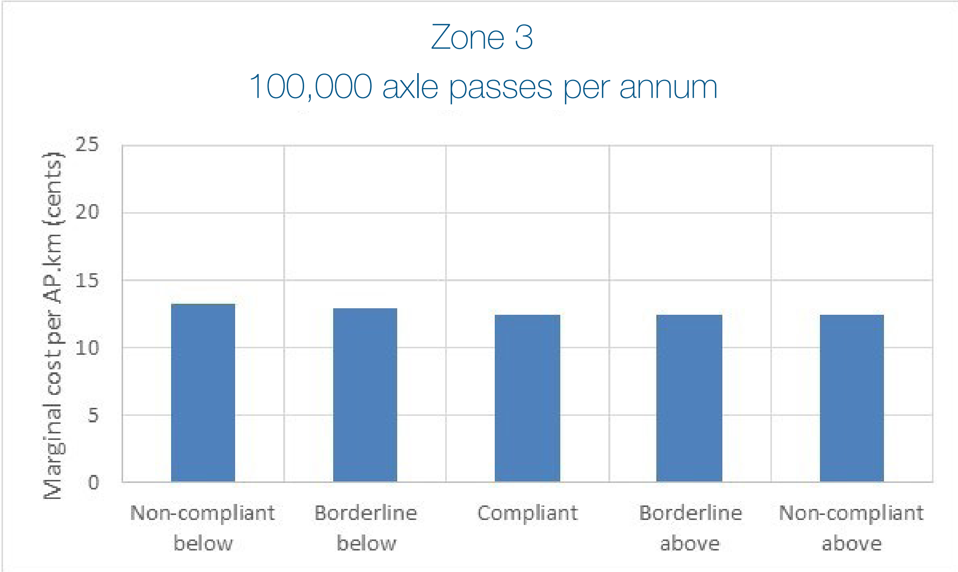

Figure B9: Marginal cost per additional axle pass (cents per km) for Zone 3 and 100,000 AP per annum

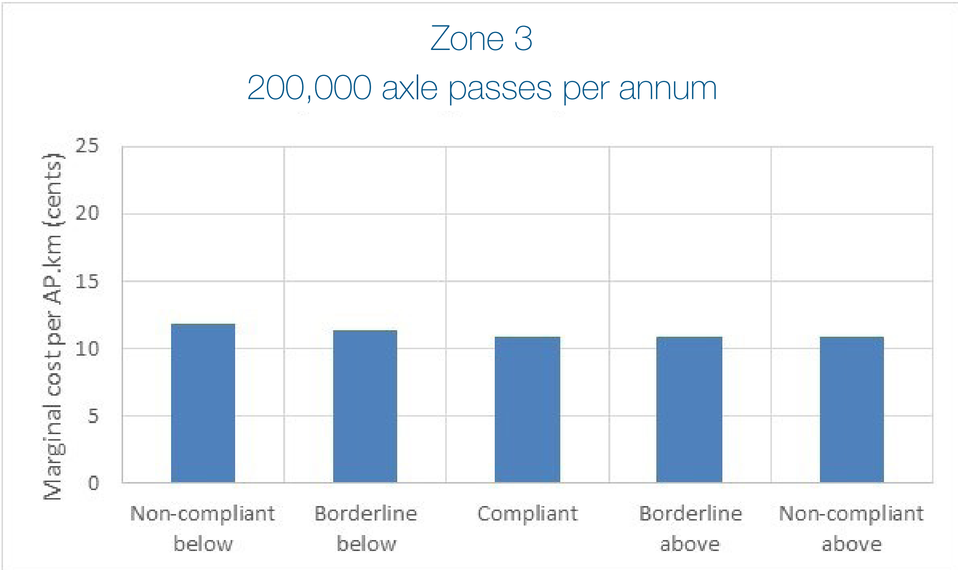

Figure B10: Marginal cost per additional axle pass (cents per km) for Zone 3 and 200,000 AP per annum

