

Royal Government of Cambodia  
Ministry of Rural Development

# Rural Road Maintenance Management

prepared by

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## Foreword

**R**ural road construction and maintenance is a relatively new responsibility of the Government of Cambodia. This issue was first raised in its current form through the labour-intensive rural infrastructure rehabilitation programme of the ILO in the north-western provinces in 1992. Since then, the Government has, with the support of several international development agencies, shown a growing interest and concern for this essential component in its efforts to develop access into the rural areas.

With the commencement of the Rural Infrastructure Improvement Project, as well as other rural infrastructure initiatives, the Government through its Ministry of Rural Development, is now in the process of building up its own capacity to rehabilitate and maintain a rural road network.

In this work, the Government clearly appreciates the value of utilising to the maximum extent the use of local resources, thus using labour-based methods for road rehabilitation and maintenance. This technology has been effectively developed in Cambodia, showing that it is feasible to build and maintain rural roads efficiently and cost-effectively using methods which also generate income and provide employment in the rural areas.

Casual labour combined with a limited use of light equipment is thus utilised to carry out all road improvement and maintenance operations providing a functional road network which responds to the dire demand for access to and within the rural areas of Cambodia.

### This manual

- sets out some basic MRD policies and standards on technical issues related to rural road maintenance
- describes in detail the management procedures for routine maintenance works
- provides guidelines on planning of works, work norms, organisation and how works are effectively measured and controlled.

The manual is aimed primarily at the provincial technical staff who are directly involved in rural road maintenance works. In addition, the manual attempts to document the maintenance management system which has already been established for the rural roads rehabilitated under the Rural Infrastructure Improvement Project.

The first Chapter attempts to summarise relevant Government policies regarding rural road maintenance. The second Chapter defines the various components of road

maintenance and describes an effective strategy and organisation which addresses the maintenance requirements of rural roads in Cambodia. Chapter 3 is a brief description of the planning, implementation and reporting cycle required in an effective road maintenance management system. Chapter 4 summarises the contracts management procedures, and finally Chapter 5 contains a detailed description of the planning and reporting system established for the execution of routine maintenance works, engaging local petty contractors using labour-based work methods.

The purpose of this manual is to provide technical staff with appropriate guidelines on the effective management of rural road maintenance works. A description of the physical works itself is covered in the four International Road Maintenance Handbooks. Hopefully, the combination of these documents should provide sufficient guidance to technical staff in carrying out maintenance of rural roads in Cambodia.

With the continuing efforts of the Government in terms of formulation and development of consistent road maintenance policies and strategies, combined with the securing of sufficient funding and a continued priority given to human resource development, it is hoped Cambodia can in the near future establish a sound maintenance and operation system for its rural road network, thus effectively addressing the needs for adequate access which is required to develop its rural areas.





# Chapter 1

## Introduction

### 1.1 The Road Sector and its Major Characteristics

Cambodia's road network is estimated to consist of about 4,200 kilometres of national roads, some 3,600 km of provincial roads and an estimated 28,000 km of local and tertiary roads. Most of the road network dates back 50 to 60 years and was built to serve light weight vehicles. Although some roads were upgraded in the 1960s, most of the existing road network remains unsuited to currently prevailing traffic volumes which include a high percentage of heavy vehicles.

During the 1970s and 1980s the road network severely deteriorated, with a significant number of the country's 4,100 bridges either damaged or destroyed. The condition of the road network has further deteriorated over recent years by continued use by heavy vehicles and with little maintenance being carried out.

As the Government has attempted to improve and upgrade the national road network, the lack of attention to maintenance has become apparent in the continued declining state of the network. In many cases, investments are now being made into reconstructing roads which were upgraded only a few years ago.

It is estimated that more than 50% of the primary road network requires urgent repair works. Furthermore, 80% of the country's local and tertiary roads are in a serious state of disrepair with the result of limiting access to large portions of the rural areas during the rainy season.

The Ministry of Rural Development (MRD), through its provincial departments, is responsible for the provision of secondary and tertiary roads, linking the rural areas to the major trunk road network. Most

provincial departments still lack the physical inputs required to meet the maintenance and rehabilitation demands in their respective provinces. Today, most of the road works activities are funded through external funding sources and often under external supervision.

Due to the low level of activity and the extreme lack of funds and human resources, the implementation capacity of the provincial authorities is limited.

“The Ministry of Rural Development and the Provincial Rural Development Committee shall have the duty to implement and to monitor the implementation of this rural road maintenance nation wide, which include:

- routine maintenance,
- periodic maintenance and
- emergency maintenance,

and shall report to the Royal Government for the progress.”

Extracts from the Circular on the Implementation of Rural Road Maintenance, signed by Prime Minister, 29 January 1999

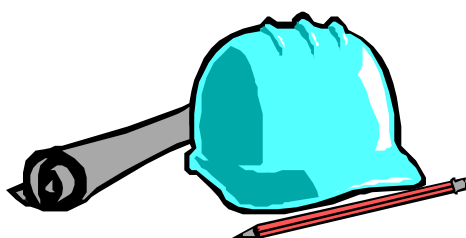
Most of the technical staff, where available, are young engineers and technicians, however, after graduation they have had very limited opportunity to practise their newly acquired skills with the result that they have not gained the necessary experience in planning, supervising and execution roads works. Furthermore, due to the low level of road works activities in the PDRDs, efficient administrative and

financial procedures are lacking, and need to be introduced before these organisations can resume their responsibilities as fully operational road works agencies.

Private sector involvement in the road sector has so far been confined to large-scale, equipment-intensive operations mainly directed towards primary roads, often consisting of international firms present in the country only during the period of their contracts. Small private contractors find it difficult to enter the road sector because of the equipment investments required and the lack of a sufficiently ample and predictable market.

From the above, it is evident that a concerted effort is now required, in terms of establishing an effective maintenance system for the road network in Cambodia. This will not only depend on sufficient and timely funding of works, but also on the creation of an effective road maintenance organisation with qualified personnel, appropriate work methods and standards, effective management systems and procedures and equipped with the logistical resources necessary to manage and monitor the rural road network.

Finally, it is also worth mentioning, that although the following chapters to a large extent focus on maintenance technology for the rural road network, there is clear evidence from other developing countries that the use of labour-based appropriate technology also provide highly viable solutions to some of the maintenance problems relating to the nation's trunk road network. Hopefully, this manual may contribute to the effective maintenance of all components of the road network in Cambodia.



## 1.2 Why Road Maintenance

**A**mong Asian countries, Cambodia has one of the most undeveloped road networks. During recent years, Cambodia has carried out considerable investments in its road network, however, the effect of this spending has been limited in terms of improving the overall road network in the country. With few exceptions, road improvement works has mainly been focusing on establishing a functional trunk road network in the country, while access to the rural areas remains limited to the areas close to the national road network. In addition, the lack of regular and preventive road maintenance have led to an accelerated decay of the recent improvements made to the road network.

Isolation is a fundamental cause of poverty. Isolation is reflected in the lack of access of the population to goods and services. If the population has no access to basic services such as water supply, health and educational services, they will even be unable to satisfactorily meet their basic needs. In addition, lack of access to, or isolation from, technology, agricultural inputs, markets and outlets for cash crop production means that there is neither the incentive nor the capability to generate economic surplus. Moreover, lack of access to information and to available government services means that the population is cut off from the mainstream of economic and social development in the country.

The important point here is that lack of access is a major factor contributing to the continuing poverty of the rural population. Major efforts are now being undertaken to improve the social and economic situation in the country. Nevertheless, it is vital that the problem of access is tackled in a comprehensive and integrated manner.

"Rural roads, which includes roads, bridges and culvert are important to the economic development and serves as the main entrance for farmers to reach and access socio-economic and other services available in other areas of Cambodia. Rural roads become a major factor for poverty alleviation activities in the rural areas and the Royal Government has concluded that rural road maintenance is essential and important to the country's development..."

Extracts from the Circular on the Implementation of Rural Road Maintenance, signed the Prime Minister, 29 January 1999

Therefore, a shift in emphasis towards improving and maintaining provincial, district and other rural roads is highly justified. Road infrastructure is limited and where it does exist, it is poorly maintained, causing a serious constraint to economic and social development.

