MEASURE OF BENEFITS FROM A TOLL ROAD FACILITY/CASE STUDY : THE TSITSIKAMMA TOLL ROAD

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A Project Report Submitted to the Faculty of Engineering University of the Witwatersrand, Johannesburg for the Degree of Master of Science

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ABSTRACT

MEASURE OF BENEFITS FROM A TOLL ROAD FACILITY CASE STUDY : THE TSITSIKAMMA TOLL ROAD

This project report examines the effects of toll on travel behaviour in an effort to predict the effect of alternative toll pricing policies on the toll revenue collected. The fundamental problem of transportation planning is to predict the behaviour of consumers faced with a particular choice set of travel opportunities, if the response of consumers can be predicted then the impact of alternative policies can be assessed and the best policy selected.

Since travel behaviour is influenced by many factors the report endeavours to identify and obtain direct measurement of all factors concerned before concentrating on the sole effects of toll. The methods used in the report include field tests for obtaining information on travel costs, traffic surveys for establishing trip patterns and a roadside interview for ascertaining traffic behaviour. All work was carried out on South Africa's only toll road, the Tsitsikamma Toll Road in the Eastern Cape Province.

DECLARATION

I declare that this project report is my own, unaided work. It is being submitted for the degree of Master of Science in the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in any other University.

W I Kennedy

30th day of January, 1985

To Lyn

For the understanding and encou.agement I received, while undertaking this study.

PREFACE

One of the most controversial areas of traffic management is toll systems. On the one hand it is desirable to obtain income for highway construction and maintenance, particularly if a section of highway has been specifically commissioned to reduce journey distances. On the other hand, it is suggested that toll systems cause economic benefit to be lost, are disruptive to traffic flow and are a continual cause of annoyance and expense.

Having been involved in studies relating to the feasibility of several potential toll roads in South Africa, I have witnessed many times the arguments for and against tolls and have concluded that no general agreement on whether these systems should, or should not be introduced, will ever be reached. What is known however, is that South Africa's first toll road does now exist and will continue to exist for many years to come. Bearing this in mind, the following report has been compiled, not with the objective of providing arguments for or against toll systems, but rather with the objective of providing quantitative evidence from the Tsitsikamma Toll Road on how traffic behaviour is being effected by the toll. In addition, since the objective of the present toll structure is to maximise revenue, the report assesses whether this objective has been obtained. By persuing this approach it is hoped that when future toll roads are introduced in South Africa, with objectives similar to those of the Tsitsikamma Toll Road, the information gathered for this report will enable these objectives to be more readily attained.

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In getting the information for this report and for the aid received during the reports compilation, my sincere thanks is expressed to the following individuals who devouted much of their time: Professor Richard Brown and Vince Newey of the University of the Witwatersrand, and Wojtek Skowronski of the National Institute for Transport and Road Research. In addition, I am deeply indebted to Mr Malcolm Mitchell and Mr Pen Mainwaring of the Department of Transport, who secured the necessary funds thereby making this study possible. Finally my appreciation is extended to the members of the Tolplan Consortium for their co-operative attitude throughout the study.

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1.0 INTRODUCTION

In view of the political sensitivity of increasing the fuel price the National Transport Commission embarked on a policy of introducing toll roads into South Africa. As a result, South Africa's first toll road in recent times, the Tsitsikamma Toll Road, was officially opened to traffic on 8 June 1984.

From a financing point of view the NTC saw the significance of revenue from tolls, not as an additional source of annual revenue, but as access to the capital loan market where the annual revenue could be used to repay capital market loans. These additional loans could then be used to extend the resources of the National Road Fund and hopefully lead to the construction of economically viable road projects whose construction would have otherwise been deferred.

Since the objective of toll roads in South Africa was to overcome the problem of insufficient funds, particular attention was given, in the project feasibility stage, to the amount of revenue obtainable from the toll road introduced. It was obvious that the financial success of the project was dependent on the annual income from the toll revenue and as such the toll rate should be set at the level which achieved maximum or near maximum revenue. Overseas studies h.. concluded that there was a relationship between the usage o. .ie toll road, the toll rate charged and the perceived saving in the cost of travel offered by the toll road over the alternative route and that this relationship could be used to identify the toll rate which achieves the maximum revenue. With no toll facility existing in South Africa at the time of the project feasibility stage, it was difficult however to assess the validity of this relationship in the South African context. The recent opening of the Tsitsikamma Toll Road and the presence of an alternative road for traffic along its complete length, does now however, provide this opportunity.

The main objective of the following report is therefore to examine and obtain field measurements at the Tsitsikamma Toll Road of the parameters involved in the decision making process of whether or not to travel via the toll road, to examine these results in an effort to derive a relationship between road usage, toll rate and the perceived cost of travel and hence to identify the toll rates which achieve the maximum revenue. In addition, in order to obtain a better understanding of the principles involved when considering the introduction of a toll facility, the report summarises some general findings from toll road studies overseas, a brief explanation of the reasons for introducing toll roads into South Africa is also included.

2.0 THE NATURE OF TOLL ROADS

The following section outlines the objectives of toll systems overseas and also explains the circumstances which resulted in these systems being introduced into South Africa.

2.1 Overseas Experience

The concept of levying tolls on users of highways is not a new one. The Assyrians are known to have constructed one of the earliest toll roads from Syria to Babylon[1)], and in Britain toll roads date back to the middle ages, when rich landowners realised that they could charge travellers for the privelege of taking a short cut across their land. Even in those days, time was money.

In 1977, the International Road Federation (IRF - Geneva) and the Swedish Road Federation (SRF) conducted a joint survey of countries using toll systems[2)]. Of the questionnaires received back eleven European and ten non-European countries acknowledged using these systems. In addition, it was found that toll roads satisfy diverse traffic needs, they can be incorporated into major traffic systems carrying over a hundred thousand vehicles per day, or, they can form part of secondary or tertiary systems with a few hundred vehicles per day. Road authorities using toll systems can either be federal, state, regional or communal, depending on legal structure.

The main objectives of overseas toll systems can be summarised under three headings:

(a) Financing of the projects capital cost

Toll systems may be employed in cases where there is a lack of sufficient capital from the normal revenue sources. In France, Italy, Spain and Portugal for example, the governments road authorities planned national freeway networks, but realised that in order to complete the projects at the earliest possible date, loans and tolls would have to be used. While it is agreed that tolls do provide one solution to the lack of funds problem, many engineers dislike their use, preferring to obtain the necessary funds from an increased fuel levy. It is beneficial therefore to examine in greater detail why these conflicting views exist.

There is a consensus of opinion among engineers and other transport experts on the criterion for the improvement of almost all rural and inter-urban roads[3)]. This is the reduction in cost - both to the road authority and the vehicle operator. Congestion in road capacity is almost never used to justify road investment, except perhaps in urban areas where traffic is very dense, although to reduce congestion may be an objective when introducing toll, this toll objective will however be discussed under a separate heading. The almost universal justification for roads in rural areas where traffic is relatively light, is the reduction in operating and maintenance costs, counterbalancing the additional fixed cost. By proposing that a rural road should be tolled it can be argued that this reduces the justification for the road since a portion of savings in operating and maintenance costs will not be realised as some drivers divert to alternative routes. The introduction of a toll road which is not congested is seen as an inefficient means of raising finance as it results not only in traffic diverting off the uncongested road but also incurs a significant increase in project cost due to the installation of the toll facility. This argument therefore concludes that if there is a case for the rural tollway there is usually an even better case for a rural freeway.

The opponents of this view argue that insufficient funds are available from the normal revenue sources, such as fuel tax, licence fees etc. and as such certain viable projects must be delayed. If it is politically unacceptable for the Government to increase the fuel levy or increase licence fees then other forms of finance must be proposed. Although there is an awareness of the lost savings as a result of the toll facility, it is concluded that the attainment of the major portion of the saving as opposed to no saving at all is preferable.

(b) Congestion

The concept that community benefits accrue by increasing the charges imposed for the use of congested facilities, whilst familiar to the economist, is not intuitively obvious. It would therefore appear beneficial to attempt, in very simple terms, to establish this point[4)].

Basic to the economic analysis, are the concepts of journey cost and benefit. Journey costs are made up of four parts, namely, private journey costs, congestion costs, road maintenance costs and environmental costs, however, as the cost of road maintenance in terms of cost per vehicle-kilometre is small compared with the other components and as environmental costs are as yet not capable of being reliably quantified, for simplicity, only the first two components will be considered.

Private journey costs sub-divide into two elements. The first is the vehicle operating cost including fuel, maintenance, depreciation etc. and may be expressed as a cost per vehicle-kilometre. The second element consists of those costs that vary with journey speed and mainly arise from the cost of individual's travel time. The congestion cost is the aggreate of those costs imposed by road users on each other, mainly in terms of extra delay. Congestion costs arise only where vehicles interact so slowing one another down. On the simplified speed/flow relationship shown in Figure 1 this interaction would begin at point A where speeds cease to be independent of flow.

Turning now to a definition of benefit. The benefit a road user obtains from a particular journey is the price that he would be prepared to pay in order to make the journey. In other words if the price charged for making the trip was gradually increased, then the point would be reached at which the trip maker would decide not to go, or to go by another mode of transport or at another time. This critical price would be his own subjective assessment of the worth of his journey as compared with the other calls upon his finance, and is thus equal to the benefit he would enjoy from making the journey. It follows that the cost actually incurred is equal or less than this benefit, so that he enjoys a net benefit equal to the difference between what he actually pays and what he is prepared to pay. This is termed by economists as the consumer surplus.

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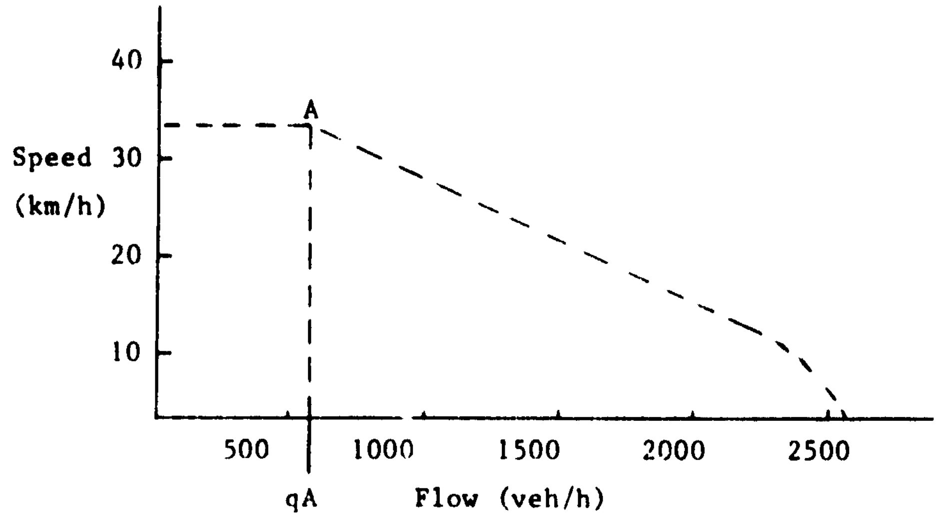

FIGURE 1

STYLISED SPEED/FLOW RELATIONSHIP

Returning to Figure 1, it can be seen that at flows in excess of qA the effect on adding an additional vehicle to the traffic stream is to reduce the speed of all vehicles thus increasing the cost of all journeys. The marginal effect of the additional vehicle can therefore be derived and used to obtain the marginal cost figure per additional vehicle. Comparing this with the expression for private costs (refer Figure 2) it can be seen that the marginal cost curve is at all values in excess of qA, greater than the private cost curve. The difference between the two curves is in fact the congestion cost component.

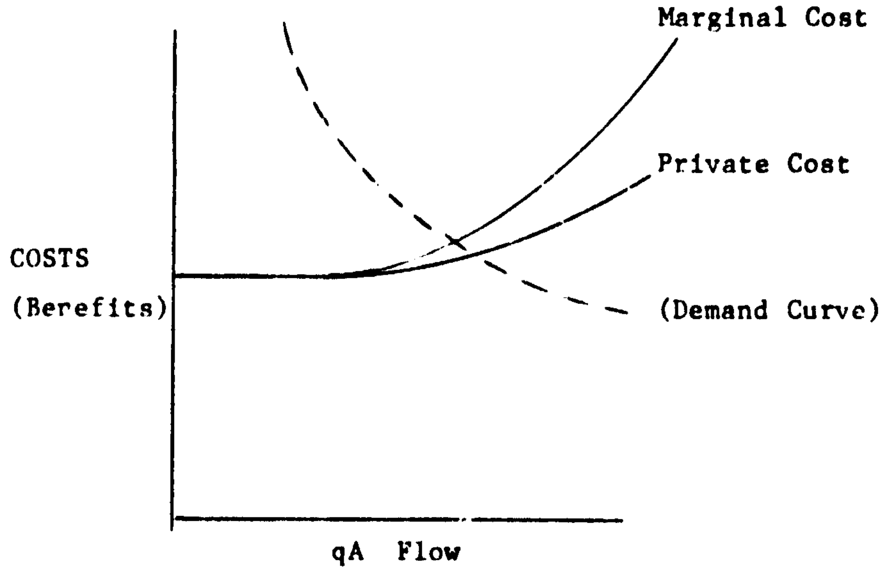

FIGURE 2

THE BENEFIT OF CHARGING

A pricing mechanism whereby the cost a road user has to pay, is more closely related to the total costs including the congestion component i.e. the marginal cost previously defined, would ensure that those road users that valued their trips highly would use the road, whilst those who did not were deferred. It is also important to note that as traffic flows increase the benefits of the individual road users decrease, this relationship being illustrated on Figure 2 by the demand curve superimposed on the private and marginal cost curves. There exists therefore a case to "toll off" traffic which in general is deriving a reduced benefit, with the aim of achieving a lower traffic volume with a much higher benefit and hence an overall increase in total benefit.

From the above it can be concluded that a case can be made for toll roads where the objective is to relieve congestion, however, as toll roads necessitate limited access roads their application in this respect is limited. It is of course possible that in the not too distant future automatic computerised methods of charging will be introduced, in such a case this toll concept could prove very attractive.

(c) Equitable Road Charging

In this process the objective is to establish toll rates for different vehicle classes which reflect the damage caused by these different vehicle classes.

There exists grounds for believing that certain road users, notably the road hauliers, do not pay their fair share of infrastructure costs. Motorcycles and heavy goods vehicles may both be direct users of a road facility, however, it is obvious that the total cost of the facility should not be shared equally between them. Toll rates can therefore be used to minimise the inequalities and remove the cross subsidisation between one vehicle class and another.

2.2 Toll Roads in South Africa

In South Africa the motivation for investigating the feasibility of toll roads stemmed from concern by the Department of Transport over the amount of money being spent in the road sector[5]. During the ten year period ending in 1976, the construction of National Roads was given a relatively high priority by the Government and many kilometres of highway were built during that time. During the period 1976 to 1983 there took place however, a continuous erosion in the real value of the National Road Fund (NRF), as the increases in the fuel levy became inadequate to compensate for the high inflation rate experienced during this period. The oil crisis and consequent fuel saving measures as well as a drop in fuel sales helped to worsen the situation. Although an extra limited. It is of course possible that in the not too distant future automatic computerised methods of charging will be introduced, in such a case this toll concept could prove very attractive.

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0,7 cents/litre from fuel sales was allocated to the NRF during the 1983/84 financial year, this allocation was fixed for the next five years. One can therefore expect this additional revenue to be eroded by inflation and should this allocation be reduced or cancelled at the end of the five years, the results will be nothing short of disastrous.

As a result of the Governments reluctance to increase the fuel price and hence increase the allocation to the NRF the National Transport Commission (NTC), in an effort to obtain additional revenue, declared its intention to open toll roads at selected sites a e country.

Although the question of toll roads was and still is highly controversial with critics pointing to the high costs of collection and the lost benefit of the facility, as a result of some users preferring not to use the road due to the toll levy, the first toll project was opened in June 1984. Further toll roads can be expected in the near future, for in the interim it would appear the choice presented to the NTC is either "toll roads or no roads".

3.0 METHOD OF APPROACH

The following section proposes a method which examines and quantifies the parameters involved in the decision making process of whether or not to travel via the toll road. An understanding of these parameters is essential if the objective of maximising revenue and loan potential is to be realised. Detailed information from overseas studies on aspects related to this method is also included. The results from the proposed method are presented and discussed in later sections of this report, in an effort to assess its performance.

3.1 The Effects of Toll on Road Usage

Before proposing a method which enables a relationship between road usage and toll rate to be derived, it is essential to understand the importance of this relationship in determining the financial viability of the project.

The financial viability of any toll project is dependent upon the toll revenue and hence the size of loan which can be supported by that toll revenue. The toll revenue is in turn, the product of the traffic volume on the toll road and the toll rate levied for each vehicle class. The calculation of the toll revenue is however not so simple, since the application of tolls will cause some drivers to divert and use alternative routes. The extent of this diversion will depend on the toll rate charged. In a zero toll situation the traffic will be at a maximum, as tolls are introduced some drivers, for whom the perceived cost of travel is less than the toll will divert to the alternative routes. As tolls are further increased more and more drivers will find the benefits of using the toll road outweighed by the cost of the toll, to the point finally where the toll is so prohibitive that the traffic volume will in theory fall to zero[6].

There are many theories relating to the reason for drivers choosing between competing routes, and the problem of modelling traffic assignment must be resolved in all highway feasibility studies, whether or not they incorporate toll collection schemes[7].

The simplest assignment models derive the route which minimises a particular travel parameter and then assigns all or some of the traffic between a particular pair of origins and destinations to that route. The three most commonly used travel parameters are time, distance and cost. In inter-urban and regional traffic studies assignments based on minimum journey time have been found to give a good correlation with observed travel behaviour. Distance based assignments are found to oversimplify peoples perception of travel costs and are not often used: they are insensitive to different standards of highway design and capacity. The use of journey cost or generalised cost is an attempt to combine time and distance costs and is particularly suitable for assignments between routes which incorporate tolls.

The 'costs' which are used in the assignment process are often referred to as the 'perceived' or 'behavioural' costs, since they are the costs which are as[illegible] to affect the decision making process of the trip ma[illegible] They are subjective and different from economic costs which represent the real resources consumed in travel and transport and which are of principal concern to government rather than the trip maker. Generally accepted research findings have shown that people base their decisions on an imperfect understanding of the true costs involved and that they generally under-estimate the running costs of vehicles; for instance, depreciation and interest costs are rarely considered by the private motorist. An example of the way in which perceived costs can be calculated is:

Vehicle Class	Perceived Cost
Car	Fuel and in-vehicle travel time
Buses and taxis	Fare plus in-vehicle travel time
Goods Vehicles	Financial cost of travel

Research has also indicated that the valuation of travel time varies according to the type and standard of road. Trip makers tend to place a higher value on time savings for journeys that involve travel on a major highway as opposed to a minor road. In the case of a journey using a toll road the toll would of course also be included in the cost of the journey.

Once journey costs between the various origins and destinations by the alternative routes have been calculated the journeys are assigned to the various competing routes. The initial process usually adopted is to undertake an 'all or nothing' assignment which assigns all the journeys between each origin and destination to one route, but this is generally considered to be unrealistic where alternative routes are close in their respective journey costs. The multi-route assignment method is designed to overcome the shortcomings of the all or nothing method and assumes that drivers have an imperfect knowledge of the cost of using each link: a randomisation technique selects a link cost from a range of values distributed around a mean value. The method is designed principally for use in urban areas and is not usually applied in rural areas, instead, the well tried diversion curve method is extensively used.

3.2 The Diversion Curve

A series of empiric diversion curves have been developed from observations of driver behaviour in the United States of America and have been based on time, distance and cost[6]. As previously explained these curves are based on the assumption that the proportion of traffic using the new toll road is related to the toll rate charged and the perceived saving in the cost of travel offered by the toll road over alternative routes. An example of such a diversion is as follows:

$$P = \frac{1}{1 + ({}^{t}/_{p})^{n}}$$

where:

P is the proportion of traffic using the new toll road,
t is the toll rate charged,
p is the perceived saving in travelling cost of the new toll road over the alternative route/s, and
n is an integer in the range 6-12.

The above diversion curve is shown graphically in Figure 3.

Work undertaken in Malaysia in 1972 confirmed that the curve is generally applicable to Malaysian conditions, however, little fundamental research has been carried out to confirm the basis of this method and the degree to which the assumed perceived costs of travel generally reflect the individual's perceptions of their travel costs.

A modified approach to the above curve is sometimes adopted by substituting the ratio C_1/C_2 for the ratio $t/_p$. In this case C_1 represents the perceived cost of travel on the toll road including toll and C_2 the perceived cost of travel on the alternative route. There is however, no evidence to suggest that this approach is more accurate in determining the diversion rates for traffic under alternative levels of tolls.

Both methods produce the same results at the mid-point of the standard curve, that is when perceived costs on the new toll road and alternative road are equal or when the toll is equal to the perceived saving.

The same diversion curve is applied in studies on French toll roads where the formula is usually expressed as[8]:

$$\frac{T1}{T2} = \left(\frac{C2}{C1}\right)^n$$

where:

C_1 and C_2 are as previously defined, and
T_1 and T_2 are the traffic volumes on the toll road and the alternative road respectively.

In Japan a set of diversion curves have been developed from practical observations on different toll facilities. The curves are available for cars, light goods vehicles and heavy goods vehicles and are expressed in general by the formula[9]:

$$P = \frac{K}{1 + \alpha (T/_S)^{\beta}}$$

where:

P = rate of diversion or more precisely the percentage usage
K = upper diversion percentage (K < 1)
T = toll/time saving
S = shift co-efficient

α and β are constants.

