

# 9

## MAINTENANCE STRATEGIES FOR LOCAL ROADS

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### 9.1 Introduction

*In the provision of a road network, the maintenance of roads is as important as their construction. Without proper maintenance, roads deteriorate rapidly and reconstruction becomes necessary prematurely. Therefore, roads should only be built if they can be maintained.*

The purpose of this chapter is to provide a synopsis of international practice for the maintenance of gravel roads, and to make recommendations with regard to the expanded network which is to be created in KwaZulu-Natal. The synopsis, and recommendations cover various technical, economic and employment aspects with special attention being given to maximising benefits at a local level.

As part of the Community Access Roads Needs Study, a Maintenance Sub-Committee was formed to investigate and make recommendations on appropriate methods of implementing a sustainable maintenance programme for community access roads. This programme presents an ideal opportunity to create work for emerging contractors and for procurement of goods and services on a basis of affirmative action, in terms of the objectives of the KwaZulu-Natal Department of Transport, KZN DoT.

The importance of maintenance has to be emphasized and understood as an important part of the Honourable Minister of Transport's objective to invest some R800 million over a period of 10 years in remedying the immediate and medium term needs for more than 11 000km of Local Roads serving the rural areas of the former KwaZulu. A sustainable and coordinated maintenance programme must thus be structured to ensure that the condition of this network is maintained.

### 9.2 Maintenance Activities

Maintenance activities for gravel community access roads are presented in Table 9.1 overleaf which is based on the Maintenance Methods Manual <sup>1</sup> of the KwaZulu-Natal Department of Transport. Non-essential activities such as fencing, vegetation control and the collection and removal of litter have been excluded.

TABLE 9.1 : RELEVANT MAINTENANCE ACTIVITIES FOR GRAVEL ROADS		
Drainage Maintenance	Gravel Maintenance	Gravel Improvements
ROUTINE MAINTENANCE (Defined as regular, planned and on a small scale).		
Cutting Mitre Drains Cleaning Minor Culverts Cleaning Waterways Gabion Protection Stone Pitching Minor Concrete Works	Normal Blading Watering and Blading Reforming Road Surface	Betterment (Only light) Patch Gravelling
PERIODIC MAINTENANCE (Defined as occasional, as the need arises and large scale).		
Culvert Installation Culvert Head-walls Upgrading System Drainage	Re-gravelling Erosion Repairs to Road Formation	Heavy betterment

### 9.2.1 Drainage Maintenance

Culverts convey water from the upstream side of a road to the downstream side. They may be built in an existing water course or where water accumulates due to the alignment of the road.

**Routine maintenance** is intended to keep the waterways clear, control scour and ensure minor repairs are carried out. If this maintenance is not attended to, silting, choking by debris and weeds, and structural collapse of culverts may occur resulting in overtopping and erosion damage to the road.

**Periodic maintenance** focuses on the upgrading and repair of major aspects of the road drainage such as the upgrading of drainage structures and the provision of additional pipe culverts etc.

### 9.2.2 Gravel Maintenance

A gravel wearing course is provided on a road to ensure a riding surface which will not form ruts and become impassable in wet weather. The gravel wearing course consists of a blend of clay, sand and gravel. The clay acts as a binder and the sand and gravel particles resist traffic loading and provide skid resistance.

Gravel has a tendency to whip off under traffic causing windrows to accumulate at the edges and between the wheel tracks. Water often lies in the wheel tracks causing potholes to develop. Routine blading with a grader is vital to maintain the road cross



section shape.

In addition to the routine repair of potholes and corrugations, the gravel wearing course is continually being worn away by traffic, eroded by rain and blown away as dust. This gravel loss may vary from 5 to 75mm per year. Variations are a function of traffic, material characteristics and road geometry. The lost gravel should be replaced as and when necessary under periodic maintenance.

### **9.2.3 Gravel Improvements**

After construction of a road it may become necessary to carry out minor improvements such as the addition of minor drainage or the improvement of sight distances. These improvements should be carried out as routine maintenance.

Heavy betterment such as a major realignment or the upgrading of a low level drift should be carried out under periodic maintenance. These changes are usually due to altered road usage such as an increase in traffic.

## **9.3 Options for Maintaining Rural Roads**

In South Africa the responsibility of maintaining formal gravel roads has generally fallen on public authorities, in KwaZulu-Natal the departments who shouldered most of the responsibility have been the Departments of Transport and Agriculture with the Department of Local Government and Housing playing a lesser role in maintaining roads within settlements and townships.

Maintenance of these formal roads has been carried out either directly by these Provincial Departments or contracted out to private enterprise.

Informal roads in the Province have been largely neglected except for a limited number mainly in farming areas known as 'By-Roads'. The maintenance and management of these roads has been carried out by the immediate road users, usually a small community or a group of farmers, under a subsidy scheme set out in the Natal Roads Ordinance 10 of 1968.

These systems, combined with others identified in research undertaken by the maintenance sub-committee, have been

grouped into 6 categories:

1. Public Authority (Departmental) Maintenance.
2. Formal 'End Specification' and 'Annual Maintenance' contracts.
3. 'Integrated Plant Hire' maintenance contracts.
4. 'Labour Based' maintenance.
5. 'Entry Level Plant' maintenance.
6. Community maintenance schemes.

### 9.3.1 Public Authority Maintenance

Key Points : Departmental Maintenance
High standards of quality. - Vast pool of experience. - Coherent organisational structure. - High utilisation of existing resources.

*Due to inadequate funding for the maintenance of existing declared roads in KwaZulu-Natal, the condition of the network is deteriorating rapidly.*

The Provincial Department of Transport is at present responsible for the maintenance of 23 000km of proclaimed rural roads in KwaZulu-Natal, of which 17 000km are gravel roads. To carry out the maintenance of these rural roads the Department owns 995 items of civil engineering construction plant and employs 6 500 staff.