The purpose of maintenance is to ensure that the road remains serviceable until the end of its design life. Maintenance is important because it:

- prolongs the life of the road by reducing the rate of deterioration, thereby safeguarding previous investments in construction and rehabilitation,
- lowers the cost of operating vehicles on the road by providing a smooth running surface, and
- keeps the road open on a continuous basis by preventing it from becoming impassable.



### 1.3 Financial Priorities

**F**unding or lack of it has been the major stumbling block for an effective maintenance system for the road network. Based on the results of ongoing works, rural road construction and rehabilitation works are currently estimated at an average total cost of US\$ 15,000:- per kilometre. The annual cost of routine maintenance is estimated at US\$ 300:- per kilometre, including supervision and inspection costs.

With the current weather conditions and traffic patterns, it is well accepted that without proper and continuous maintenance a rural road in Cambodia will disintegrate within two years after its rehabilitation.

Traditionally, solutions to road network improvements have focused entirely on construction works, totally ignoring the crucial role of an effective maintenance system.

When prioritising limited resources to the road sector, there are clear guidelines which can be followed in terms of maintenance economics. A basic rule for any road works programme is to protect previous investments and therefore to allocate available funds according to the following order:



First, provide routine maintenance to the sections of the network which are in a good and maintainable condition. "Good" condition is regarded as when the road section requires a minimum of routine maintenance, consisting of preventive works measures which can be carried out utilising local labour, tools and materials.



Secondly, provide spot improvements and periodic maintenance to halt the deterioration of road sections in fair condition, thereby upgrading them to a maintainable condition.



Thirdly, rehabilitate existing roads which has fallen into total disrepair.



Finally, once the three activities above have been secured, including regular maintenance for the newly upgraded road sections, one can start looking into new construction and expanding the road network. Once again, new projects should only be accepted when sufficient maintenance resources are available or can be secured when the construction of the new roads has been completed.

The above basic prioritisation rules, does not imply that new roads should not be constructed. The point here, once again, is first to secure necessary resources for maintenance of existing roads. Once this is taken care of, serious attention should also be given to expanding the rural road network to the large portion of the country which remains without all-weather access. However, when embarking on this enormous task, it is important to integrate maintenance into every step taken.



## Chapter 2 Approach

### 2.1 Definition

**R**oad maintenance can be divided into three distinct categories, which are clearly defined according to their timing and nature of work:

- routine maintenance,
- periodic maintenance and
- emergency maintenance.



#### 2.1.1 Routine Maintenance

##### Routine Maintenance Tasks

- ✓ Repair, fill and compact pot holes and ruts;
- ✓ Erosion control of shoulders and slopes
- ✓ Clear side and mitre drains to allow free passage of water;
- ✓ Clear culverts and other water ways;
- ✓ Cut grass and bushes;
- ✓ Maintain road signs in place;
- ✓ Perform minor repairs to culverts and retaining structures;
- ✓ Repair and replace scour checks.

Routine maintenance of low traffic rural roads is a widely dispersed activity, requiring small resource inputs over a large number of widely separated points. For this reason, this operation is very well suited for labour-based work methods thereby relying to a high extent only on locally available resources. The amount of work needed to keep a length of road in good condition depends on several factors, such as type of road surface, traffic volume (number, type and size of vehicles), the severity of climatic conditions, especially

rain fall, type of soil; the susceptibility of the terrain and road gradients to erosion, and the presence of bush and vegetation.



Under average conditions, one full time worker should be able to cover the routine maintenance works each year of 1-2 km of single lane laterite surfaced road, with traffic of about 50 vehicles per day. This activity can be most economically performed by petty contractors which recruit workers living in the vicinity of the roads. Local workers are also under social pressure from their neighbours to do the job well. Former road construction workers are ideal maintenance workers, because they already have some training and experience in the work involved.

#### 2.1.2 Recurrent or Periodic Maintenance

Periodic road maintenance works involve activities such as reshaping of the road surface, re-gravelling and repair or reconstruction of damaged drainage structures. Such works could be organised the same way as rehabilitation and new construction works, works carried out by small-scale private contractors or force account (with a limited amount of equipment), and supervised and managed by staff of the provincial authorities.

Periodic maintenance is best identified during the annual maintenance needs assessment exercise. The required funds need to be specifically budgeted for, as they are not part of the normal maintenance allocations. Forward planning for this

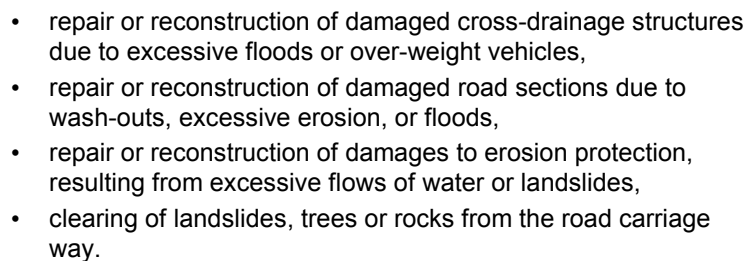


component is important, as periodic maintenance activities can be very costly. For example, the re-surfacing of a road can amount to as much as 30 percent of the total construction cost.

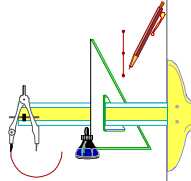
### 2.1.3 Emergency Maintenance

This component is required from time to time when sudden and unforeseen damage occurs on a section of a road. In most cases this requires the deployment of additional resources. Emergency activities cannot be estimated during the annual maintenance needs assessment and no advance planning can be made. However, it is necessary to reserve a certain portion of the maintenance budget for emergency works.

Emergency maintenance normally consist of:

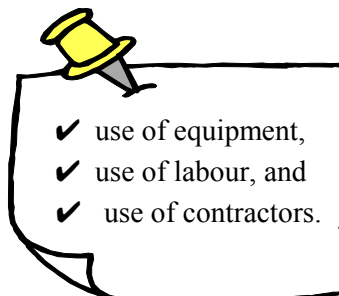
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- repair or reconstruction of damaged cross-drainage structures due to excessive floods or over-weight vehicles,
  - repair or reconstruction of damaged road sections due to wash-outs, excessive erosion, or floods,
  - repair or reconstruction of damages to erosion protection, resulting from excessive flows of water or landslides,
  - clearing of landslides, trees or rocks from the road carriage way.

To be able to realistically plan and organise emergency activities, when they occur, it is necessary to identify the extent and kind of damage as fast and exactly as possible. The assessment should give sufficient information to:

- 
- ✓ estimate the required input of resources, i.e. labour, materials, tools and equipment,
  - ✓ estimate the financial requirements,
  - ✓ develop a workplan and immediately organise the work, and
  - ✓ control and monitor the work.

## 2.2 Technology Choice

**R**oad maintenance offers considerable scope for increasing efficiency by adopting different operational and organisational approaches. Some of these approaches include:



In order to achieve the above mentioned objectives, it is important to investigate alternative approaches to road maintenance which should be tested and introduced if they prove efficient and cost-effective.

### Equipment-intensive Methods

The use of heavy equipment requires high initial capital investments. In addition, the use of heavy equipment is generally a big drain on scarce foreign exchange resources, since most machines, their spares and fuel have to be imported. Cases of under-utilisation of machines have been observed due to lack of even minor spare parts and high running costs. Moreover, due to the high initial investments, small-scale domestic contractors are thereby barred from carrying out works contracts which could be possible for them to manage if alternative work methods are allowed for.



The lack of equipment or working equipment is often a major constraint when carrying out maintenance. Equipment is expensive, consumes fuel and lubricants, and require spare parts which may have to be imported. Equipment also requires skilled operators, skilled mechanics and proper workshop facilities. If any of these items are not available, the equipment stands idle and road maintenance is not carried out.

### Use of Labour



By contrast, labour is practically always readily available and can be employed at a low cost. In addition, labour-based techniques are very well suited to a large range of maintenance activities, particularly when labour are well managed on a performance-based payment system. However, labour-based approaches demand intensive and good quality planning and skilled supervision.

### Combined Use of Equipment and Labour

In most cases, a combined use of labour and machines provide the most appropriate solution. Certain maintenance tasks can be carried out more effectively by machines while others are best carried out using labour. The most appropriate technology will therefore depend on the nature of the work and the availability of labour and equipment in the area.