It is interesting to note that with this formula the usage of the toll facility is expressed as a function of the toll/time saving and that only travel time and not travel cost appears in the analysis. However, it is not clear how the graph is applied, for example, if the toll rate is zero the usage of the road is not 100%. It should also be noted that the formula is based on Japanese perception of time and as such is probably not applicable to the South African situation.

The importance of the diversion curve lies in its ability to identify the toll rate which achieves the maximum revenue. Since the objective of toll roads in South Africa, including the Tsitsikamma Toll Road, is to provide an additional revenue source, there is an obvious need to obtain such a curve which is applicable to the particular toll road introduced and/or South African toll roads in general.

In order to identify the toll rate which achieves the maximum revenue the diversion curve is analysed in the following manner, let us assume that the curve is of the following form:

$$P = \frac{1}{1 + (^{t}/_{p})^{n}}$$

where P and n are as previously defined and the integer n has a value of 6.

The total revenue R is equal to the proportion of traffic on the toll road multiplied by the toll rate.

$$R = Pt$$

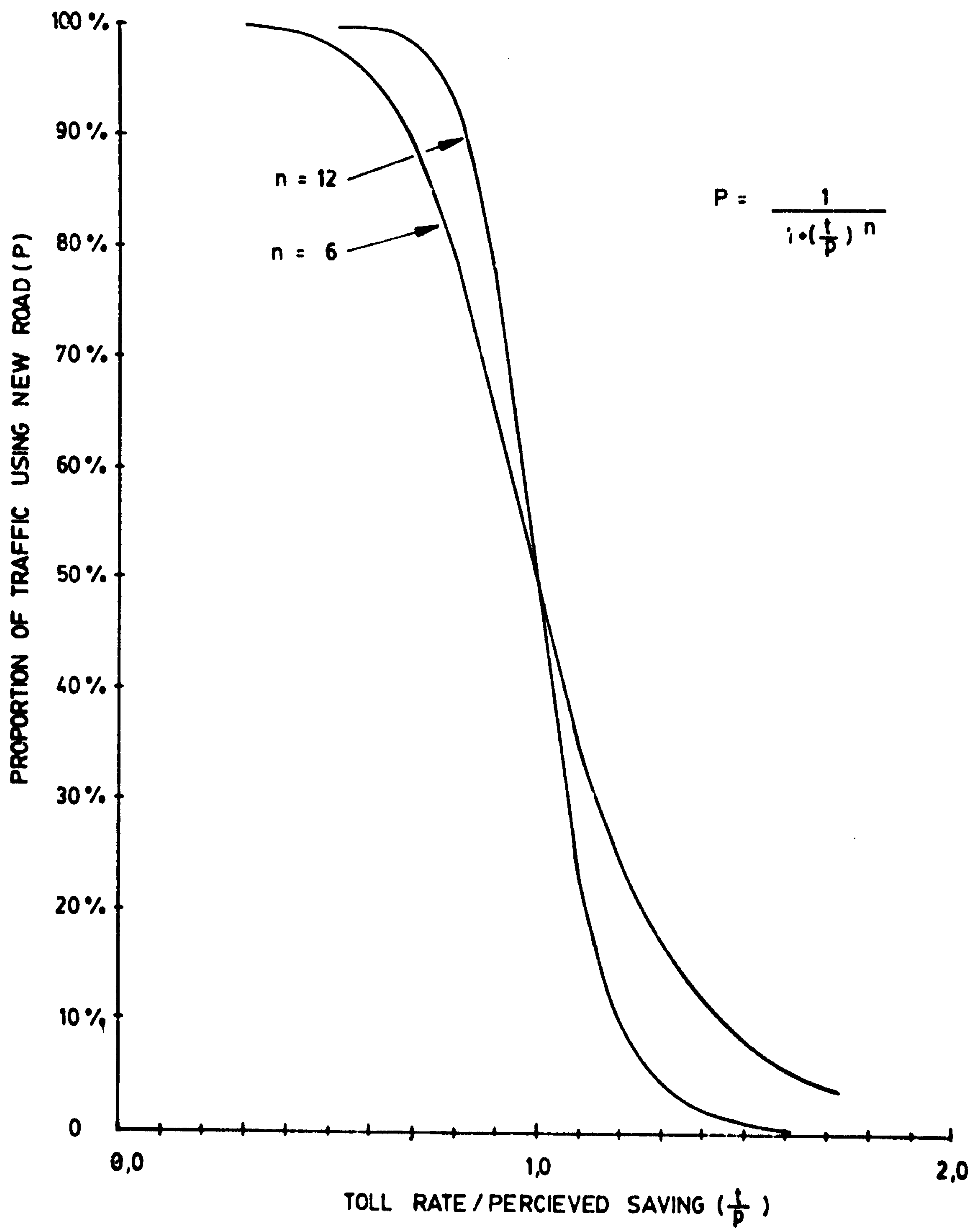
$$\therefore \; R = \frac{t}{1 + (^{t}/_{p})^{6}}$$

to maximise the revenue $\frac{dR}{dt} = 0$

$$\therefore \quad \frac{dR}{dt} = \frac{1 - 5\,(^t/p)^6}{\left[1 + (^t/_p)^6\right]^2} = 0$$

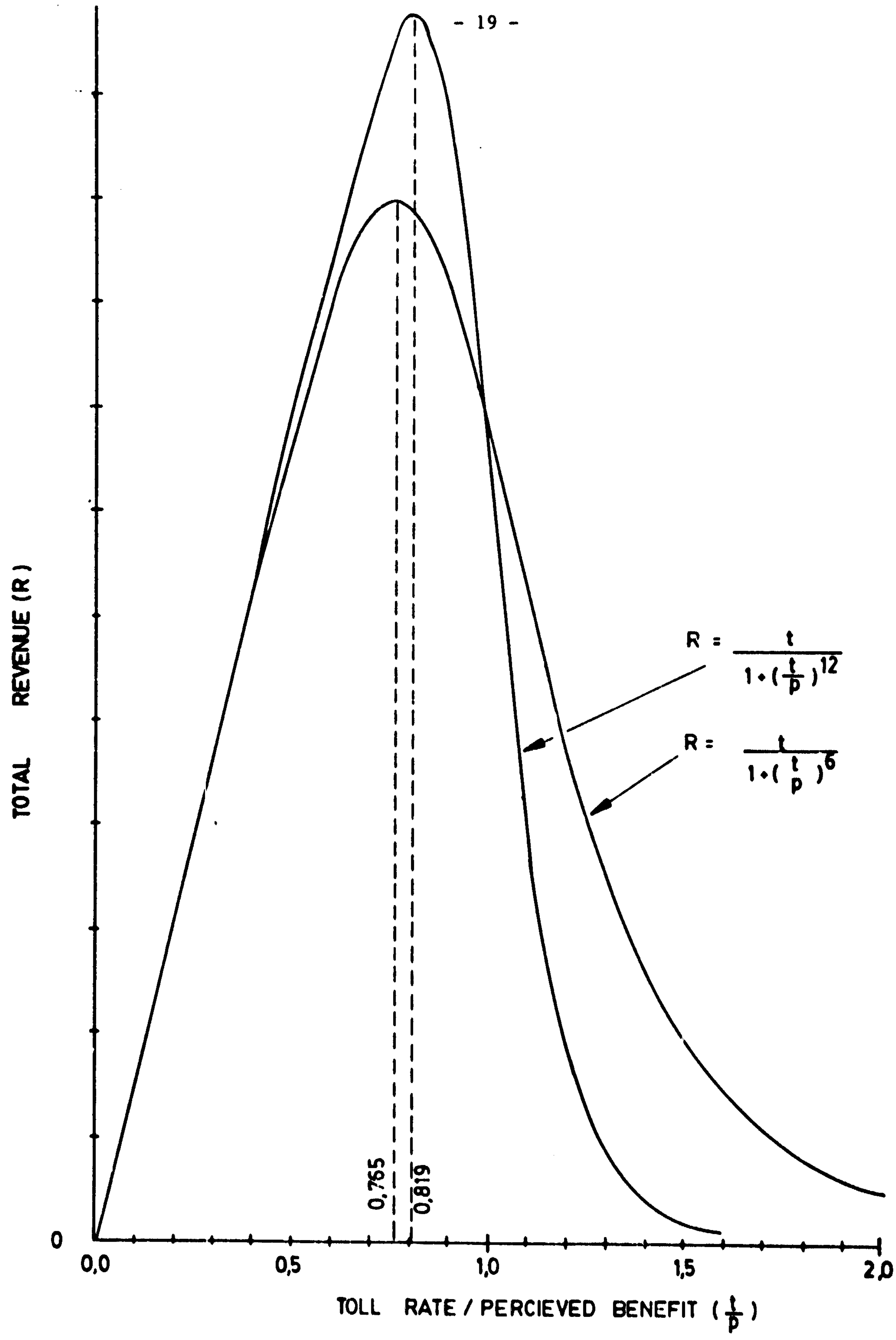
$$\therefore \quad {}^t/_p = 0{,}765 \text{ at } n = 6$$

The toll rate which achieves the maximum revenue therefore equals 0,765 of the perceived saving. The curve showing the relationship between the total revenue and the toll rate/perceived saving is shown in Figure 4.



TRAFFIC DIVERSION CURVE

FIGURE 3



OPTIMUM TOLL RATE

FIGURE 4

3.3 The Proposed Method

In order to obtain information on two of the parameters involved in the diversion curve relationship, namely, road usage and perceived travel cost and to determine the effects of the third parameters, toll rate, the following methods were proposed.

(a) Road Usage

It was obvious that to obtain information on the traffic using the new toll road and the alternative route, traffic surveys would be required. Existing traffic information was also identified and used where appropriate, however, it was evident that this information, by itself, was insufficient for the needs of the study. As road usage is dependent on many variables, e.g. trip purpose, trip frequency, origin and destination, etc., as well as the toll rate charged, it was concluded that the surveys should also be used to establish these variables. In addition, as the opening of the Tsitsikamma Toll Road on 8 June 1984 offered the opportunity of conducting traffic surveys before and after the opening of this facility, it was concluded worthwhile to use this opportunity for the purposes of determining possible traffic generation as a result of the introduction of the new toll road. For this reason the traffic counting surveys were implemented in May 1984 and August 1984.

(b) The Perceived Cost of Travel

In the project feasibility stage of the Tsitsikamma Toll Road the travelling costs and/or the perceived travelling costs incurred on the new toll road and the alternative road were derived by applying the RODES 2 computer programme[10]. The components of the travelling costs calculated by this programme are fuel, time, oil, tyres, accidents, vehicle depreciation and maintenance. In calculating these costs the programme takes into account horizontal and vertical alignment, stop signs, traffic volumes and speed limits. The horizontal and vertical alignment was obtained from the "photo-logger" of the National Institute of Transport and Road Research (NITRR) while for the new toll road this information was obtained from the detail design drawings.

Although from past experience the results from the RODES 2 programme have proved reliable, certain disadvantages were encountered with this method. These can be briefly summarised as follows:

(i) The vehicle classification system used at the Tsitsikamma Toll Road (refer to Figure 5) does not directly correspond to that used by the RODES 2 programme. In order to derive the travelling costs of vehicles in terms of the toll classification system interpolation is required.

(ii) The results from the RODES 2 programme for the 8 ton and 25 ton heavy vehicle are used to determine the travelling costs of the Class 2 and Class 4 vehicles of the toll classification system. There is evidence to suggest that these two vehicles are not representative of all vehicles contained within these two toll vehicle classes.

VEHICLE TYPE CLASSIFICATION

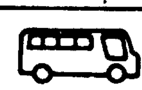
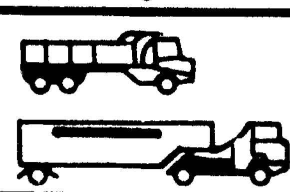
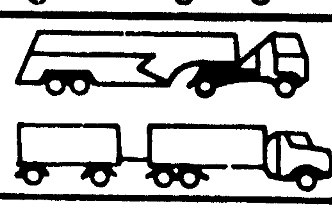
CLASS 1	MOTORCYCLES	
	CARS WITH SHORT WHEELBASE	
	CARS WITH MEDIUM SIZE WHEELBASE	
	CARS WITH LONG WHEELBASE	
	CARS WITH SINGLE AXLE TRAILER	
	CARS WITH TWO AXLES TRAILER	
	TRUCKS OR UTILITY VEHICLES WITH TWO AXLES AND SINGLE WHEELS	
	SMALL BUSES	
CLASS 2	TRUCKS WITH TWO AXLES AND TWIN WHEELS	
	LARGE BUSES	
CLASS 3	TRUCKS WITH THREE AXLES	
CLASS 4	TRUCKS WITH MORE THAN THREE AXLES	

FIGURE 5

(iii) By defining a heavy vehicle in terms of mass only e.g. 25 ton, it was difficult to assess to what particular heavy vehicle the results apply, for instance a 25 ton heavy vehicle could be a 10 ton unladen vehicle with a 15 ton payload or a 15 ton unladen vehicle with a 10 ton payload. In practice one would expect a substantial difference in operating costs for these different vehicle types.

(iv) The RODES 2 programme cannot calculate the operating costs of heavy vehicles for the unloaded and loaded cases. Again one would expect a substantial difference in operating costs for these two curves.

(v) It has bee difficult for the officials of the Department of Transport to assure the public at large that the operating costs derived by the RODES programme correctly reflect the actual costs incurred. The public in general do not understand how these costs have been derived and are generally suspicious of computer programmes which calculate the costs they personally experience.

In view of the above, it was thought benefical to investigate an alternative method which could be used to establish the required parameters. This alternative method would be of great value if it was capable of being understood by the public at large and if it could verify the results previously obtained.

It was concluded that one obvious method was to undertake field tests where the two major components of the perceived cost of travel, namely, the fuel and time costs, could be recorded for various vehicles on both the toll road and the alternative road. It was known that the NITRR was currently expanding the scope of the Traffic Engineering Logger (TEL) so that it could be used in such areas of work and as such the NITRR were contacted in this regard.

The T.E.L.[11)] which was developed at the NITRR, was initially intended to record arrival time, speed, length and type of vehicle travelling over a set of loops embedded in the road surface. With this stage of the development successfully completed it was evident that the instrument had a great potential for the retrieval of various other traffic data. The small dimensions and low cost of the equipment make it well suited for in-vehicle use, where it can be used to monitor and obtain data relating to the trip being undertaken. In this case the TEL equipment is placed next to the driver of the vehicle and connected through a four channel input to transducers which accurately measure the fuel consumption, time taken, speed attained, distance travelled and riding quality of the road. By using this equipment in road tests on both the alternative road and the new toll road, the savings in fuel and time and comparisons of speed and rideability can be attained. This accurate knowledge, on the major components of travel cost, can then be supplemented with information, from the NITRR and/or the Public Carriers Association, on the other costs involved in travel, such as, oil, tyre, maintenance, depreciation and accident costs which may or may not be, depending on vehicle type, involved in the perceived travel cost. (The components of the perceived travel cost per vehicle type will be discussed later in this section.)

After discussions with representatives of the NITRR, permission was obtained to use the TEL equipment at the Tsitsikamma Toll Road, however the use of this equipment was restricted to a passenger vehicle only, namely, the test vehicle of the NITRR. Since heavy vehicles could only be obtained through hiring and as such were not the property of either the DOT or the NITRR the required modifications to these vehicles, which are necessary when installing the TEL equipment, could not be made. In order to derive a complete set of results from the field tests it was decided to establish fuel and time measurements for the heavy vehicles by more conventional methods. Travel times were recorded by stop watch and fuel consumptions by "topping up the tank", all refuelling of the heavy vehicles being undertaken at the same location. Although the topping up method may appear somewhat lacking, it was noted that with the length of travel involved the heavy vehicles would consume in the order of twenty to seventy litres of fuel per run, depending on the vehicle and route used. An error in measurement, of say, one litre would therefore only induce a maximum error of 5%. In addition, in order to verify the accuracy of the "topping up" method, it was proposed that this method also be used with the NITRR test vehicle and a second passenger car, in this way comparisons could be made.

Having decided on how to obtain values for the major components of the travel cost the next step was to decide which types of heavy vehicle should be involved in the field tests. It was noted that Freeman[12)] when choosing five heavy vehicles to represent the full spectrum of heavy vehicle usage in South Africa, adopted the following:

(i) 4 x 2 Rigid Truck, Gross Mass (loaded) = 14,2 tons
(ii) 6 x 4 Rigid Truck, Gross Mass (loaded) = 22,4 tons
(iii) 4 axle artic, Gross Mass (loaded) = 32,7 tons
(iv) 5 axle artic, Gross Mass (loaded) = 39,0 tons
(v) 7 axle artic, Gross Mass (loaded) = 49,0 tons

In selecting the above it was the intention to cover the main vehicle classes within the heavy vehicle category and the range of gross weights up to 50 tons. Other possibilities were rejected because they were not significant or because it was extremely difficult with existing data to allocate costs successfully. As the heavy vehicle category is highly sensitive to axle configuration, the more popular types of heavy vehicles, in terms of past vehicle sales were chosen.

By examining the above vehicles in terms of the toll classification system at the Tsitsikamma Toll Road it was concluded that (i) and (ii) represent Class 2 and Class 3 respectively and hence the use of these vehicles in the field tests was proposed. (At a later stage the field tests for the Class 3 vehicle were cancelled for financial reasons.) The vehicles in (iii), (iv) and (v) were all however defined by the Class 4 classification, so in order to select one of these three vehicles the vehicle sales for each of the three were examined. This examination revealed that nearly 50% of the combined sales of the three vehicles were for the 5 axle artic. As a result this vehicle was selected as representative of Class 4 and was consequently used in the field tests.

The above proposals enable the individual costs involved in the travel cost to be determined, they do not however identify which costs are involved in the perceived travel cost. In the project feasibility stage of the Tsitsikamma Toll Road the perceived travel cost was defined in terms of the fuel and time cost only. The fuel cost used was self-explanatory in that this was the number of litres consumed multiplied by the price paid per litre at the "pump", however the time cost used needs further explanation as this varied per vehicle type.

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The above proposals enable the individual costs involved in the travel cost to be determined, they do not however identify which costs are involved in the perceived travel cost. In the project feasibility stage of the Tsitsikamma Toll Road the perceived travel cost was defined in terms of the fuel and time cost only. The fuel cost used was self-explanatory in that this was the number of litres consumed multiplied by the price paid per litre at the "pump", however the time cost used needs further explanation as this varied per vehicle type.

The objective when undertaking a journey by passenger vehicle is the convey the occupants of that vehicle to a predetermined destination. the time costs incurred on the trip are therefore related to the costs of the occupants time. When undertaking a journey involving a goods vehicle however, the objective of the trip is to convey the goods to a pre-determined destination, one could therefore presume a time cost related to the goods being carried, in addition to time costs for the operating staff of the goods vehicle. The time cost related to the goods carried, alternatively termed the productivity cost, would result from the earlier arrival of the goods at their destination and hence the opportunity for the vehicle concerned to undertake an additional trip elsewhere. This additional trip can therefore be used to derive income. This opportunity to derive income is important in that the income can be used to offset the fixed or standing cost of the vehicle; a cost which is very obvious to the owner of the goods vehicle and which is incurred whether the vehicle is in operation or not. In the feasibility stage the time cost was therefore assumed to equal the fixed or standing cost incurred for heavy vehicles, while for passenger vehicles the time cost related to the occupants time only. This approach resulted in the following rates:

Vehicle Class	Class 1	Class 2	Class 3	Class 4
Time cost/h	R 4,00	R 8,00	R17,20	R26,80

The above approach appears logical when discussing cost savings resulting from the saving of several hours of time, however, when related to small increments of time it is dubious whether such an approach is valid. A reduced travel time of several minutes or even one hour (which may be the case for the heaviest goods vehicle when comparing alternative routes at the Tsitsikamma Toll

Road) can hardly provide the opportunity to undertake additional revenue earning trips and hence no time cost saving for the goods vehicle should be assumed, however, on the assumption that the driver of the vehicle is paid on a hourly basis, an argument for the inclusion of time related costs for the driver, and any other on vehicle staff, could be made. It is acknowledged that the owners of goods vehicles are more readily aware of the costs of travel than car owners and with this in mind, the following approach for determining the components of the perceived travel cost is preferred for this study.

From the literature search undertaken, it is obvious that for passenger vehicles the components of the perceived cost of travel are the fuel and oil cost and the occupants time cost. Since the oil cost is negibible this cost approximates to the cost of fuel and time only. This approach is identical to that used in the project feasibility stage and is also adopted for this study. For heavy venicles, the definition of the perceived cost of travel is based on the assumption that the owner is aware of all the costs incurred, for this reason it is defined as the financial cost of travel. The need is therefore to identify the financial costs which are involved in the decision making process of whether tc travel via the toll road or the alternative road. This process concludes that these costs are in fact solely the full operating costs plus the cost of the drivers and any other on-vehicle staff time. The fixed cost which is comprised of costs such as licence fees, depreciation, insurance, interest or capital, etc. does not influence route choice and should therefore not be included in the perceived cost of travel and hence toll rate determination. The components of the perceived travel cost used in this study can therefore be summarised as follows:

Class 1	Fuel cost and occupants time cost
Class 2, 3 & 4	Fuel, oil, tyre and variable maintenance cost and occupants time cost

(c) Toll Rate

Since it is not possible to vary the toll rates at the plaza, the reaction of drivers to different toll rates must be assessed by means of a roadside interview. The first decision to be made was therefore where the interview should take place. The siting of the interview station was of course dependent on the geometrics of the road concerned, however, what had been established initially was whether the interview should take place on the toll road itself and/or on the alternative road.

