Harden Contributions Plan for Heavy Haulage Developments

Adopted by Council
Resolution No. 277/11/11 ï 16th November, 2011

Prepared by

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1. Introduction

1.1 Overview

Harden Shire Council (Council) from time to time receives applications for developments that involve the haulage of material using heavy vehicles. These developments can be located anywhere within the rural areas of the Shire.

Concentrated heavy vehicle movements generated by these developments are known to accelerate deterioration of road pavements that were designed to meet demands of rural rather than industrial development.

Councils are not generally able to impose additional fees, charges or rates to meet the extra costs associated with accelerated deterioration of roads caused by heavy vehicle movements from developments, except for development contributions imposed under the *Environmental Planning and Assessment Act 1979* (EP&A Act).

Council therefore, utilising the powers available to it under section 94 of the EP&A Act, will require contributions from developments that generate significant heavy vehicle movements to meet the additional cost burden of providing and maintaining the affected roads in the Shire.

This plan sets out:

- the relationship or nexus between the expected development in the area and the road infrastructure that is required to meet the demands of that development;
- the formulas to be used for determining the reasonable contributions required from expected development for the required infrastructure;
- the contribution rates applying to development affected by this plan;
- a map showing the location of the infrastructure proposed to be provided under this plan supported by a works schedule setting out an estimate of their cost; and
- the administrative and accounting arrangements applying to contributions that are required by this plan.

This plan has been prepared in accordance with the requirements of the EP&A Act and *Environmental Planning and Assessment Regulation 2000* (EP&A Regulation). In preparing the plan Council has had regard to practice notes issued by the NSW Department of Planning in accordance with clause 26(1) of the EP&A Regulation.

1.2 Works and contribution rates schedules

Works schedule

Council will collect monetary contributions from development and apply the contributions toward the roads that are affected by the particular development.

Potential roads that will be the subject of works partly or fully funded under this plan are sealed regional or rural roads that the Council has responsibility for. The locations of these roads are shown in Figure 1.

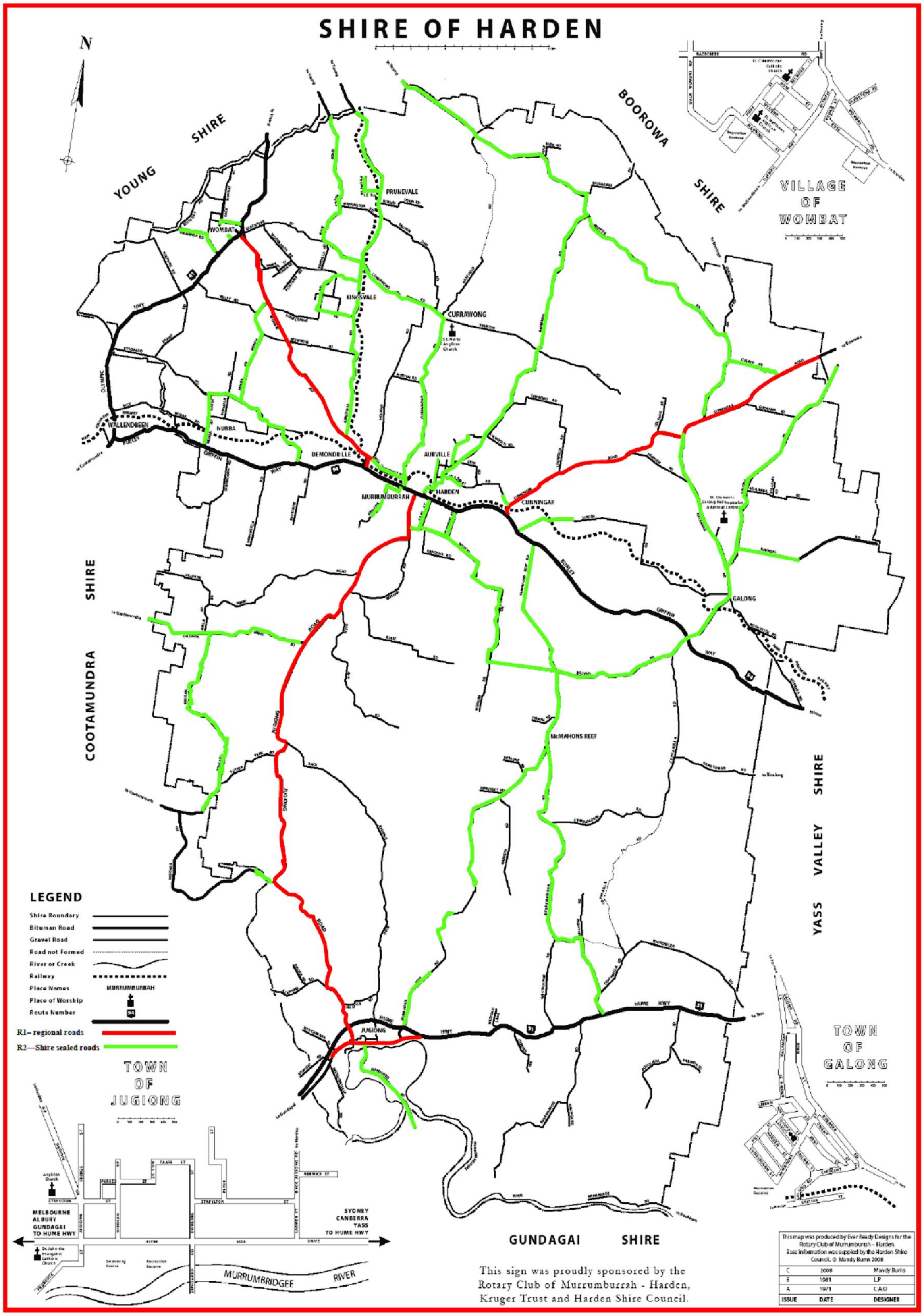


Figure 1 Regional and rural sealed roads

Development that is likely to occasion significant heavy vehicle movements may be approved in any location throughout the Shire.

As a result it is not possible for Council to specify in this plan which sections of the roads shown in Figure 1 will be upgraded or maintained using contributions collected under this plan. It is intended that works programs and application of funds collected under this plan to those works will be determined as part of Council's annual Management Plan process.

Contribution rates

Contribution rates for road infrastructure upgrading and maintenance are shown in the following table.

$0.20 per ESA per km of sealed regional road (or R1) travelled by laden heavy vehicles.

$0.32 per ESA per km of rural sealed road (or R2) travelled by laden heavy vehicles.

The total monetary contribution is the sum of the R1 and R2 contributions.

The monetary contribution is calculated on a quarterly basis using the results of a traffic classifier placed on the development's vehicular exit point(s).

1.3 Calculating a contribution under the plan

Contributions in this plan are levied on the basis of:

- the location of the development site;
- the anticipated cost of upgrading and maintaining sealed regional (R1) and rural (R2) roads;
- the periodic laden heavy vehicle movements generated by the development; and
- the length of sealed rural roads used by laden heavy vehicles generated by the development.

The formula for calculating a contribution under this plan is included in clause 3.4.1 of this plan.

Worked examples of calculating a contribution under this plan are included in clause 3.4.2 of this plan.

The contribution rates values used in the examples reflect the contribution rates at the time that the plan commenced. Rates are regularly adjusted for inflation in accordance with the provisions of clause 2.13 of this plan. Applicants should inquire at the Council for information on the latest contribution rates.

2. Administration and operation of this plan

2.1 Legal basis for development contributions

Development contributions are contributions made by those undertaking development approved under the EP&A Act toward the provision of public infrastructure.

A council can require, through imposition of a condition or conditions on a development consent, development contributions if:

- it has adopted a contributions plan justifying the contribution (such as this plan); and
- the contribution is imposed in accordance with the provisions of such a plan.

There are two kinds of development contributions for local infrastructure that may be required by a consent authority section 94 contributions and section 94A levies. However, only one or the other type may be imposed on any individual development consent.

This plan is only concerned with section 94 contributions.

The power to levy a section 94 contribution on development relies on there being a clear relationship (or ‘nexus’) between the development being levied and the need for the public amenity or service for which the levy is required.

Section 94 of the EP&A Act allows consent authorities to seek the following types of contributions from development:

- a reasonable development contribution for the provision, extension or augmentation of public services and public amenities within the area, and/or
- a reasonable monetary contribution towards recoupment of the cost of providing existing public services and public amenities within the area.

Section 3 of this plan describes how the development contributions to be required under this plan from heavy haulage development were arrived at.

2.2 Definitions

In this plan, the following words and phrases have the following meanings:

Council means Harden Shire Council.

EP&A Act means the Environmental Planning and Assessment Act 1979.

EPA Regulation means the Environmental Planning and Assessment Regulation 2000.

ESA means the Equivalent Standard Axles, which is a measure used to describe the life of a section of road.

LGA means local government area.

Planning Agreement means a voluntary planning agreement referred to in section 93F of the EP&A Act.

Works in kind means the undertaking of a work or provision of a facility by a person entitled to act on a development consent which is already nominated in the works schedule of a contributions plan.

2.3 Name of this plan

This contributions plan is called the Harden Contributions Plan for Heavy Haulage Development.

2.4 Purposes of this plan

The primary purpose of the plan is to authorise the Council, when granting consent to an application to carry out development to which this plan applies, to require a monetary contribution to be made towards:

- the provision, extension or augmentation of road infrastructure only where development is likely to require the provision of or increase the demand for that infrastructure; and
- the recoupment of the cost of providing, extending or augmenting road infrastructure within the area to which this plan applies.

Other purposes of the plan are:

- to provide the framework for the efficient and equitable determination, collection and management of development contributions toward the provision of infrastructure generated by heavy haulage development within the area;
- to determine the demand for public amenities and services generated by the heavy haulage development the area and ensure that development makes a reasonable contribution toward the provision of amenities and services that are required to meet that development;
- to ensure that the existing community is not unreasonably burdened by the provision of public infrastructure required as a result of heavy haulage development in the area; and
- to ensure Council's management of development contributions complies with relevant legislation and practice notes, and achieves best practice in plan format and management.