The Department has a long tradition of setting high standards for quality and it has in its staff a vast store of road building experience. Due to limited budgets over the past number of years the Department has been hard pressed to attend to the needs of the existing proclaimed network and it is not feasible for the Department to carry out the maintenance of the local access road network without increasing its capacity and resources.

The Department has always been able to augment its construction and maintenance capacity with the use of private enterprise and it is envisaged that the private sector will be able to play a vital role in the maintenance of the new local access road network. The Department, with its experienced organisational structure, will be able to administer several different private enterprise contract systems which are described below. This strength should prove invaluable in the implementation of a new maintenance strategy.

### 9.3.2 Formal 'End Specification' and 'Annual Maintenance' Contracts

'End specification' contracts have been in use for a number of years by the Department of Transport and are ideally suited to periodic maintenance activities. To date 'end specification' contracts have focussed on the processing of layer works, small concrete works, bituminous sealing, grass cutting, line marking



and installation of reflectors.

These contracts are based on delivery of a specific product and payment is only made once the product has been inspected, tested and measured. The main advantages of this type of contract is that supervision is relatively low and contracts are not project specific. Rates are also fixed for a region with the only variable being the establishment and relocation costs for each separate road project.

Up to about 2 years ago the majority of these contracts were awarded to established contractors who were based in the major urban areas of the Province. More recently however, the situation has begun to change with the recent award of several contracts to local emerging contractors.

It is envisaged that these contracts will carry on being used for the periodic maintenance of roads and the further development of this form of contract in order that they be more inclusive, should be encouraged. A similar approach may be adopted for the routine maintenance of roads whereby DoT officials can inspect the finished product and only certify payment once set standards have been met.

The 'integrated plant hire contract' system is particularly suited to, and has been used extensively in the betterment of gravel roads. The differences between this and conventional contracts are described below.

The standard features of any conventional contract for civil engineering works are a set of design drawings, a specification and a bill of quantities. For a conventional contract, the tenderer is required to tender rates which are largely influenced by his assessment of the complexity and cost of the task, and the risk associated with meeting the client's requirements. During the construction phase completed work is measured, and payment is made in terms of these rates.

An alternative to this conventional method of engaging a contractor to undertake civil engineering works, is the integrated plant hire contract system. The fundamental difference between

Key Points : 'End Specification' Contract
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|---|
| <ul style="list-style-type: none"><li>- Requires limited supervision.</li><li>- Quick mobilisation of formal sector in times of crises.</li><li>- Appropriate for periodic maintenance.</li></ul> |
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### 9.3.3 'Integrated Plant Hire Contracts'

this system and the conventional contract system is the method of measurement. The integrated plant hire contract system operates on the concept of hiring plant, equipment and personnel using time-based rates, where the Engineer is responsible for managing the resources and the client carries the risk; whereas in the conventional contract system, the contractor manages his resources and therefore carries the risk in delivering a product which complies with the client's specification.

Key Points : 'Integrated Plant Hire' system
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| <ul style="list-style-type: none"><li>- This form of contract caters for less experienced civil contractors.</li><li>- Present contracts are geared for periodic rather than routine maintenance.</li></ul> |
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The 'integrated plant hire' contract system does not require a conventional Schedule of Quantities and also design drawings are not required. In preparing the contract document, the Engineer merely decides on the items of plant, equipment, materials and personnel he intends to use to carry out the works. To facilitate the adjudication of tenders, it is also necessary to estimate the length of time for which each item is required.

In this way personnel such as concrete foremen, earthworks foremen, administration clerks and artisans can be engaged on a weekly rate, while the employment of labour can be provided for by a provisional sum or a daily rate. Alternatively, the employment of specialist sub-contractors can be provided for by means of a provisional sum in the contract document.

Tendering for an integrated plant hire contract basically only requires a knowledge of plant and equipment operating costs, and since the risk is largely carried by the client, the system has the potential to provide opportunities for less experienced civil engineering contractors who have the required types of construction plant.



### 9.3.4 'Labour Based' Maintenance

Labour based road construction and maintenance methods have been supported by international funding organisations over the last three decades because the system is employment intensive and it provides for employment opportunities at a grass roots level.

Labour based contracts range from the employment of the individual, as is the case with the 'lengthman' system, to the award of 'labour only' contracts or sub-contracts to individuals or communities. With labour being the only major input this system has inherently low capital and running costs and it can be considered as a low risk option for job creation and the first step in the development of emerging contractors. However, there are various road maintenance activities which cannot be carried out by labour only, such as the hauling of gravel or heavy betterment.

Two forms of road maintenance systems based on labour only principles are described below to provide background to international practice; ie The 'Lengthman' and the 'Labour Based Contract' systems.

#### 'Lengthman' System

Key Points : 'Lengthman' System
<ul style="list-style-type: none"><li>- Limited overhead costs.</li><li>- Individual payments based on performance.</li><li>- Part-time employment best suited to subsistence farmers.</li><li>- Only practical in densely populated rural areas.</li><li>- Timely payment of contractors is vital.</li></ul>



The 'lengthman' system has been implemented in numerous countries in Sub-Saharan Africa. Kenya has been at the forefront of this system with the Rural Access Roads Programme (RARP) which focussed on the construction of roads and the Minor Roads Programme (MRP) which focussed on the routine maintenance of minor roads.<sup>2</sup>

The system is based on the appointment of a 'lengthman' on a contract basis to maintain a section of road. He is provided with basic hand tools and supervised once a month by an overseer. The employment of an ex-construction worker with experience in road work as the 'lengthman' has proved very popular in developing countries.

To reduce transport and accommodation costs a person living adjacent to the road is usually appointed as the 'lengthman'. The length of each individual's section is dependent on local conditions and is normally between 1,5 and 2 km. Payment is based on a 12 day working month which allows the contractor time to attend to other interests during the remainder of the

month. The contractor can be replaced if he consistently performs badly.