It was concluded that during the interview the driver should be asked if he/she will travel on the toll road at a specific toll rate and then have the question repeated for different toll rates. This method was preferred to the method where the driver was simply asked at what toll rate he/she would decide to use or decide not to use the toll road, the question being phrased depending on which road the interview was being undertaken. Although the initial approach was preferred it was in proposing that the interview be conducted in either of the above methods that the advantage of having the interview on the alternative road became apparant, for the following reason.

In conducting the interview on the toll road the drivers reaction to higher toll rates, than those presently levied at the Tsitsikamma must be assessed. In answering any question aimed at establishing this reaction, it was evident that it was in the drivers interest to keep the value of his/her answer as low as possible, as there would be suspicion that the toll rates were to be increased. Previous studies[13)] have encountered this problem where it has been difficult to interpret the respondents stated intentions to reflect their actual actions. If the roadside interview was carried out on the alternative road with the question structured as recommended and asked in order of decreasing toll rates e.g. R1,20 then R1,00 etc., then the driver would not believe that the object of the interview was to introduce a lower toll rate.

In addition to proposing that the roadside interview be conducted on the alternative road it was evident that various other factors influencing road usage would have to be assessed. These factors were identified as follows:

- Trip Origin and Destination. It was reasoned that a high percentage of local traffic would continue to use the alternative road for reasons related to convenience rather than because the new road was tolled, it was therefore necessary to identify both local and through traffic movements.

- Trip Purpose. Since a large porportion of the perceived benefit of the toll road is comprised of time savings it was necessary to distinguish between work trips and pleasure trips. The value of time for these two trip types being significantly different.

- Trip Frequency. Preference for use of the toll road or the alternative road could be dependent on trip frequency. For example, persons visiting the area for the first time may have a desire to view the passes along the alternative road while on the contrary, persons involved in daily trips may have the desire only to choose the quickest route.

- Other Reasons for not Using the Toll Road. It is widely known that the passes on the alternative road have great scenic beauty. A driver undertaking a work trip for example, could therefore still show a preference for using the alternative road. Not all work trips, especially if they are return trips, are time dependent.

The effect on the above factors on road usage was considered vitally important since it should be remembered that the objective of the study was to assess traffic diversion with respect to toll. If this diversion was derived by simply comparing the ratio of the total traffic on the alternative road to the total traffic on both the alternative road and the toll road, the results obtained would not achieve this objective. A portion of the traffic on the alternative road could be using this road for any of the reasons listed above and not for reasons associated with the toll, in other words, this traffic would not have used the toll road even if no toll existed. Identification of the factors listed above was therefore necessary to obtain the correct ratio required, which is:

$$\frac{\text{Through Traffic on Toll Road (at } t=o) - \text{Through Traffic on Toll Road (at } t = t)}{\text{Through Traffic on Toll Road (at } t = o)}$$

where t = the toll rate imposed.

For the toll rate presently employed at the Tsitsikamma the above ratio could be determined with the aid of the information gathered at the roadside interview. In addition the drivers reaction to the lower toll rates would also be used to determine how the traffic on the toll road could be increased as a result of these lower tariffs. To determine drivers reaction to higher toll rates it was proposed that the curve obtained from the two former cases be extrapolated to achieve the overall result, this method being preferred, for the reason previously stated, to the alternative of conducting a second interview on the toll road.

Having established the requirements of the survey it was concluded that meaningful results on the toll rate/road usage relationship could only be achieved for passenger vehicles. For heavy vehicles the decision on whether to use the toll road or the alternative road would be taken not by the driver but rather by the owner, hence the drivers reaction to different toll rates would be somewhat irrelevant. For this reasion the questionnaire was designed specifically with passenger vehicles in mind. Interviews with heavy vehicle drivers, using the same questionnaire, were still proposed, but in this case only questions relating to trip origin, destination, frequency etc. would be asked.

In addition it was decided that the race of the driver and the vehicle occupancy would be logged in order to provide additional information on time cost implications, while the age and sex of the driver would also be logged for cross tabulation purposes.

Finally, with the knowledge that the interview would take place on the alternative road an appropriate site with the required sight distance and safe stopping area was identified. This site was located adjacent to the traffic counter at the Old Road Centre Station and as such was in the vicinity of the toll plaza. The questionnaire design was finalised by taking into account the abovementioned requirements and the suvey scheduled for Friday 24 August and Saturday 25 August 1984. The questionnaire used in the roadside survey is shown on the following page.

DEPARTMENT OF TRANSPORT/UNIVERSITY OF THE WITWATERSRAND JOINT RESEARCH PROJECT

ROADSIDE SURVEY FOR TSITSIKAMMA TOLL ROAD

DATE: .... LOCATION OF SURVEY STATION: ....

Good Morning/Afternoon. I am .... from the Department of Transport, Pretoria. I am involved in research aimed at establishing the public's reaction to the toll road. I would appreciate your co-operation in answering a few questions.

1. How frequently do you drive along this road?

   [Every day] [Once a week] [Once a month] [Less than once a month]

2. What is your destination? ....

3. Where are you coming from? ....

4. What is the purpose of your journey?

   [Work] [Pleasure]

5. Why did you NOT use the toll road?

   [Too expensive] [Less direct] [Less scenic] [Refuse to pay toll] [Other]

6. The present toll rate for a car is R1,50, if the toll was decreased to:

   R1,20 would you use the toll road? [ ]

   R1,00 would you use the toll road? [ ]

   R0,80 would you use the toll road? [ ]

   R0,60 would you use the toll road? [ ]

Thank you for your co-operation.

Direction of travel [Eastbound] [Westbound]

Sex of respondent [Male] [Female]

Race of respondent [Non-white] [White]

Age of respondent [Under 30] [30 - 60] [Over 60]

Vehicle occupancy [1] [2] [3] [4] [> 4]

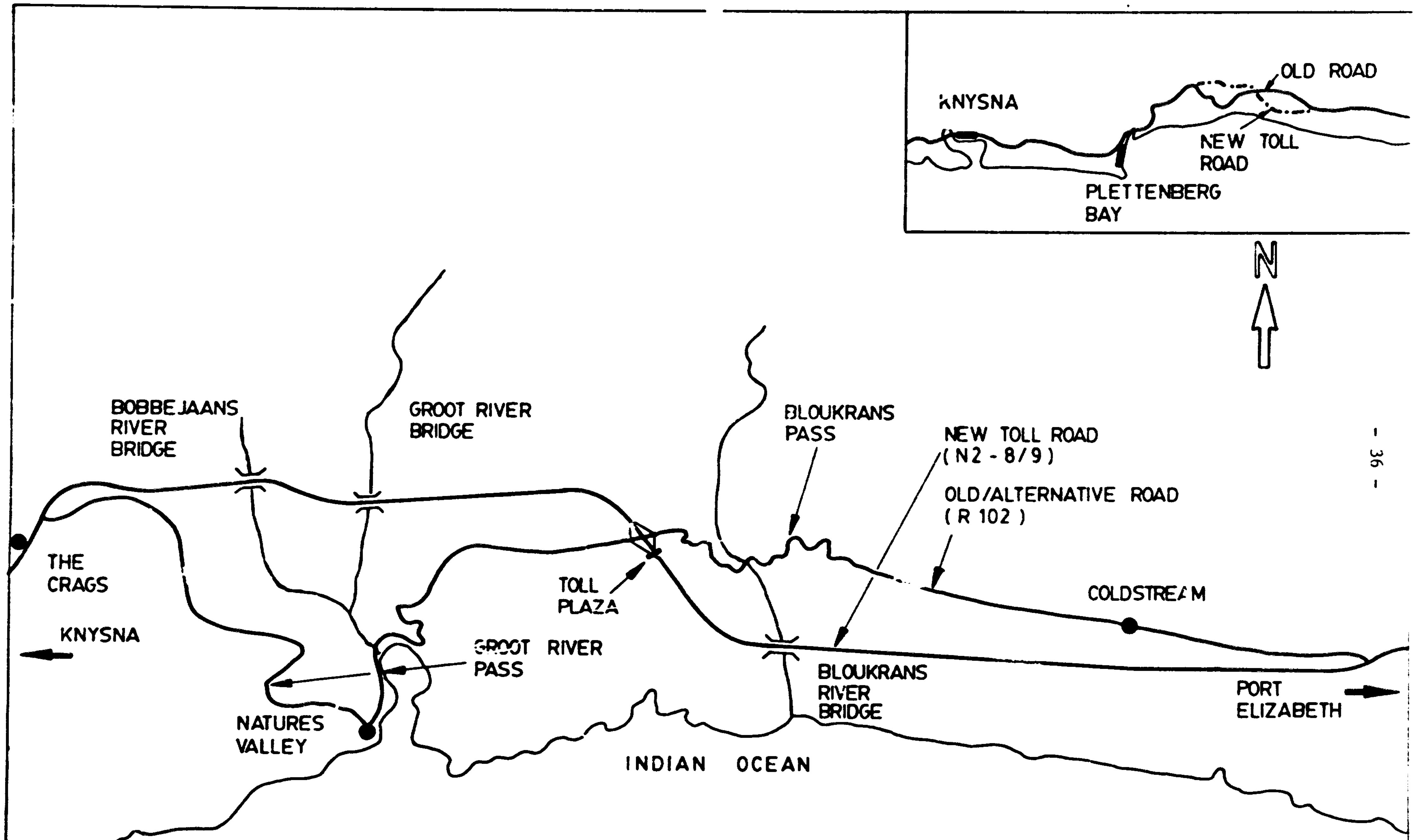
4.0 TRAFFIC COUNTING SURVEY RESULTS

The following section describes the alignment of the old road and the toll road within the study area and details the results of the traffic surveys undertaken on these two roads.

4.1 Road Network (refer Figure 6)

The Tsitsikamma Toll Road, otherwise referred to as National Route 2 Sections 8 and 9, begins at a point 21 km east of Plettenberg Bay. The road extends eastwards from this point crossing the Bobbejaans, Groot and Bloukrans Rivers before ending approximately 5 km east of Coldstream. At the crossing of the above rivers the now well known Garden Route Bridges may be found while at the mid point of this new road, South Africa's first toll plaza, in recent times, is situated. The plaza is located at the diamond interchange at the crossing of the old and new roads. The new road is in total, 28 km long.

Along the complete length of the new road the old road is still open to traffic and provides an alternative road of scenic beauty. This alternative road traverses two passes, the Groot River Pass and the Bloukrans Pass which are also well known, the passes being constructed approximately a century ago by pioneer civil engineer, Thomas Bain. The old/alternative road is in total, 37 km long.



LOCALITY PLAN

SCALE 1 : 100 000

FIGURE 6

4.2 Existing Traffic Data

In December 1982 the Department of Transport installed a permanent traffic counter on the old road just east of the Groot River Pass (refer to Figure 7). Although overall this counter proved reliable, the figures from the count were distorted as they included the construction traffic which was involved in the bridge and road contracts and which also used the old road. As the counter distinquished between light, medium and heavy vehicles and did not classify the traffic per the envisaged toll classification system and, as it was necessary to determine the proportion of construction traffic recorded, several additional surveys involving the manual classification of vehicles were undertaken. The results from all the surveys were then analysed and the following results derived:

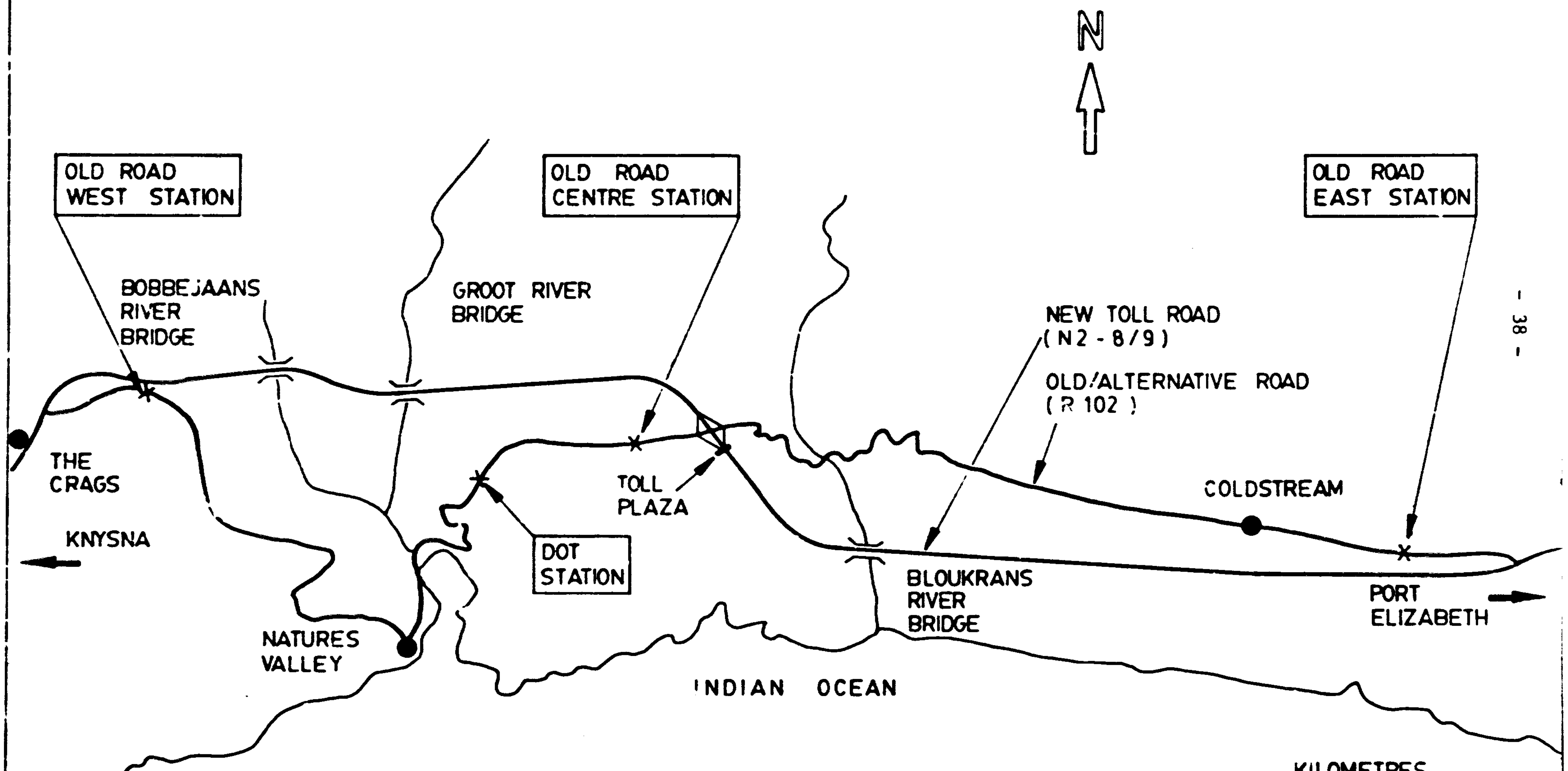
- The average annual daily traffic, AADT in 1983 was estimated as 1 162 vehicles/day

- The average annual daily traffic, AADT (excluding construction traffic) in 1983 was 967 vehicles/day

- The composition of the traffic in terms of the toll classification system was as follows:

Class 1	Class 2	Class 3	Class 4
85%	6%	3%	6%

The seasonal variation in the above traffic flows are shown in Figure A-1, Appendix A.



LOCATION OF TRAFFIC COUNTING STATIONS

SCALE 1 : 100 000

FIGURE 7

4.3 Traffic Counting Survey - May 1984

The main objective of the survey prior to the opening of new road was to verify the average daily traffic figures and the composition of the traffic initially determined by the DOT.

By examining Figure 6 it can be seen that the only significant development along the old road is concentrated at Natures Valley and Coldstream. In order to allow for variations in traffic flows due to these local generators it was thought beneficial to set up three counting stations; one west of Natures Valley, one between Natures Valley and Coldstream and one east of Coldstream (refer to Figure 7). Results from these stations when analysed, would therefore indicate the average daily traffic along the entire length of the old road. In addition, as the construction traffic from the bridge and road contracts had necessitated additional surveys in order to ascertain the true ADT at the DOT counter, it was thought advantageous to undertake the counts as close as possible to the opening date of the new road. At this time the new road and bridges, although not open to the public in general, would be open to construction traffic. This construction traffic on the new road would therefore not interfere with the counts on the old road.

Although the counting at the three stations was over five days only, it should be remembered that the permanent DOT station had recorded the traffic flows for everyday in 1983. As the objective of the survey was to verify the results of the DOT counter the comparison of the five day period in 1984, namely 24 May to 29 May to the same period in 1983, was considered adequate for this purpose.

The results obtained from the May 1984 survey were as follows:

- The ADT at the three old road stations shown in Figure 7, for the period 24 May to 29 May 1984 was:

Old Road West Station	809 vehicles/day
Old Road Centre Station	714 vehicles/day
Old Road East Station	875 vehicles/day

The daily variations in the above traffic flows are shown in Figures A-2, A-3, A-4 and Tables A-1, A-2 and A-3, Appendix A.

- The ADT at the DOT station, east of the Groot River Pass, for the same time period in 1983 (excluding construction traffic) was 733 vehicles/day.

As the old road centre station is the closest station to the DOT station and as both stations are situated between the two passes the above results show good correlation. The DOT concluded that the AADT on the old road in 1983 (excluding construction traffic) was 967 vehicles/day. The counts undertaken in May 1984 confirm that this figure is realistic, however, it must be noted that the figure of 967 vehicles/day is the average total traffic between the two passes only, and should not be interpreted as the average through traffic on the old road. Further surveys are required to determine this latter parameter.

- The average composition of the traffic at the three stations for the period 24 May to 29 May 1984 was:

Class 1	Class 2	Class 3	Class 4
88%	7%	2%	3%

- The average composition of the traffic recorded at the DOT station in 1983 was:

- The ADT at the three old road stations shown in Figure 7, for the period 24 May to 29 May 1984 was:

Old Road West Station	809 vehicles/day
Old Road Centre Station	714 vehicles/day
Old Road East Station	875 vehicles/day

The daily variations in the above traffic flows are shown in Figures A-2, A-3, A-4 and Tables A-1, A-2 and A-3, Appendix A.

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Class 1	Class 2	Class 3	Class 4
88%	7%	2%	3%

- The average composition of the traffic recorded at the DOT station in 1983 was:

Class 1	Class 2	Class 3	Class 4
85%	6%	3%	6%

Although the correlation between the above traffic compositions is not as good as the correlation between the vehicle counts, it should be remembered that the presence of the construction traffic on the old road for the greater part of the DOT count, did complicate derivation procedures. In some instances the construction traffic was not easily identifiable and assumptions were required. It is therefore concluded that these assumptions introduce the differences found above.

4.4 Traffic Counting Surveys - August 1984

The objective of the counting surveys after the opening of the toll road was to determine the average daily traffic figures and the composition of the traffic on both the toll road and the alternative road. To determine the ADT on the alternative road the same three counting stations were used, the duration of the count being seven days, namely, 23 August to 30 August 1984. To determine the ADT and the composition of the traffic on the toll road, the counts from the toll plaza were used. Traffic counts for all classes of vehicles on both the through road and the four ramps for the month of August were available.

The results obtained from these two sources are detailed below:

- The ADT at the three old road stations shown in Figure 7, for the period 23 August to 30 August 1984 was:

Old Road West Station	239 vehicles/day
Old Road Centre Station	119 vehicles/day
Old Road East Station	277 vehicles/day

The daily variations in the above traffic flows are shown in Figures A-5, A-6 and A-7 and Tables A-4, A-5 and A-6, Appendix A.

- The ADT on the toll road east and west of the toll plaza for the month of August 1984 was 818 vehicles/day and 784 vehicles/day respectively, the average composition of this traffic being:

Class 1	Class 2	Class 3	Class 4
86,9%	4,9%	2,85%	5,35%

- The average daily through traffic on the new toll road was 770 vehicles/day, the composition of this traffic being:

Class 1	Class 2	Class 3	Class 4
87,7%	4,9%	2,5%	4,9%

(Additional traffic information collected at the toll plaza is shown in Figures A-8, A-9, A-10, A-11 and A-12, Appendix A.)

4.5 Comparison between 1983 and 1984 traffic data

From the DOT counter, east of the Groot River pass, the ADT figures for May and August 1983 are as follows: (refer Figure A-1, Appendix A)

	May 1983	August 1983
Total Traffic (vehicles/day)	983	752
Excluding Construction Traffic (vehicles/day)	733	655

From the traffic information obtained in May and August 1984, the ADT figures on the old road and the toll road are as follows:

	May 1984	August 1984
Old Road	714	119
Toll Road	-	784
Totals	714	903

Since the combined ADT figures on the old road and the toll road for August 1984, are approximately 40% higher than those on the old road for August 1983 it would appear that the opening of the toll road has resulted in an incredible amount of generated traffic. Since the percentage increase is so high however it is appropriate not to draw any conclusions at this stage. In all probability this effect is more short-term and is the result of curiosity over the three Garden Route Bridges and South Africa's only toll road.

5.0 FIELD TEST RESULTS

Section 5.0 details the results of the field tests undertaken between the 26th and 29th August 1983. A comparison between these results and those used in the project feasibility stage, namely, the results from the RODES 2 programme, is also included.