The table below shows which activities are best suited for labour and which are best carried out by equipment.

Activity	Potential	
	Equipment	Labour
Ditch cleaning and reshaping	good <sup>1</sup>	good
Minor bridge and culvert repairs	poor	good
Building scour checks	poor	good
Repair of structures	poor	good
Grading un-paved surfaces	good	poor
Patching, sanding or local sealing of bituminous surfaces	poor	good
Filling of unpaved surfaces and slopes	poor	good
Grass cutting	good	good
Repairing and replacing traffic signs	poor	good
Road line markings	good	good
Stock piling gravel	good	fair
Regravelling	good	fair
Producing chippings	good	fair
Surface dressings	good	fair

(1) Requires a V-shaped ditch.

The choice between equipment and labour-based work methods also affects the basic organisation of road maintenance. Relying to a high degree on the use of equipment will entail a more centralised organisation, whereas labour-based solutions favours decentralised and thereby more responsive organisations.

Before it is possible to select the optimal approach to road maintenance, there are certain pieces of information which needs to be collected and analysed. Road data relating to issues such as the function and condition of individual road links, traffic levels and available resources in terms of funds, labour, machines and materials need to be clarified. This includes data on staff skills and training requirements, equipment performance and utilisation, labour productivities, and the effect of critical resource constraints on general performance.

In most cases, the choice between labour and machines is not an either/or situation - it is possible to find cost-effective solutions combining the two approaches. Moreover, past experience has shown that an inventive use of intermediate equipment can be extremely cost-effective for excavation, compaction and hauling, provided that locally available skills and materials are drawn upon in an imaginative way.



## 2.3 Organisation

**M**aintenance systems based on the utilisation of local resources have as their key characteristic that they relate to the maximum extent possible to the local environment, involving local people in the planning and execution of maintenance work. The figure below summarises different options which can be applied either separately or in combination.

MRD (incl. provincial and project offices)	
1	Paid permanent staff supported by equipment
2	Paid casual workers for defined tasks
3	Direct contracts with individuals or groups (payment by result)
4	Contracts with petty, medium or large scale contractors
5	Agreements with communities
6	Agreements with defined village level organisations
7	Self-help: (i) voluntary (ii) collect funds and hire people or contractors (iii) collect funds and combine self help with rented equipment inputs

A combination of approaches 1 and 2 is normally used by line ministries responsible for road maintenance. The effectiveness of these maintenance approaches is largely dependent on the availability and utilisation of transport and equipment. The alternative approaches such as the ones specified under 3 to 7 are likely to require substantial technical and managerial inputs, certainly in the establishment phase. Sometimes, the technical line ministry might be able and interested to provide part of this required technical and material support. More often however, support from external sources would be required to build up a capacity within authorities to execute road maintenance tasks on local roads.

In applying any of the alternative options, the key element is the motivation of the workers and their supervisors. Incentives at all levels must be incorporated as part of the system in order to make it sustainable. Concerning the workers at village level such incentives may not necessarily be in the form of money. If there is a significant local interest in the road (or road section), some assistance in the form of tools, construction materials and supervision could be a sufficient incentive to mobilise adequate numbers of labour.

The use of community self-help is an issue which is often susceptible to simplistic solutions. An argument often heard is that rural roads are built specifically for the benefit of the people and they should therefore shoulder the responsibility for maintaining the road.

One has to remember that roads are built to carry vehicles. Many communities recognise the benefits that will come to their village from the better access to markets, easier access to government services and better connection to the outside. Nevertheless, they do not necessarily recognise the individual benefit that will come to them. After all, most of them do not own a vehicle. In Cambodia, many are subsistence farmers and have no real need of roads and markets. Indeed they may feel that as individuals they cannot see the benefit that will accrue to them. At best, they may be prepared to maintain the road where it runs through the village but, experience suggests that, they will be unwilling to maintain more than that.

In the majority of cases, however, further inputs in the form of regular cash wages will be necessary in order to establish a continuous and sustainable maintenance system. Regular and sustained inputs can also be commercially negotiated with individuals, villages, village organisations (youth organisation, farmers associations, etc.) acting as petty contractors.

In all cases, it is advisable for the technical line ministry to use the local administration in the setting up, implementation and monitoring of locally based maintenance approaches. In order for the maintenance organisation to be sufficiently responsive to the demands of the network, it is crucial for its success that the organisation is decentralised to where the roads are located. Furthermore, it is important that sufficient authority is vested into the local organisations, enabling them to promptly take necessary decisions and action when required, and when doing so, they have access to the required resources for carrying out the works.

Funds for rural roads should be directed to and controlled by the provincial authorities as they would be expected to manage and supervise future improvement of the rural roads. This implies that contracts should be managed at provincial level and that funds are at disposal for payment of works in the provinces, based on agreed annual rural road works programmes. Based on progress and expenditure reports from the provinces, the funds are then replenished on a regular basis.

An ideal road maintenance system making optimum use of local resources would most likely comprise of several of the maintenance alternatives indicated in the figure above. The optimum maintenance approach for a particular road would be determined by factors such as:

- level of maintenance service required, which in turn depend on the function and purpose of the road),
- the local interest in the road,
- the availability of local labour, equipment, finance and technical supervision.



## 2.4 Structure

**B**esides the choice of maintenance approach, also the type of maintenance activities influence the organisational set-up. An effective road works organisation needs to cater for all categories of works covering routine, periodic and emergency maintenance.

It will need to be organised in a manner so that it (i) is able to cope with routine maintenance at all times, (ii) has enough capacity to carry out periodic maintenance

### Tasks of the Maintenance Unit

**Inventory:** recording the list of roads and basic characteristics of each section of the road network.

**Inspection:** examining the road network and measuring and recording its condition.

**Determination of maintenance requirements:** analysing effects, their causes; and specifying what maintenance activities are needed to rectify them and delay any further deterioration.

**Resource estimation:** costing the needed maintenance activities in order to define an overall budget, and detailed cost estimates for bill of quantities.

**Identification of priorities:** deciding the work that has to take precedence if resources are limited.

**Work scheduling and implementation:** timing and controlling the works implementation, preparation of contract documents, award and supervision of maintenance contracts.

**Monitoring:** checking the quality, its progress and effectiveness of the works.

(including contracts award and supervision), and (iii) has sufficient extra capacity to cater for suddenly appearing emergency works.

The extra capacity for urgent maintenance must be ensured at all times in order to limit the extent of damages and to avoid serious disruptions in access to the rural communities. For larger unforeseen defects, eventually additional funding must be made available by the programme management (i.e. major flood damages). For smaller defects, the implementing organisation's own resources must be sufficient.

Periodic maintenance, such as regravelling and spot improvements, demands a special organisation which cannot normally be dealt with by the normal routine maintenance unit. For example, regravelling requires the same organisation structure and resources as the gravelling operation during the initial construction phase. Most organisations therefore prefer to establish separate periodic maintenance units from the continuous routine maintenance organisation.

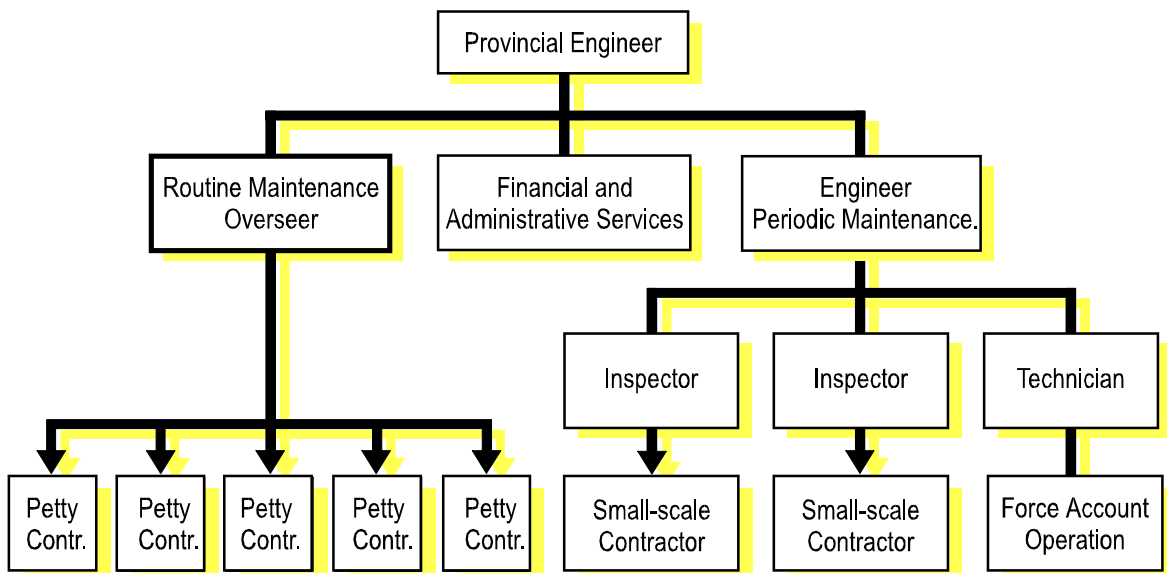
A rural road maintenance management unit would normally consist of the following cadres of staff:

- The *Provincial Engineer* is in charge of planning and supervision of all rural road works including the maintenance. His/her duties would also include overall cost estimates, budget preparation, contract preparation and management and occasional field inspections.
- An *Assistant Engineer* would be responsible for the detailed programming and implementation of road maintenance. These tasks should be combined with preparing and maintaining the road condition inventories.
- A *Routine Maintenance Overseer* would be assigned to the regular inspection and supervision of petty contractors engaged on routine road maintenance works.
- *Inspectors* would need to be assigned to periodic maintenance works carried out by small-scale road contractors, providing supervision of works as well as works measurement, quality control, etc.
- *Technicians and Supervisors* need to be assigned to periodic maintenance works carried out through force account. This staff is directly responsible for instruction of workers, sub-contractors, work progress reporting and monitoring.



- The regular PIU *Finance Officer* will also need to process payments for maintenance works, keep proper accounts, process budgetary allocations and exercise financial control on behalf of the Engineer.
- *Administrative Support Staff* such as drivers, secretaries and office assistants will need to be provided in addition to sufficient means of transport and office equipment.

The figure below describes a provincial road maintenance unit catering for both routine, periodic and emergency works. As can be seen from the figure, there is no specific staff which is assigned to emergency works. Normally, the staff requirements for this activity would be drawn from the regular resources assigned to routine and periodic maintenance. When sudden damages occur to the road network and emergency works are required, it is normal to reduce the regular activities to a minimum and thereby release sufficient resources to address the emergency works.



### Job Description - Provincial Routine Maintenance Overseer

#### General:

The *Provincial Maintenance Overseer* will participate in the Provincial Department of Rural Development's efforts of providing adequate and timely maintenance for rural road roads. This involves inspection of roads, preparation of annual road maintenance budgets and workplans, the recruitment of petty contractors to carry out the physical works, provide training and work guidance to petty contractors, inspecting and certifying completed maintenance works, following the technical, administrative and financial procedures as established in the Ministry of Rural Development.

#### Main Responsibilities:

The main duties and work responsibilities of the Maintenance Overseer consist of:

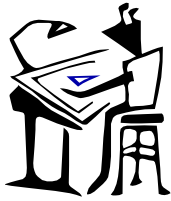
- ✓ inspection of the condition of all maintainable roads, inventorising deficiencies and estimating remedial maintenance works,
- ✓ estimating annual provincial road maintenance budgets and preparing annual road maintenance work plans based on the above mentioned field surveys,
- ✓ prepare detailed workplans and cost estimates for each of the rural roads placed under maintenance,
- ✓ prepare contracts documents for routine maintenance works to be carried out by petty contractors,
- ✓ estimate required inputs and costs of tools and materials for maintenance,
- ✓ assist in procurement of tools and laterite supply for maintenance purposes, including contracts documents preparation, award and supervision,
- ✓ identify and select potential petty contractors in the areas in close proximity to the roads,
- ✓ award and negotiate routine maintenance contracts,
- ✓ ensure that appropriate hand tools are issued to the petty contractors,
- ✓ instruct and train the petty contractors in correct and efficient execution and organisation of works,
- ✓ monitor and supervise the implementation of works by the petty contractors,
- ✓ measure and issue payment certificates for completed works,
- ✓ maintain physical progress and cost records of all maintenance works, including labour inputs, tools, materials, and other costs,
- ✓ continuously monitor the effect of ongoing maintenance works as compared to the condition of the road network, and introduce when required revisions to the overall province maintenance workplan,
- ✓ monitor the effects of intensive rainfalls or other extreme wear and tear to the road network, and initiate emergency maintenance measures as and when required,
- ✓ monitor and evaluate the effectiveness of work methods, system and procedures, and if necessary propose and introduce changes which will further improve the efficiency of the system,
- ✓ liase with local authorities and villagers on administrative matters relating to the maintenance works (e.g. security, use of borrow pits, recruitment of petty contractors, maintaining road barriers and other road furniture, stockpiling laterite, etc.),
- ✓ liase with local authorities and the road users on the proper maintenance and operation of the roads (speed and weight limitations, reporting, importance of emergency maintenance, etc.)
- ✓ carry out any other administrative or technical work as directed by the Provincial Engineer.

#### Reporting:

The Provincial Maintenance Overseer reports directly to the Provincial Engineer. He will provide inputs as requested into the established reporting system.

#### Duty Station:

The Provincial Maintenance Overseer will be based in the Project Implementation Unit of the Provincial Department of Rural Development. He/she will be expected to make frequent visits to the districts where the road maintenance works are located.



# Chapter 3

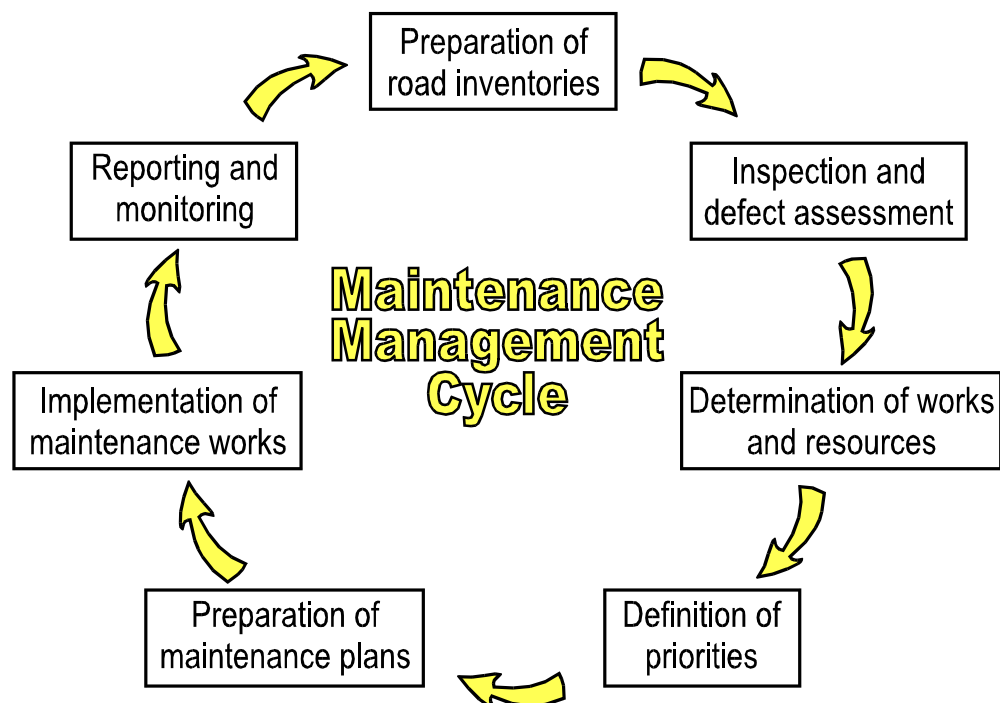
## Management Activities

### 3.1 The Process

All maintenance operations require careful planning, supervision and control. Proper monitoring of outputs and the resources required to achieve these outputs provide the basic information needed for planning and estimating of future maintenance works.

However, before these planning and implementation activities can commence there is a need for proper and regular road condition inspection and defects assessments, which form the basis for all consecutive engineering inputs.