### **'The 'Community Based Approach'**

Emphasis has been placed on the construction of low volume tribal roads in rural KwaZulu-Natal using labour-intensive methods since the initiation of the KwaZulu Tribal Roads Study in 1989.<sup>3</sup>

Construction methods were generally based on the employment of individuals within a community. The construction process was divided into various activities and rates for these activities were agreed on after discussion with local roads committees. The roads committees were responsible for selecting suitable candidates for employment on their projects and for administering any disciplinary action. The roads committee also assisted with the determination of the route and the resolution of any conflicts with local residents. Payments were generally made on tasks completed and minimal daily wages were paid.

Unfortunately this initiative concentrated mainly on the construction of new roads and no allowances were made by the authorities for the maintenance of these roads after their completion.

For this form of labour based maintenance to be effective each community would have to be accountable for both the standards of maintenance on their roads and the selection and discipline of the individuals they employ. Training of communities to meet these challenges would be vital.

Developing countries, faced with the problem of stemming the flow of funds allocated to rural development back into the urban areas (and sometimes out of the country) have sought to encourage the development of locally based contractors for the construction and maintenance of their rural roads.

The problem faced by these developing countries has always been the lack of expertise in the rural areas. The route followed by most countries has been to identify promising individuals within the community and to set up programmes which allow for the training and development of emerging contractors.<sup>4, 5, 6, 7</sup>

Key Points : Community Based Labour Contract system
<ul style="list-style-type: none"><li>- Training of communities essential.</li><li>- Technical input minimal.</li><li>- Payment based on a subsidy rather than performance.</li><li>- Limited scope for identifying and training emerging contractors.</li></ul>

### **'The Emerging Contractor' Approach**



Key Points : Labour Based  
Emerging Contractor approach

- Technical input minimal.
- 'Earn as you learn' training.
- Initial stages in the development of an emerging contractor.
- Maximum retention of contract expenditure within the rural areas.
- Unable to address all of the routine maintenance needs of a gravel road.

**9.3.5 'Entry Level Plant'  
Systems**

Key Points : 'Entry Level Plant'  
System

- Tenderers must initially be protected from market forces.
- Restricted to routine maintenance activities.
- Adequate training and support structures necessary.
- Entrepreneurial development and confidence building of contractors.
- Timely payment of contractors is vital. <sup>4</sup>
- Addresses most of the routine maintenance needs of a gravel road.
- Important to select appropriate plant.

Experience has shown that professional management, supervision and training are vital to achieve satisfactory progress on projects. To reduce the risk of early failure most programmes concentrated on the effective use of labour before introducing sophisticated plant. Findings on these labour only contracts show that dual benefits can be achieved by this approach; firstly employment opportunities are created for the rural population and secondly the emerging contractor is exposed to formal tendering procedures and contract documentation.

The Soweto Contract Development Programme, which is one of the longest running programmes of this nature in South Africa, has focussed more on 'on the job training' or 'earn as you learn' than on formal training.

To improve efficiency and address all of the routine maintenance needs on their gravel road networks several developing countries such as Tanzania, Zimbabwe and Ghana have actively encouraged the equipping of locally based contractors with basic light equipment such as tractors, rollers and water bowsers to carry out construction and maintenance tasks on their road network. <sup>8</sup>

Tractor drawn equipment was chosen because conventional construction plant lacks versatility since most of the plant cannot be cross utilised in farming type operations. Also, with the present exchange rates, conventional plant costs are extremely high and high utilisation rates are necessary in order that finance charges can be met.

The transition of a labour based contractor to a plant enhanced contractor requires substantial financing and it is for this reason that developing countries have identified the need for an intermediate stage in the gradual mobilisation of an emerging contractor.

In both Zimbabwe and the former Transkei the maintenance of gravel access roads has been successfully addressed by the use of tractor drawn plant. <sup>9,10</sup> However, the use of tractor drawn plant for tribal road maintenance in KwaZulu in the late 1980's was considered a failure mainly due to the high incidence of

breakdowns. These were usually attributed to plant abuse although some plant was found to be inappropriate. Limited hiring of conventional plant would therefore ensure that the entry-level plant is not used outside of its capacity or capability.

Due to the increased demands placed on an emerging plant based contractor training is essential. It is here that retired members of the Department could play a vital role by becoming the backbone of the new emerging contractors. Contact with these retired staff members should be maintained in order that they may be fully informed of the role they can play in the new maintenance strategy.

### **9.3.6 Subsidised Maintenance by Communities**

The Natal Road Ordinance requires the Department of Transport to be responsible for the maintenance and management of all proclaimed roads. However, there are a number of minor public roads in KwaZulu-Natal which do not warrant being proclaimed as provincial roads. These roads, known as 'By-Roads', are classified in terms of the ordinance as public rural roads or paths which provide a reasonable means of access to other public amenities.

Key Points : 'By-Roads' System
<ul style="list-style-type: none"><li>- Private organisations and communities are responsible for minor public roads.</li><li>- Requires limited supervision.</li><li>- Suitable for minor roads but there have been instances where proclaimed roads have been handed over to the public for maintenance.</li></ul>



After an application for the registration of a 'By-Road' has been accepted, the Department provides an annual subsidy for the maintenance of the road. In this way the Department is able to incorporate minor roads in it's network without extending it's responsibilities. In recent years, due to the Department of Transport's limited capacity, agreements have been drawn up for private organisations to maintain certain proclaimed main and district roads under this subsidy scheme.



## 9.4 Costs of Maintenance Methods

**R**outine maintenance, because of its very nature, can be carefully planned and monitored and costs comparisons of various systems are possible. However, planning and monitoring of the periodic maintenance of gravel roads is not practical since activities such as re-gravelling and heavy betterment are only carried out when the need arises. Therefore only the costs for the various routine maintenance systems will be presented for comparison.