2.5 Commencement of this plan

This plan commences on the date on which public notice was published, pursuant to clause 31(4) of the EP&A Regulation.

2.6 Land to which this plan applies

This plan applies to all of the land situated within the Harden LGA.

2.7 Development to which this plan applies

For the purpose of this clause 'heavy haulage development' includes extractive industry, forestry, landscape and garden supplies, industry, mining, rural industry, timber and building supplies, and any other development that involves the movement of laden heavy vehicles.

Heavy haulage development that in the opinion of the consent authority generates a significant amount of laden heavy vehicle movements may be required to make a contribution under this plan.

2.7.1 Development exempted from contributions under this plan

Council may consider exempting types of development, or components of development, from a requirement to make a contribution under this plan:

In order for an exemption to be approved, any such development will first need to make a comprehensive submission arguing the case for exemption.

2.8 Relationship to other plans and policies

This plan repeals Harden Shire Council ï Section 94 Contributions Plan ï Road Works as a Result of Unpredictable Developments which Generates Additional Heavy Vehicle Traffic Movements.

Nothing in this Plan affects the operation and application of any other contributions plans that are in force and that apply to land in the Shire of Harden.

This plan complements existing environmental planning instruments and Councilôs various development control plans and policies applying to land in the Shire of Harden. However, developers and owners should check other relevant plans and policies for further information and development standards that may relate to their site.

2.9 Monetary contributions may be required as a condition of consent

This plan authorises the Council, when determining a development application relating to development to which this plan applies, to impose a condition under section 94 of the EP&A Act requiring the payment of a monetary contribution to Council towards the provision, extension or augmentation of public amenities and public services.

This plan also authorises the Council to require monetary contributions from development towards recouping the cost of the provision of existing public amenities and public services that have been provided by the Council for or to facilitate the carrying out of development and which the development will benefit from.

Monetary contributions that are required as conditions of consent will be applied to meet the cost of maintaining Shire roads to a satisfactory standard.

2.10 Roadworks may be required to be undertaken in addition to contributions required under this plan

The Harden Shire road network has been constructed and is maintained by Council as necessary to ensure an acceptable standard of service. It is possible that these roads may or may not be able to accommodate additional heavy vehicle loading generated by heavy haulage development at their current standard. New roads, or upgrades to sections of the existing road network may be required to accommodate the additional heavy vehicle loading. Unformed, natural material roads may also be required to be sealed in order to accommodate the extra heavy vehicles.

Where a development requires capital works to the road network to be undertaken, the requirement will be by way of a condition imposed on the development consent under section 80A(1)(f) of the EP&A Act.

Such development will also be subject to a condition requiring payment of road maintenance contributions under this plan both for the section(s) of new or upgrade road, and for the other sections of the road network to be used for haulage purposes.

2.11 Planning Agreements

Nothing in this plan prevents the Council and a developer from entering into a Planning Agreement that either/both:

- requires the developer to make monetary contributions, undertake works or provide material public benefits for road infrastructure identified in this plan; and
- excludes the operation of section 94 of the EP&A Act to the development.

Such an agreement may address, for example, a situation where the vehicle loadings in a proposed heavy haulage development can be more accurately measured by audited weighbridge receipts instead of the traffic classifier method included in this plan.

2.12 Other contributions to be taken into account

The purpose of this clause is to describe Council's policy in implementing section 94(6) of the EP&A Act.

Council, in proposing to impose a requirement for a contribution under this plan, will take into consideration any land, money or other material public benefit that the applicant has elsewhere dedicated or provided free of cost within the area (or any adjoining area) or previously paid to the consent authority, other than:

- a benefit provided as a condition of the grant of development consent under the EP&A Act, or
- a benefit excluded from consideration by a planning agreement.

In order for Council to consider the previous benefits made by the applicant, details must be submitted at the time of the development application.

A reduction in the contribution requirement under this plan may be considered where it can be demonstrated by the applicant that:

- the land, money or other material public benefit previously provided continues to provide an ongoing benefit to the community;
- the benefit was not required to provided under a condition of consent or under a planning agreement entered into with Council;
- the benefit offsets some of the need for local infrastructure identified in this plan;
- the financial implications for cash flow and the continued implementation of the works schedule included in this plan (including whether the council would need to make up for any shortfall in contributions by its agreement to reduce the contribution).

2.13 Adjustment of contribution rates under this plan

The purpose of this clause is to ensure that the monetary contribution rates at the plan adoption date are adjusted to reflect the indexed cost of the provision of infrastructure included in this plan.

Council may, without the necessity of preparing a new or amending contributions plan, make changes to the monetary contribution rates set out in this plan to reflect quarterly changes to the Consumer Price Index (All Groups Index) for Sydney issued by the Australian Statistician.

The contribution rate will be indexed as follows:

$$\frac{\$C_A \times \text{Current CPI}}{\text{Base CPI}}$$

Where:

$\$C_A$ is the contribution rate for at the time of adoption of the plan expressed in dollars

Current CPI is the *Consumer Price Index (All Groups Index) for Sydney* as published by the Australian Statistician at the time of the review of the contribution rate

Base CPI is the *Consumer Price Index (All Groups Index) for Sydney* as published by the Australian Statistician at the date of adoption of this plan

Note: The contribution rate will not be less than the contribution rate specified at the date of the adoption of this plan.

2.14 Adjustment of contributions required by a condition imposed under this plan

The purpose of this clause is to ensure that the monetary contributions imposed on developments at the time of consent are adjusted at the time of payment to reflect the indexed cost of the provision of infrastructure included in this plan.

A monetary contribution required by a condition of development consent imposed in accordance with this plan will be indexed between the date of the grant of the consent and the date on which the contribution is paid in accordance with the *Consumer Price Index (All Groups Index) for Sydney* as provided by the Australian Bureau of Statistics.

2.15 Timing of payment of monetary contributions required under this plan

Monetary contributions will be paid within 28 days of the developer's receipt of a quarterly notice from the Council stating the contribution amount pursuant to the previous quarter's heavy haulage vehicle activity.

2.16 Policy on deferred payments

Council generally does not accept deferred payment of contributions required under this plan.

However, Council may consider and approve a written request from an applicant that seeks to defer the maintenance contributions applicable to any section of R2 road constructed by the developer. In any case that Council approves such a request:

- the maximum deferral period is five (5) years from the date the relevant section of road becomes operational;
- Council will adjust the contribution rate imposed on the consent to reflect the revenue from contributions forgone due to Council granting the deferral request;

2.17 Material public benefits and dedication of land offered in part or full satisfaction of contributions

A person may make an offer to the Council to carry out works or provide another kind of material public benefit or dedicate land, in lieu of making a contribution in accordance with a condition imposed under this plan.

Any offer shall be made in writing to the Council.

If the offer is made prior to the issue of a development consent then the offer must be made by way of a planning agreement, and the Council will consider the request as part of its assessment of the development application.

Council will generally only consider offers of land or material public benefits where those offers relate to improvements to the Shire's road network. This is because the monetary contributions under this plan that may be forgone as a result of an approved offer relate to the provision of roads and traffic management facilities. It is therefore reasonable that Council should only consider alternatives to the payment of the monetary contributions that result in similar facilities being provided directly by the developer.

The Council will take into account the following matters in deciding whether to accept an offer of material public benefit:

- the overall benefit of the proposal; and
- the financial implications for cash flow and the continued implementation of Council's road maintenance program (including whether the council would need to make up for any shortfall in contributions by its acceptance of the offer).

If Council approves the offer then it will require the applicant to enter into a written agreement for the provision of the works in a suitable time period. If the offer is made by way of a draft planning agreement under the EP&A Act, the council will require the agreement to be entered into and performed via a condition in the development consent.

The value of any land or material public benefit offered by the applicant may, at Council's discretion, be used to offset monetary contributions applicable to the development under this plan. The value of any land or material public benefit will be determined by a process agreed to between the Council and the applicant.

2.18 Policy on timing of provision of infrastructure identified in this plan

This plan addresses the provision, upgrading and maintenance of the Shire's road network that is required as a result of development that incorporates concentrated heavy vehicle usage of that network.

These developments can be located anywhere within the rural areas of the Shire. Similarly, Council is responsible for the provision and maintenance of the vast majority of roads existing in the Shire.

Council will therefore expend contributions collected, and deliver roads infrastructure, under this plan in a manner that fairly takes account of:

- the location of the contributing developments;
- the likely impact of heavy haulage movements from those developments on specific sections of the Shire road network; and
- the requirement to provide the public amenities and services within a reasonable time.

Council will therefore plan the expenditure of funds collected under this plan on an annual basis in response to these factors.

The planned expenditure program will be published in Council's draft Management Plan, which will allow for public input into proposed spending priorities.

2.19 Pooling of funds

To provide a strategy for the orderly delivery of the infrastructure, this plan authorises monetary local infrastructure contributions paid under this or any other contributions plan approved by the Council to be pooled and applied progressively for those purposes.

The priorities for the expenditure of pooled monetary contributions under this plan are the priorities for works as set out in Council's annual Management Plan.

2.20 Accountability and access to information

Council is required to comply with a range of financial accountability and public access to information requirements in relation to development contributions. These are addressed in Divisions 5 and 6 of Part 4 of the EP&A Regulation and include:

- maintenance of, and public access to, a contributions register;
- maintenance of, and public access to, accounting records for contributions receipts and expenditure;
- annual financial reporting of contributions; and
- public access to contributions plans and supporting documents.

These records are available for inspection free of charge at the Council's administration office.

2.21 Review of contributions plan

Council will undertake review of this plan every 5 years from the date of commencement to ensure that:

- the plan remains financially sustainable;
- the plan continues to address the infrastructure needs generated by new development;
- the infrastructure will be delivered in a reasonable time; and
- and that contribution rates remain reasonable over time.

Review, amendment and updating of the plan (except for the types of amendments specified in clause 32(3) of the EP&A Regulation) will require preparation and public exhibition of a new contributions plan.

2.22 Savings and transitional arrangements

A development application which has been submitted prior to the adoption of this plan but not determined shall be determined in accordance with the provisions of the plan which applied at the date of determination of the application.