The maintenance management cycle below shows the various steps and their logical sequence necessary for achieving an effective maintenance management system:



## 3.2 Road Inventory

The preparation of a road inventory forms the basis for a road maintenance programme. An inventory should list and describe all features of each individual road. The recorded data form the basic reference for all subsequent inspections and plans.

A well established and maintained system is comprised of two parts:

- a district/area inventory, and
- a road condition inventory.

### (i) District/Area Inventory

The area inventory can be a simple road map of the area showing all roads under maintenance. This map should provide information on:

- road classification and category,
- surface types,
- major structures,
- average daily traffic,
- details of maintenance organisation, e.g. location of maintenance camps and division of responsibility.

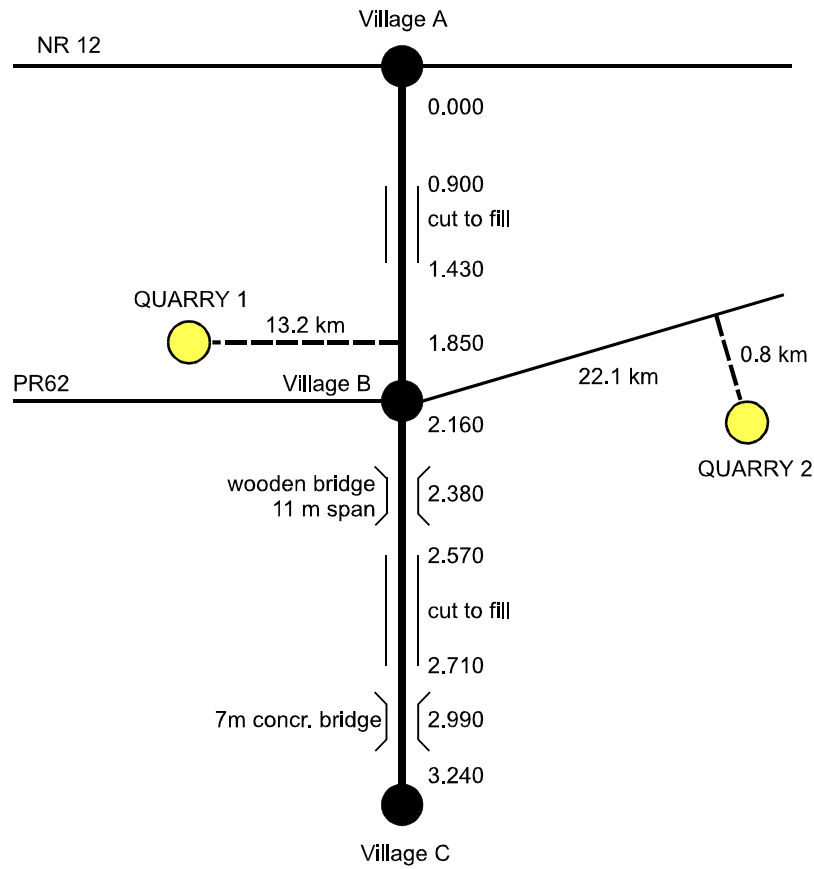
### (ii) Road Condition Inventory

The road condition inventory contains all the details of each individual road in the network. The following items should be recorded:

- Geometry
  - alignment
  - profile
  - cross-section
- Pavement and subgrade characteristics
  - soil conditions
  - gravel or other surface dressing conditions
- Drainage features
  - culverts
  - drifts
  - mitre drains
  - catch water and cut-off drains
- Structures
  - type
  - size
  - location
- Junctions
  - location
  - type of connected road
- Climate
  - rainfall
  - flood patterns
  - adjacent water management schemes
- Traffic
  - annual average daily traffic
- Maintenance
  - details on routine maintenance, i.e. names of petty contractors,
  - details on rehabilitation and urgent maintenance works, e.g. date, location



It is helpful to supplement road inventories with simple drawings like *strip maps*. Such diagram maps are useful in the office when preparing the operations plans. It helps the management to see at a glance the whole situation of a particular road.



Clear procedures for preparing road conditions inventories have already been established by MRD which are applied during the planning of construction and rehabilitation works. This information should be stored and later updated when future road maintenance assessment are carried out.

### 3.3 Technical Standards

The immediate objective of road maintenance works is to preserve the road in its original state, in other words repairing damages caused by the environment and traffic thereby reinstating it to the standards and design it was originally constructed.

The design standards set out in this manual refers to those applied for the construction of rural roads in the Rural Infrastructure Improvement Project. These are also the standards to be applied when carrying out road maintenance of such roads. When maintaining roads constructed by other rural road works programmes (e.g. WFP, TRIP), it would be natural to apply the original standards to which these roads were constructed, unless it has been explicitly decided to improve the road to a different design standard.

The design standards and work specifications for the RIIP are described in detail in the Technical Manual, however, for easy reference the main design features are described in the following figure.

Three types of cross sections are used in the RIIP:

- (i) in flat terrain,
- (ii) rolling terrain, and
- (iii) with embankments.

#### Earthworks

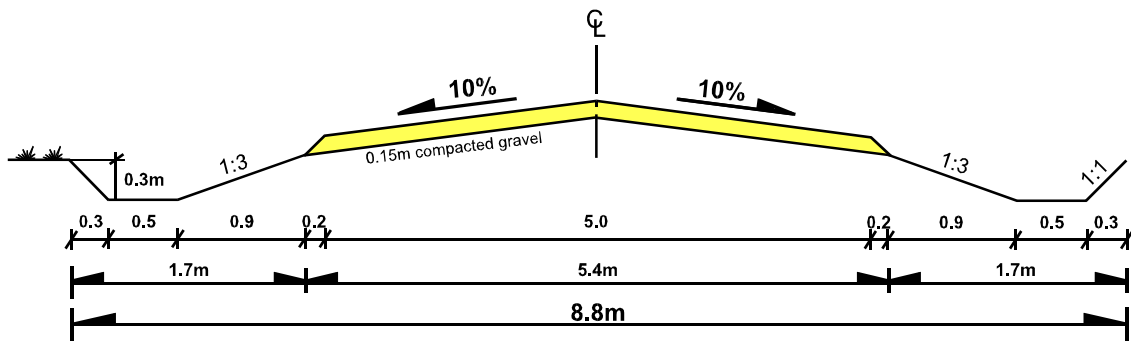
Earthworks are normally carried out by excavating soils from the vicinity of the road utilising manual labour. Make sure that the excavation works is at a safe distance from the road body thus avoiding any future erosion to the road body caused by the borrow pits.

Should there be insufficient suitable material adjacent to the road to complete the earth works, the Superintendent shall identify an alternative location for a borrow pit. Any such borrow pit, selected and approved by the Superintendent, shall be operated in such a way as to cause the minimum of environmental damage to the location and nuisance to the public.

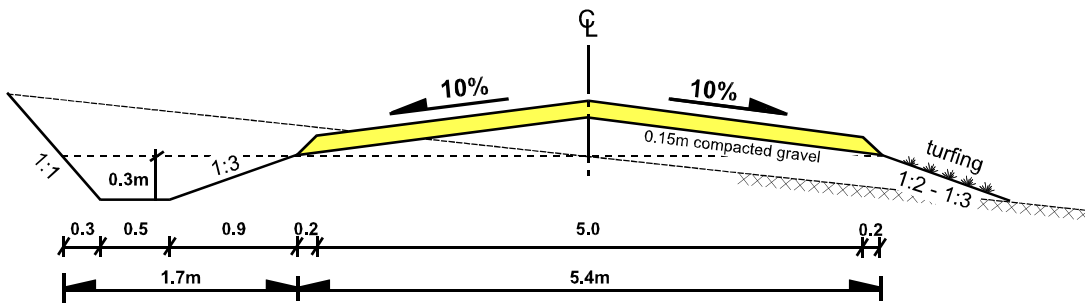
#### Laterite Surfacing

The gravel thickness shown are those specified at original construction or rehabilitation. All three standards prescribe a carriage way 5 metres wide with a 0.15 metres surface layer of compacted laterite gravel.