It should also be stated that the cost of routine maintenance is dependent on the productivity of each of the different maintenance activities and these are in turn affected by variations in local conditions such as climate, material type and road geometry.

The derivation of these costs is presented in section 9.8 of this report. Labour costs of R30,00 a day which is the present accepted rate in rural areas has been used throughout.

### 9.4.1 Entry-level Plant System

The annual cost for this system is based on a plant list comprising a tractor, a tow behind grader, a water bowser, a roller and a labour team of 6 men supervised by a CAR foreman and his operator. The cost for this system is:

R1 460,00/km per annum (Type 6 or 7A road).

R1 080,00/km per annum (Type 7B road).

### 9.4.2 Labour Based System

The annual cost for this system is based on an effective team comprising 20 labourers and a foreman. Research has shown that the team can carry out the routine maintenance of at least 1,5 to 2,0km of gravel road per day. Allowing for three visits per section per year, the cost for the team is:

R2 090,00/km per annum (Type 6 or 7A road).

R1 550,00/km per annum (Type 7B road).

### 9.4.3 'Lengthman System'

Research has shown that it is possible for one 'lengthman' working for 12 days a month to look after the routine maintenance requirements of between 1,5 to 2 kilometres of gravel road. The cost of this system is:

R2 880,00/km per annum (Type 6 or 7A road).

R2 400,00/km per annum (Type 7B road).

#### **9.4.4 'Subsidised Maintenance System'**

The Road Ordinance allows for various levels of subsidy depending on the ratio of immediate road user traffic to through traffic.

1. Predominantly local (subsidy of 50%).
2. Mostly local some through traffic (subsidy of 65%).
3. Mostly through some local (subsidy of 80%).
4. Predominantly through traffic (subsidy of 100%).

The maximum subsidy for general or routine repairs which is set every three years and was last revised in 1995 is R800,00/km per annum.

### **9.5 Requirements for a Maintenance Budget**

**T**he KZN-DoT is responsible for the maintenance of all proclaimed roads within the Province. However, with the introduction of a new class of road within the Province, ie local access roads, additional funding is necessary. The recently completed field study has estimated the size of this tertiary network to be in excess of 11 000km and it is therefore necessary to formulate budgets for both the construction and maintenance of this tertiary network. The maintenance budgets proposed in this section are based on the same ten year time scale used in the planning of the construction of the network.

#### **9.5.1 Formulation of a Maintenance Model**

The major road authorities in South Africa in the past have not been directly involved in the construction and maintenance of lower order roads, except for the 'By-Road' subsidy scheme described in Section 9.3.6. To obtain realistic cost figures for maintaining these new classes of road a maintenance model proposed in a publication issued by the National Department of Transport Function Committee on Roads <sup>12</sup> was investigated.

This model produced a recommended annual maintenance cost (MG) for a kilometre of gravel road. This cost included all routine maintenance such as blading and periodic maintenance such as re-gravelling. In applying this model to Community Access Roads it has been assumed that MG includes all the maintenance activities presented in Table 9.1.



The formula presented in the report is as follows:

$$MG_{1994} = (1\ 850 + 100\ ADT)/BCG\ (R/km)$$

... where

MG is the maintenance cost per kilometre of gravel road,

BCG is the benefit-cost ratio for a particular class of gravel road and

ADT is the annual daily traffic.

Cost from the model which, was produced in 1994, is affected by inflation and it is proposed that the model be escalated by a factor of 9% per annum to provide current costs, ie:

$$MG_{1997} = (2\ 400 + 130\ ADT)/BCG\ (R/km)$$

Table 9.2 presents the benefit-cost ratios as proposed by the National DoT report and Figure 9.1 graphically illustrates the maintenance costs as they relate to Average Daily Traffic (ADT).

TABLE 9.2 : BENEFIT-COST RATIOS FOR VARIOUS ROAD TYPES - Ref 12			
ROAD CLASS (PER DoT REPORT)	B/C "BCG"	ROAD CLASS (AS PER KZN-DoT)	PROBABLE ADT
Primary	1.3	Type 5 : Main Road	> 1 000
Secondary	2.3	Type 6 : District Road	100 - 50
Tertiary	3.3	Type 7A: Desirable Local Access Road	50 - 30
Local Access Road	4.3	Type 7B: Minimum Local Access Road	< 30

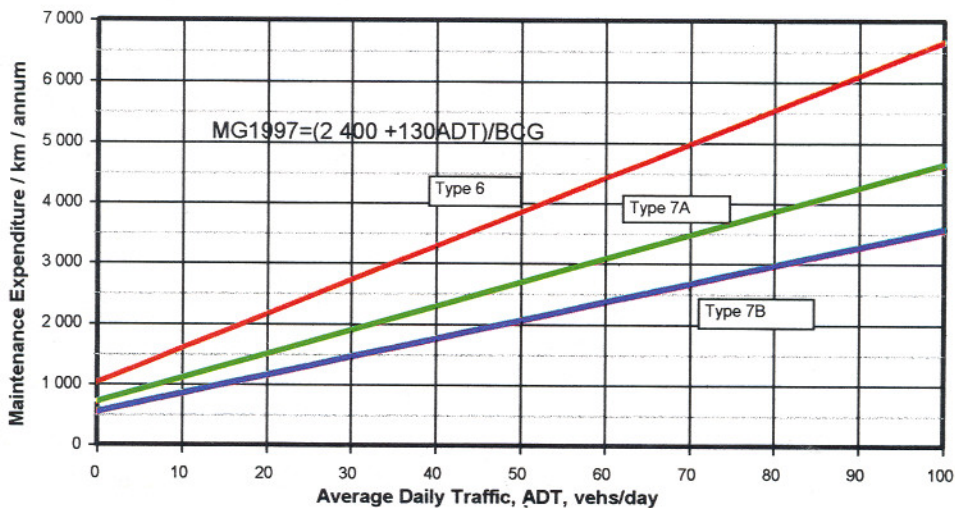


Figure 9.1 Maintenance Cost Model

It is therefore possible from Table 9.2 and Figure 9.1 to derive the budgetary requirements for both the routine and periodic maintenance of the various types of road depending on their traffic volumes:

Class 6 Road :

R3 900 for low daily traffic estimates (ADT) of 50 and  
R6 680 for normal daily traffic estimates (ADT) of >100.