3. Relationship between expected development and demand for infrastructure

3.1 Basis for imposing contribution requirements on heavy haulage developments

The Shire of Harden from time to time receives applications for developments that involve the haulage of supplies using heavy vehicles. These developments can be located anywhere within the rural areas of the Shire.

Concentrated heavy vehicle movements generated by these developments are known to accelerate deterioration of road pavements that were designed to meet demands of rural rather than industrial development.

Councils are not generally able to impose additional fees, charges or rates to meet the extra costs associated with accelerated deterioration of roads caused by heavy vehicle movements from developments, except for development contributions imposed under the EP&A Act.

Council therefore will require contributions from developments that generate significant heavy vehicle movements to meet the additional cost burden of providing and maintaining the affected roads in the Shire.

3.2 Public amenities and services that will be required as a result of the expected development

The existing Shire road network has been generally designed to accommodate the needs generated by rural uses. Harden Shire Council maintains four types of rural road. The road types are detailed in Table 3.1.

Table 3.1 Harden Shire Road Types

Road type category	Traffic volume (AADT)	Existing road surface
A (or R1)	> 500	Sealed 7.5m wide, 8m formation
B (or R2)	100 – 500	Sealed 6.5m wide, 7 – 9m formation
C	40 – 100	Gravel / natural material 4 – 7m wide
D	1 - 40	Shaped natural material 4m wide

AADT = Average Annual Daily Traffic

Type óAôroads are otherwise known as regional roads. Type óBôroads are otherwise known as rural sealed roads. Types óCôand óDôare rural unsealed road types.

For the purposes of this plan:

- Regional roads in Harden Shire will be identified as R1.
- Sealed rural roads in Harden Shire will be identified as R2.

The existing sealed road network is shown in Figure 1.

Harden Shire may accommodate development in the future that will result in accelerated deterioration of the Shire road network. It is generally accepted that road surface deterioration is caused by heavy vehicles. This is further discussed in clauses below.

Consequently, higher numbers of heavy vehicles on roads means Council will need to find additional funds to meet the extra demands placed on the Shire's roads. These funds will be required to maintain the Shire's roads to an acceptable sealed rural standard.

Future development of the area for the purposes of heavy haulage development can only be sustained by investment in the provision, extension and augmentation of road infrastructure. Council considers it appropriate that any new heavy haulage development make a reasonable contribution toward this infrastructure.

3.3 The impact of expected development on road infrastructure

3.3.1 Heavy vehicle use occasions greater road maintenance expenditure

As stated above, Council has a responsibility to maintain the Shire's road infrastructure to an acceptable standard. The standard is such to ensure the roads:

- are kept to an appropriate level of safety for the road user; and
- remain trafficable for the duration of their design life.

The Austroads publication *Pavement Design: A Guide to the Structural Design of Road Pavements* (1992) documents that the performance of road pavements is "influenced significantly by the heavy end of the traffic spectrum". This means that generally, there is no requirement to account for cars or light commercial traffic as far as pavement loadings is concerned. The only effect light vehicles have on the road is in terms of capacity. The performance and subsequent failure of pavements is determinate on heavy vehicle axle passes, the axle loading and the configuration of these axles.

Consequently, any additional heavy vehicle loadings on a public road that may occur due to heavy haulage development will accelerate the deterioration of that road's pavement. The consequence of this additional heavy traffic is that in order for the roads authority (i.e. Council) to maintain the road pavement at its existing level of service, additional maintenance spending will be required due to the extra heavy traffic causing damage sooner.

This contributions plan is premised on the principle that it is reasonable to expect that additional heavy vehicle users of the road infrastructure should contribute their share of the additional upkeep.

A review of contribution plans from other NSW councils confirmed that there are various methodologies used to derive a reasonable monetary contribution from heavy haulage development towards road maintenance costs. The most common methods found are for the purposes of extractive industries and,derive a contribution that is based on the amount of material hauled per kilometre of haul route. This method works well for uses where the heavy vehicles have access to a weighbridge. A method based on heavy vehicle movements is used in this plan. This is to enable Council to capture objective data on vehicles that may not require or have access to weighbridges.

3.3.2 Design life of a standard road

In pavement design, the damage caused by different axle groups is dependent on the axle spacing, the number of tyres / wheels per axle, the load on the group and the suspension of the vehicle (Austroads 1997). Generally, for design purposes axle groups are broken into 4 types namely:

- single axle with single wheels;
- single axle with dual wheels;
- tandem axels both with dual wheels; and
- tri-axels all with dual wheels.
- For simplicity, the damage to the pavement associated with any particular axle load has been expressed as a standard axle. The standard axle is a single axle with dual wheels that carries a load of 8.2 tonnes. Loads that cause similar damage to a pavement as a standard axle are shown in Table 3.2.

Table 3.2 Axle Load Configurations

Axle Configuration	Load (Kilo Newton)
Single axle, single tyre	53
Single axle, dual tyre	80
Tandem axle, dual tyre	135
Tri-axle, dual tyre	181

▪

For the purposes of design, all vehicle class configurations are converted to equivalent standard axles (ESA). The design life of a road pavement can also be expressed in ESA.

Appendix E of the Austroads Pavement Design Guide provides a methodology for the adoption of ESAs for axle group types in accordance with NSW conditions and road functional classes (A copy of the relevant sections of Austroads is provided in the Attachments to this plan).

For the purposes of this plan, Harden Shire will assume a functional class 3 road that is defined as:

õA road whose main function is to form an avenue of communication for movements:

- between important centres and the Class 1 and Class 2 roads and /or key towns; or
- between important centres; or
- of an arterial nature within a town in a rural area.ö

Council uses the Austroads vehicle classification system to identify heavy vehicle traffic numbers from traffic counters. A copy of the vehicle classification system information used in this plan is in provided in the Attachments to this plan. From this classification system, ESAs for each vehicle class can be calculated using Table E4 in Appendix E of Austroads Design Guide. The resulting total vehicle ESA for each class is provided in Table 3.3.

Table 3.3 Total Vehicle ESA per Vehicle Class

Vehicle class	Vehicle type (Austroads classification)	ESA per vehicle
1	Car	0
2	Light vehicle with towing/ commercial van	0
3	Two axle truck	1.2
4	Three axle truck	1.6
5	Four axle truck	2.2
6	Three axle articulated truck	1.8
7	Four axle articulated truck	2.2
8	Five axle articulated truck	2.8
9	Six axle articulated truck	2.8 (average)
10	Seven + axle articulated truck	3.4

For clarity, the above vehicles are assumed to be loaded. If higher order vehicle classes are used by the developer, those vehicles will be assumed to be class 10.

Using the information in Table 3.3 it can be seen that a loaded class 10 vehicle has almost three times the impact of a class 3 vehicle on a road pavement.

As mentioned above, the conversions in Table 3.3 are for the purposes of road design. Austroads Pavement Design Guide provides methodologies for both rigid and flexible pavements. Harden Shire sealed roads are primarily flexible pavements with a sub-base, base and wearing surface of asphalt or bitumen. The wearing surface is generally due for replacement every 12 years at current traffic use.

Austroads (Figure 7.2 in Section 7) contains a design conversion figure that allows pavement design life to be expressed in accordance with design traffic. Thus a standard 20 year pavement can be expressed as ESAs. This means that the life of a pavement can be expressed as the total number of equivalent axles that should pass over it prior to replacement.

The standard 20 year life for the two road types in Harden expressed as ESA are:

R1 roads approximately 2,000,000 ESA

R2 roads approximately 1,000,000 ESA

It is considered that all laden heavy vehicles on Harden roads contribute to the deterioration of the road pavement. It is also understood from the above design methodology that a road pavement has a finite life in terms of ESA. Due to the geographical location of Harden Shire, there are limited heavy vehicles on the road at present. Growth of heavy vehicle use on the local roads is limited to growth in the transportation of goods and haulage. Significant increases of heavy vehicles on Shire roads would only likely result from new or expanded heavy haulage development within or adjacent to the Harden LGA.

Consequently, it is considered reasonable to expect heavy haulage development make a contribution per additional loaded vehicle on Shire roads.

3.3.3 Costs of maintaining rural sealed roads over the design life

Council maintains a rural sealed road network and three regional roads. The rural sealed road network is approximately 320 km. The extent of regional roads is approximately 80km.

All local roads are funded by Council. Council may receive Commonwealth Government funding from time to time for upkeep of the road network, while the regional roads are eligible for grant funds from the Roads and Traffic Authority of NSW.

From 2006 to 2010 inclusive the approximate maintenance expenditure on the rural sealed road network (that is, R2 roads) was $15,000 per kilometre. This means that on average the Council spend is $3,000 per kilometre per year. Council acknowledges that this figure is the bare minimum and the amount that should be spent on maintaining the regional road to a serviceable standard is closer to $5,000 per kilometre per annum.

Over the same period the amount spent to maintain the regional road network (that is, R1 roads) has been in the order of $40,000 per kilometre of road. On average this is $8,000 per kilometre per year, however the amount that should be spent on maintaining the road at the appropriate level of service would be closer to $9,500 per kilometre per annum. Harden Council receives funding in the order of $3000 per kilometre of road from the RTA annually. Presently this funding is not subject to qualification or consultation with Council. Hence the amount to maintain the regional road work that should be spent by Council is in the order of $6,500 per kilometre.

In addition to general maintenance, it is assumed that roads will need to be resealed once during their design life. Reconstruction of the road is required at the end of the design life and this work involves the total excavation and relaying of the sub-grade layers. Reseals are necessary every 12 years to keep the level of service at an acceptable standard. Reconstruction is usually required after 20 years.

Council's pavement management system has been developed to allow better understanding of the value of Council's existing road infrastructure asset. From this tool it has been established that the existing average cost to reseal the R2 roads is in the order of $22,000 per kilometre. Similarly, the cost to reseal R1 roads is approximately $28,000 per kilometre. The difference is due to the variance in pavement construction and road widths.

From this information the total cost of a rural road and regional road can be approximated over a 20 year life.