The Results from the Field Tests

previously outlined the decision on route choice is based, the most part, on a comparison between the fuel that will used and the time that the journey will take. From the easurements taken on the field tests on the old road and the toll road at the Tsitsikamma, the differences in fuel used and time taken were re[illegible]led as follows:

VEHICLE TYPE	VEHICLE CLASS PER TOLL CLASSIFICATION	TIME SAVINGS (MINS)	FUEL SAVINGS (LITRES)
CAR 1600 cc	1	14,93	0,90
CAR 2000 cc	1	15,30	1,02
4 x 2 TRUCK UNLOADED G.M. 6,2t	[illegible]	19,53	2,90
4 x 2 TRUCK LOADED G.M. 14,2t	2	38,18	5,65
5 AXLE ARTIC UNLOADED G.M. 15,8 t	[illegible]	23,70	12,00
5 AXLE ARTIC LOADED G.M. 38,8 t	[illegible]	58,91	17,80

TABLE 1

RESULTS FROM FIELD TESTS

5.0 FIELD TEST RESULTS

Section 5.0 details the results of the field tests undertaken between the 26th and 29th August 1983. A comparison between these results and those used in the project feasibility stage, namely, the results from the RODES 2 programme, is also included.

5.1 The Results from the Field Tests

As previously outlined the decision on route choice is based, for the most part, on a comparison between the fuel that will be used and the time that the journey will take. From the measurements taken on the field tests on the old road and the toll road at the Tsitsikamma, the differences in fuel used and time taken were recorded as follows:

VEHICLE TYPE	VEHICLE CLASS PER TOLL CLASSIFICATION	TIME SAVINGS (MINS)	FUEL SAVINGS (LITRES)
CAR 1600 cc	1	14,93	0,90
CAR 2000 cc	1	15,30	1,02
4 x 2 TRUCK UNLOADED G.M. 6,2t	2	19,53	2,90
4 x 2 TRUCK LOADED G.M. 14,2t	2	38,18	5,65
5 AXLE ARTIC UNLOADED G.M. 15,8 t	4	23,70	12,00
5 AXLE ARTIC LOADED G.M. 38,8 t	4	58,91	17,80

TABLE 1

RESULTS FROM FIELD TESTS

5.2 Calculation of the Perceived Travel Cost Saving

Since this report proposes that different components be used to establish the perceived cost of travel for heavy vehicles, than those used in the project feasibility stage, the perceived cost of travel for all vehicles will be derived by both of the following methods:

- The method proposed by this report
- The method used in the project feasibility stage

In addition the results derived in the project feasibility stage are also included for comparative purposes.

(a) The method proposed by this report - Method A

The following rates are used in conjunction with the results from the TEL given in Section 5.1.

Class 1	Fuel	59,6 cents/litre
	Occupants Time	8,00 Rand/hour

The figure of R8,00/h was based on rates for occupants time from the NITRR[14)] and supplemented with information on vehicle occupancy, trip purpose and race of driver from other rural road toll studies in South Africa (refer to Appendix B for detailed calculations).

Class 2	Fuel	59,0 cents/litre
	Occupants Time	4,20 Rand/hour
	Oil	1,2 cents/km
	Tyre Wear	5,3 cents/km
	Variable Maintenance	12,7 cents/km
Class 4	Fuel	59,0 cents/litre
	Occupants Time	9,20 Rand/hour
	Oil	1,9 cents/km
	Tyre Wear	16,0 cents/km
	Variable Maintenance	14,1 cents/km

The results for the perceived cost of travel are therefore as follows:

VEHICLE TYPE	VEHICLE CLASS PER TOLL CLASSIFICATION	TIME SAVINGS (RAND)	FUEL SAVINGS (RAND)	DISTANCE SAVED 9 KM			TOTAL SAVING (RAND)
				OIL SAVINGS (RAND)	TYRE SAVINGS (RAND)	VARIABLE MAINTENANCE SAVINGS (RAND	
CAR 1600 cc	1	1,99	0,54	N/A	N/A	N/A	2,53
CAR 2000 cc	1	2,04	0,61	N/A	N/A	N/A	2,65
4 x 2 TRUCK UNLOADED	2	1,37	1,71	0,11	0,48	1,14	4,81
4 x 2 TRUCK LOADED	2	2,67	3,33	0,11	0,48	1,14	7,73
5 AXLE ARTIC UNLOADED	4	3,63	7,08	0,17	1,44	1,27	13,59
5 AXLE ARTIC LOADED	4	9,03	10,50	0,17	1,44	1,27	22,41

TABLE 2

PERCEIVED TRAVEL COST SAVING - PREFERRED APPROACH USING MEASUREMENTS OBTAINED FROM FIELD TESTS

(b) The method used in the project feasibility stage - Method B

The following rates are used in conjunction with the results from the TEL given in Section 5.1.

Class 1	Fuel	59,6 cents/litre
	Time	4,00 Rand/hour
Class 2	Fuel	59,0 cents/litre
	Time	8,00 Rand/hour
Class 3	Fuel	59,0 cents/litre
	Time	26,80 Rand/hour

VEHICLE TYPE	VEHICLE PER TOLL CLASSIFICATION	TIME SAVINGS (RAND)	FUEL SAVINGS (RAND)	TOTAL SAVINGS (RAND)
CAR 1600 cc	1	1,00	0,54	1,54
CAR 2000 cc	1	1,02	0,61	1,63
4 x 2 TRUCK UNLOADED	2	2,60	1,71	4,31
4 x 2 TRUCK LOADED	2	5,09	3,33	8,42
5 AXLE ARTIC UNLOADED	4	10,59	7,08	17,67
5 AXLE ARTIC LOADED	4	26,31	10,50	36,81

TABLE 3

PERCEIVED TRAVEL COST SAVING - FEASIBILITY REPORT APPROACH USING MEASUREMENTS OBTAINED FROM FIELD TESTS

(c) The results derived in the project feasibility stage - Method C

In the project feasibility stage the same rates as given in Section 5.2(b) were used. The savings in fuel consumed and time taken were however obtained from the RODES 2 programme. The results were as follows:

VEHICLE TYPE	VEHICLE CLASS PER TOLL CLASSIFICATION	TIME SAVINGS (MINUTES)	FUEL SAVINGS (LITRES)	TIME SAVINGS (RAND)	FUEL SAVINGS (RAND)	TOTAL SAVINGS (RAND)
CAR	1	13,8	1,21	0,92	0,72	1,64
TRUCK G.M. 8t	2	16,9	4,24	2,25	2,50	4,75
TRUCK G.M. 25t	4	27,9	11,98	12,48	7,07	19,55

TABLE 4

PERCEIVED TRAVEL COST SAVING - FEASIBILITY REPORT APPROACH USING RESULTS OBTAINED FROM RODES 2 PROGRAMME

5.3 Comparison of Results

The value of the perceived travel cost savings when derived by the three different methods are summarised in Table 5. To enable further comparisons between the TEL results and the RODES 2 results, the speed profiles measured by the TEL and calculated by the RODES 2 programme are shown in Figures 8, 9, 10 and 11. Other profiles, namely, acceleration rates w.r.t. time and distance w.r.t. time, which were obtained from the TEL but which are not available from the RODES 2 programme are included in Appendix B.

METHOD	CLASS 1	CLASS 2		CLASS 4	
		UNLOADED	LOADED	UNLOADED	LOADED
A. METHOD PROPOSED BY THIS REPORT	R2,53 to R2,65	R4,81	R7,73	R13,59	R22,41
B. FEASIBILITY METHOD & TEL	R1,54 to R1,63	R4,31	R8,42	R17,67	R36,81
C. FEASIBILITY METHOD & RODES 2	R1,64	R4,75		R19,55	

TABLE 5

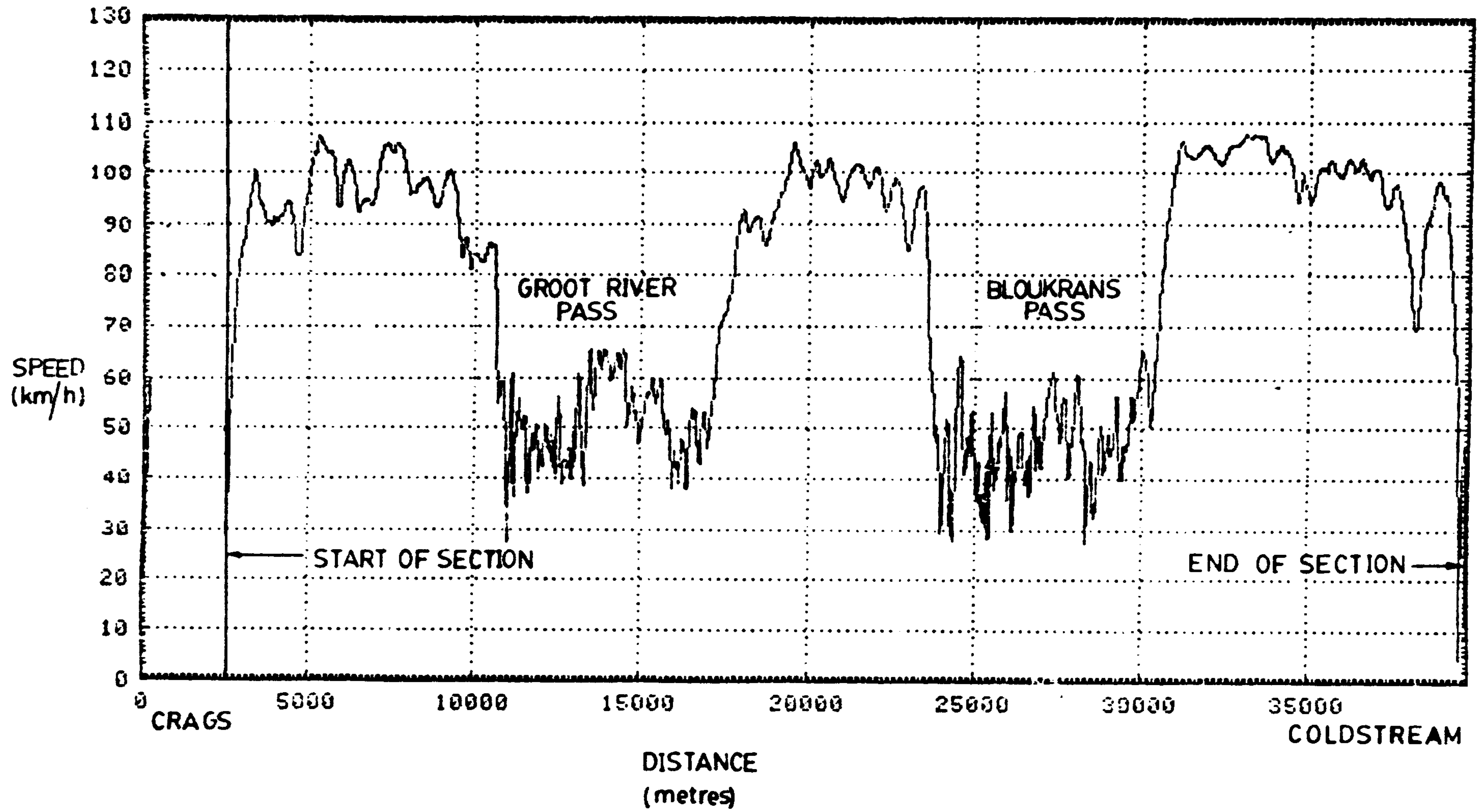
COMPARISON OF RESULTS

On analysing the results the following is concluded:

(a) Passenger Car, Class 1

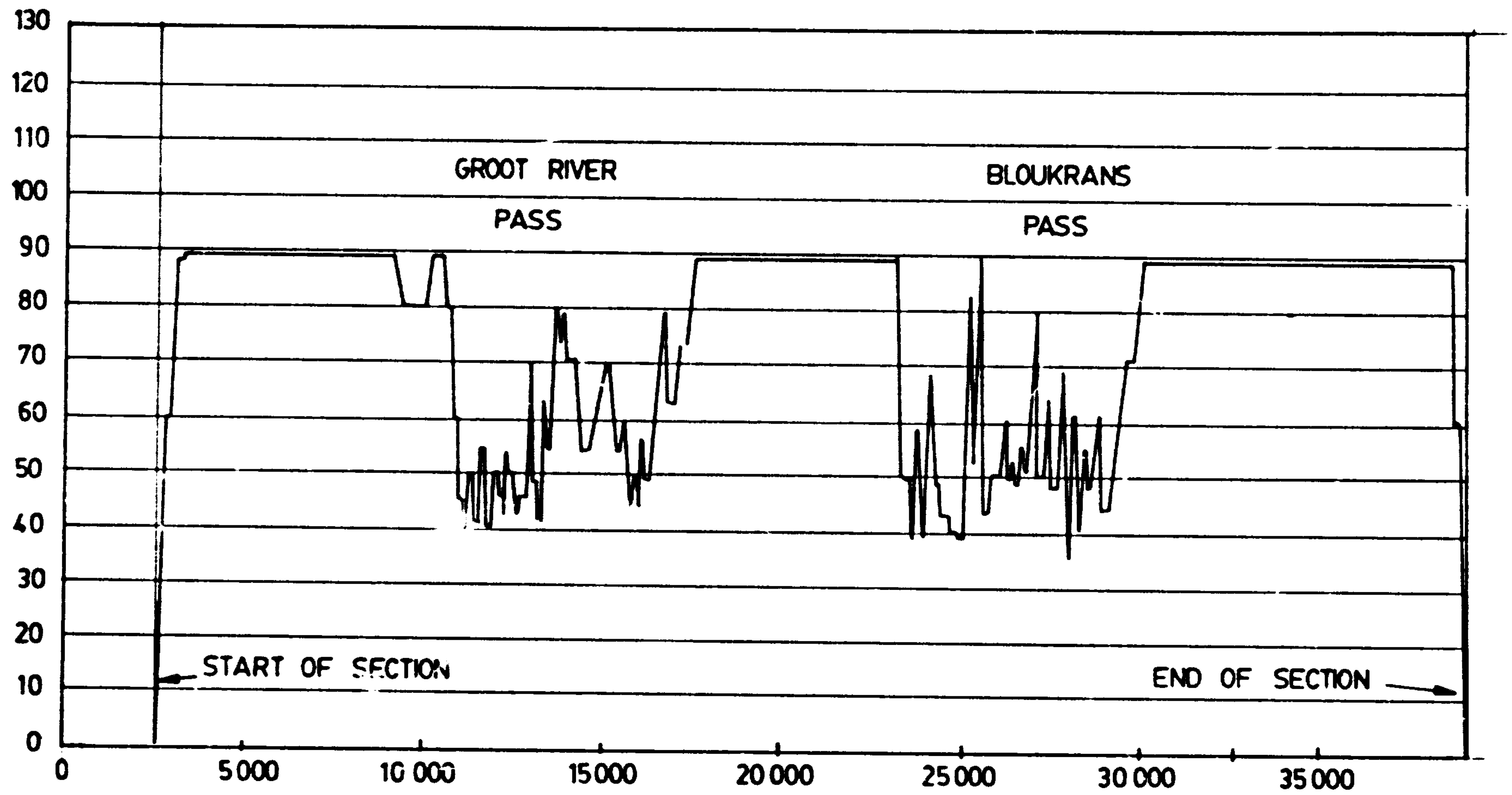
The individual components of the perceived saving, namely, the fuel saving (litres) and the time saving (minutes) do differ slightly, however, but this is only to be expected as different drivers "trade off" the benefits of reduced time against increased fuel consumption and vice versa. Any difference in the value of the total saving is due to the different time costs used by the individual methods.

On comparing the speed profiles obtained from the two methods it can be seen that the speeds on both the toll road and the old/alternative road from RODES 2 are slightly lower than those from the TEL. The other characteristics are however very similar.



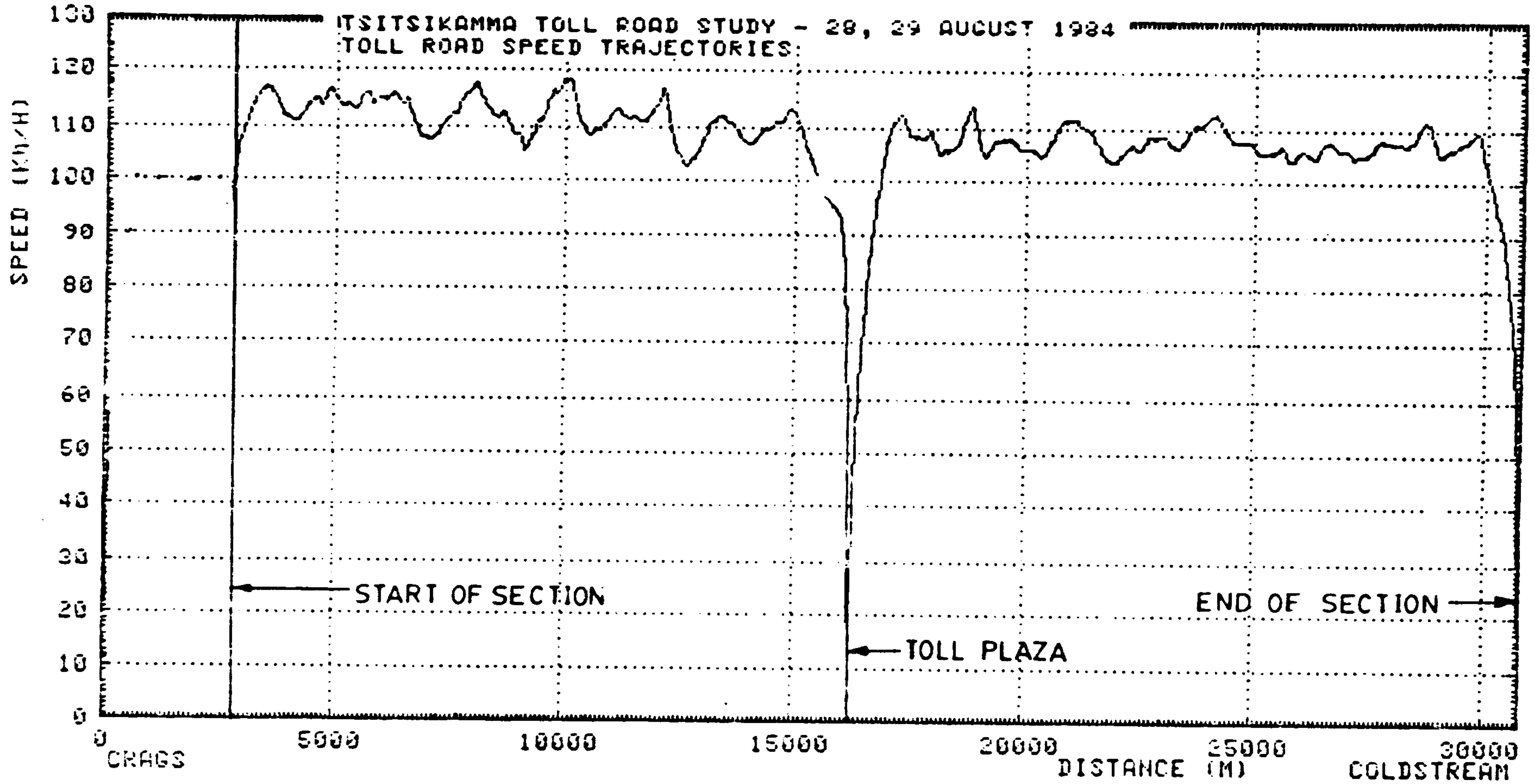
SPEED PROFILE ON OLD ROAD FROM TEL

FIGURE 8

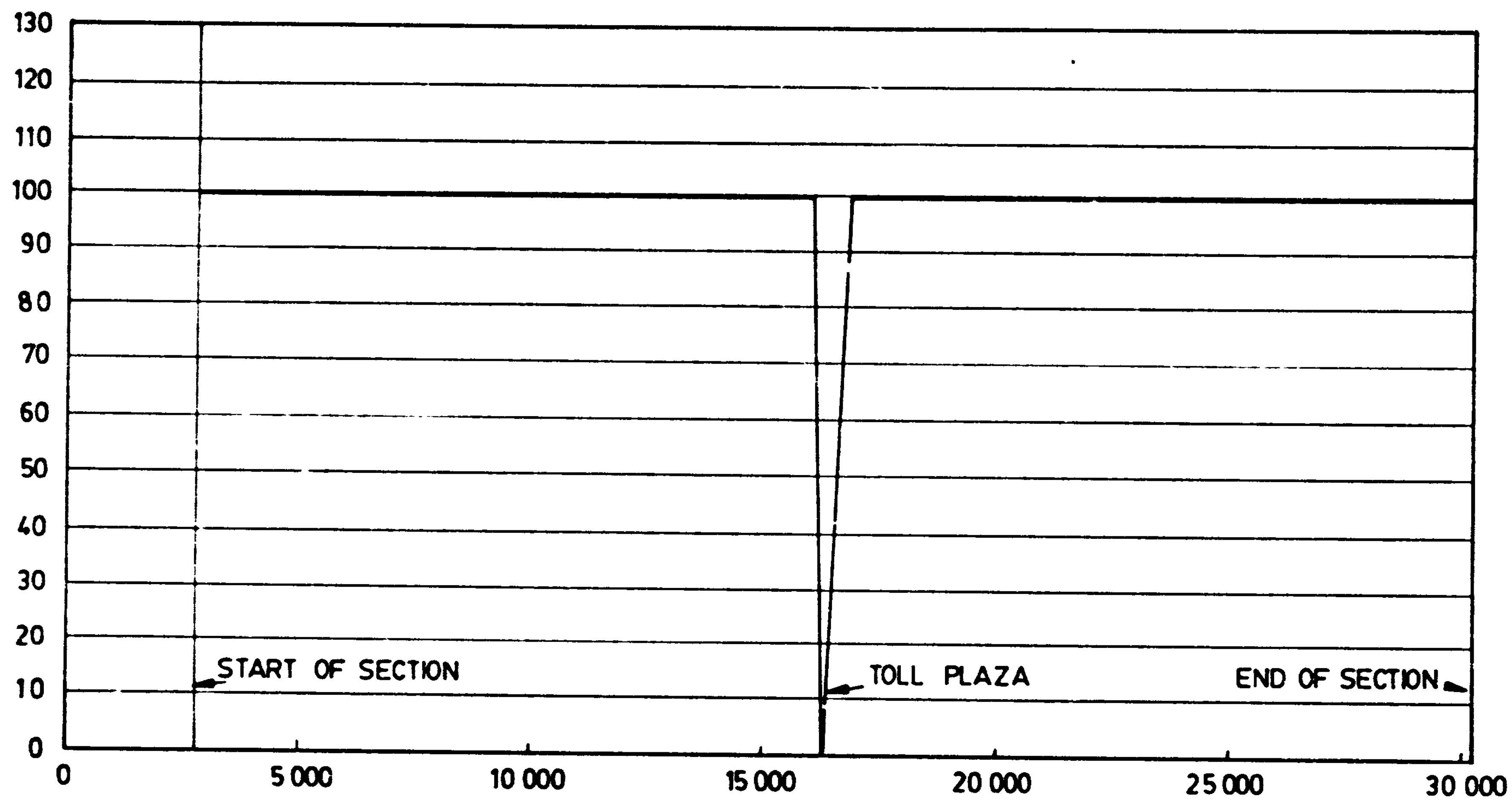


SPEED PROFILE ON OLD ROAD - FROM RODES 2

FIGURE 9



SPEED PROFILE ON TOLL ROAD FROM T.E.L.