Class 7A Road :

R1 900 for low daily traffic estimates (ADT) of 30 and  
to R2 690 for normal daily traffic estimates (ADT) of 50.

Class 7B Road :

R 560 for negligible daily traffic estimates and  
R1 460 for normal daily traffic estimates (ADT) of 30.

### **9.5.2 Maintenance Model Budgets vs Routine Maintenance System Costs**

The costs of each maintenance system presented in Section 9.3 was compared with the maintenance budget figures derived in Section 9.4.

#### **Model Costs vs the 'Lengthman' System**

The 'Lengthman' system has been used mostly on low volume, low speed roads. The maintenance allowance for a low volume Type 7B road of R1 460/km per annum is well below the expected cost of R2 400/km per annum for this system which it impractical for South Africa conditions. The root cause for the high costs is high labour costs for South Africa relative to other developing countries.

#### **Model Costs vs the 'Labour Based' System**

The 'Labour Based' contract system is also affected by high labour costs but higher standards of quality and productivity can be expected from this system. With costs of between R1 550 and R2 090/km per annum and allowing for adequate supervision, 'Labour Based' maintenance of Type 6 and 7A roads is feasible.

#### **Model Costs vs the 'Entry Level Plant' system**

The introduction of 'Entry Level Plant' to the 'Labour Based' contract would increase both productivity and quality. With costs of between R1 090 and R1 460/km per annum, this system could prove to be the ideal system for the routine maintenance

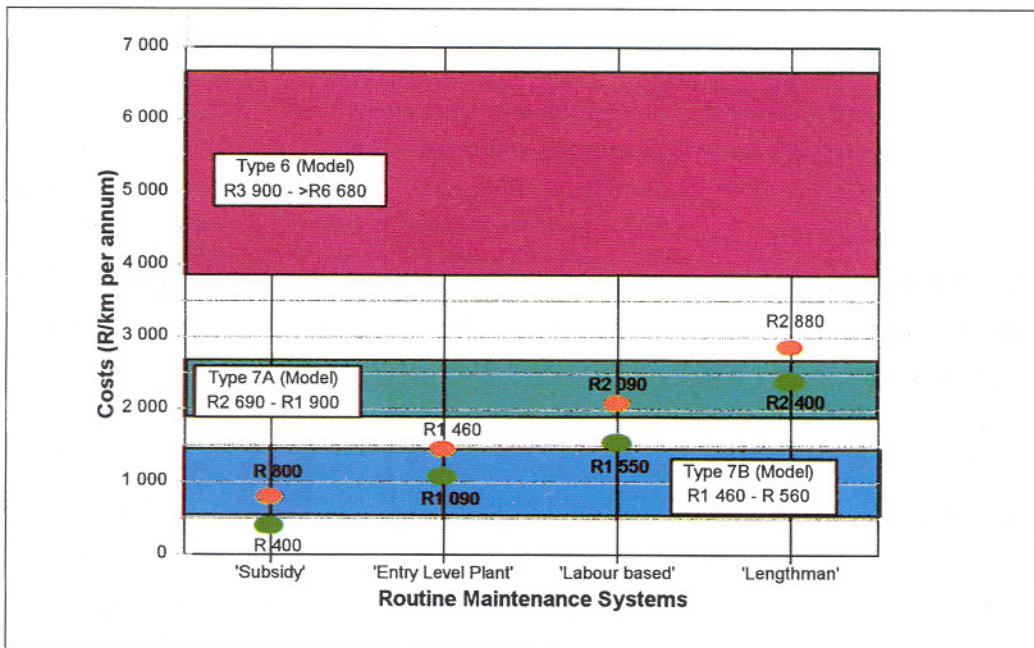


needs of all types of gravel roads.

Model Costs vs the Community  
Subsidy system

It is evident from Figure 9.2 that it is not possible to carry out formal maintenance on those Type 7B roads with low traffic expectations. It is therefore proposed that these lower order roads be maintained by the community on a subsidy system based on the existing 'By-road' subsidy scheme. At present subsidies for the routine maintenance of by-roads range from R400/km to R800/km per annum depending on road usage.

FIGURE 9.2 : GRAVEL ROAD MAINTENANCE SYSTEM COSTS vs THE MAINTENANCE MODEL



## 9.6 Evaluation of Maintenance Methods

The substantial backlog of Community Access Roads identified by the field study indicates that the budget as proposed by the Honourable Minister will not allow for the construction of anything but the most important roads to any one community in the next five years (see Section 10 of this Report). It would therefore be difficult to make community based road maintenance sustainable since training and supervision will have to be carried out in each and every community which has been supplied with a road, a requirement which would burden both the Department of Transport personnel and the newly formed RRTFs. For a system to be sustainable, in the short term at least, it would have to be based on regions. This fact has been taken into account in the comparison of the various systems presented in Table 9.3.