Therefore the total cost per kilometre of a R2 (rural) road is:

$5,000 x 18 yr + $22,000 reseal (@ 10th year) + $204,000 reconstruction (@20th year)

= $316,000 per km

The total cost per kilometre of a R1 (regional) road is:

$6,500 x 18 yr + $28,000 reseal (@ 10th year) + $256,000 reconstruction (@20th year) =

$401,000 per km

3.4 Calculation of a reasonable contribution

From the information contained above it is proposed that the monetary contribution from development should be made on a periodic basis and should be per ESA for the total distance of R1 and R2 roads anticipated to be travelled by the development's laden heavy vehicles.

It has been shown that the life of a road can be expressed in total ESA loads that can pass over the pavement until the pavement deteriorates to the point of needing reconstruction. As mentioned previously the life of a typical road in Harden is approximately 20 years and equivalent to either 1 million or 2 million ESA, depending on the road type.

3.4.1 Formulas

Total contribution amount for any heavy haulage development

The calculation of the periodic contribution relating to any heavy haulage development is as follows:

$$\$C_{Period} = \frac{(\$R1_{Life}) \times ESA \times R1_{Length}}{R1_{Life}} + \frac{(\$R2_{Life}) \times ESA \times R2_{Length}}{R2_{Life}}$$

Where:

$\$C_{Period}$ is the monetary contribution payable by the development for the preceding period (i.e. preceding quarter) in dollars

$\$R1_{Life}$ is the standard cost of regional road per kilometre over the design life in dollars, being $401,000

$\$R2_{Life}$ is the standard cost of rural sealed road per kilometre over the design life in dollars, being $316,000

ESA is the number of ESAs generated by the development in the preceding period (as recorded by the traffic classifier at the development exit)

$R1_{Life}$ is the assumed design life of a standard road, being 2,000,000 ESA

$R2_{Life}$ is the assumed design life of a standard road, being 1,000,000 ESA

$R1_{Length}$ is the total length of road type R1 that will be travelled by the development's laden heavy vehicles estimated at the time of the development application, in kilometres

$R2_{Length}$ is the total length of road type R1 that will be travelled by the development's laden heavy vehicles estimated at the time of the development application, in kilometres

Contribution rate

The contribution rate - that is the contribution per ESA per kilometre of road used - can be expressed as follows.

The contributions for each sealed road type per ESA can be expressed as:

$$\$R_{Rate} = \frac{\$R_{Life}}{R_{Life}}$$

Where

$\$R_{Rate}$ is the monetary contribution rate for each road type (R1 or R2) per ESA per kilometre of road type in dollars

$\$R_{Life}$ is the standard cost of each road type (R1 or R2) regional road per kilometre in dollars, being $401,000 for R1 and $316,000 for R2

R_{Life} is the assumed design life of a standard road, being 1 million or 2 million ESA

Using the above formula and values:

$\$R1_{Rate}$ = $0.20 per ESA per kilometre

$\$R2_{Rate}$ = $0.32 per ESA per kilometre

3.4.2 Worked examples

Worked example 1

It is proposed to extract of sandstone from a quarry (Quarry ‘A’) located within Harden Shire. The development application states that the quarry will be operational for approximately 20 years. The distance travelled on Harden roads as shown from the quarry to the Hume Highway is approximately 20 km of regional road (R1) and 12 km of rural road (R2).

A condition requiring a section 94 contribution per ESA exiting the site consistent with the rates shown in clause 1.2 is imposed on the development consent.

A traffic classifier has been installed at a location outside the quarry exit. This classifier is to be reviewed on a quarterly basis. The first quarter results have been extracted and are shown in Table 3.4.

Table 3.4 Quarry ‘A’ traffic classifier results for 1st quarter of operation

Vehicle class	6	7	8	9	10
Standard ESA per vehicle	1.1	2.2	2.8	2.8	3.4
Number of vehicles for the period	0	25	35	20	0

The monetary contribution required for the quarter is calculated as follows:

$$\$R1 = \frac{401{,}000 \times \{(2.2 \times 25) + (2.8 \times 35) + (2.8 \times 20)\} \times 20}{2{,}000{,}000}$$

$$= 0.20 \times 209 \times 20$$

$$= \$836.00$$

$$\$R2 = \frac{316{,}000 \times \{(2.2 \times 25) + (2.8 \times 35) + (2.8 \times 20)\} \times 12}{1{,}000{,}000}$$

$$= 0.32 \times 209 \times 12$$

$$= \$802.56$$

Total contribution for 1st quarter = $836.00 + $802.56

= $1,638.56

Worked example 2

Quarry "B" is proposed near McMahons Reef. The developer has advised that the extracted material is to be hauled in two directions. Half the material is to go north to Burley Griffin Way and half is to go south to the Hume Highway.

A condition requiring a section 94 contribution per ESA exiting the site consistent with the rates shown in clause 1.2 is imposed on the development consent.

A traffic classifier is again located outside the quarry gate and shows the same result for the quarter as shown in the previous example.

In the simplest case there are two distinct routes to be used by the development. One heads north the other south. The total of road length and type used to haul north and south can be identified and traffic allocated on a 50% basis in each direction.

Thus if North R1 = 15km; R2 = 2.3km, then

$$\$North = (0.20 \times 104.5 \times 15) + (0.32 \times 104.5 \times 2.3)$$

$$= \$313.50 + \$76.91$$

$$= \$390.41$$

And similarly a calculation is possible for loads hauled south.

This proportional allocation can be used in any configuration that may arise.

3.4.3 Measures to ensure contributions are reasonable

To ensure contributions are reasonable, the following will be undertaken:

- The heavy haulage travel route(s) from the site will be identified at the time of development application and nominated as the total distance in kilometres that laden heavy vehicles will travel along R1 and R2 routes within Harden Shire.
- The following will be required as conditions of consent for heavy haulage developments:
  - A traffic classifier to be installed (at the applicantǿs cost) at a suitable location to classify and count the number of loaded heavy vehicles that enter or exit the development site over a set period. The plan assumes quarterly notices to the operators of developments. The classifier will be used to determine the number of ESAs that leave the development and are subject to contributions.
  - Responsibility for keeping the traffic classifier in good working order throughout the life of the development will rest with the operator of the heavy haulage development.
  - Council officers are to be provided access to the traffic classifier data on a regular (i.e. at least quarterly) basis.
  - In the event of the traffic data being corrupted, then the Council at its discretion may determine the levy for the preceding period.
- There may be circumstances where the likely length or lengths of roads to be used by laden heavy vehicles related to a heavy haulage development is difficult to quantify. In such cases Council will determine the length or lengths of road to be levied based on the information submitted with the development application. It is the duty of the applicant to provide sufficient and accurate information on likely laden heavy vehicle use at the application stage.

4. References

Donges. C.C & Associates v Baulkham Hills Shire Council (1989)

Council of the Shire of Ballina, Section 94 Contributions Plan: Heavy Vehicle Traffic Generating Development ï Maintenance & Construction of Roads (1996)

Baulkham Hills Shire Council, Section 94 Contributions Plan No. 6 Extractive Industries (2003)

Great Lakes Council, Section 94 Contributions Plan, Section 7 Road Haulage (2007)

Port Stephens Council, Section 94 Development Contributions Plan, Section 4.5 Roadworks (2007)

Austroads (1992) Vol.1, Pavement Design: A Guide to the Structural Design of Road Pavements, Section 7 ï Design Traffic; Appendix A ï Terminology; Appendix E ï Methods for Characterising Initial Daily Traffic.

Austroads Vehicle Classification System (2002)

5. Attachments

Austroads (1992) Vol.1, Pavement Design: A Guide to the Structural Design of Road Pavements, Section 7 ï Design Traffic; Appendix A ï Terminology; Appendix E ï Methods for Characterising Initial Daily Traffic.

Austroads Vehicle Classification System (2002)

7 DESIGN TRAFFIC

7.1 GENERAL

This section contains procedures for assessing traffic loadings for the design of flexible and rigid pavements and for the design of overlays.

The general procedure used is shown in Figure 7.1. Detailed procedures depend on the type of traffic data available, the pavement type being designed and the design method adopted.

Features of traffic that largely determine performance are:

- The number of axle passes
- The axle loadings
- The axle configurations.

For all pavements, performance is influenced only by the heavy end of the traffic spectrum. No account need be taken of cars and light commercial vehicles as far as loadings are concerned though their existence may affect road capacity (Section 7.3).

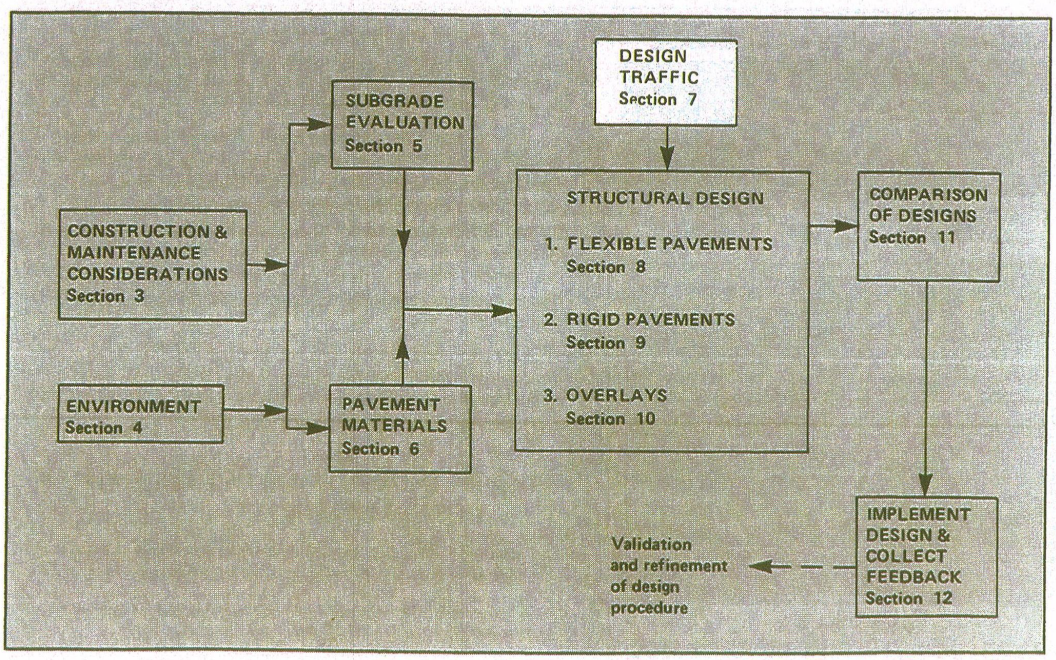
7.1.1 Axle Configurations and Equivalencies

The damage due to different axle groups is dependent on the axle spacing, the number of tyres per axle, the load on the group and the suspension. For design purposes, it is generally appropriate to consider axle groups in terms of the following four types:

- single axle with single wheels
- single axle with dual wheels
- tandem axles both with dual wheels
- tri-axles all with dual wheels

The relative damage associated with any particular axle load can be expressed in terms of relationship as shown in Table 7.1.