SPEED PROFILE ON TOLL ROAD - FROM RODES 2

FIGURE 11

(b) Medium Trucks, Class 2

The measured values of the perceived travel cost saving vary from ± R4,80 for the unloaded vehicle to ± R7,70 for the loaded vehicle. The perceived travel cost saving calculated in the project feasibility stage, namely, R4,75 would therefore appear to be applicable to an unloaded Class 2 vehicle. Since this report recommends Method A as the preferred approach, it is concluded that the average perceived saving for a Class 2 vehicle is ± R6,75, this being based on a 2:1 ratio of ladened trips to unladened trips[16)].

(c) Heavy Trucks, Class 4

The measured values of the perceived travel cost saving vary from ± R13,60 for the unloaded vehicle to ± R22,40 for the loaded vehicle. The average perceived saving is therefore ± R19,50. For this vehicle type the perceived saving calculated during the project feasibility stage is almost identical, i.e. R19,55, even though the costs used in the two methods are significantly different. It is interesting to note that the perceived saving for a loaded vehicle when calculated by the feasibility stage method but using measurements from the field tests is R36,81. This figure appears unrealistically high and suggests that the time costs used during the project feasibility stage should be examined more closely.

[illegible]

Information gathered at the roadside survey on the factors which influence route choice is presented below. Only by obtaining knowledge on all these factors can the importance of one, namely toll rate, be fully understood.

Sample Size

Although it was initially recommended that a two day survey be implemented, severe weather conditions on the second day resulted in the interview being carried out on one day only, namely, Friday the 24th August 1984. Fortunately the results obtained from the one day survey were so conclusive that little additional benefit could have been gained if the survey had lasted the planned two days.

The duration of the survey on the Friday was for 9 hours between 09h00 and 18h00, all traffic in both directions was interviewed. This resulted in one hundred interviews being undertaken.

Results

Of the one hundred interviews undertaken the reasons for this traffic being on the alternative road were as follows:

		Number	% of Total Completed Questionnaires
(a)	Traffic from outside the study area whose destination was on the alternative road	34	34,7%
(b)	Through traffic needing to stop at locations along the alternative road	9	9,2%
(c)	Local traffic whose origin and destination was on the alternative road	12	12,2%
(d)	Tourist traffic using the alternative road because of its scenic beauty	33	33,7%
(e)	Traffic as a result of drivers having no money to pay the toll	8	8,2%
(f)	Traffic as a result of drivers refusing to pay any toll no matter what the toll rate	1	1,0%
(g)	Traffic as a result of drivers refusing to pay the specific toll rate employed	1	1,0%
(h)	Vehicles where the driver refused to answer	2	-
	TOTAL	100	100%

6.3 Conclusions

Although the sample size was small, it is evident that only a small percentage of the traffic on the alternative road, is using this road because of the toll imposed on the new road. Only ten questionnaires i.e. those from e, f and g above, of the ninety eight completed questionnaires or just over 10% of the traffic on the alternative road, uses the alternative road for reasons related to the toll on the new road.

7.0 ANALYSIS OF ALL RESULTS

The results detailed in Sections 4.0, 5.0 and 6.0 are collectively examined in the following section in order to estimate the following:

(a) The average daily through traffic on the new road for the month of August 1984 if no toll had been imposed.

(b) The present diversion in traffic due to the toll rates presently imposed.

(c) The relationship between road usage, toll rate and the perceived travel cost saving.

(d) The toll rates which will maximise the revenue.

7.1 The Average Daily Through Traffic at Zero Toll

From Section 4.4, the average daily through traffic on the toll road for the month of August was 770 vehicles/day and the average daily total traffic on the alternative road at the Old Road Centre Station was 119 vehicles/day. From Section 6.2, 10,2% of the vehicles on the alternative road i.e. 12 vehicles, used this road because a toll was levied on the new road. It is therefore concluded that the average daily through traffic on the new road for the month of August would have been 782 vehicles/day if this road had not been tolled.

7.2 The Present Diversion in Traffic

The results from Section 7.1 conclude that the present diversion in traffic due to the toll is 1,5% (12/782 x 100). Although values have also been derived for the three vehicle classes investigated, namely, Class 1 1%, Class 2 5% and

Class 4 10%, the small sample obtained throws doubt on the accuracy of these results. There can be no doubt however that diversion rates in general are very low.

7.3 The Relationship Between Road Usage, Toll Rate and Perceived Travel Cost Saving

The roadside interview showed that only a handful of vehicles use the alternative road because of the toll on the new road and that most of these trips were a result of drivers having no money and not because of the specific toll rate imposed, as a result, no actual diversion rate at any other toll rate can be calculated. The knowledge obtained does however enable a diversion curve to be postulated on the following basis:

From overseas experience it would appear the diversion curve should have the following form:

$$P = \frac{1}{1 + ({}^{t}/_{p})^{n}}$$

Four unknowns are present in the above equation, however, in this study measurement or knowledge of three of these components, namely, A, t and p, has been obtained. For the three vehicle classes investigated the following calculations have therefore been included with the aim of determining what value n must have to satisfy the equation.

- Class 1 Vehicles

$$P = \frac{1}{1 + ({}^{t}/_{p})^{n}}$$

P = 0,99, t = R1,50 & p = R2,65, therefore n = 8,1

- Class 2 Vehicles

$P = 0{,}95$, $t = R4{,}00$ & $p = R6{,}75$, therefore $n = 5{,}6$

- Class 4 Vehicles

$P = 0{,}90$, $t = R15{,}00$ & $p = R19{,}50$, therefore $n = 8{,}4$

Using the traffic composition figures from Section 4.4 for through traffic on the toll road in August 1984, the weighted average value of n is 8,0 and therefore the formula most applicable for diversion due to toll at the Tsisikamma Toll Road is

$$P = \frac{1}{1 + ({}^{t}/_{p})^{8}}$$

7.4 Toll Rates for Maximum Revenue

Using the method employed in Section 3.2 and a value of n of 8, the toll rates which achieve the maximum revenue are equal to 0,784 p. These toll rates, "rounded off" to enable a quicker money exchange at the plaza and the toll rates presently in use are as follows:

	Proposed by this Report	Present Rates
Class 1	R 2,00	R 1,50
Class 2	R 5,00	R 4,00
Class 4	R15,00	R15,00

If the toll rates proposed by this report were introduced, it is anticipated that the gross revenue would increase by approximately 12% p.a.

- Class 2 Vehicles

  P = 0,95, t = R4,00 & p = R6,75, therefore n = 5,6

- Class 4 Vehicles

  P = 0,90, t = R15,00 & p = R19,50, therefore n = 8,4

Using the traffic composition figures from Section 4.4 for through traffic on the toll road in August 1984, the weighted average value of n is 8,0 and therefore the formula most applicable for diversion due to toll at the Tsi. .kamma Toll Road is

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Class 4	R15,00	R15,00

If the toll rates proposed by this report were introduced, it is anticipated that the gross revenue would increase by approximately 12% p.a.

8.0 DISCUSSION

The method used in this report to determine the relationship between toll rate and road usage is simple and straightforward in its approach and, in general, has been successful. Problems which were encountered at the Tsitsikamma Toll Road were mainly due to the vast difference in road standards between the alternative road and the toll road and the relatively small traffic volume in the corridor. The vast difference in road standards led to relatively little diversion, and as the total traffic volumes in the corridor were not large initially, few vehicles, less than 12 per day, diverted because of the toll. To achieve more accurate estimates on the road usage/toll rate relationship, roadside interviews spanning several weeks would have been required, unfortunately for this study, surveys of this duration were not possible. Since future toll roads, which are presently being planned, do not have the same problems in this regard, it is anticipated that the method used herein would be far more successful if used on these projects when opened.

In analysing the information obtained from the different surveys it was necessary, in certain instances, to supplement this information with general information from other on-going rural toll road feasibility studies and/or general statistics supplied by the NITRR. In an effort to overcome this shortcoming any further work in this field should endeavour to obtain more specific information on the ratio of ladened to unladened trips undertaken by heavy vehicles, the occupancy of vehicles on both the alternative road and the toll road and the purpose of all trips be they on the alternative road or the toll road.

The ratio of ladened to unladened heavy vehicle trips is especially important in the case where the alternative road is of a reasonably high standard. Although this was not the case at the Tsitsikamma, it is obvious that an alternative road of high standard could result in a large diversion of unladened vehicles, if toll rates were based on the benefits for a fully ladened vehicle or even an "average" ladened vehicle. Since statistics from the NITRR show that, in general, the ratio of ladened to unladened trips is 2:1, and since it is known that approximately 50% of the gross revenue collected is derived from heavy vehicles, this possible diversion in unladened vehicles gives cause for concern. For this reason one would like to witness greater liason with the Public Carriers Association and other independent fleet owners, to ensure that toll tariffs for heavy vehicles correctly reflect the benefits they perceive.

With regard to passenger vehicles it is obvious that the majority of the benefit consists of time cost savings. The hourly time cost rate proposed therefore plays the important role in determining the value of the toll rate levied. The time cost rate used in this study is considerably higher than that used in the feasibility study i.e. R8,00/h as opposed to R4,00/h, however a valid case for the former rate appears to exist, since vehicle occupancy, trip purpose and race of driver were all considered in its derivation. A time cost rate of R4,00/h seems therefore more appropriate as an average rate for one individuals time but would appear conservative when attempting to derive the total time costs of all occupants and the purpose of the trip being undertaken.

Since the diversion curve derived for this study is similar to that presently used in toll road feasibility studies, it is important to note that the components and value of the perceived cost of travel for the different vehicle classes used by the two studies is very different. The use of the feasibility studies perceived travel costs in conjunction with the diversion curve derived by this study would therefore be incorrect.

9.0 CONCLUSIONS

The toll rates presently levied at the Tsitsikamma Toll Road cause only 1,5% of the through traffic to divert to the alternative road. Since the diversion rate is negligible, virtually no lost economic benefit is experienced due to the toll.

The toll rates presently levied do not derive the maximum gross revenue possible from the facility; to attain this objective the toll rates (in 1984 Rand) should be increased to the amounts shown below:

Class 1	R 2,00
Class 2	R 5,00
Class 4	R15,00

(As no field tests were undertaken with any Class 3 vehicle, no results for this vehicle class are available.)

If the above toll rates were introduced, it is concluded that the gross revenue would increase by approximately 12% p.a., however, since the present toll rates result in virtually no lost economic benefit any motion recommending an increase in toll rate to the amounts shown above, should carefully consider the advantages of an increased revenue against the disadvantage of an increased lost economic benefit.

From overseas experience and from the work undertaken for this study, it would appear that the most appropriate diversion curve for the Tsitsikamma Toll Road is as follows:

$$P = \frac{1}{1 + (^t/_p)^8}$$

where P is the proportion of traffic using the toll road
t is the toll rate charged
p is the perceived saving in travelling cost of the toll road over the alternative road

If the above curve is to be used in further analyses on the Tsitsikamma Toll Road it is important to note that the values of the perceived benefit, p, for all vehicle classes, derived in this study are significantly different to those values presently used in toll feasibility studies in South Africa. Use of the latter values with the above diversion curve would therefore be incorrect.

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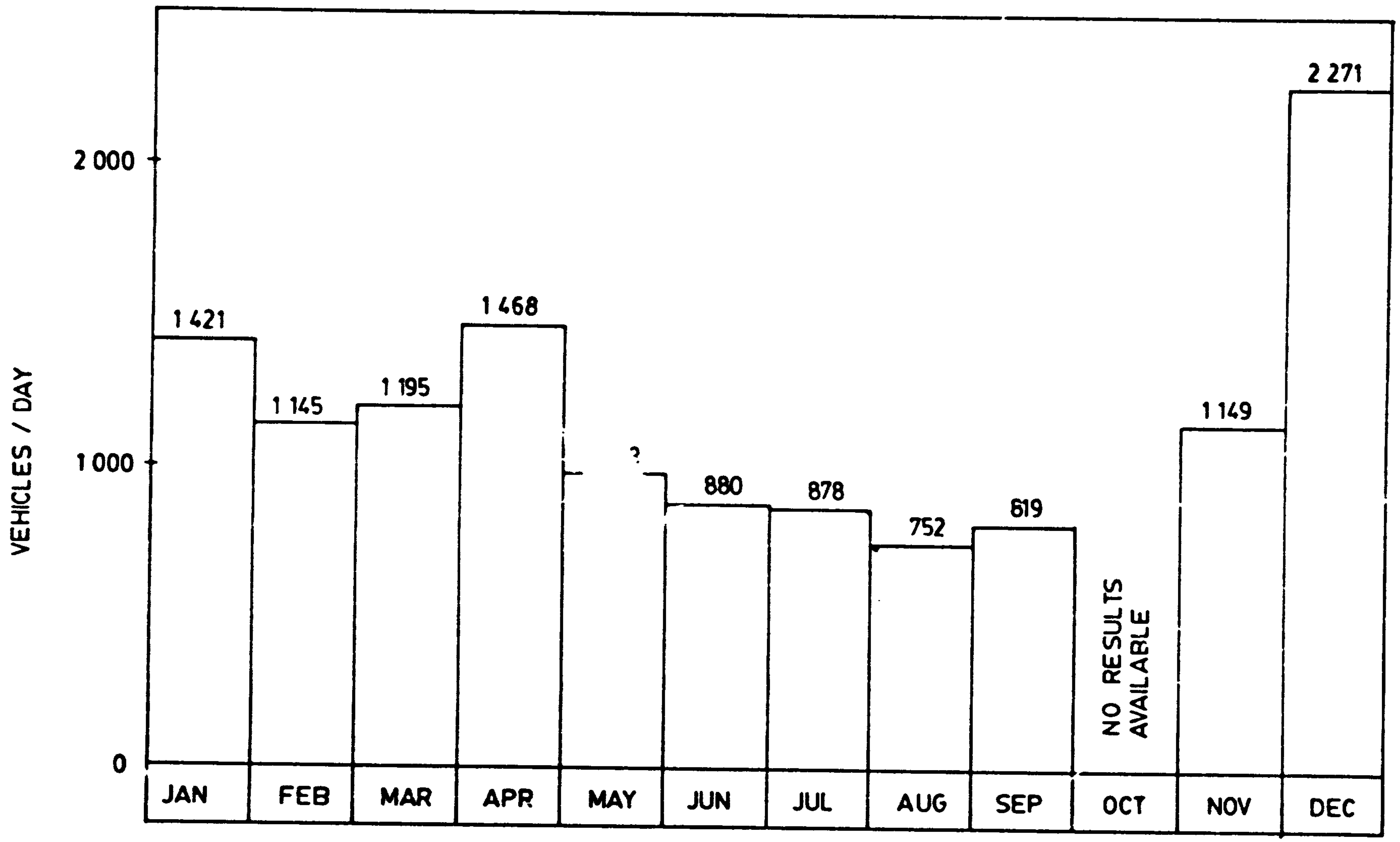
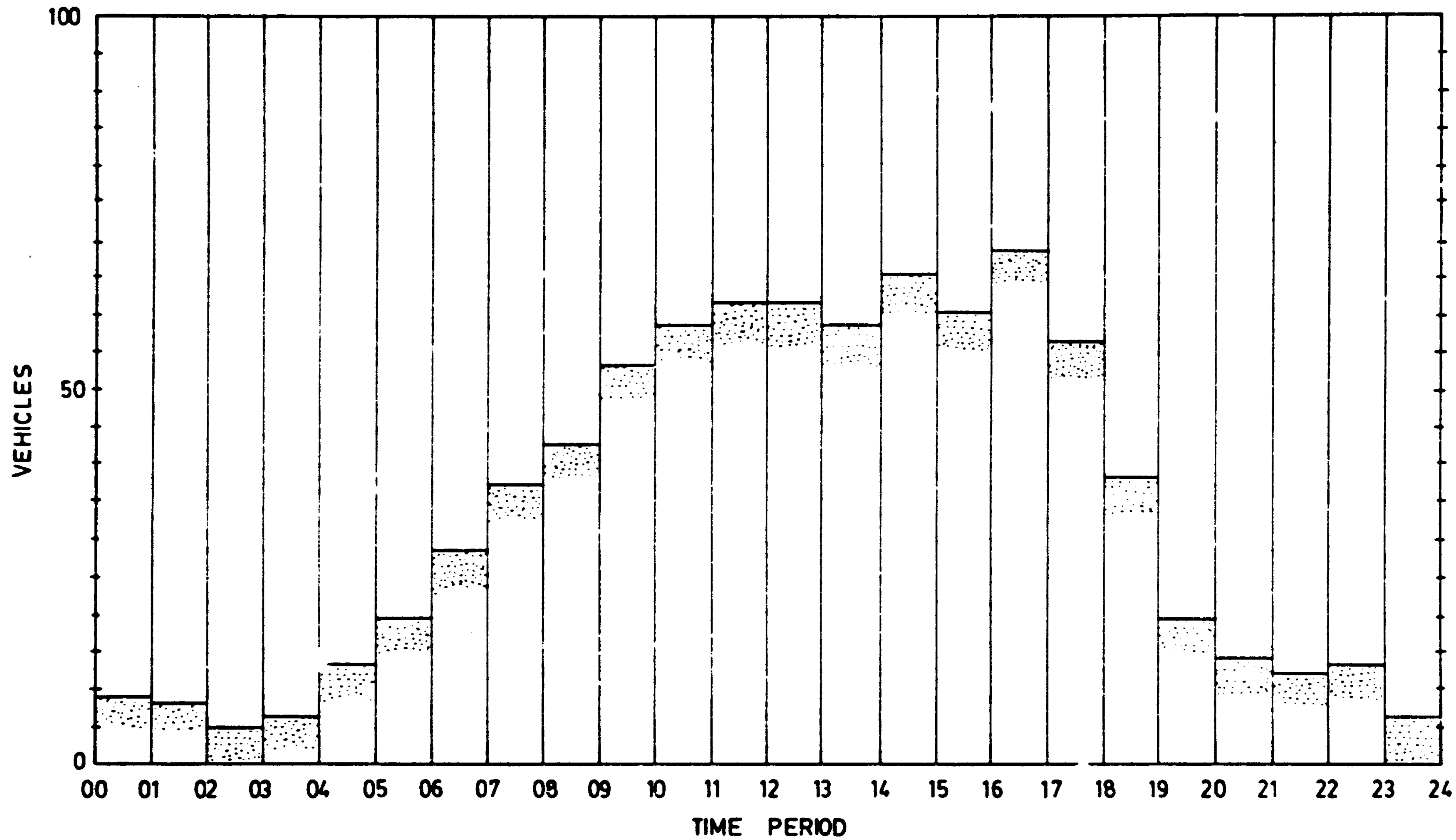
APPENDIX A