**TABLE 9.3 : A COMPARISON OF MAINTENANCE SYSTEMS**

MAINTENANCE SYSTEM	APPLICATIONS AND COSTS	ADVANTAGES	DISADVANTAGES
Public Authority Maintenance	Dept. of Transport is responsible for all proclaimed roads. Dept. of Agriculture is responsible for agricultural and 'in-field' roads and Dep. Local Government and Housing is responsible for 'closer settlement' roads  Costs not available	<ul style="list-style-type: none"> <li>- High quality standards.</li> <li>- Vast experience available.</li> <li>- Good support structure.</li> <li>- Strong, coherent organisational structure which focuses purely on the maintenance of roads.</li> </ul>	<ul style="list-style-type: none"> <li>- Existing capacity is limited by the high utilisation of resources.</li> <li>- No development of entrepreneurs within the local communities.</li> </ul>
'End Specification' and 'Annual Maintenance' Contracts	Extensive exposure in SA, especially in KwaZulu-Natal.  Usually periodic maintenance. Costs not applicable.	<ul style="list-style-type: none"> <li>- Allows flexibility of approach to improvement/construction of local roads.</li> <li>- Quick mobilisation possible in times of crisis or emergency.</li> <li>- Requires limited technical supervision.</li> <li>- Payment on meeting specification.</li> <li>- Risk transferred to contractor.</li> </ul>	<ul style="list-style-type: none"> <li>- Appropriate to periodic maintenance rather than routine maintenance.</li> <li>- In the past focussed on the formal construction sector who are based in urban areas.</li> <li>- Creates net outflow of funds from the rural regions to the urban regions.</li> </ul>
'Integrated Plant Hire' Contracts	Extensive exposure in SA, especially in KwaZulu-Natal.  Usually periodic maintenance. Costs not applicable.	<ul style="list-style-type: none"> <li>- Allows flexibility of approach to improvement/construction of local roads.</li> <li>- Quick mobilisation possible in times of crisis or emergency.</li> </ul>	<ul style="list-style-type: none"> <li>- Appropriate to periodic maintenance rather than routine maintenance.</li> <li>- In the past contracts precluded informal construction sector.</li> <li>- Creates net outflow of funds from rural to urban.</li> <li>- Requires intense technical supervision due to speed of progress.</li> <li>- Contractor not responsible for quality control.</li> <li>- High capital cost of procuring plant.</li> <li>- Risk carried by client.</li> </ul>

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**TABLE 9.3 : A COMPARISON OF MAINTENANCE SYSTEMS**

MAINTENANCE SYSTEM	APPLICATIONS AND COSTS	ADVANTAGES	DISADVANTAGES
'Lengthman System'	Numerous countries in Africa eg Kenya and Botswana.  Cost : R2 880/km per annum.	<ul style="list-style-type: none"> <li>- Addresses the principles of the RDP.</li> <li>- Community based construction possible.</li> <li>- Technical input minimal.</li> <li>- Performance based payment possible</li> <li>- Part time employment makes it suitable for rural subsistence farmers.</li> </ul>	<ul style="list-style-type: none"> <li>- Inflexible due to accommodation and transport requirements when network is widespread.</li> <li>- Able to carry out limited amount of maintenance activities.</li> <li>- High wage expectations could jeopardise the viability of large scale, long term maintenance strategies.</li> </ul>
'Labour Based' Contracts	Numerous countries in Africa eg Kenya, Lesotho, Ghana and Botswana.  Cost : R2 090/km per annum.	<ul style="list-style-type: none"> <li>- Addresses affirmative procurement.</li> <li>- Adheres to the principles of the RDP.</li> <li>- Low risk option (Level 1) for developing emerging contractors.</li> <li>- Technical input minimal.</li> <li>- Performance based payment possible</li> <li>- Involves private individuals who fulfil certain criteria.</li> <li>- Can be community based.</li> <li>- Part time employment makes it suitable for rural subsistence farmers.</li> </ul>	<ul style="list-style-type: none"> <li>- Flexibility dependent on overseer's manner of transport when network is widespread.</li> <li>- Able to carry out most but not all routine maintenance activities.</li> <li>- High wage expectations could jeopardise the viability of large scale, long term maintenance strategies.</li> </ul>
'Entry Level Plant' Systems	Numerous countries in Africa eg Zimbabwe, Kenya, Ghana.  Cost : R1 460/km per annum.	<ul style="list-style-type: none"> <li>- Addresses affirmative procurement.</li> <li>- Adheres to the principles of the RDP.</li> <li>- Medium risk option (Level 2 and 3) for developing emerging contractors.</li> <li>- Equipment is locally manufactured and therefore saves on foreign exchange.</li> <li>- Technical input needed.</li> <li>- Performance based payment possible</li> <li>- Involves the private sector who fulfil certain criteria.</li> <li>- Stepping stone to formal construction industry.</li> <li>- Possibility of using privately owned equipment from within the community.</li> </ul>	<ul style="list-style-type: none"> <li>- Unable to carry out heavy betterment and other periodic maintenance activities.</li> </ul>
Subsidised Maintenance by Communities	Numerous minor roads and some proclaimed roads in South Africa	<ul style="list-style-type: none"> <li>- Possibility of using privately owned equipment from within the community.</li> <li>- Technical input minimal.</li> <li>- Payment of subsidy only after road has been satisfactorily maintained.</li> </ul>	<ul style="list-style-type: none"> <li>- The assumption is that communities have the capacity and expertise to carry out their own maintenance programmes. Reality is that communities will have to be suitably trained.</li> <li>- Without strict controls the system would degenerate cycle of handouts to a community.</li> <li>- This would produce a dependency cycle as has been the case in some other developing countries.</li> </ul>

## **9.7 Implementation of a Maintenance Strategy**

### **9.7.1 Identification and Selection Process**

The objective of this programme is to ensure that both the routine and periodic maintenance requirements of the gravel road network are carried out within the budgetary constraints set up in section 9.5 and that the development and training needs of local entrepreneurs to perform as contractors are met.

Advertisements, placed in local newspapers and on radio, would invite local residents interested in being trained as road maintenance contractors to submit details of their experience and education. The main selection criteria would be the ability to read and write in preferably English or Zulu, proven business skills and preferably some exposure to the construction industry.

### **9.7.2 Training Process**

Training will then be provided in both technical and tendering aspects Prior to the commencement of any contracts, which may initially need to be guided by an experienced 'mentor' from the Department or the private sector.