The standard axle is defined as a single axle with dual wheels that carries a load of 8.2 t. Loads on the axle configurations given above that cause the same amount of damage as the standard axle are given in Table 7.1.



For axle group loads other than those in Table 7.1, the lamage caused is expressed as the number of standard ıxles which produce the same damage and is calculated as ollows:

$$\text{No of standard axles for same damage} = \left[\frac{\text{Load on Axle Group}}{\text{Appropriate Load from Table 7.1}}\right]^{EXP}$$

Where the exponent EXP may vary depending on the ype of pavement. Commonly a value of 4 is adopted for the xponent in which case the number of standard axles for the same damage is termed the number of equivalent standard ıxles (ESAs).

Tandem axles which have dual wheels on one axle and ingle wheels on the other may be considered to be quivalent to tandem axles (both with dual wheels), which are loaded to 1.2 times the load on the six-wheeled tandem.

Spread Tandem axles, because of their wide axle pacings, (more than 2.4m) can be regarded as two single ıxles with the total load on the spread tandem configuration being divided equally between the two single axles.

For the design of flexible pavements, twin steer axles nay be considered to be equivalent to tandem axles (both vith dual wheels) which are loaded to 1.5 times the load on he twin steer axles. For the design of rigid pavements they nay be considered to be equivalent to tandem axles (both vith dual wheels) which have the same load as the twin teer axles.

'.1.2 Design Lanes

Construction of new pavements and overlaying of existing pavements usually affects two or more traffic lanes. It is usual practice to adopt the same pavement design for all lanes. The design traffic should be that in the lane which carries the most commercial vehicular traffic and it is designated the design lane.

TABLE 7.1
AXLE LOADS WHICH CAUSE EQUAL DAMAGE

Axle Configuration	Single Single	Single Dual	Tandem Dual	Triaxle Dual
Load (kN)	53	80	135	181

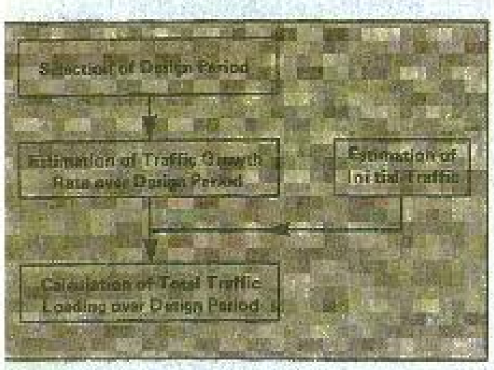


FIGURE 7.1
PROCEDURE FOR DETERMINING DESIGN TRAFFIC

7.2 DESIGN PERIOD

The design period is the length of time expressed in years before it is anticipated that rehabilitation of the pavement will be necessary to restore shape, repair other forms of distress, or to provide additional pavement strength.

Rehabilitation, which may consist of granular or asphalt overlay, major patching or improvements or removal of selected areas of pavement materials, initiates a new design period.

In this regard, resurfacing a pavement with a sprayed seal or a very thin asphalt overlay does not in itself constitute rehabilitation in the pavement design sense.

Some typical design periods are outlined below:

- New granular pavements = 20 - 25 years
- New rigid pavements = 20 - 40 years
- Asphalt overlays = 10 - 15 years
- Granular overlays = 10 - 20 years

Various factors will influence the choice of design period. They include:

- Maintenance strategies. Highly trafficked facilities will demand long periods of low maintenance.
- Funding considerations.
- Other factors, such as inadequate geometry or traffic capacity, may limit the life of the roadway and necessitate early reconstruction.

7.3 TRAFFIC GROWTH

Based on road traffic survey information, it is reasonable, in most circumstances, to assume that traffic volumes will increase geometrically either for the entire design period or up to a stage where "road capacity" is reached (in which case traffic volumes are assumed to remain constant for the remainder of the design period.

If there is an indication that "road capacity" is likely to be reached within the design period, it is recommended that the designer establish that there is no planned upgrading of the road geometry within the design period before he adopts "no growth" traffic volume for the period of "full capacity". Adoption of "no-growth" traffic volumes for a period of "saturation" will entail modification of the approach used below to aggregate daily traffic volumes for total design traffic.

For geometric traffic growth throughout the design period, total traffic over the design period is determined by multiplying the total traffic in the first year by the appropriate Cumulative Growth Factor from Table 7.2.

7.4 METHODS OF CALCULATION OF DESIGN TRAFFIC

The method to be used depends on the traffic data that are available and the design procedure to be adopted.

Ideally the traffic data should include the numbers of and loading on each axle type in the traffic stream.

TABLE 7.2 CUMULATIVE GROWTH FACTORS (GF)

Design Period (Years)	Growth Rate (% pa) 0	2	4	6	8	10
5	5	5.2	5.4	5.6	5.8	6.1
10	10	10.9	12.0	13.2	14.5	15.9
15	15	17.3	20.0	23.3	27.2	31.8
20	20	24.3	29.8	36.8	45.8	57.3
25	25	32.0	41.6	54.9	73.1	98.3
30	30	40.6	56.1	79.1	113.3	164.5
35	35	50.0	73.7	111.4	172.3	271.0
40	40	60.4	95.0	154.8	259.1	442.6

In many cases information at this level of detail is not available and recourse will have to be made to survey information.

This guide caters for three levels of traffic data:

(i) initial annual average daily number of axles by type and by load

(ii) initial annual average daily number of axles by type

(iii) initial annual average daily traffic (AADT) plus percent commercial vehicles.

The application of these data to the design procedures is shown in Table 7.3.

7.5 DESIGN TRAFFIC FOR FLEXIBLE PAVEMENTS CONTAINING ONE OR MORE BOUND LAYERS

7.5.1 For Traffic in Terms of Annual Average Daily Number of Axles by Type and by Load

Because asphalt, cemented materials and subgrades each have different performance relationships (allowable number of strain repetitions vs level of strain), it is necessary to determine separately for each material the number of standard axles which will cause the same level of accumulated damage as the actual traffic load spectrum. Hence the following three distinct parameters may be required:

- Number of standard axles that produce the same cumulative damage in asphalt as the design traffic (N_{SA})
- Number of standard axles that produce the same cumulative damage in the subgrade as the design traffic (N_{SS})
- Number of standard axles that produce the same cumulative damage in cemented materials as the design traffic (N_{SC}).

Initial annual average daily values of these parameters N_{SA}, N_{SS}, N_{SC} are calculated using method 1 of Appendix E.

TABLE 7.3 APPLICATION OF TRAFFIC DATA TO DESIGN PROCEDURES

Design Procedure	Traffic Data Available: Annual Average daily number of axles by type & load	Annual Average daily number of axles by type	AADT and percent Commercial Vehicles	Specialised Loading
Flexible pavements containing one or more bound layers	Sec 7.5.1 & Appendix E method 1	Sec 7.5.2 & Appendix E method 2	Sec 7.5.3 & Appendix E method 3	Sec 7.5.4
Flexible pavements consisting of unbound granular materials	Sec 7.6.1 & Appendix E method 4	Sec 7.6.2 & Appendix E method 2	Sec 7.6.3 & Appendix E method 3	Sec 7.6.4
Rigid Pavements	Sec 7.7.1	Sec 7.7.1	N/A	N/A
Overlays for flexible pavements	Sec 7.6.1 & Appendix E method 4	Sec 7.6.2 & Appendix E method 2	Sec 7.6.3 & Appendix E method 3	N/A

The design loading is then calculated as follows. Design number of standard axles for:

asphalt = N_{SA} x 365 x GF
subgrade = N_{SS} x 365 x GF
cemented materials = N_{SC} x 365 x GF

where GF is the cumulative growth factor from Table 7.2. These values are used as input to steps 10, 15 and 16 of the design procedure outlined in Table 8.1.

7.5.2 For Traffic in Terms of Annual Average Daily Number of Axles by Type.

The three required design parameters are as defined in Section 7.5.1. Annual average daily number of ESAs. N is calculated using method 2 of Appendix E.

N_{SA}, N_{SS} and N_{SC}, as defined in Section 7.5.1, are then calculated as:

$$N_{SA} = 1.1\,N_E$$
$$N_{SS} = 1.1\,N_E$$
$$N_{SC} = 10.0\,N_E$$

These constants have been calculated using the procedure described in method 1 of Appendix E using the traffic distribution given in Table 8.3. If a different traffic distribution is to be used the method described in Section 7.5.1 should be used.

The design loading is then calculated as follows. Design number of standard axles for:

asphalt = N_{SA} x 365 x GF
subgrade = N_{SS} x 365 x GF
cemented materials = N_{SC} x 365 x GF

where GF is the cumulative growth factor from Table 7.2. These values are used as input to steps 10, 15 and 16 of the design procedure outlined in Table 8.1(a).

7.5.3 For Traffic in Terms of Annual Average Daily Traffic (AADT) and Percentage of Commercial Vehicles.

The three required design parameters are as defined in Section 7.5.1. Annual average daily number of ESAs, N_E is calculated using method 3 of Appendix E.