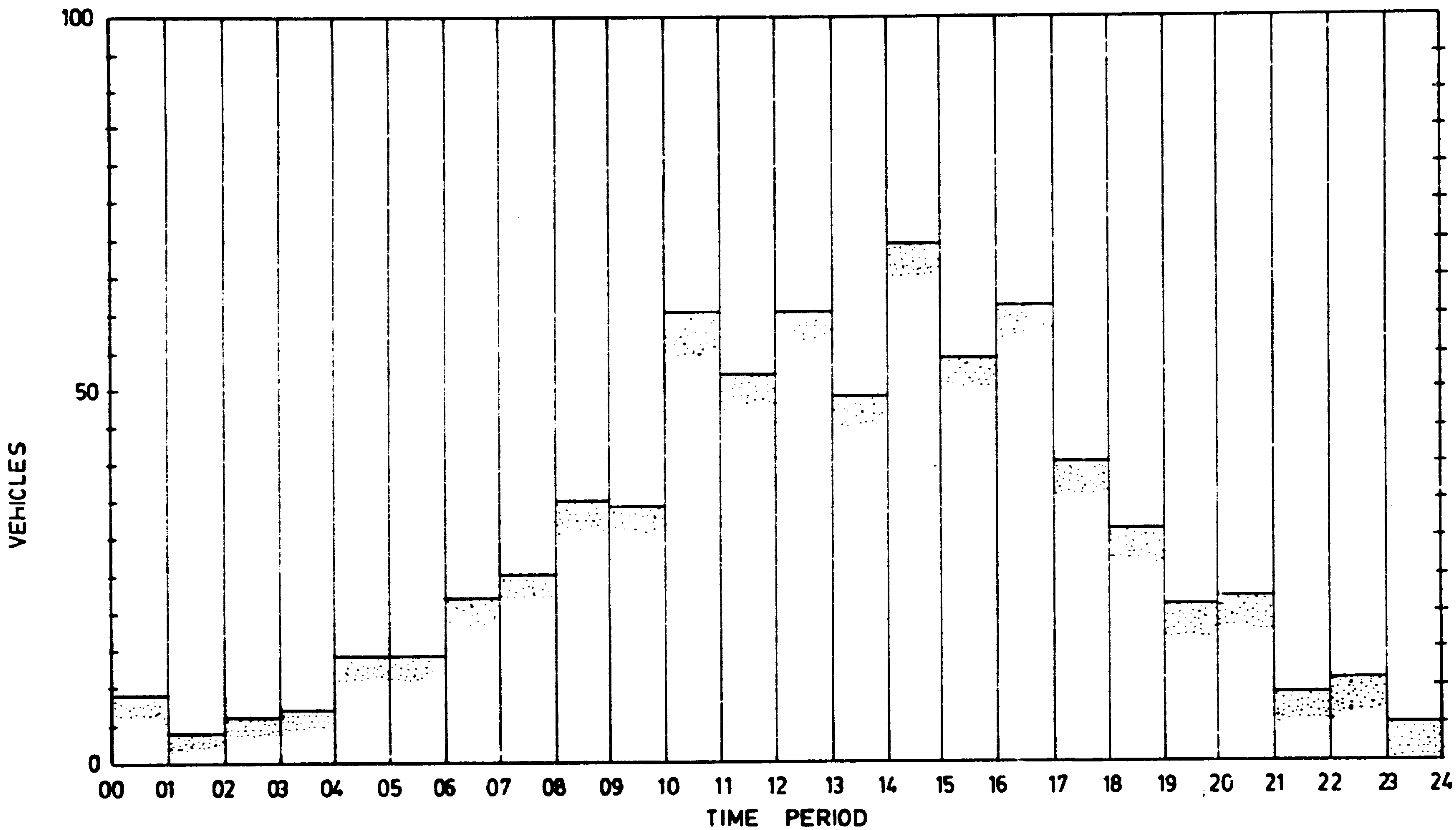
SEASONAL VARIATION RECORDED
AT D.O.T. COUNTER IN 1983

FIGURE A-1



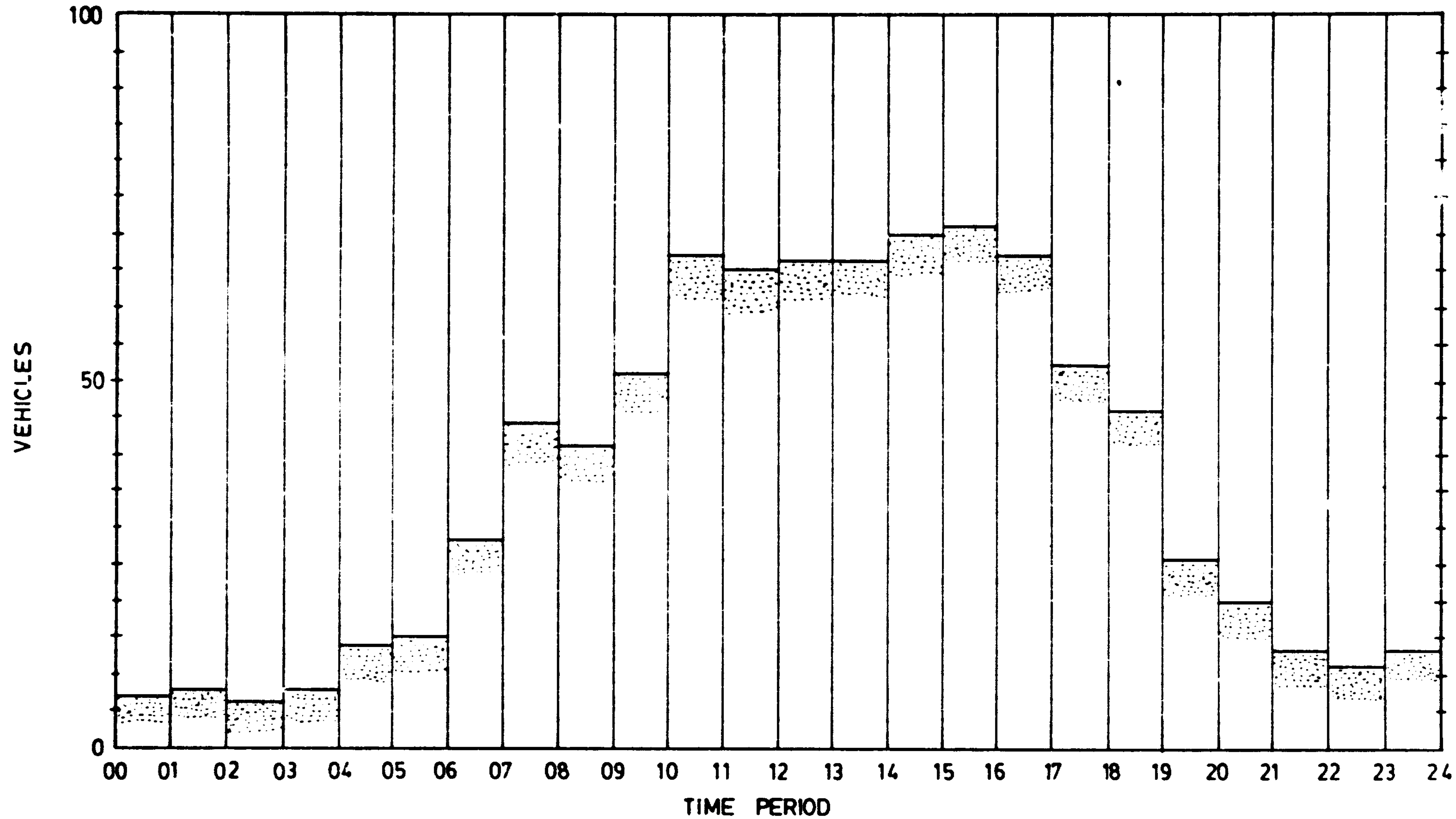
24 HOUR ΓLOWS BASED ON 7 DAY AVERAGES
(BEFORE OPENING OF TOLL ROAD)
OLD ROAD WEST STATION
TOTAL VEHICLES - 809

FIGURE A-2



24 HOUR FLOWS BASED ON 7 DAY AVERAGES
(BEFORE OPENING OF TOLL ROAD)
OLD ROAD CENTRE STATION
TOTAL VEHICLES - 714

FIGURE A-3



24 HOUR FLOWS BASED ON 7 DAY AVERAGES
(BEFORE OPENING OF TOLL ROAD)
OLD ROAD EAST STATION
TOTAL VEHICLES - 875

FIGURE A-4

OLD ROAD WEST STATION - BEFORE OPENING OF TOLL ROAD

TIME	HOURLY VEHICLE FLOWS						AVERAGE HOURLY FLOW		% 24 HOUR FLOW	
	THURS	FRI	SAT	SUN	MON	TUES	WEEKDAYS	ALL DAYS	WEEKDAYS	ALL DAYS
0-1	-	5	10	FAILED	5	14	8	9	0,91	1,11
1-2	-	5	10	"	5	10	7	8	0,80	0,99
2-3	-	10	5	"	0	5	5	5	0,57	0,62
3-4	-	5	10	"	5	5	5	6	0,57	0,74
4-5	-	10	19	"	19	5	11	13	1,25	1,61
5-6	-	14	24	"	19	19	17	19	1,93	2,35
6-7	-	19	48	"	24	19	21	28	2,39	3,46
7-8	-	33	43	"	33	38	35	37	3,98	4,57
8-9	-	29	43	"	43	53	42	42	4,78	5,19
9-10	-	53	33	"	72	-	63	53	7,17	6,55
10-11	-	57	58	43	72	-	65	58	7,39	7,17
11-12	-	57	62	53	72	-	65	61	7,39	7,54
12-13	-	72	48	53	72	-	72	61	8,19	7,54
13-14	-	77	33	62	58	-	68	58	7,74	7,17
14-15	-	82	33	72	72	-	77	65	8,76	8,03
15-16	-	72	57	62	48	-	60	60	6,83	7,42
16-17	78	86	58	57	62	-	75	68	8,53	8,41
17-18	72	72	29	48	57	-	67	56	7,62	6,92
18-19	43	53	14	53	29	-	42	38	4,78	4,70
19-20	24	29	10	14	19	-	24	19	2,73	2,35
20-21	14	19	5	19	14	-	16	14	1,82	1,73
21-22	14	19	10	10	5	-	13	12	1,48	1,48
22-23	14	19	10	14	10	-	14	13	1,59	1,61
23-24	5	10	FAILED	5	5	-	7	6	0,80	0,74
24 HOUR TOTALS	-	907	-	-	820	-	879	809	100,00	100,00

TABLE A - 1

OLD ROAD CENTRE STATION - BEFORE OPENING OF TOLL ROAD

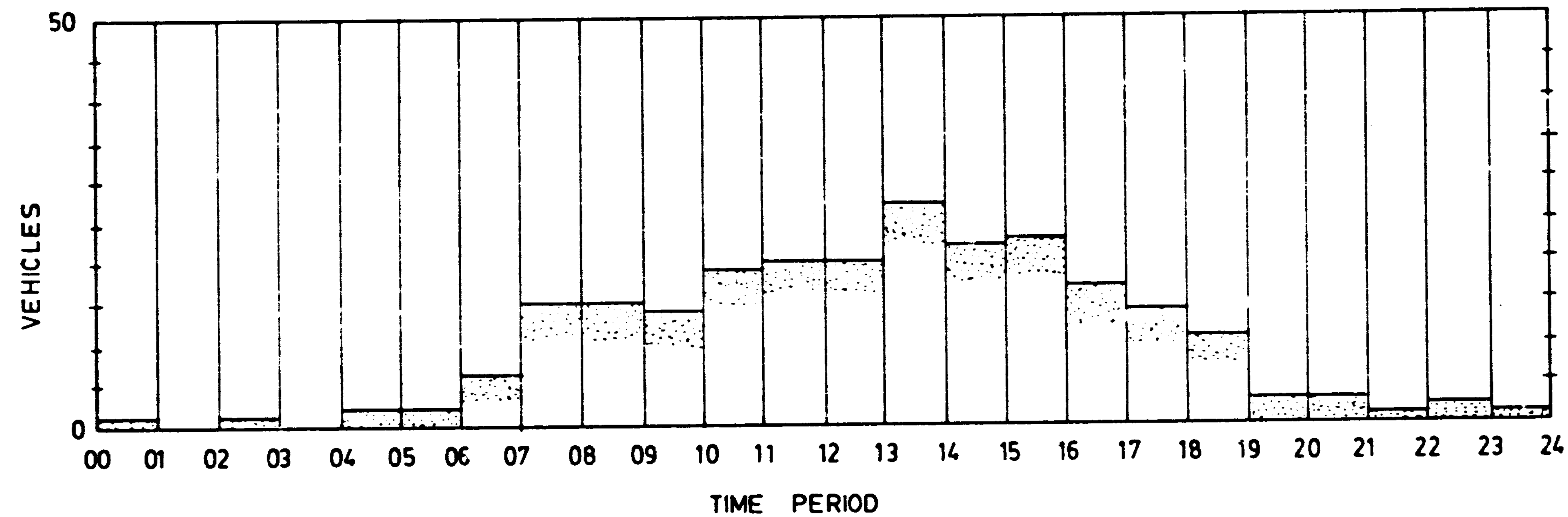
T I M E	HOURLY VEHICLE FLOWS						AVERAGE HOURLY FLOW		% 24 HOUR FLOW	
	THURS	FRI	SAT	SUN	MON	TUES	WEEKDAYS	ALL DAYS	WEEKDAYS	ALL DAYS
0-1	-	5	14	10	5	10	7	9	0,89	1,26
1-2	-	5	5	0	5	5	5	4	0,64	0,56
2-3	-	10	5	5	0	10	7	6	0,89	0,84
3-4	-	5	10	10	5	5	5	7	0,64	0,98
4-5	-	10	29	5	14	10	11	14	1,40	1,96
5-6	-	14	24	0	24	10	16	14	2,04	1,96
6-7	-	14	57	5	19	14	16	22	2,04	3,08
7-8	-	24	34	10	33	24	27	25	3,44	3,50
8-9	-	33	43	14	38	48	40	35	5,09	4,90
9-10	-	38	29	23	44	-	41	34	5,22	4,76
10-11	-	53	72	43	72	-	63	60	8,02	8,40
11-12	-	67	38	48	53	-	60	52	7,63	7,28
12-13	-	72	38	48	82	-	77	60	9,80	8,40
13-14	-	67	34	48	48	-	58	49	7,38	6,86
14-15	-	63	62	77	72	-	68	69	8,65	9,66
15-16	-	67	48	53	48	-	58	54	7,38	7,56
16-17	-	91	38	72	44	-	68	61	8,65	8,54
17-18	48	58	19	38	38	-	48	40	6,11	5,60
18-19	33	43	14	48	19	-	32	31	4,07	4,34
19-20	29	33	10	19	14	-	25	21	3,18	2,94
20-21	14	43	14	23	14	-	24	22	3,05	3,08
21-22	10	10	5	10	10	-	10	9	1,27	1,26
22-23	10	14	5	10	14	-	13	11	1,65	1,54
23-24	5	10	0	5	5	-	7	5	0,89	0,70
24 HOUR TOTALS	-	849	647	624	720	-	786	714	100,00	100,00

TABLE A - 2

OLD ROAD EAST STATION - BEFORE OPENING OF TOLL ROAD

T I M E	HOURLY VEHICLE FLOWS						AVERAGE HOURLY FLOW		% 24 HOUR FLOW	
	THURS	FRI	SAT	SUN	MON	TUES	WEEKDAYS	ALL DAYS	WEEKDAYS	ALL DAYS
0-1	-	0	19	5	5	5	3	7	0,29	0,80
1-2	-	10	15	5	5	5	7	8	0,68	0,91
2-3	-	0	10	5	5	10	5	6	0,49	0,69
3-4	-	14	0	5	10	10	11	8	1,08	0,91
4-5	-	5	33	10	10	10	8	14	0,78	1,60
5-6	-	10	33	0	24	10	15	15	1,47	1,71
6-7	-	33	33	10	33	29	32	28	3,13	3,20
7-8	-	58	38	19	67	38	54	44	5,28	5,03
8-9	-	53	43	19	38	53	48	41	4,70	4,69
9-10	-	48	43	19	63	82	64	51	6,26	5,83
10-11	-	72	62	53	82	-	77	67	7,53	7,66
11-12	-	87	48	52	72	-	80	65	7,83	7,43
12-13	-	77	48	52	86	-	82	66	8,02	7,54
13-14	-	91	38	62	72	-	82	66	8,02	7,54
14-15	-	72	53	62	91	-	82	70	8,02	8,00
15-16	-	110	48	62	63	-	87	71	8,51	8,11
16-17	-	96	53	72	48	-	72	67	7,05	7,66
17-18	-	63	29	53	62	-	63	52	6,16	5,94
18-19	48	67	29	48	38	-	51	46	4,99	5,26
19-20	29	43	15	29	14	-	29	26	2,84	2,97
20-21	19	38	15	14	14	-	24	20	2,35	2,29
21-22	19	19	10	5	10	-	16	13	1,57	1,49
22-23	10	14	5	10	14	-	13	11	1,27	1,26
23-24	14	19	5	10	19	-	17	13	1,66	1,49
24 HOUR TOTALS		1099	725	681	945		1022	875	100,00	100,00

TABLE A - 3



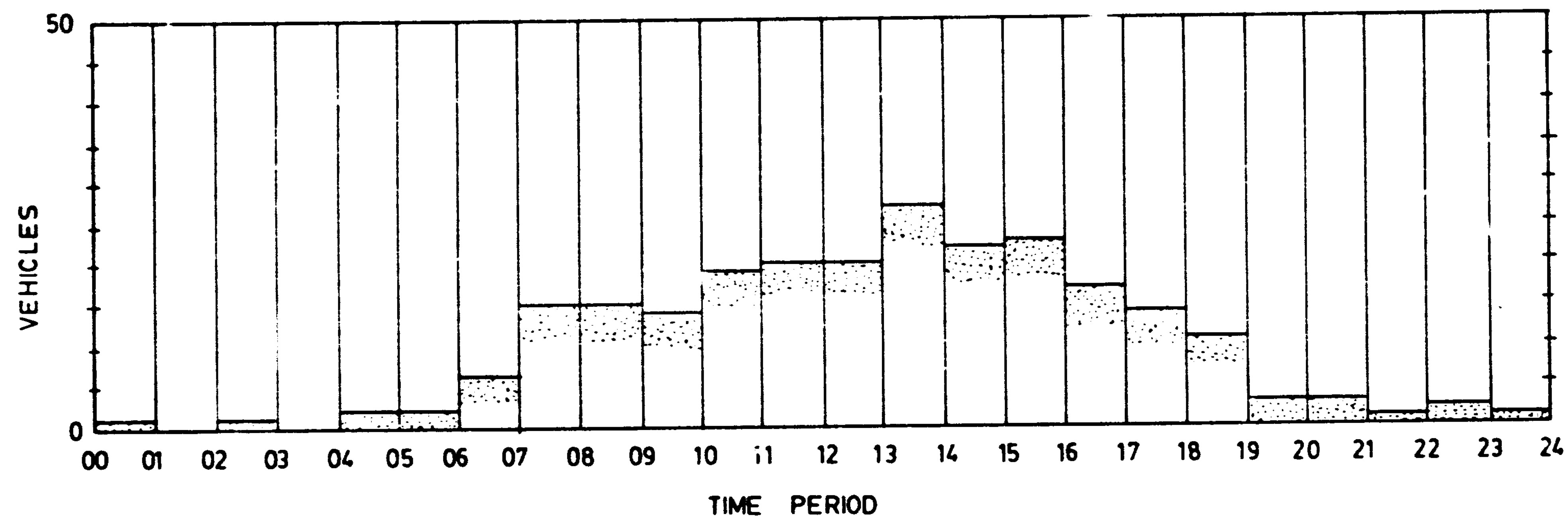
24 HOUR FLOWS BASED ON 7 DAY AVERAGES

(AFTER OPENING OF TOLL ROAD)

OLD ROAD WEST STATION

TOTAL VEHICLES - 239

FIGURE A-5



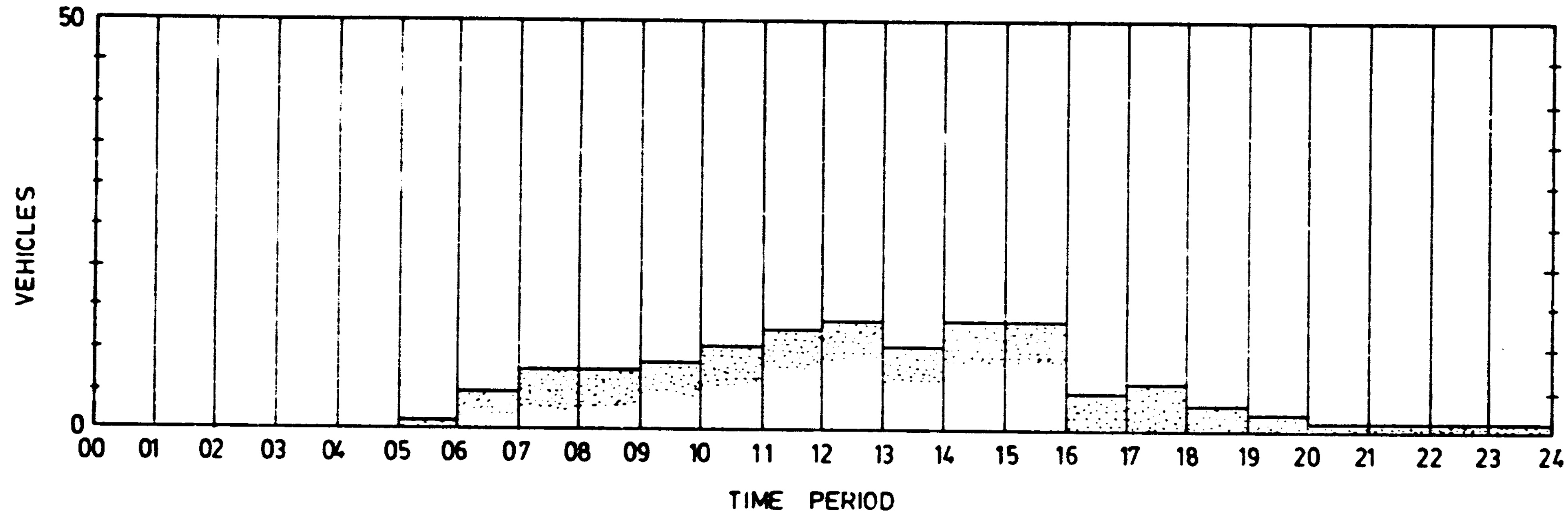
24 HOUR FLOWS BASED ON 7 DAY AVERAGES

(AFTER OPENING OF TOLL ROAD)