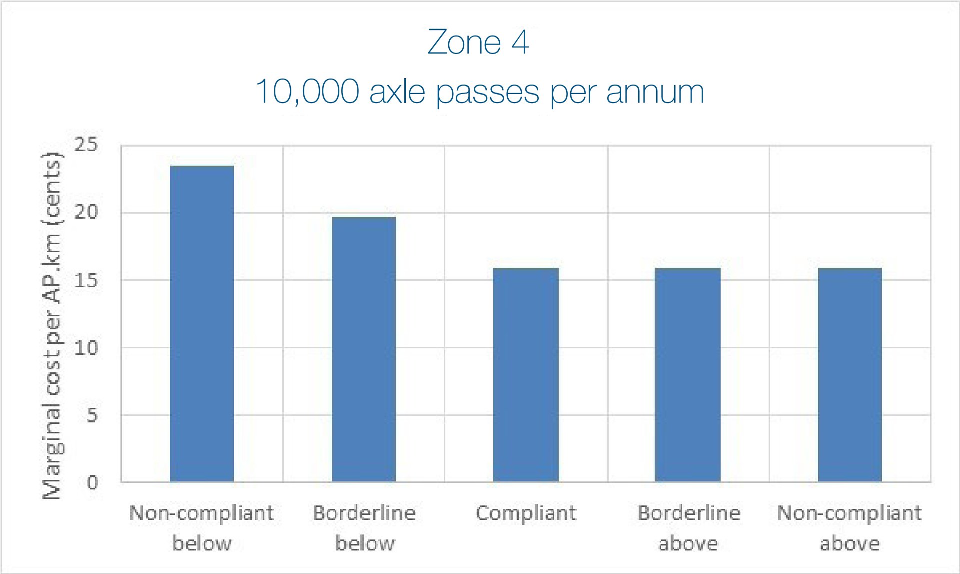

Figure B11: Marginal cost per additional axle pass (cents per km) for Zone 4 and 10,000 AP per annum

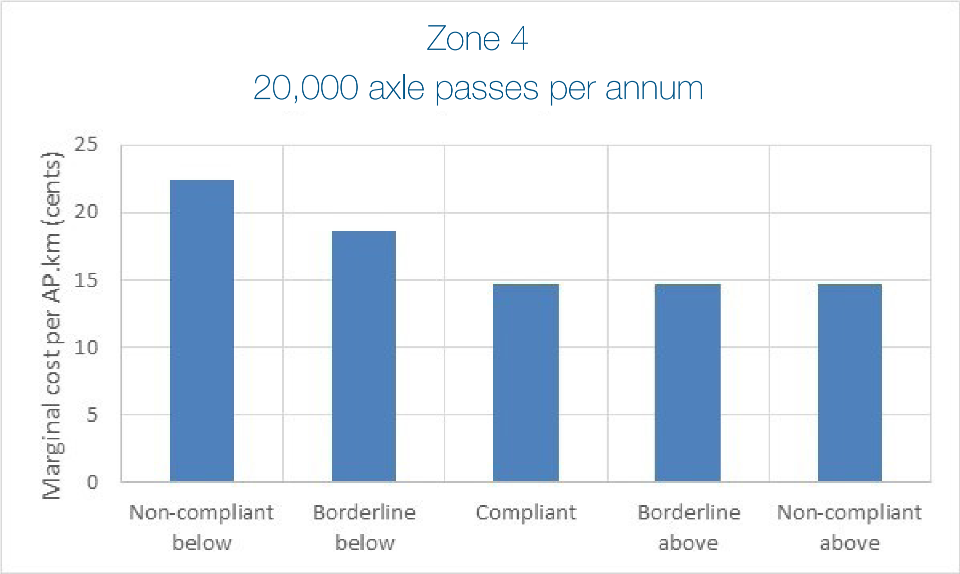

Figure B12: Marginal cost per additional axle pass (cents per km) for Zone 4 and 20,000 AP per annum

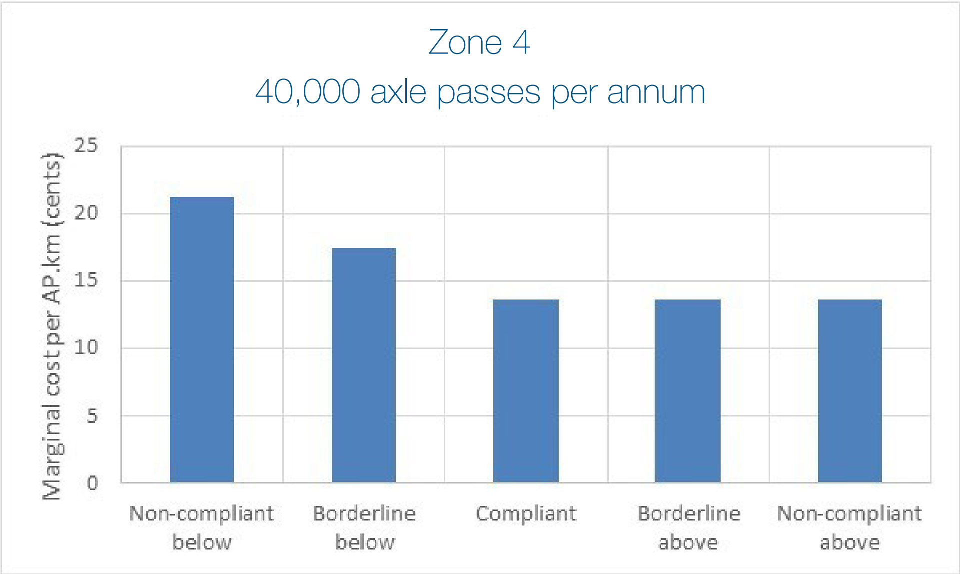

Figure B13: Marginal cost per additional axle pass (cents per km) for Zone 4 and 40,000 AP per annum