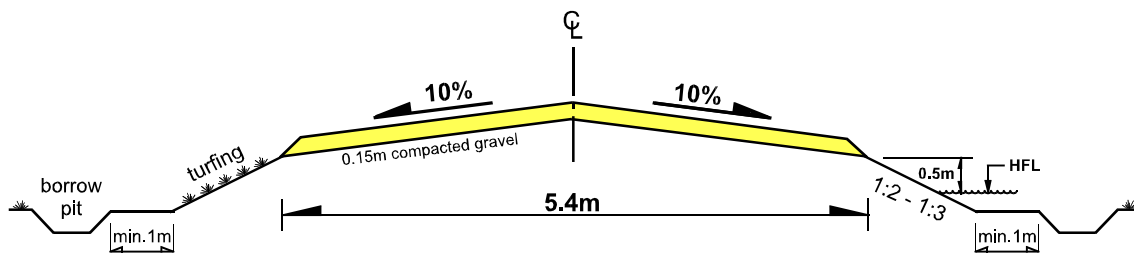
Regravelling should be carried out when the residual gravel thickness is reduced to 0.05m. Regravelling may also involve only parts of the carriageway, when wheel ruts or potholes have reduced the thickness on parts of the wearing course layer, or restricts proper drainage off the road surface.



Type 1 Cross Section



Type 2 Cross Section



Type 3 Cross Section

**Notes:**

1. Cross sections may be modified to suit specific site conditions, subject to approval of the site engineer.
2. Side slopes are indicative and should be determined on the basis of prevalent soil conditions.
3. Embankments are to be built in layers of maximum 0.15m thickness, and compacted at optimal moisture content.

Ministry of Rural Development  
Rural Infrastructure Improvement Project

**Standard Cross Sections for Rural Roads**

Prepared by:  
Bjørn Johannessen  
I. T. Transport Ltd  
Consultants in Transport  
for Rural Development

Approved by:  
Toun Sophal  
Project Manager

Revision Date: 8 June 1999

Not to Scale

Laterite gravel materials shall be watered and compacted in 150mm layers at its optimum moisture content to 95% maximum dry density and to the approval of the Inspector/Superintendent. Work shall cease during wet periods and shall only recommence on the approval of the Inspector/Superintendent.

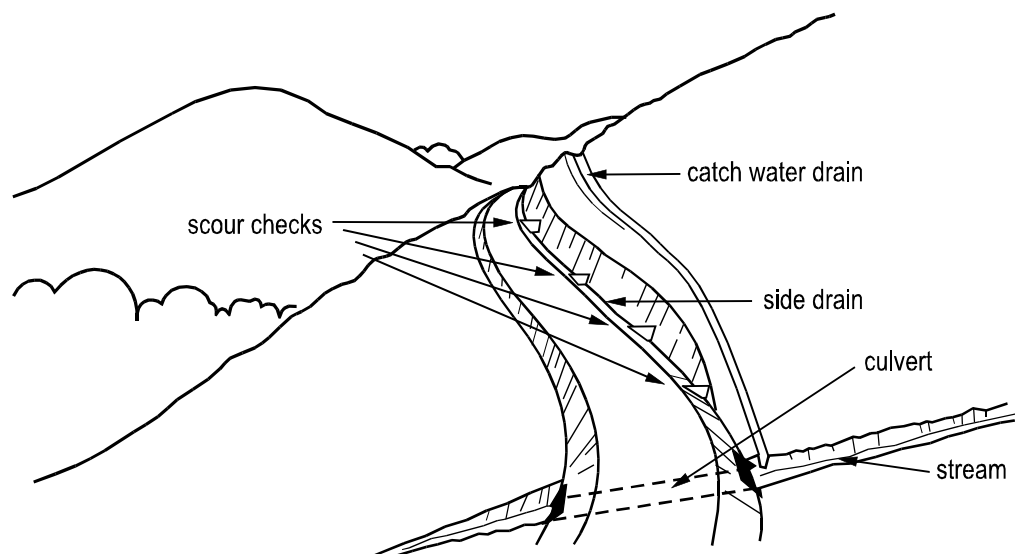
The Superintendent shall conduct in-situ density tests using a Dynamic Cone Penetrometer as and when required.

Laterite gravel shall conform to the requirements as defined by the Superintendent and the laterite must be free of all contaminants including organic soils. Any change in the composition or quality of the laterite must be closely monitored. If the laterite changes its composition, the Supplier shall inform the Superintendent and arrangements shall be made to sample and test the laterite.

The camber is originally constructed at a 10% gradient and should be maintained at a minimum of 8% in order to secure sufficient road surface drainage. During regravelling of the entire road surface, the 10% camber gradient should be reinstated.

### Drainage

Most damages to rural roads are caused by a failing drainage system. The drainage system consists of several components, each equally important, as described in the figure below.



A common denominator for an effective drainage system is to keep it free from all obstructions such as rocks, branches, silt and other debris. In addition, it is important that the drainage system for a newly constructed road is closely monitored during heavy rains to establish that its capacity is sufficient to cater for the prevailing volumes of water movement adjacent to the road.

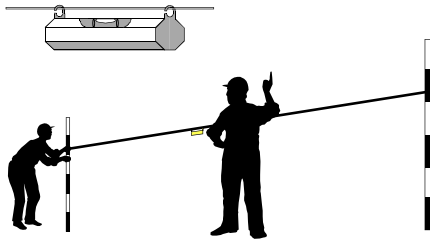
Side drains are constructed when applying the "cut to fill" designs with a recommended minimum longitudinal gradient of 2 percent. When the road has been constructed on an embankment, there is usually no need for side drains. However, it

is important to monitor average flood levels ensuring that the embankment has a 0.5 metre clearance from the highest flood level.

### Setting Out

To comply with the construction standards required using labour-based appropriate technology, the works will be expected to make extensive use of a variety of setting out and other construction aids. These will include:

- ranging rods
- profiles and boning rods
- pegs and string lines
- line levels
- ditch templates



The works shall be set out, using pegs and string lines, the various construction operations in sufficient detail to ensure that the required standards and tolerances are achieved, and in such a way that any task work system adopted may be easily checked by the Inspector/ Superintendent.