OLD ROAD WEST STATION

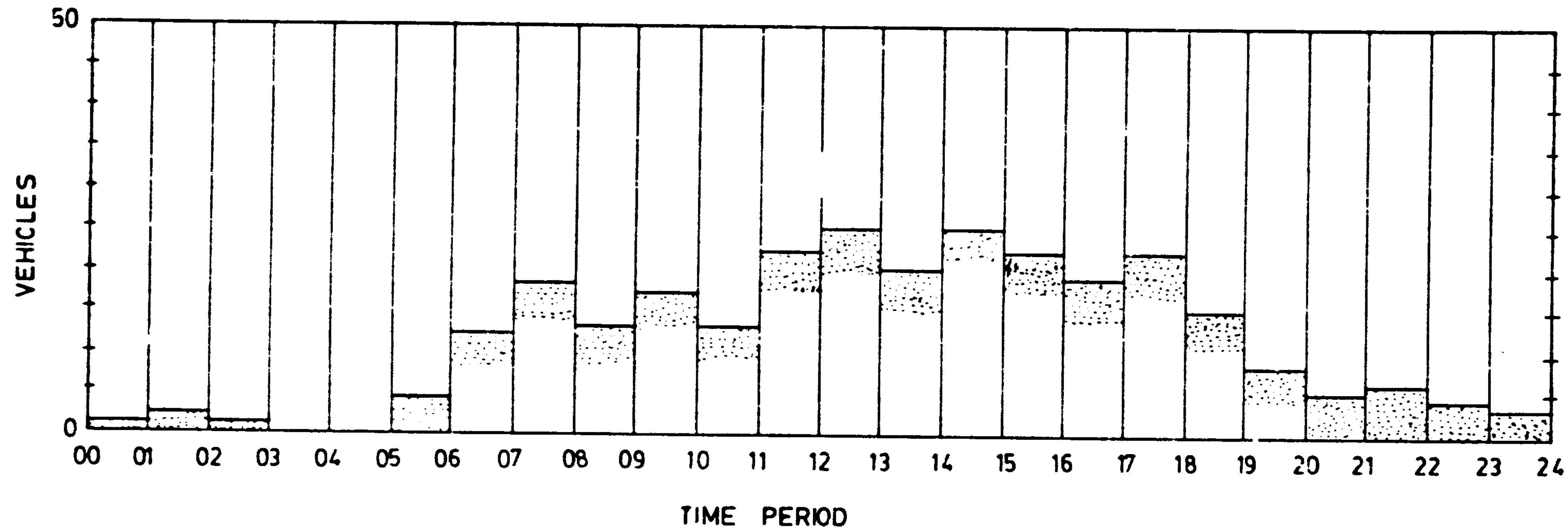
TOTAL VEHICLES - 239

FIGURE A-5



24 HOUR FLOWS BASED ON 7 DAY AVERAGES
(AFTER OPENING OF TOLL ROAD)
OLD ROAD CENTRE STATION
TOTAL VEHICLES - 119

FIGURE A-6



24 HOUR FLOWS BASED ON 7 DAY AVERAGES
(AFTER OPENING OF TOLL ROAD)
OLD ROAD EAST STATION
TOTAL VEHICLES - 277

FIGURE A-7

OLD ROAD WEST STATION - AFTER OPENING OF TOLL ROAD

TIME	HOURLY VEHICLE FLOWS							AVERAGE HOURLY FLOW		% 24 HOUR FLOW	
	THURS	FRI	SAT	SUN	MON	TUES	WED	WEEKDAYS	ALL DAYS	WEEKDAYS	ALL DAYS
0-1	-	0	0	0	5	0	0	1	[illegible]	0,38	0,42
1-2	-	0	0	0	0	0	0	0	0	0,00	0,00
2-3	-	0	0	0	0	5	0	1	1	0,38	0,42
3-4	-	0	0	0	0	0	0	0	0	0,00	0,00
4-5	-	5	5	0	0	0	0	1	2	0,38	0,84
5-6	-	5	0	0	5	0	0	3	2	1,14	0,84
6-7	-	10	0	5	5	0	14	7	6	2,66	2,51
7-8	-	14	10	10	14	24	19	18	15	6,84	6,28
8-9	-	29	5	10	24	[illegible]	5	19	15	7,22	6,28
9-10	-	10	14	14	5	24	19	15	14	5,70	5,86
10-11	-	23	23	14	14	19	19	19	19	7,22	7,95
11-12	-	24	19	19	15	19	[illegible]	21	20	7,98	8,37
12-13	-	24	19	14	19	19	[illegible]	22	20	8,37	8,37
13-14	-	29	23	34	15	24	[illegible]	27	27	10,27	11,30
14-15	19	29	10	24	14	38	24	25	22	9,51	9,21
15-16	38	14	10	29	24	19	24	24	23	9,13	9,62
16-17	19	29	5	19	19	10	-	19	17	7,22	7,11
17-18	19	14	5	14	14	19	-	17	14	6,46	5,86
18-19	14	5	10	10	14	15	-	12	11	4,56	4,60
19-20	5	10	5	0	0	0	-	4	3	1,52	1,26
20-21	0	0	0	5	5	5	-	3	3	1,14	0,42
21-22	0	5	0	0	0	0	-	1	1	0,38	0,42
22-23	5	5	5	0	0	5	-	3	2	1,14	0,84
23-24	0	5	0	0	0	0	-	1	1	0,38	0,42
24 HOUR TOTALS	-	288	168	221	211	264	-	263	239	100,00	100,00

TABLE A - 4

OLD ROAD CENTRE STATION - AFTER OPENING OF TOLL ROAD

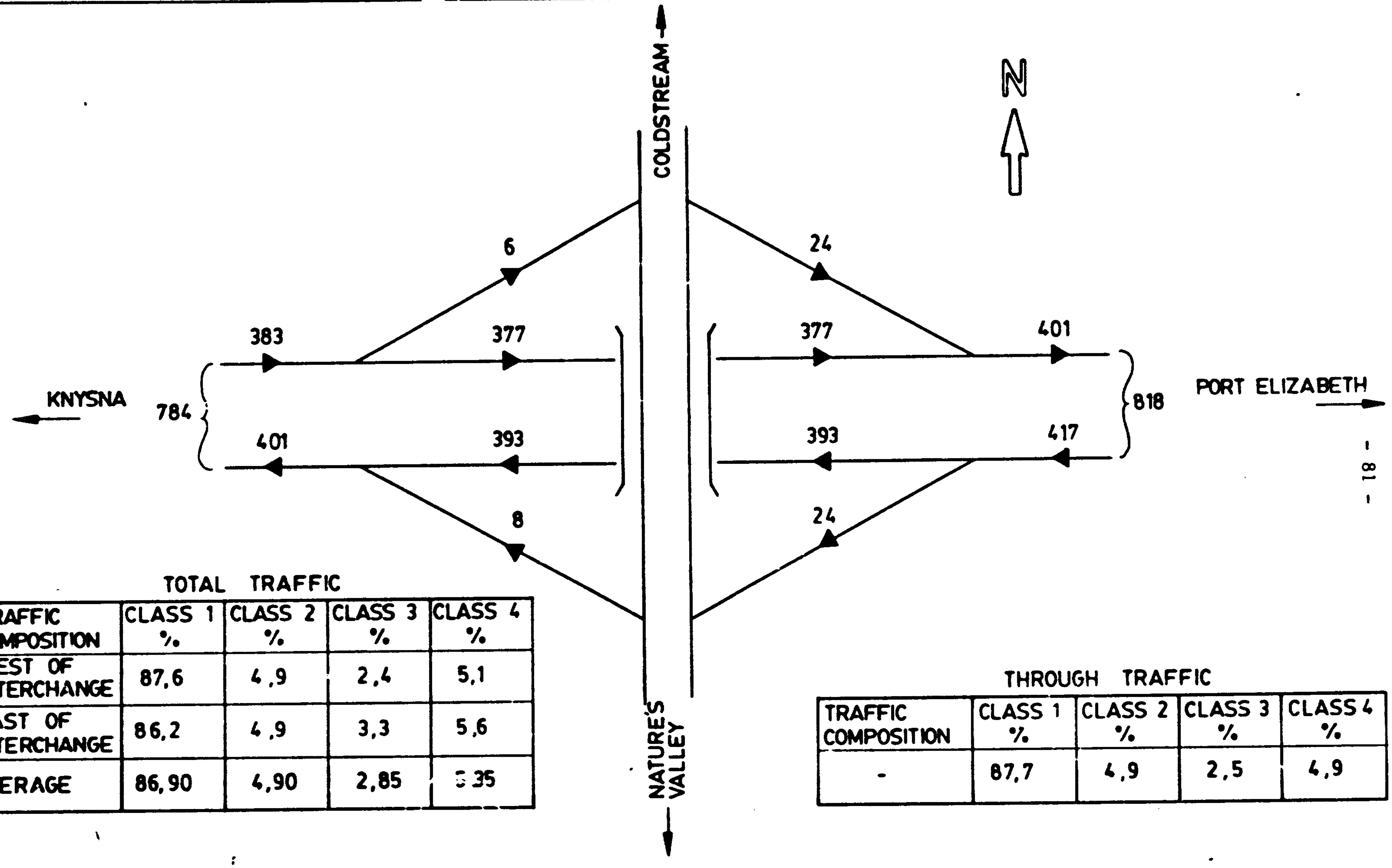
TIME	HOURLY VEHICLE FLOWS							AVERAGE HOURLY FLOW		% 24 HOUR FLOW	
	THURS	FRI	SAT	SUN	MON	TUES	WED	WEEKDAYS	ALL DAYS	WEEKDAYS	ALL DAYS
0-1	-	0	0	0	0	0	0	0	0	0,00	0,00
1-2	-	0	0	0	0	0	0	0	0	0,00	0,00
2-3	-	0	0	0	0	0	0	0	0	0,00	0,00
3-4	-	0	0	0	0	0	0	0	0	0,00	0,00
4-5	-	0	0	0	0	0	0	0	0	0,00	0,00
5-6	-	0	0	0	0	0	3	1	1	0,72	0,84
6-7	-	7	3	0	3	7	10	7	5	5,07	4,20
7-8	-	10	4	3	10	14	3	9	7	6,52	5,88
8-9	-	7	4	1	7	14	7	9	7	6,52	5,88
9-10	-	6	3	3	20	7	10	11	8	7,97	6,72
10-11	-	13	14	7	7	7	10	9	10	6,52	8,40
11-12	-	10	10	7	17	13	14	14	12	10,14	10,08
12-13	-	24	10	7	14	10	10	15	13	10,87	10,92
13-14	7	17	7	10	10	7	14	11	10	7,97	8,40
14-15	14	17	3	10	17	20	7	15	13	10,87	10,92
15-16	10	17	7	17	14	10	-	13	13	9,42	10,92
16-17	7	0	3	7	3	10	-	5	5	3,62	4,20
17-18	7	7	4	7	7	7	-	7	6	5,07	5,04
18-19	3	4	0	0	4	7	-	5	3	3,62	2,52
19-20	3	4	0	0	0	3	-	3	2	2,17	1,68
20-21	0	4	0	0	0	0	-	1	1	0,72	0,84
21-22	3	0	0	0	0	3	-	1	1	0,72	0,84
22-23	3	0	0	3	0	0	-	1	1	0,72	0,84
23-24	0	3	3	0	3	0	-	1	1	0,72	0,84
24 HOUR TOTALS	-	150	75	82	136	139	-	138	119	100,00	100,00

TABLE A - 5

OLD ROAD EAST STATION - AFTER OPENING OF TOLL ROAD

T I M E	HOURLY VEHICLE FLOWS							AVERAGE HOURLY FLOW		% 24 HOUR FLOW	
	THURS	FRI	SAT	SUN	MON	TUES	WED	WEEKDAYS	ALL DAYS	WEEKDAYS	ALL DAYS
0-1	-	0	5	0	0	0	0	1	1	0,33	0,36
1-2	-	0	5	5	0	0	0	1	2	0,33	0,72
2-3	-	0	0	0	0	0	5	1	1	0,33	0,36
3-4	-	0	0	0	0	0	0	0	0	0,00	0,00
4-5	-	0	0	0	0	0	0	0	0	0,00	0,00
5-6	-	5	5	0	5	0	10	5	4	1,67	1,44
6-7	-	24	10	5	10	14	10	15	12	5,00	4,33
7-8	-	24	5	5	33	29	14	18	18	6,00	6,50
8-9	-	24	14	0	19	5	14	14	13	4,67	4,69
9-10	-	14	24	5	19	19	19	19	17	6,44	6,14
10-11	-	14	10	14	14	5	19	12	13	4,00	4,69
11-12	-	24	24	14	10	24	38	28	22	9,33	7,94
12-13	10	29	33	24	14	38	24	27	25	9,00	9,03
13-14	19	19	24	14	24	14	24	20	20	6,67	7,22
14-15	24	28	14	20	29	29	33	26	25	8,67	9,03
15-16	18	33	19	24	24	14	-	21	22	7,00	7,94
16-17	19	24	19	14	19	19	-	20	19	6,67	6,86
17-18	29	33	14	5	24	29	-	26	22	8,67	7,94
18-19	24	10	14	14	14	14	-	16	15	5,33	5,42
19-20	10	14	5	5	5	10	-	10	8	3,33	2,89
20-21	5	5	5	0	5	10	-	6	5	2,00	1,81
21-22	10	0	5	5	10	5	-	5	6	1,67	2,17
22-23	5	5	5	5	0	5	-	5	4	1,67	1,44
23-24	5	5	5	0	5	0	-	4	3	1,33	1,08
24 HOUR TOTALS	-	336	264	178	283	283	-	300	277	100,00	100,00

TABLE A - 6



TOTAL TRAFFIC

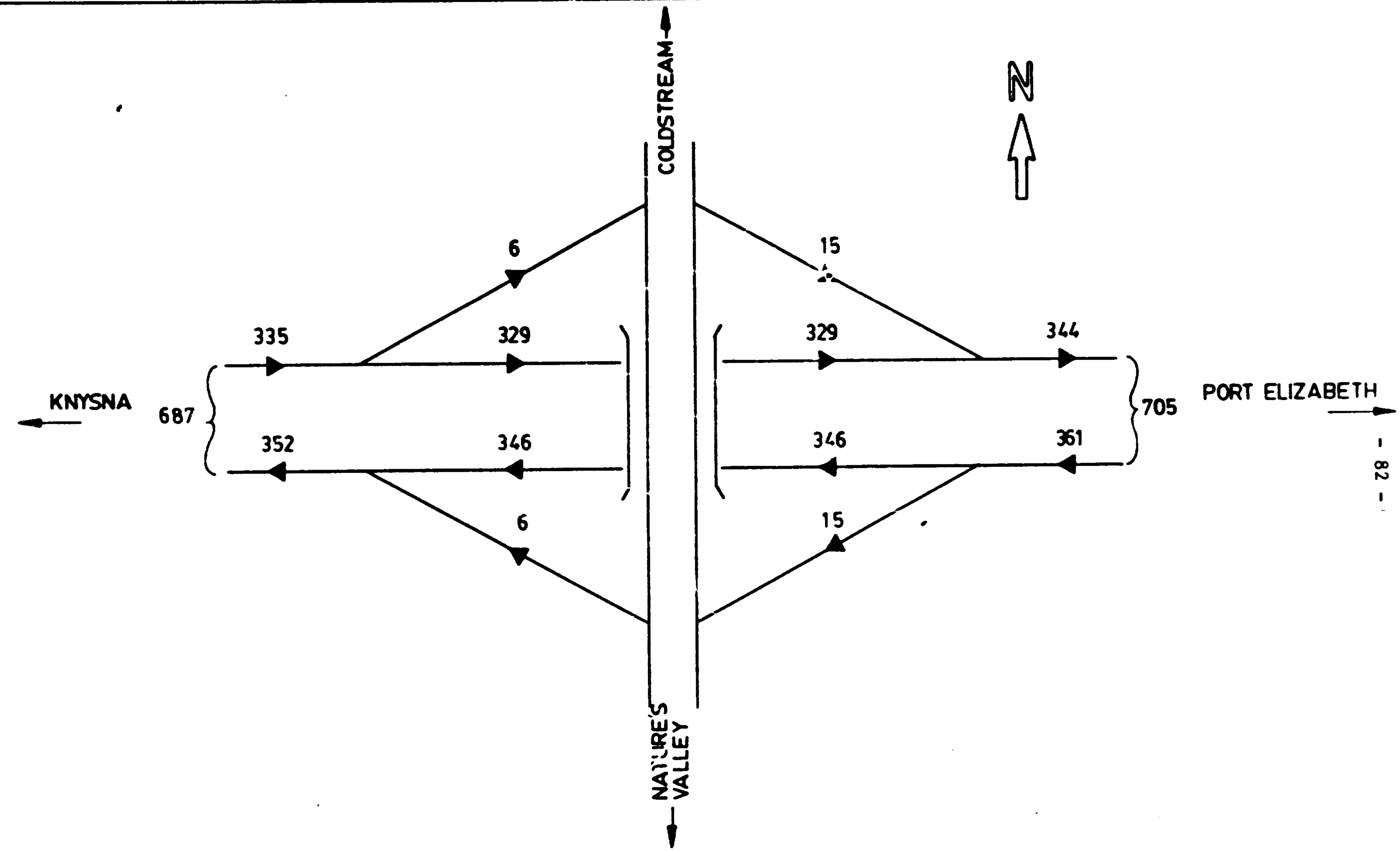
TRAFFIC COMPOSITION	CLASS 1 %	CLASS 2 %	CLASS 3 %	CLASS 4 %
WEST OF INTERCHANGE	87,6	4,9	2,4	5,1
EAST OF INTERCHANGE	86,2	4,9	3,3	5,6
AVERAGE	86,90	4,90	2,85	[illegible]35