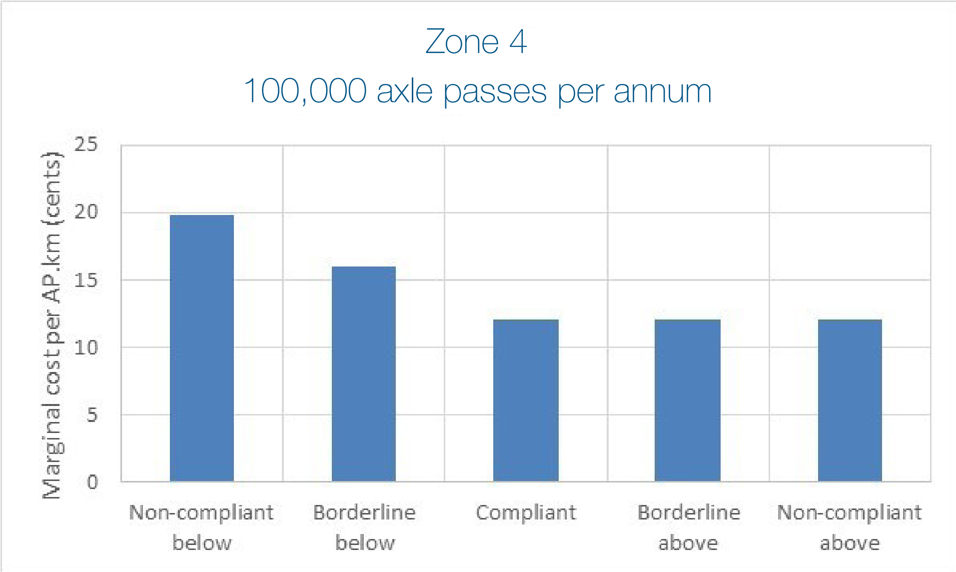

Figure B14: Marginal cost per additional axle pass (cents per km) for Zone 4 and 100,000 AP per annum

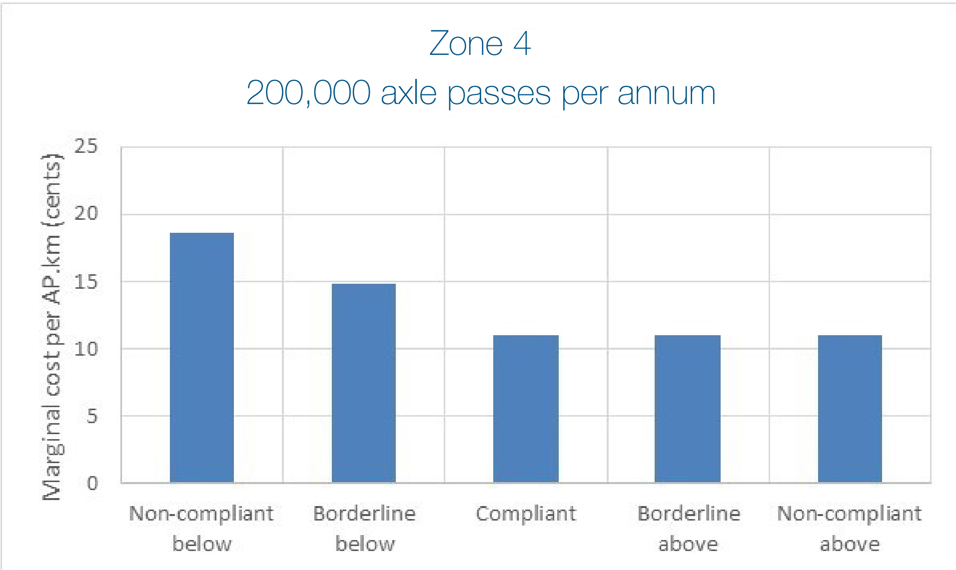

Figure B15: Marginal cost per additional axle pass (cents per km) for Zone 4 and 200,000 AP per annum

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