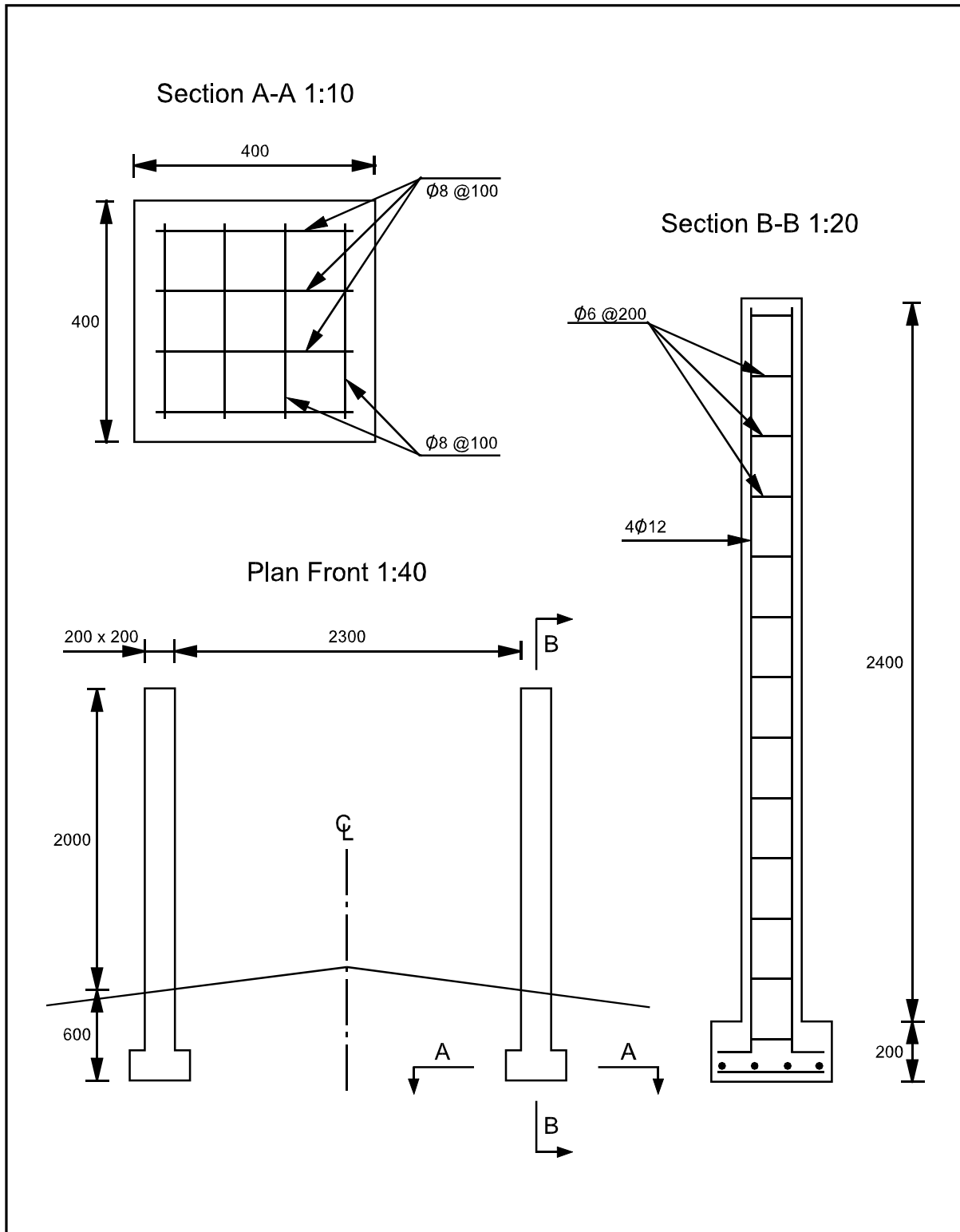
### Road Barriers

During the rainy season, it is recommended that vehicle loads are restricted on the rural road network. For this purpose road barriers are erected to stop heavy traffic and only allowing light traffic to enter the roads.

The main reason for erecting the road barriers is to protect the road body during periods of rain, during which the rainwater reduces the bearing strength of the road. In order to avoid serious deformations to the road surface, road barriers are installed to prohibit large and heavy vehicles from entering the road. The local traffic, mainly consisting of lighter vehicles is still allowed to pass.

During the dry season, there is no need for these barriers and therefore they can be removed until the next rainy season.

The standard design for barriers for rural roads is presented in the following figure.



Ministry of Rural Development  
Rural Infrastructure Improvement Project

**Standard Barrier for Rural Roads**

Prepared by:  
Van Samsan  
Road Maintenance Adviser

**I. T. Transport Ltd**  
Consultants in Transport  
for Rural Development

### 3.4 Assessment of Maintenance Requirements

In order to assess the maintenance needs and to plan maintenance works, it is necessary to carry out regular road condition surveys. Such surveys should be done on a regular basis in advance of the start of the next working season. These surveys form the basis for future work programmes and funding requirements so they need to be carried out well in advance of the next budget approval process. A complete system with detailed procedures on how to carry out the road condition survey and how to plan required routine maintenance works is described in Section 5.1.

Road condition surveys enable the road authority to:

- become thoroughly familiar with the road network and its maintenance problems,
- make objective and quantified assessments of the conditions of each road,
- obtain an objective impression of the effectiveness of the existing routine maintenance organisation,
- review periodic maintenance activities carried out since the previous inspection, and
- determine routine and periodic maintenance to be carried out in the next construction season.

Usually, an engineer controls a large road network and with the limited resources and time available, it is necessary to assess the roads in an accurate and time-saving manner as possible. Therefore, it is useful to concentrate on the identification of defects using a few well defined key indicators for the road condition. Such indicators must be defined for each programme, depending on local conditions and requirements. However, there are some features which need high priority on all roads:

#### (i) Drainage

Drainage is undoubtedly the most important feature of any road. If this component of the road fails, serious damage will occur on the remaining parts of the road. Indicators for the drainage condition can be defined as follows:

Item	Indicator
Culvert/drift	<ul style="list-style-type: none"> <li>• degree of silting-up/blockage</li> <li>• degree of functionality (correct dimensions)</li> </ul>
Side drains and mitre drains	<ul style="list-style-type: none"> <li>• degree of silting-up/blockage</li> <li>• degree of erosion</li> </ul>
Catch-water and cut-off drains	<ul style="list-style-type: none"> <li>• degree of silting-up/blockage</li> <li>• degree of erosion</li> <li>• degree of functional length</li> </ul>

To ease inspection works, the degree of silting/blockage can be described using simple measurements, e.g. fully blocked - half silted - correct size - eroded. Such assessments allow the repair work required to be efficiently quantified and costed.



The most important feature of the running surface is the camber. The lack of a camber on the road carriage way will prevent rainwater from running off the road and lead to accelerated deterioration of the road surface. For the user of the road, the smoothness of the running surface is the most important feature.

Earth and gravel roads require a continuous surface maintenance. Simple indicators for the running surface of gravel roads can be defined as follows:

Surface	Indicator
Camber	<ul style="list-style-type: none"> <li>• degree of camber (slope gradient)</li> </ul>
Condition	<ul style="list-style-type: none"> <li>• length of road section affected by potholes or ruts</li> <li>• length of road section affected by corrugation</li> <li>• thickness of gravel layer</li> <li>• condition of gravel</li> </ul>

The loss of gravel can be measured by digging small holes in the road surface until the subgrade is reached. Measurements should be made at regular intervals along the road at the centre line, in the wheel ruts as well as at the road shoulders.

**(iii) Structures**

Inspections of structures should not only be carried out to assess their general appearance. Thorough inspection implies checking all elements of a structure. Elements which are not visible are usually the most important, such as foundations, beams and bearings. The table below provides a check-list of items which needs to be inspected on various structure elements:

Element	Defect	Element	Defect
Foundation	<ul style="list-style-type: none"> <li>• cracks</li> <li>• erosion along and underneath</li> </ul>	Approaches	<ul style="list-style-type: none"> <li>• drainage</li> <li>• visibility</li> <li>• settlement</li> </ul>
Head and wing walls	<ul style="list-style-type: none"> <li>• cracks</li> <li>• blocked seepage holes</li> <li>• erosion behind walls</li> </ul>	Beams	<ul style="list-style-type: none"> <li>• cracks</li> <li>• bends</li> <li>• corrosion</li> <li>• rotting</li> </ul>
Abutments, piers	<ul style="list-style-type: none"> <li>• cracks</li> <li>• blocked seepage holes</li> <li>• erosion behind abutment</li> <li>• blocked drainage</li> </ul>	Waterway	<ul style="list-style-type: none"> <li>• vegetation growth</li> <li>• deposits of sand, silt or organic debris</li> </ul>
Culverts	<ul style="list-style-type: none"> <li>• blocked or silted</li> <li>• cracks</li> <li>• uneven settlement</li> </ul>	Road furniture	<ul style="list-style-type: none"> <li>• damaged</li> <li>• missing</li> </ul>
Decking	<ul style="list-style-type: none"> <li>• deflection</li> <li>• drainage</li> </ul>	Banks	<ul style="list-style-type: none"> <li>• faded paint</li> </ul>
		Hand and guard rails	<ul style="list-style-type: none"> <li>• eroded</li> <li>• damaged</li> <li>• missing</li> </ul>

### 3.5 Setting Priorities



Often, the financial resources available are not sufficient to carry out all the maintenance activities identified during the road condition survey. It is therefore necessary to set priorities for what maintenance activities and which road sections are most important.

First priority is usually given to urgent maintenance activities (i) to ensure that the road network remains passable and basic access is provided and (ii) to limit the extent of damages exerted to a road section. Critical elements of the drainage system, such as culverts and drains need particular attention and first priority should be given to the removal of obstacles which block the water passage away from the road. Small erosion channels should be repaired before the next rains can deepen and widen them. Both these tasks require regular inspection.

Lowest priority should generally be given to those tasks which require significant inputs and produce limited results in terms of prolonging the lifetime of the road (i.e. grass cutting and bush clearing).