Trainees will be introduced to and will be required to undertake the various maintenance activities as part of the training programme. During these activities, the trainees will be required to record the amount of manpower, equipment and materials required to complete each task and the duration of each task.

A specially designed standard tender document which includes standard forms to calculate rates will be prepared and trainees will have to undergo a practical training programme on tendering.

Candidates who successfully complete the training programme will then be invited to tender. After the closure of tenders, a meeting can be held with each tenderer to rectify mistakes and for each tenderer to justify his input costs. Alternative strategies can be proposed which may reduce input costs. The client and consultant will then be able to determine realistic rates for each activity.

### **9.7.3 Contract Monitoring and Supervision**

Strict contract supervision will be necessary but a counsellor, who can provide the contractors with advice and guidance on technical, financial, administration and organisational aspects, should also be appointed. This is necessary as it is difficult for



the client to be a strict disciplinarian regarding quality control and at the same time be supporting and understanding as a mentor.

#### **9.7.4 Financial Support**

The Department, as the client, should support the emerging contractors to secure loans from financial institutions such as the KwaZulu Finance Corporation and the Small Business Development Corporation. However, if at first these applications are not successful the contractors must be allowed to continue with the labour based activities which require little initial costs. During this period the contractor has the opportunity of strengthening his financial position, but at the same time will experience heavy cash flow obligations with the need to pay for labour and running costs of vehicles and plant. The 'cash flow' implications of this may be assisted by reducing the period of payment from a month to a fortnight. The emerging contractor may at any time during his contract, once his financial position is strong enough reapply for loans for the purchase of his capital equipment and tools

In order for the contractors to develop fully, guidance and support must be provided for a period of time and therefore negotiated tenders should be considered. The duration of the contract must be sufficient to ensure that the contractors have a fair opportunity to learn all the skills required and also to ensure that the contractor is in at least the same financial state as he was before the programme commenced, provided that he has performed honestly and diligently. The contract period should however not be so long that the emerging contractor begins to feel he need not be competitive to secure a job.

An element of competitive pricing could be introduced by allowing the lowest tenderer the area or contract of his preference.

#### **9.7.5 Tendering and Costing**

Simplified conditions of contract and specifications should be used as the standard SABS or CSRA contract documentation require a high level of expertise. Detailed method specifications based on the Maintenance Methods Manual should be prepared and labour, plant and materials requirements for each activity listed. The recently published Short Conditions of Contract (1996) for Minor Works of Civil Engineering Construction published by

Benchmark Consultants should be investigated for this purpose.

Detailed method specifications based on the Maintenance Methods Manual should be prepared and labour, plant and materials requirements listed for each activity. In order to ensure effective learning, the contractors should be required to keep records of productivity per activity and submit these with the payment certificate each month.

As indicated above initially the contract rates should be negotiated with emerging contractors. The rates would be based on envisaged overhead costs, production rates and material costs per unit which should be included in overall rates for the work items. Site establishment should be paid, but it should not be necessary to pay time related P&G as all costs should be included in the work payment items.

Production rates should be monitored on each contract and weighted average rates determined. These rates are measured in man-days per activity and all overhead costs assigned proportionally to the unit cost rates by attaching an overhead cost to a man-day. As there is no allowance for preliminary and general items, all costs, excluding materials, should be considered as overhead costs. To determine the total unit cost rate per activity the man-day/unit is multiplied by the man-day cost per unit and the material cost added.

To improve the contractor's understanding of rates, the contractor must record man-days and keep simple records to enable him to undertake costing exercises to develop the awareness of the relationship between costs and income for each item.



## 9.8 MAINTENANCE COSTS



### Cost of the 'Lengthman' system

This section presents the development of the costs for the maintenance methods set out in Section 9.4. To determine the overall monthly costs of each of the maintenance systems as described in Section 9.3, costs of the following were derived:

1. Total capital costs for tools and plant appropriate to the system. (It was assumed that all equipment was purchased new.)
2. Monthly loan repayments of the capital amounts at an interest rate of 20.5%.
3. Monthly operating and maintenance costs of tools and plant.
4. Monthly labour costs.
5. Contractor's overheads and profit.

This system is based on a 'lengthman' working for 12 days a month and being able to maintain 1,5km of Type 7A or 1.8km of Type 7B road a month.

The minimum cost per km for Type 7A road is:

$$((12\text{days} \times R30/\text{day}) \times 12 \text{ months})/1.5\text{km} =$$

**R2 880/km per annum.**

The minimum cost per km for Type 7B road is:

$$((12\text{days} \times R30/\text{day}) \times 12 \text{ months})/1.8\text{km} =$$

**R2 400/km per annum**

### Cost for 'Labour Based' Maintenance Contracts

Research has shown that, on a 6m gravel road with reasonable drainage, productivity rates of 1,5 to 2,5km per 7 hour working day can be achieved. Based on these figures and assuming that work is carried out on 22 days per month, 11 months per year and at an efficiency of 80%, then 385km of Type 7A and 520km of Type 7B road can be maintained per year. Allowing for three visits per road per year, then approximately 130 and 175km of road can be maintained per year.