N_{SA}, N_{SS} and N_{SC} as defined in Section 7.5.1, are then calculated as follows:

$$N_{SA} = 1.1\,N_E$$
$$N_{SS} = 1.1\,N_E$$
$$N_{SC} = 10.0\,N_E$$

These constants have been calculated using the procedure described in method 1 of Appendix E using the traffic distribution given in Table 8.3. If a different traffic distribution is to be used the method described in Section 7.5.1 should be used.

The design loading is then calculated as follows. Design number of standard axles for:

asphalt = N_{SA} x 365 x GF
subgrade = N_{SS} x 365 x GF
cemented materials = N_{SC} x 365 x GF

where GF is the cumulative growth factor from Table 7.2. These values are used as input to steps 10, 15 and 16 of the design procedure outlined in Table 8.1.

7.5.4 Specialised Loading

The aim is to analyse the damage caused by each axle/load configuration and to determine the total damage using Miner's Law.

7.5.4.1 Current Traffic Spectrum

For each of the axle types which will use the pavement, estimate from the available data the daily number with loads within specific load ranges. Designate these as N_{Cij} where i refers to axle configuration type and j refers to the load magnitudes for configuration i.

7.5.4.2 Growth Factors

Either

(a) Assume that the growth of numbers of all axle configurations and load magnitude will be equal, and select the appropriate factor from Table 7.2, or

(b) Adopt different growth factors for the numbers of different axle configuration and/or load magnitudes depending on the assumed change in the traffic spectra during the design period, selecting appropriate values from Table 7.2.

7.5.4.3 Calculation of Design Traffic

Determine the total number of each load configuration and magnitude which will be applied to the pavement during the design period N_{ij} using the formula:

$$N_{ij} = 365 \cdot N_{Cij} \times GF_{ij}$$

where GF is the adopted growth factor from Table 7.2 for load configuration i and load magnitude j.

The values of N_{ij} are then used in steps 10, 15, 16 of the mechanistic design procedure described in Table 8.1.

The load magnitudes and configurations themselves are used in steps 11a and 13a of the mechanistic design procedure described in Table 8.1.

7.6 DESIGN TRAFFIC FOR FLEXIBLE PAVEMENTS CONSISTING OF UNBOUND GRANULAR MATERIALS AND OVERLAYS FOR FLEXIBLE PAVEMENTS

7.6.1 For Traffic in Terms of Annual Average Daily Number of Axles by Type and by Load

The design parameter required is the number of ESAs. Annual average daily number of ESAs, N_E, is calculated from method 4 of Appendix E.

The design number of ESAs is then calculated as:

$$N_E \times 365 \times GF$$

where GF is the cumulative growth factor from Table 7.2.

This value is used as input to the design procedure outlined in Section 8.3 for flexible pavements and Section 10.4.5 for overlays.

7.5.2 For Traffic in Terms of Annual Average Daily Number of Axles by Type

The design parameter required is the number of ESAs. Annual average daily number of ESAs, N_E, is calculated from method 2 of Appendix E.

The design number of ESAs is then calculated as:

$$N_E \times 365 \times GF$$

where GF is the cumulative growth factor from Table 7.2.

This value is used as input to the design procedure outlined in Section 8.3 for flexible pavements and Section 10.4.5 for overlays.

7.5.3 For Traffic in Terms of Annual Average Daily Traffic (AADT) and Percentage Commercial Vehicles

The design parameter required is the number of ESAs. Annual average daily number of ESAs, N_E, is calculated from method 3 of Appendix E.

The design number of ESAs is then calculated as:

$$N_E \times 365 \times GF$$

where GF is the cumulative growth factor from Table 7.2.

This value is used as input to the design procedure outlined in Section 8.3 for flexible pavements and Section 10.4.5 for overlays.

7.5.4 Specialised Loading

For the design of flexible pavements consisting of unbound granular materials for the case of specialised traffic loading, the design procedure in Section 8.3 is not appropriate. It is necessary to use the Mechanistic Procedure (Section 8.2) and hence adopt the traffic characterisations in Section 7.5.4.

7.7 DESIGN TRAFFIC FOR RIGID PAVEMENTS

7.7.1 Traffic Estimation for Thickness Design Procedure

The design traffic is characterised by the cumulative number of commercial vehicle axle groups expected in the design lane during the design period, together with the proportions of each type of axle group and the distribution of loads on each type of axle group.

Loads on an axle group type are typically grouped into 10 kN intervals. Appendix I contains examples of load distributions.

The design number of commercial vehicle axle groups over the design life of the pavement is given by:

$$C_{dg} = C_d \times 365 \times GF$$

where

- C_{dg} = design number of commercial vehicle axle groups.
- C_d = initial number of commercial vehicle axle groups per day.
- GF = the cumulative growth factor from Table 7.2.

The design procedure in Chapter 9 caters for each of the following axle types:

- single axles with single wheels;
- single axles with dual wheels;
- tandem axles with dual wheels; and
- triaxles with dual wheels.

Other axle types are to be converted to one of the above as follows:

(i) Convert spread tandem axle loads to dual-tyred single axle loads on the basis that a spread tandem axle is equivalent to two dual tyred single axles, each of which has half of the spread tandem axle load.

(ii) Convert twin steer axles to single axles with single wheels on the basis that a twin steer axle is equivalent to two single axles with single wheels, each with half the load.

7.8 INITIAL AND TERMINAL PAVEMENT CONDITIONS

The design procedure for new flexible pavements presented in Section 8.1 is based on the premise that pavement roughness at the end of the design period will be approximately 150 counts/km, assuming that the initial roughness is approximately 50 counts/km.

A suitable initial roughness value can be determined by measurements of recently constructed pavements. To allow flexibility in the choice of the terminal condition of the pavement, and also to allow for variations in the initial pavement condition the designer may modify the value of design traffic determined above before undertaking the pavement design.

To determine the modified value, the designer enters Figure 7.2 with the already determined design traffic and also the desired ratio of initial/final roughness. The modified design traffic is then read from the vertical axis. For example, if the design traffic as determined above is 10^6 and the designer seeks a pavement design which will result in terminal roughness being four times initial roughness, the value of the modified design traffic is 4×10^6.

This modification applies only to cases where the subgrade strain criterion governs. As a guide, suggested terminal roughness values for different classes of road are in Table 7.4.

TABLE 7.4 VALUES OF TERMINAL ROUGHNESS

NAASRA Road Functional Class[1]	Terminal Roughness NAASRA counts per km
1 and 2	110
3 and 6	150
4, 5, 7, 8 and 9	175

1 For definition of Classes see Appendix A

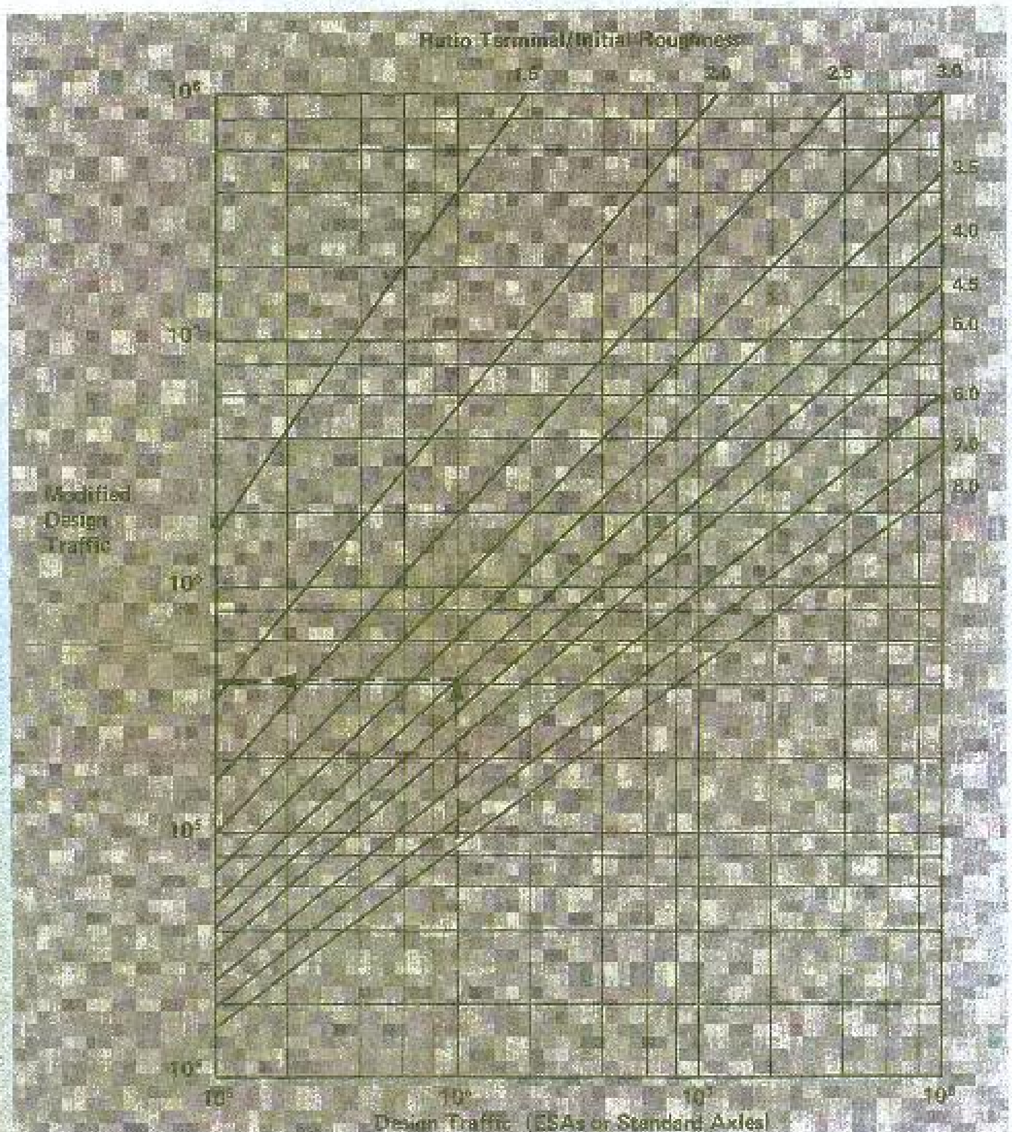


FIGURE 7.2 MODIFIED DESIGN TRAFFIC VS DESIGN TRAFFIC AND RATIO FINAL / INITIAL ROUGHNESS (FOR USE IN DESIGN OF NEW FLEXIBLE PAVEMENTS)

APPENDIX A TERMINOLOGY

The terminology used in the Guide is basically in accordance with Australian Standard 1348.1 (1986), *Road and Traffic Engineering - Glossary of Terms, Part 1 - Road Design and Construction*. This Appendix lists and defines terms used which do not appear or differ in definition from that shown in AS 1348.1, or accord with AS 1348.1, but which are considered so important within the context of this document to warrant having them reproduced.