THROUGH TRAFFIC

TRAFFIC COMPOSITION	CLASS 1 %	CLASS 2 %	CLASS 3 %	CLASS 4 %
-	87,7	4,9	2,5	4,9

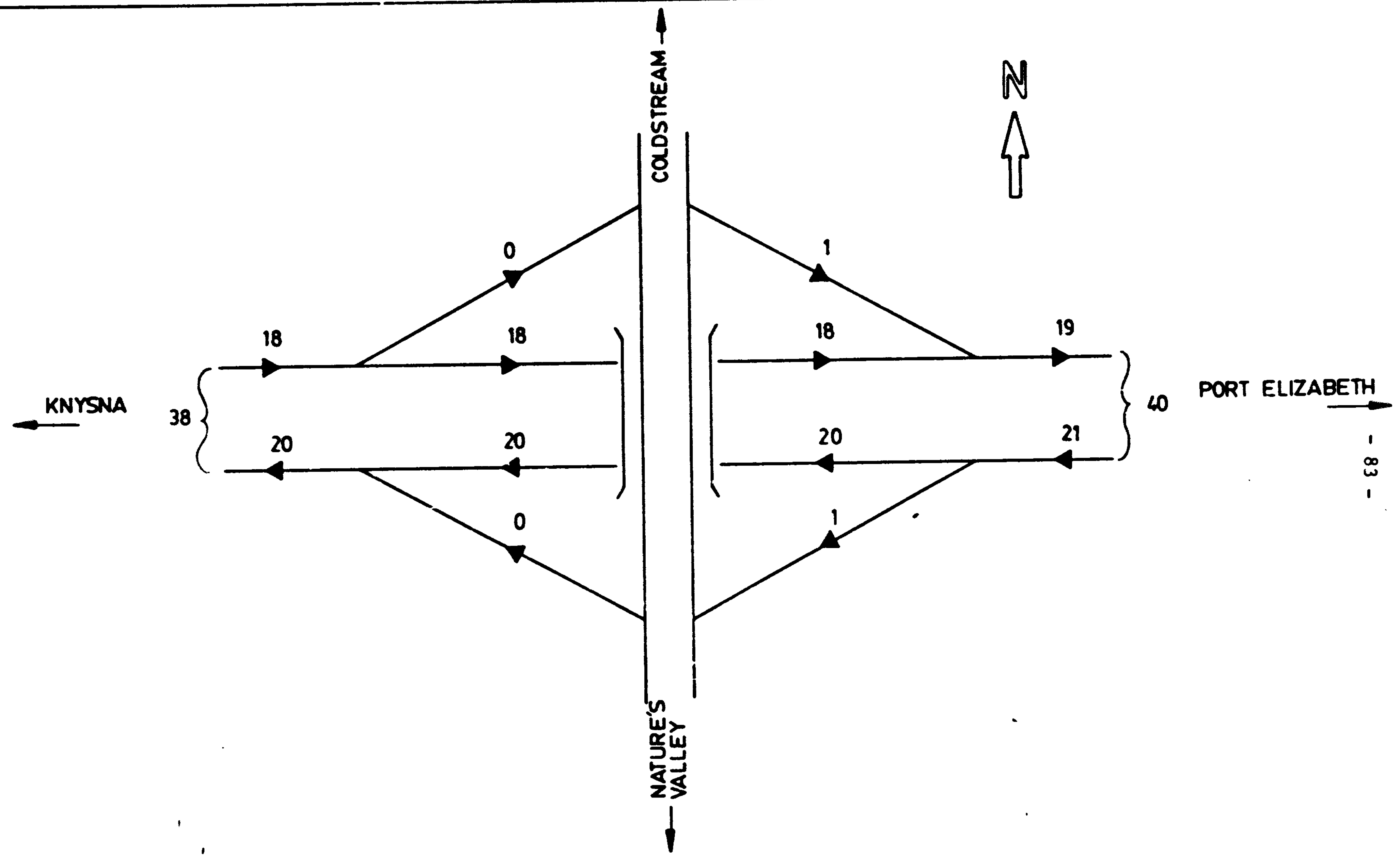
AVERAGE DAILY TRAFFIC (VEH/DAY) FOR MONTH OF AUGUST AT TOLL PLAZA INTERCHANGE

FIGURE A-8



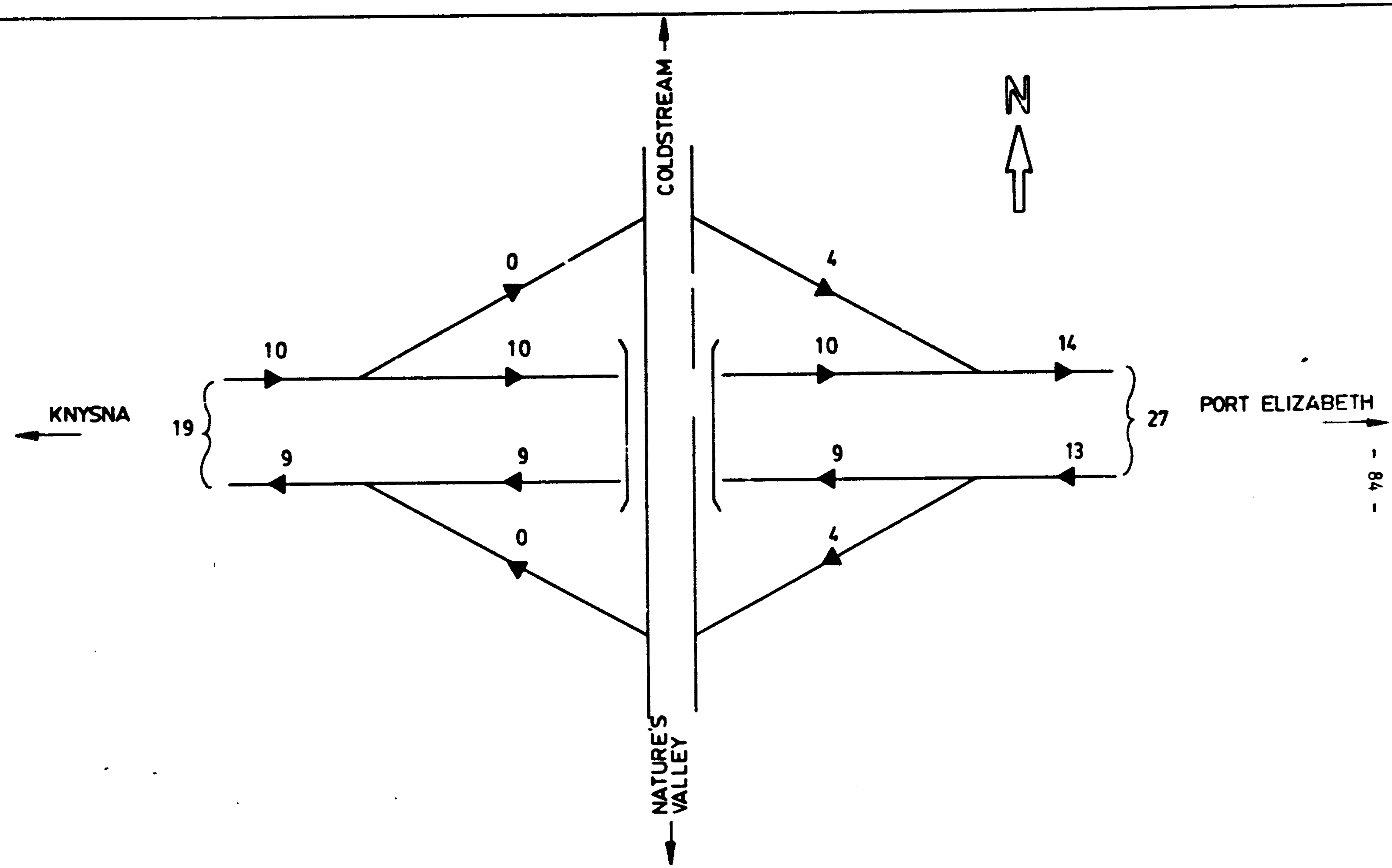
AVERAGE DAILY VOLUME FOR CLASS 1 VEHICLES FOR MONTH OF AUGUST AT TOLL PLAZA INTERCHANGE

FIGURE A-9



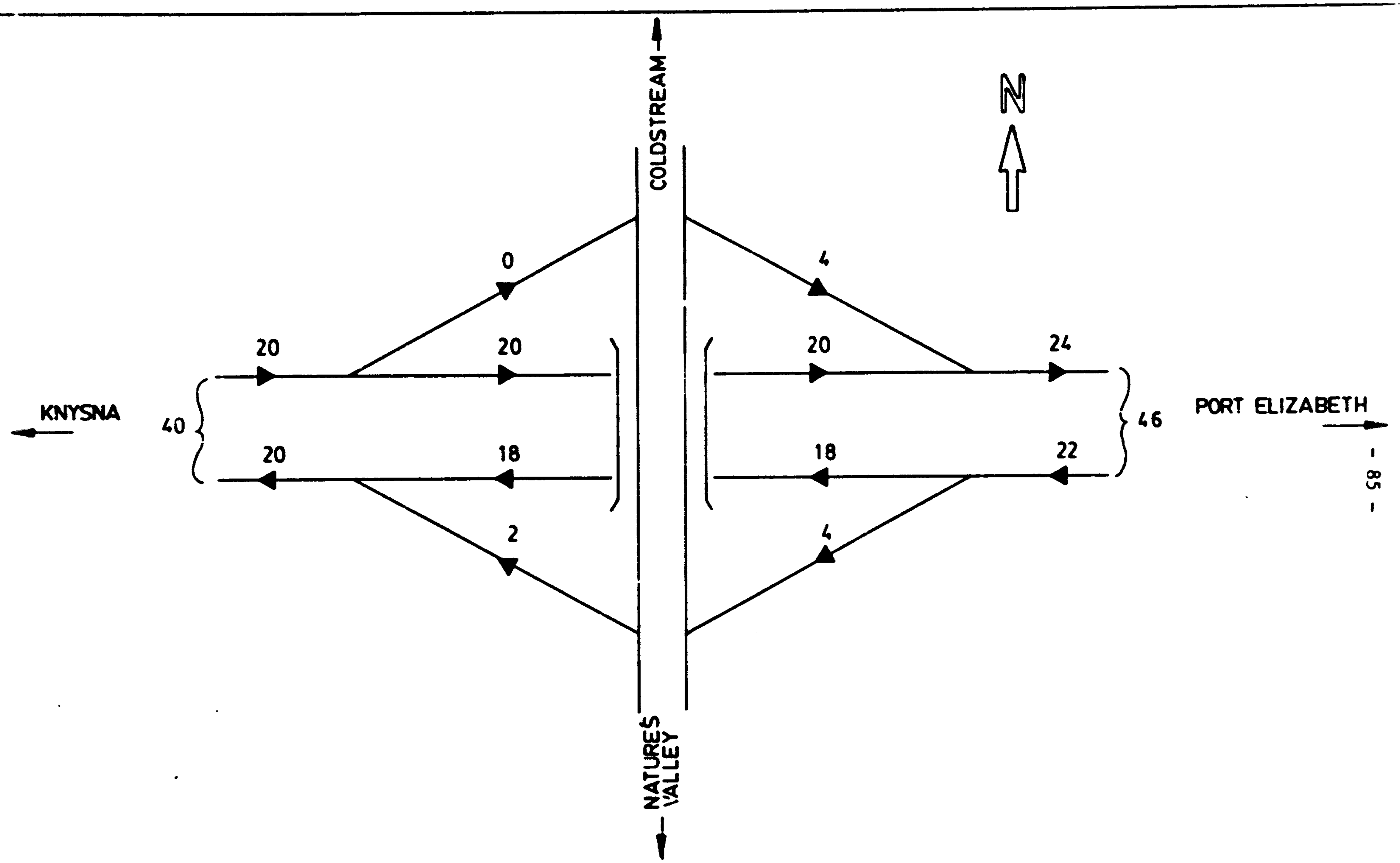
AVERAGE DAILY VOLUMES FOR CLASS 2 VEHICLES FOR MONTH OF AUGUST AT TOLL PLAZA INTERCHANGE

FIGURE A-10



AVERAGE DAILY VOLUMES FOR CLASS 3 VEHICLES FOR MONTH OF AUGUST AT TOLL PLAZA INTERCHANGE

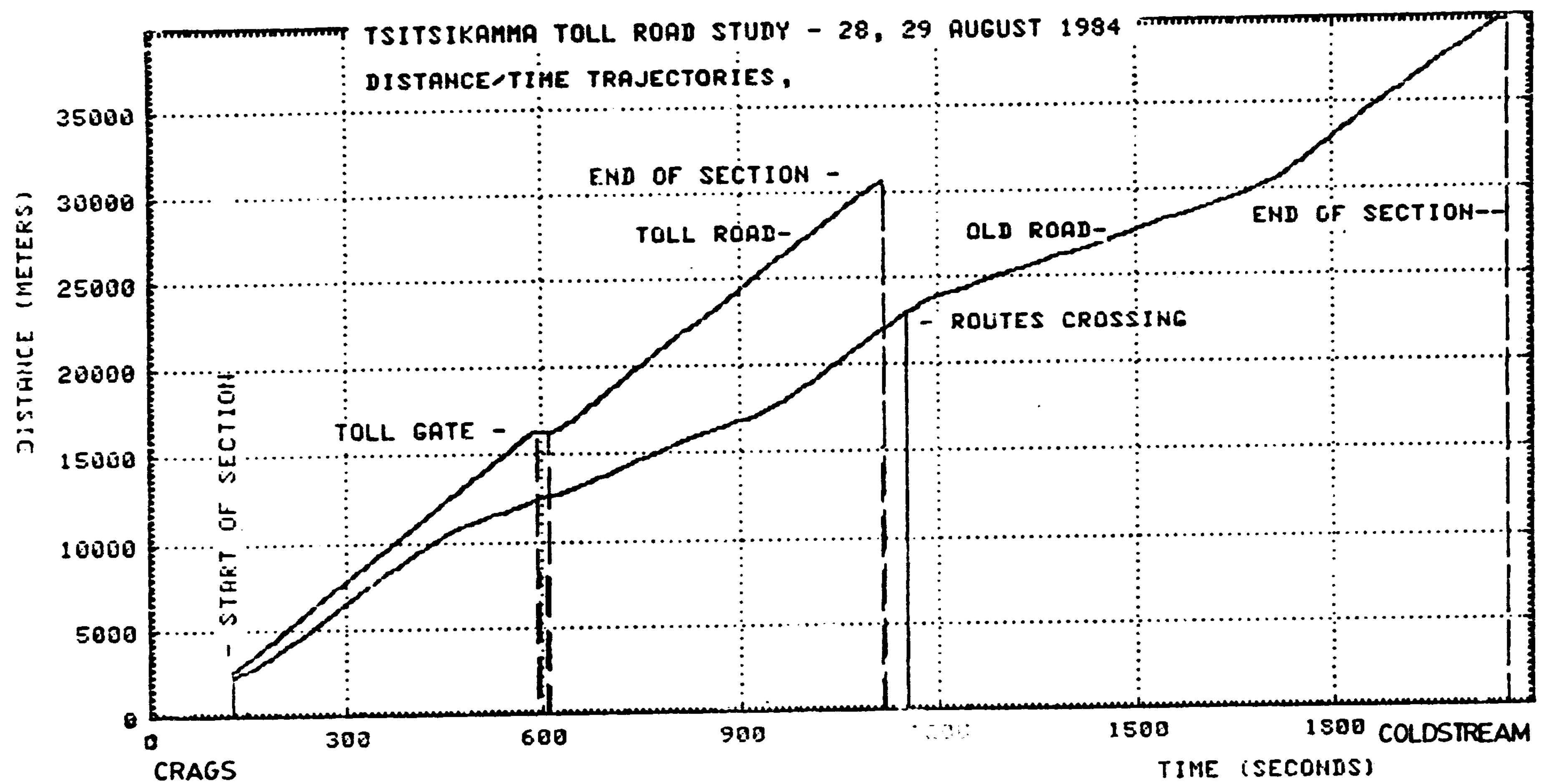
FIGURE A-11



AVERAGE DAILY VOLUMES FOR CLASS 4 VEHICLES FOR MONTH OF AUGUST AT TOLL PLAZA INTERCHANGE

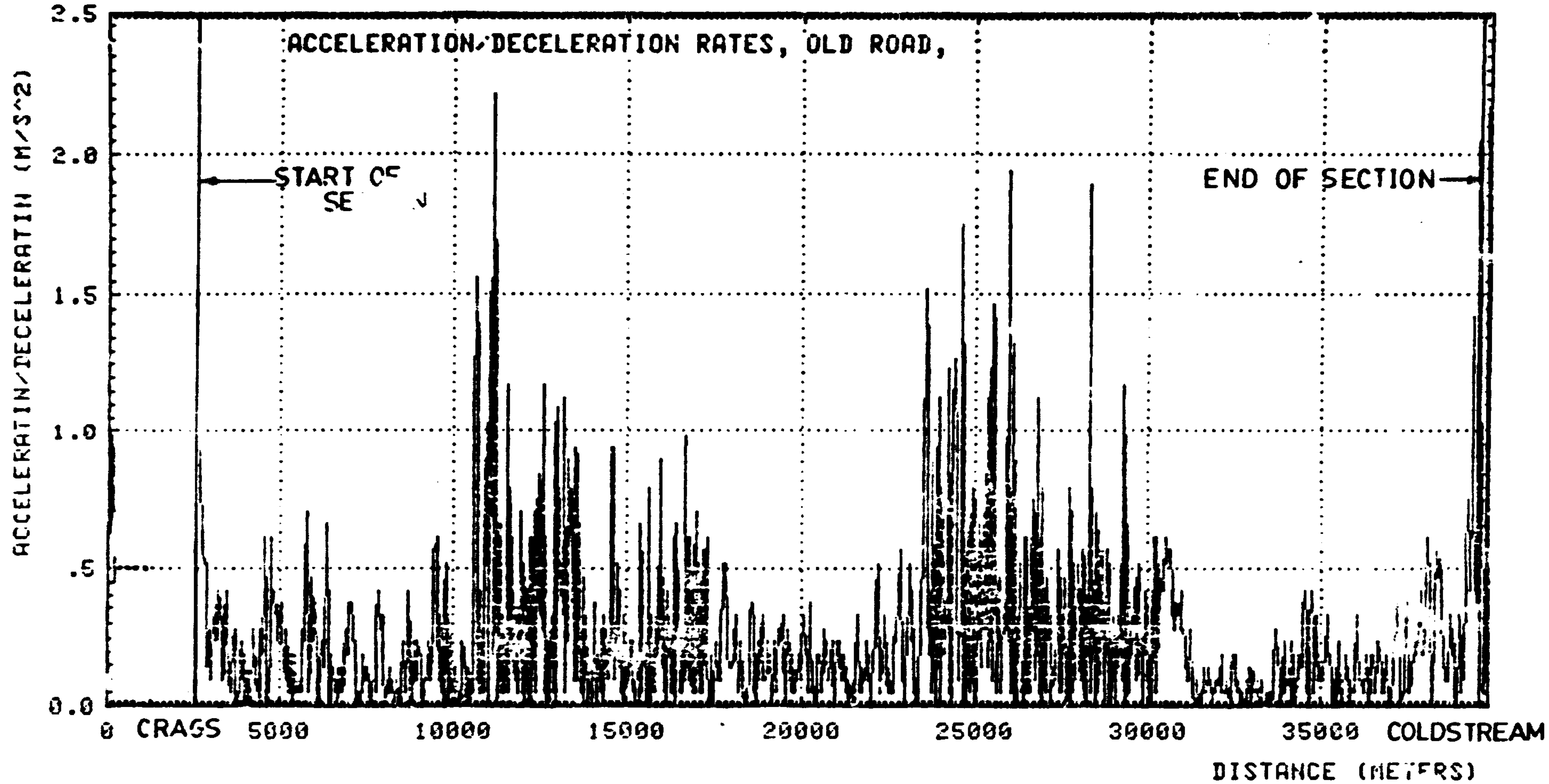
FIGURE A-12

A P P E N D I X B



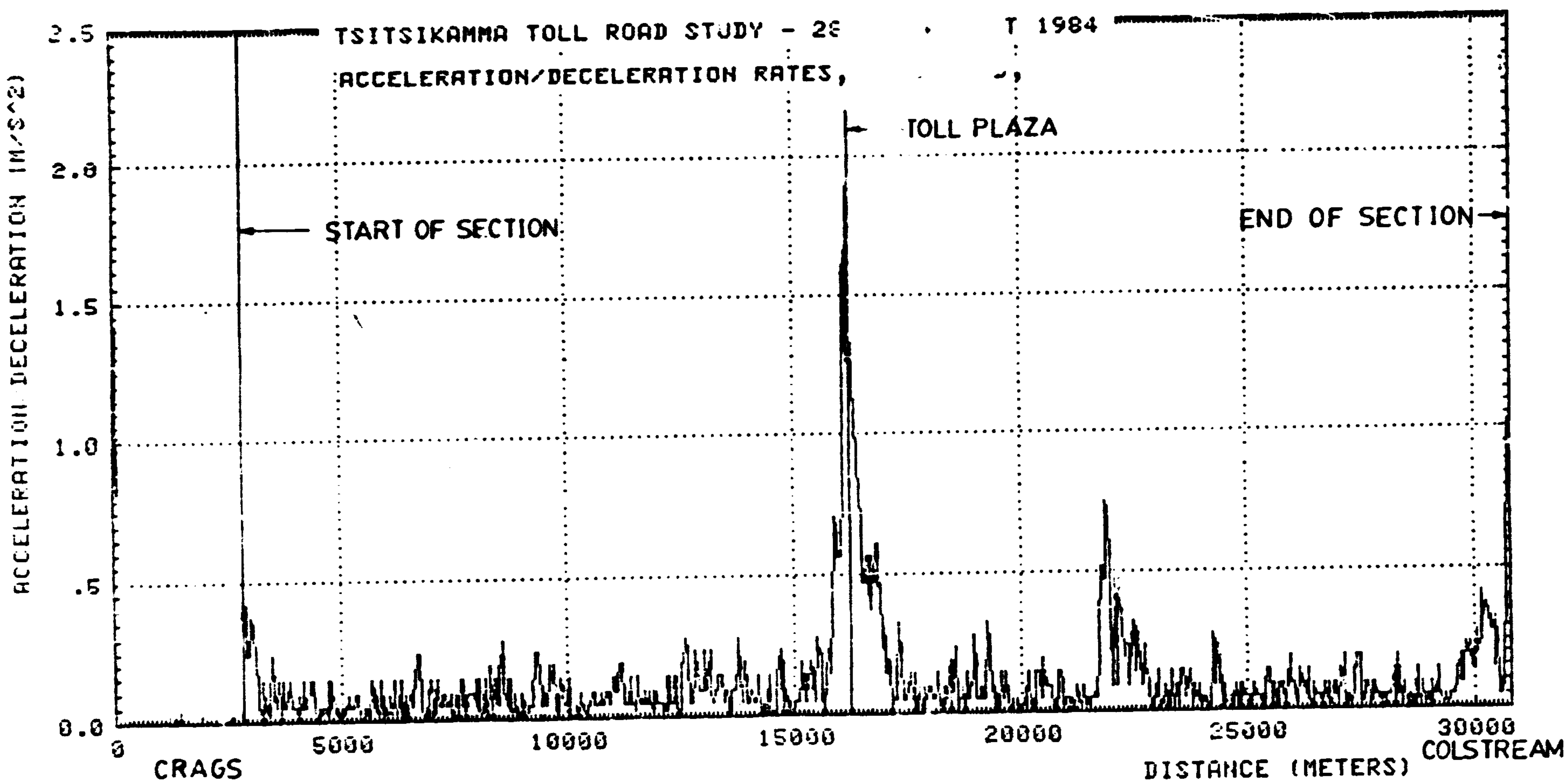
DISTANCE/TIME PROFILES FROM T.E.L.

FIGURE B-1



ACCELERATION / DECELERATION RATES, OLD ROAD FROM T.E.L.

FIGURE B-7



ACCELERATION / DECELERATION RATES, TOLL ROAD FROM T.E.L.

FIGURE B-3

DERIVATION OF TIME COST FOR CLASS 1 VEHICLES

1. From traffic observations carried out at the Tsitsikamma and other prospective rural toll road sites, the following was concluded:

(a) Percentage of cars	driven - by whites	=	87,5%
	- by non-whites	=	12,5%
(b) Trip purpose	- pleasure	=	40%
	- non-pleasure	=	60%
(c) Occupancy-pleasure	(drivers time only)	=	1 No
	- non-pleasure	=	1,3 No

2. For every 100 vehicles the distribution is as follows:

	White		Non-white	
	Pleasure 34	Non-pleasure 53	Pleasure 5	Non-pleasure 8
Occupancy	1,0	1,3	1,0	1,3
Total number of time related occupants	34	69	5	10
NITRR rates escalated to August 1984	R 2,07	R 8,28	R 0,61	R 2,42
Cost sub-total	R70,38	R571,32	R 3,05	R24,20
Convenience 20% of time cost	R14,08	R114,26	R 0,61	R 4,84
Total time and convenience cost for 100 vehicles	R84,46	R685,58	R 3,66	R29,04
Cost for one vehicle		R8,03		