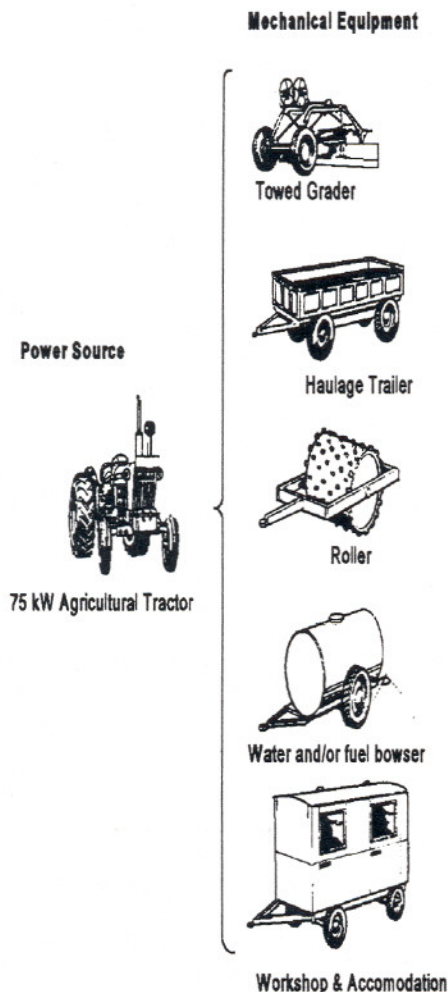


TABLE 9.4 : MONTHLY LABOUR BASED CONTRACT COSTS	
ITEM	MONTHLY COST R
<b>Capital Items</b>	
Bakkie	44 000
Roller	25 000
Tools	10 000
<b>Total Capital</b>	<b>80 000</b>
<b>Capital Loan Repayments</b>	<b>2 450</b>
<b>Overheads &amp; Maintenance Cost</b>	
Fuel & lubrication	450
Depreciation	150
Preventative maintenance	100
Insurance	150
Opportunity Interest	300
<b>O &amp; M Total</b>	<b>1 150</b>
<b>Labour and Tools</b>	
Labour (20 lab. at R30,00/day)	12 000
Tools	3 000
<b>Labour (20 No.) &amp; Tools</b>	<b>15 000</b>
<b>Overheads &amp; Profit</b>	<b>4 000</b>
<b>TOTAL MONTHLY COST</b>	<b>22 600</b>

The minimum cost per kilometre for a Type 7A road to maintain such a unit would therefore be:

$$(R22\ 600 \times 12) / 130\text{km} = \underline{\underline{R\ 2\ 090 / km per annum}}$$

And the minimum cost per kilometre for a Type 7B road to maintain such a unit would therefore be:

$$(R22\ 600 \times 12) / 175\text{km} = \underline{\underline{R\ 1\ 550 / km per annum}}$$

### Cost for the 'Entry Level Plant' Maintenance system

Studies on productivity of tractor drawn graders used in maintaining roads in Zimbabwe show that on a 6m gravel width (similar to a Type 6 or 7A road) and the grader making 4 - 6 passes, productivity rates of 6km per 7hour working day can comfortably be achieved. Based on a 3m wide, Type 7B road productivity rates would be increased by 35%.

Based on the above and assuming that approximately 22days per month, 11 month per year and an efficiency of 60% then



870km can be maintained per year. Allowing for three visits per section per year, then approximately 290km of Type 6 and 7A roads or 390km of Type 7B roads can be maintained per year.

<b>TABLE 9.5 : ENTRY LEVEL PLANT CONTRACT COSTS</b>	
<b>ITEM</b>	<b>MONTHLY COST R</b>
<b>Capital Items</b>	
Tractor	140 000
Towed grader	46 000
Water Bowser	12 000
Roller	25 000
Maintenance Tools	10 000
<b>Total Capital</b>	<b>233 000</b>
<b>Capital Loan Repayments</b>	
	<b>7 150</b>
<b>Overheads &amp; Maintenance Cost</b>	
Fuel & lubrication	2 770
Depreciation	1 550
Preventative maintenance	2 070
Insurance	570
Opportunity Interest	1 480
Operator & Assistant	6 000
<b>O &amp; M Total</b>	
	<b>14 440</b>
<b>Labour and Tools</b>	
Labour	6 000
Tools	2 000
<b>Labour &amp; Tools</b>	
	<b>9 000</b>
<b>Overheads &amp; Profit</b>	
	<b>4 590</b>
<b>TOTAL MONTHLY COST</b>	
	<b>35 180</b>

The cost per kilometre to maintain such a unit would therefore be:

Type 7A road

$$(R35\ 180 \times 12) / 290\text{km} = \underline{\underline{R1\ 460 / km per annum}}$$

Type 7B road

$$(R35\ 180 \times 12) / 390\text{km} = \underline{\underline{R1\ 080 / km per annum}}$$

## 9.9 Conclusions and Recommendations

Conclusions and Recommendations
<ul style="list-style-type: none"><li>- Ideal method for providing long term sustainable employment for emerging contractors.</li><li>- The systems proposed in this report are appropriate for all gravel roads.</li><li>- Training, both informal, 'earn as you learn' and formal are essential</li><li>- Provide a structured growth path for emerging contractors starting from 'Labour Only' contractors to fully fledged formal contractors.</li><li>- Proceed with maintenance of existing roads immediately.</li><li>- Proceed with pilot studies on 'Entry Level Plant' as soon as possible.</li></ul>

The maintenance of gravel roads should prove to be the ideal method of providing sustainable, long term opportunities for the development of emerging contractors in the rural areas of KwaZulu-Natal. It is therefore vital that a structured development programme with the long term goal of developing emerging contractors into competitive conventional contractors be implemented.

A substantial number of 'Tribal' Roads, constructed under previous programmes, exist in the rural areas of KwaZulu-Natal. These roads are at present not being maintained and it is therefore essential that a suitable maintenance programme must be implemented for them as soon as possible.

The systems proposed in this section are not only applicable for the maintenance of community access roads but also roads forming part of the Province's proclaimed network. It is therefore recommended that emerging contractors be established in a specific geographical areas and that they be given the responsibility of maintaining all gravel roads in their areas.

Training of the emerging contractor must become the main emphasis of the programme. Training, both formal and informal, must initially concentrate on the effective utilisation of labour and equipment and then progress onto developing technical, financial and administrative skills.

Although it is possible to initiate an emerging contractor programme immediately it is acknowledged that it may take a number of years before these emerging contractors have progressed to a stage where they are able to purchase their own plant and become 'Entry Level Plant' contractors.

During this period the programme should proceed with pilot studies to evaluate the suitability of tractor based plant in KwaZulu-Natal conditions.



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