DEFINITION OF TERMS

Annual Average Daily Traffic (AADT)

The total yearly traffic volume divided by 365.

California Bearing Ratio (CBR)

The ratio expressed as a percentage between a test load and an arbitrarily defined standard load. This test load is that required to cause a plunger of standard dimensions to penetrate at a specified rate into a specifically prepared soil specimen.

Commercial Vehicle

A vehicle having at least one axle with dual wheels and/or having more than two axles.

Course

One or more layers of the same material within a pavement structure.

Curvature Function

Of a deflection bowl is the difference in maximum deflection at a test site and the deflection at a point 200 mm from the point at which the maximum deflection was produced (in the direction of travel).

Cemented Materials

Those produced by addition of cement, lime or other hydraulically binding agent to granular materials in sufficient quantities to produce a bound layer with significant tensile strength.

Deflection

The vertical elastic (recoverable) deformation of a pavement surface between the tyres of a standard axle.

Design Period

A period considered appropriate to the function of the road. It is used to determine the total traffic for which the pavement is designed.

Design Subgrade Level (DSL)

The level of the prepared formation after completion of stripping and excavation or filling and upon which the pavement is to be constructed. (Design Subgrade Level = Finished Surface Level-Nominated Pavement Thickness).

Layer

The portion of a pavement course placed and compacted as an entity.

Modified Materials

Granular materials to which small amounts of stabilising agent have been added to improve their performance (eg, by reducing plasticity) without causing a significant increase in structural stiffness. Modified materials are considered to behave as unbound materials.

Modulus of Subgrade Reaction

The slope of the straight line drawn from the origin to a given point on the stress deflection curve obtained from a plate bearing test.

Pavement (Structure)

The portion of the road, excluding shoulders, placed above the design subgrade level for the support of, and to form a running surface for, vehicular traffic.

Permeability Reversal

Occurs at a pavement layer interface when the coefficient of saturated permeability of the upper layer is at least 100 times greater than that of the layer below it.

Roughness

The roughness of the pavement surface in counts/km as measured by a NAASRA Roughness Meter.

Shoulder

The portion of the road contiguous and flush with the pavement.

Stabilisation

The treatment of a road pavement material to improve it or to correct a known deficiency and thus enhance its ability to perform its function in the pavement.

Standard Axle

Single axle with dual wheels loaded to a total mass of 8.2t.

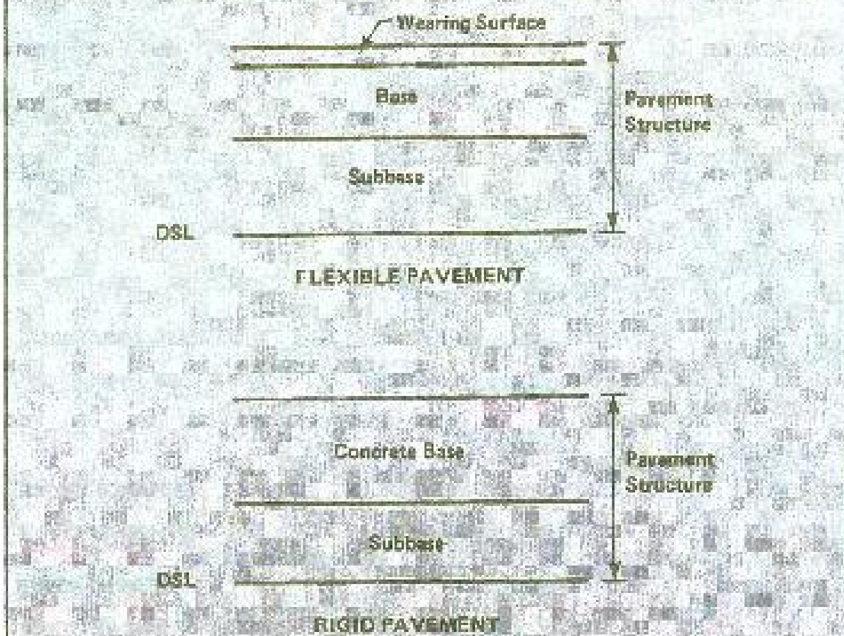
Traffic Lane

The portion of a carriageway alloted for use of a single lane of vehicles.

The components of flexible and rigid road pavement structures are shown in Figure A.1. ❑

TABLE A.1 DEFINITION OF ROAD CLASSES

RURAL AREAS	
Class 1	Those roads which form the principal avenue for communications between major regions of Australia, including direct connections between capital cities.
Class 2	Those roads, not being Class 1, whose main function is to form the principal avenue of communication for movements : • between a capital city and adjoining states and their capital cities; or • between a capital city and key towns; or • between key towns.
Class 3	Those roads, not being Class 1 or 2, whose main function is to form an avenue of communication for movements : • between important centres and the Class 1 and Class 2 roads and/or key towns; or • between important centres; or • of an arterial nature within a town in a rural area.
Class 4	Those roads, not being Class 1, 2 or 3, whose main function is to provide access to abutting property (including property within a town in a rural area).
Class 5	Those roads which provide almost exclusively for one activity or function which cannot be assigned to Classes 1, 2, 3 or 4.
URBAN AREAS	
Class 6	Those roads whose main function is to perform the principal avenue of communication for massive traffic movements.
Class 7	Those roads, not being Class 6, whose main function is to supplement the Class 6 roads in providing for traffic movements or which distribute traffic to local street systems.
Class 8	Those roads not being Class 6 or 7, whose main function is to provide access to abutting property.
Class 9	Those roads which provide almost exclusively for one activity or function and which cannot be assignec to Classes 6, 7 or 8.



NOTES

1. DSL = Design Subgrade Level
2. Base or Subbase may comprise more than one layer
3. Wearing surface of a flexible pavement may be asphalt or a bituminous seal and may contain more than one layer
4. Subbase may comprise more than one course
5. In a rigid pavement the concrete may be provided with an asphalt wearing surface
6. Subgrade material which has been stabilised is generally considered to be a subbase course

FIGURE A.1 COMPONENTS OF FLEXIBLE AND RIGID ROAD PAVEMENT STRUCTURES

APPENDIX E
METHODS FOR CHARACTERISING INITIAL DAILY TRAFFIC

Method 1

Determine, for each load range for each type of axle group, the number of Standard Axles which produce the same damage as one pass of the axle group, using the following formula :

$$F_{Aij} \ (\text{or } F_{Cij} \text{ or } F_{Sij}) = \left[\frac{L_{ij}}{L_{Si}}\right]^{EXP}$$

where

L_{ij} = jth load magnitude on axle type i

L_{Si} = magnitude of Standard Load on axle type i (Table 7.1)

EXP = exponent contained in the relation between limiting strain and strain repetitions which defines the performance of asphalt, cemented material or subgrade as applicable.

The values of F_{Aij}, F_{Cij} and F_{Sij} contained in Tables E1, E2, E3 respectively were derived using the above formula and the exponents 5, 18 and 7.14. These exponents are derived from the performance criteria in Figure 6.8, Figure 6.1 and equation 5.1 (Section 5.9).

If the designer wishes to use other performance criteria, the above formulas should be used to recalculate the entries in Tables E1, E2, and E3.

Calculate for each relevant damage mode, the number of Standard Axles (N_S) which is equivalent to the initial daily traffic, using the following equations:

For asphalt distress

$$N_{SA} = \sum_j N_{A1j} F_{A1j} + \sum_j N_{A2j} F_{A2j} + \sum_j N_{A3j} F_{A3j} + \sum_j N_{A4j} F_{A4j}$$

Where N_{Aij} is the average daily number of axles (in the first year of type i carrying a load of magnitude j.

For damage of cemented materials

$$N_{SC} = \sum_j N_{A1j} F_{C1j} + \sum_j N_{A2j} F_{C2j} + \sum_j N_{A3j} F_{C3j} + \sum_j N_{A4j} F_{C4j}$$

For subgrade damage

$$N_{SS} = \sum_j N_{A1j} F_{S1j} + \sum_j N_{A2j} F_{S2j} + \sum_j N_{A3j} F_{S3j} + \sum_j N_{A4j} F_{S4j}$$

with the summations being taken over the appropriate load ranges.

These three quantities characterise the initial daily traffic for the mechanistic procedure.

TABLE E1
NUMBER OF STANDARD AXLES PER AXLE GROUP FOR EQUIVALENT ASPHALT DAMAGE ACCORDING TO TYPE OF AXLE GROUP AND AXLE GROUP LOAD (FACTOR F_{Aij})

Load on Axle Group (kN)	Number of Standard Axles for equivalent asphalt distress axle / tyres			
	Single single	Single dual	Tandem dual	Triaxle dual
20	0.01	0	0	0
30	0.06	0.01	0	0
40	0.25	0.03	0	0
50	0.75	0.10	0.01	0
60	1.9	0.24	0.02	0
70	4.0	0.51	0.04	0.01
80	7.8	1.0	0.07	0.02
90		1.8	0.13	0.03
100		3.1	0.22	0.05
110		4.9	0.36	0.08
120		7.6	0.56	0.13
130			0.83	0.19
140			1.2	0.28
150			1.7	0.39
160			2.3	0.54
170			3.2	0.73
180			4.2	0.97
190			5.5	1.3
200			7.1	1.6
210			9.1	2.1
220				2.7
230				3.3
240				4.1
250				5.0
260				6.1
270				7.4
280				8.9

TABLE E2
NUMBER OF STANDARD AXLES PER AXLE GROUP FOR EQUIVALENT DAMAGE TO CEMENTED MATERIALS, ACCORDING TO TYPE OF AXLE GROUP AND AXLE GROUP LOAD (FACTOR F_{Cij})

Load on Axle Group (kN)	Number of Standard Axles for equivalent damage of cemented materials axle / tyres			
	Single single	Single dual	Tandem dual	Triaxle dual
20	0	0	0	0
30	0	0	0	0
40	0.03	0	0	0
50	0.50	0	0	0
60	4.43	0.03	0	0
70	29.2	0.20	0	0
80	139.9	1	0	0
90		4.11	0.01	0
100		11.6	0.03	0
110		45.7	0.09	0
120		129.7	0.24	0.01
130			0.64	0.02
140			1.35	0.05
150			3.54	0.10
160			7.36	0.23
170			15.9	0.47
180			31.3	0.94
190			60.4	1.79
200			111.8	3.31
210			200.7	5.95
220				10.4
230				17.7
240				29.5
250				48.2
260				77.2
270				121.4
280				187.8
290				289.2

TABLE E3
NUMBER OF STANDARD AXLES PER AXLE GROUP FOR EQUIVALENT SUBGRADE DAMAGE ACCORDING TO TYPE OF AXLE GROUP AND AXLE GROUP LOAD (FACTOR F_{Sij})

Load on Axle Group (kN)	Number of Standard Axles for equivalent subgrade damage axle / tyres			
	Single single	Single dual	Tandem dual	Triaxle dual
20	0	0	0	0
30	0.02	0	0	0
40	0.13	0.01	0	0
50	0.68	0.04	0	0
60	2.4	0.13	0	0
70	7.3	0.39	0.01	0
80	18.9	1.0	0.02	0
90		2.3	0.06	0.00
100		4.9	0.12	0.01
110		8.7	0.23	0.03
120		16.1	0.43	0.05
130			0.76	0.09
140			1.3	0.16
150			2.1	0.26
160			3.6	0.42
170			5.2	0.64
180			7.3	0.96
190			11.5	1.4
200			16.5	2.0
210			23.5	2.9
220				4.0
230				5.5
240				7.5
250				10.0
260				13.3
270				17.4
280				22.5
290				29.0

Method 2

(i) Estimate the daily number of each of the 4 types of axle groups listed in Table E4. Designate these as $N_{A1}, N_{A2}, N_{A3}, N_{A4}$

(ii) Estimate the number of ESAs for each type of axle group (F_1, F_2, F_3, F_4) from Table E4 or other relevant information

(iii) Calculate initial daily ESAs (N) as follows:

$$N_E = N_{A1} F_1 + N_{A2} F_2 + N_{A3} F_3 + N_{A4} F_4$$

Method 3

(i) Estimate AADT for the design lane and percent commercial vehicles (C%) from traffic census information

(ii) Estimate the number of ESAs per commercial vehicle (F) from Table E5 or other relevant information

(iii) Calculate initial daily ESAs (N) as follows:

$$N_E = AADT\ F\ C / 100$$

Method 4

Calculate initial daily ESAs (N_E) as follows:

$$N_E = \sum_j N_{A1j} F_{E1j} + \sum_j N_{A2j} F_{E2j} + \sum_j N_{A3j} F_{E3j} + \sum_j N_{A4j} F_{E4j}$$

where N_{Aij} is the average daily number of axles (in the first year) of type i, carrying a load of magnitude j and F_{Eij} is the number ESAs for each pass of the axle group i carrying load j with the summations being taken over the appropriate load ranges. Values for F_{Eij} are contained in Table E6.

TABLE E4
NUMBER OF ESAs PER AXLE GROUP TYPE ACCORDING TO STATE AND ROAD FUNCTIONAL CLASS (FACTOR F_i)

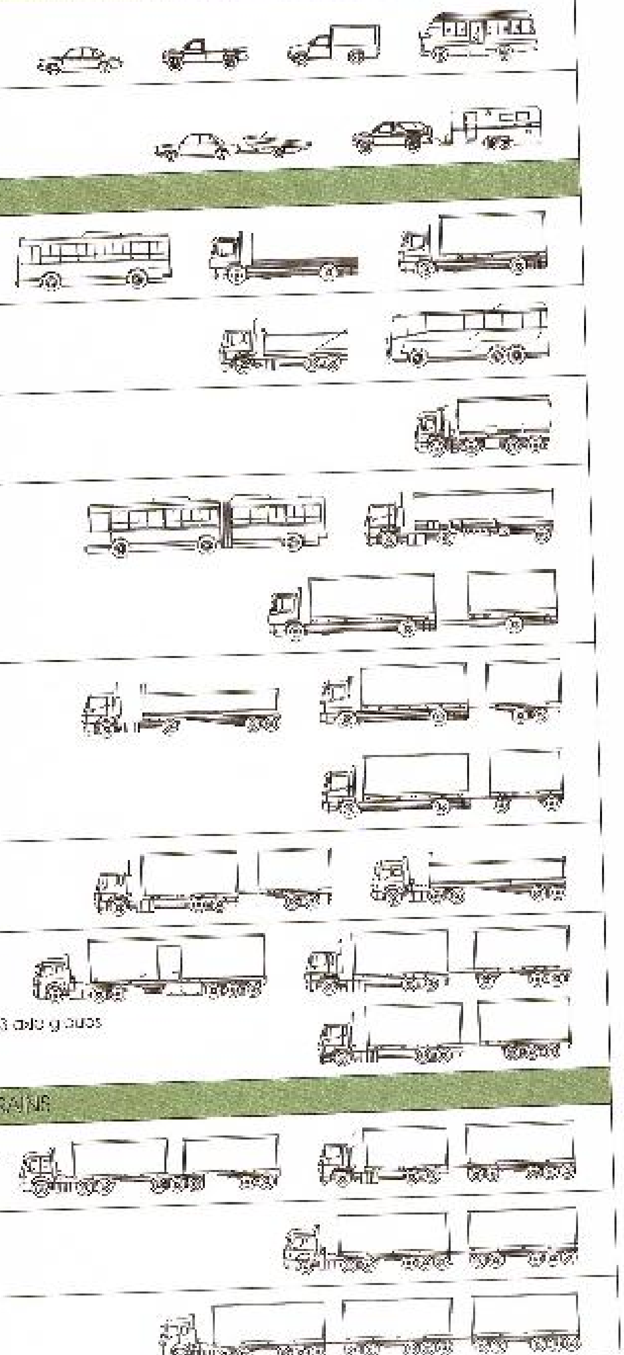
Road Functional Class [1]	Axle Group Type	State/Territory NSW	VIC	QLD	WA	SA	TAS	ACT	NT
1	SAST	0.6	0.6	0.4	0.5	0.7	0.4	-	0.4
	SADT	0.4	0.5	0.3	0.4	0.4	0.3	-	0.2
	TADT	0.9	0.9	0.7	0.7	0.9	0.6	-	0.7
	TRDT	0.8	0.7	0.6	0.7[2]	0.6	0.4[2]	-	0.6
2	SAST	0.6	0.4	0.4	0.5	0.5	0.4	-	-
	SADT	0.5	0.3	0.3	0.4	0.3	0.3	-	-
	TADT	1.0	0.7	0.7	1.0	0.9	0.9	-	-
	TRDT	0.7	0.4	0.6	0.5	0.6[2]	0.5[2]	-	-
3	SAST	0.6	0.4	0.4	0.5	0.5	0.4	-	0.5
	SADT	0.6[2]	0.4	0.2	0.3	0.3	0.3	-	0.5
	TADT	1.0	0.7	0.7	0.8	0.7	1.1	-	0.8
	TRDT	0.8[2]	0.4[2]	0.5[2]	0.9[2]E	0.7	0.8[2]E	-	0.6
6	SAST	0.6	0.4	0.3	0.4	0.5	0.3	0.3	-
	SADT	0.4	0.3	0.2	0.3	0.2	0.2	0.2[2]	-
	TADT	1.0	0.6	0.7	1.2	0.8	0.7	0.8	-
	TRDT	0.8	0.4	0.6[2]	0.8[2]	0.6	0.5[2]	-	-
7	SAST	0.6	0.3	0.3	0.3	0.2E	0.1E	-	-
	SADT	0.6[2]	0.2	0.2	0.2	0.3E	0.4E	-	-
	TADT	1.6	0.7	0.6	1.2	0.3[2]E	1.2[2]E	-	-
	TRDT	-	-	-	-	-	-	-	-

1 Road Functional Classes are defined in Appendix A
2 Average based on a sample of between 50 and 100 axle groups
E Extrapolated from 1973 survey data

VEHICLE CLASSIFICATION SYSTEM

AUSTROADS

CLASS	
	LIGHT VEHICLES
1	SHORT Car, Van, Wagon, 4WD, Utility, Bicycle, Motorcycle
2	SHORT - TOWING Trailer, Caravan, Boat
	HEAVY VEHICLES
3	TWO AXLE TRUCK OR BUS 2 axles
4	THREE AXLE TRUCK OR BUS 3 axles, 2 axle groups
5	FOUR (or FIVE) AXLE TRUCK 4 (5) axles, 2 axle groups
6	THREE AXLE ARTICULATED 3 axles, 3 axle groups
7	FOUR AXLE ARTICULATED 4 axles, 3 or 4 axle groups
8	FIVE AXLE ARTICULATED 5 axles, 3 + axle groups
9	SIX AXLE ARTICULATED 6 axles, 3 + axle groups or 7 + axles, 3 axle groups
	LONG VEHICLES AND ROAD TRAINS
10	B DOUBLE or HEAVY TRUCK and TRAILER 7+ axles, 4 axle groups
11	DOUBLE ROAD TRAIN 7+ axles, 5 or 6 axle groups
12	TRIPLE ROAD TRAIN 7+ axles, 7+ axle groups



Asset and Network Information - January 200[illegible]

Dwg No: 0292 009