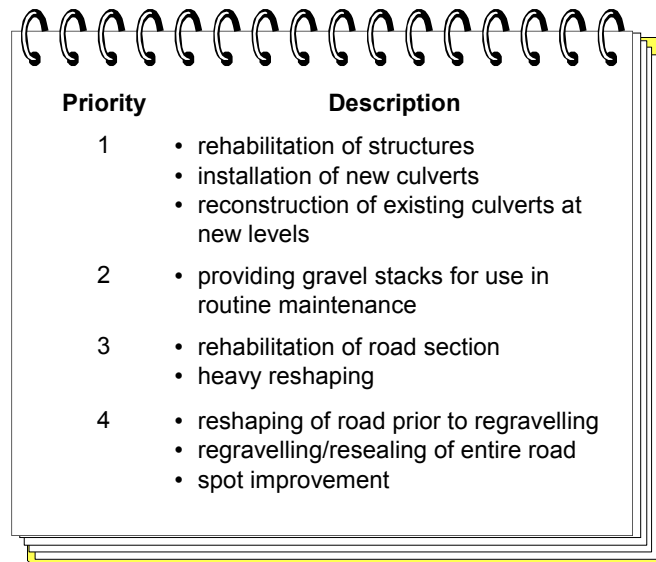
For each maintenance operation (routine, periodic and urgent) priority lists must be established. They may differ from area to area according to the prevailing conditions.

When priorities are set, the climatic conditions must be considered. For example, grass cutting during the rainy season does not make sense when at the same time the ditches and culverts are left un-touched and are becoming seriously silted. The following table provides a list of priorities for **routine maintenance** according to the climatic seasons:

Season	Priority	Description
Before rains	1	• clean culverts and drifts
	2	• clean side and mitre drains
	3	• repair side drain erosion and scour checks
	4	• fill potholes
During rains	1	• inspect and remove obstacles
	2	• clean culvert and drifts
	3	• clean side and mitre drains
	4	• repair side drain erosion and scour checks
End of rains	1	• repair erosion on shoulders, on back slopes and in drains
	2	• reinstate scour checks
	3	• reshape carriage way
	4	• fill potholes and ruts in carriage way
	5	• cut grass
Dry season	1	• repair structures
	2	• reshape carriage way
	3	• clear bush

From the table above it is clear that the most important routine maintenance activities throughout the year is to keep the drainage system in good running order - any other activity is of secondary importance.

This also applies to **periodic maintenance** as can be seen from the table below:



Priority	Description
1	<ul style="list-style-type: none"> <li>rehabilitation of structures</li> <li>installation of new culverts</li> <li>reconstruction of existing culverts at new levels</li> </ul>
2	<ul style="list-style-type: none"> <li>providing gravel stacks for use in routine maintenance</li> </ul>
3	<ul style="list-style-type: none"> <li>rehabilitation of road section</li> <li>heavy reshaping</li> </ul>
4	<ul style="list-style-type: none"> <li>reshaping of road prior to regravelling</li> <li>regravelling/resealing of entire road</li> <li>spot improvement</li> </ul>

Urgent maintenance work requires immediate action. Priority should be given to those activities which make the road (even partially) passable. For example, a broken culvert may disrupt the whole road while a landslide only covers part of the carriageway, allowing the traffic to still pass the affected section.

However, it should be noted that sudden damages to the road may start as a minor defect, but if unattended to, may escalate into serious damages to a road. For example, debris blocking the flow through a culvert may eventually lead to serious erosion of the adjacent road body, if the culvert is left unattended. Therefore, it is important that roads are regularly inspected during periods of heavy rains.

### 3.6 Planning Maintenance Works

**F**or road maintenance, as for all other works activities, it is always advantageous to prepare a work plan. There are two major types of road maintenance plans, long-term and short-terms plans.

The long term plans that are important are the general routine maintenance and the periodic maintenance plans. Long term maintenance plans are established by the PDRDs. The PDRD should know the current maintenance requirements and would know what resources are available over a longer period of time. Based on data from the road condition surveys, it is possible to forecast and plan the works according to the demand for maintenance and resources available.

#### Example



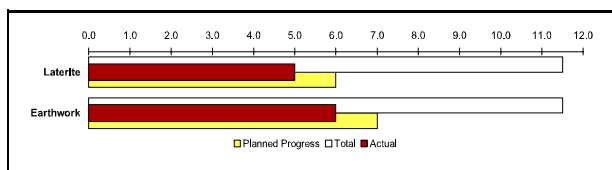
An assessment shows that the existing gravel layer of a certain road is presently on average 5cm thick, while the thickness of the layer when the road was gravelled 5 years ago was 15cm. Based on this, it is assumed that the yearly gravel loss is about 2cm. So if nothing is done, the road will have completely lost its gravel surface within 2 - 3 years. It is then decided that the road should not be left to deteriorate completely, so regravelling is programmed for the following year, or at the latest, two years from now.

Short term plans are the operational plans which are prepared prior to the execution of any specific works carried out on a road section. The basis for these plans would normally be more detailed inspection of the road condition, thereby ensuring that the assessment of work requirements are accurate, and that deviations from the work plan would be minor during work implementation.

For routine maintenance works, short term planning may cover a period of say three to four weeks covering each individual road section to which a petty contractor has been assigned.

For periodic maintenance, which normally cover larger amounts of work, it is necessary to prepare plans similar to construction and rehabilitation works, including bill of quantities, time location charts and detailed specifications of work methods and quality standards.

Total Quant.			1999												Percent
Unit	Plan	Actual	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Compl.
Earthwork km	11.5	6.0	Plan	0.5	1.0	1.5	2.0	2.0	1.5	1.5	2.5				52
			Actual	0.5	1.0	1.5	2.0	1.0							
Laterite km	11.5	5.0	Plan			2.0	4.0	2.0		1.5	1.0	1.0			43
			Actual			2.0	3.0								
<b>Cumulative Up to This Month</b>															Percent
	Plan	Actual													Progress
Earthwork km	7	6	Plan	0.5	1.5	3.0	5.0	7.0	8.5	10.0	11.5				86
			Actual	0.5	1.5	3.0	5.0	6.0							
Laterite km	6	5	Plan			2.0	6.0	8.0		9.5	10.5	11.5			83
			Actual			2.0	5.0								



Regardless of whether this work is carried out by contractors or by force account, proper time management planning should be carried out for periodic maintenance works. These plans will then form the basis for reporting and monitoring once the physical works commence.

The PIU will need to carefully coordinate the maintenance works with the sub-contracts for delivery of laterite and other repair works along the road alignment. In this respect, it is important that this planning starts already before the preparation of the individual contracts.

## 3.7 Implementation

### (i) General

**T**he quality standards to be achieved when maintaining roads are basically the same as for road construction works. Therefore, the maintenance staff must be aware of these standards and the work methods used to achieve them.

For the implementation of labour-based routine maintenance, different organisation methods are possible:

- *the lengthman system*: a worker is assigned to carry out all routine maintenance activities over a specific length of the road and throughout the year. He/she is solely responsible for his/her section and carries out all work as instructed.
- *petty contractors*: a number of workers employed by a local "contractor" carry out all activities as a group, covering a longer road section. Each petty contractor is responsible for a specific road section. The manager of the petty contractor is responsible for hiring and supervising its workers according to the instruction issued by the Client.
- another possibility is to have the lengthmen or petty contractors working only once or twice a year (for example before and after the rainy season) to carry out all necessary activities in one go. After works have been completed their employment is terminated, and must be re-employed before the next period.

### (ii) Work Activities and Task Rates

#### Routine maintenance

Routine maintenance of low traffic rural roads is a widely dispersed activity, requiring small resource inputs over a large number of widely separated points. This activity is best suited for manual labour. The amount of work needed to keep a length of road in good condition depends on several factors, such as type of road surface, traffic volume (number, type and size of vehicles), the severity of climatic conditions, especially rain fall, type of soil; the susceptibility of the terrain and road gradients to erosion, and the presence of bush and vegetation.

Under average conditions, one full time worker should be able to cover the routine maintenance works each year of 1 - 2 km of single lane gravel road, with traffic of about 25 - 75 vehicles per day (ref. table below). This activity is most economically performed by persons living along the roads contracted for road maintenance. Local workers are also under social pressure from their neighbours to do the job well. Former road construction workers are ideal maintenance workers, because they already have some training and experience in the work involved. Former gangleaders from previous road construction works have proven to be suitable petty contractors for routine road maintenance works covering road sections of 10 to 20 kilometres.

R1: Inspection 5.0 km/day		PRODUCTIVITY GUIDELINES FOR ROUTINE MAINTENANCE					
ACTIVITY		Unit	TASK DIFFICULTY				NOTES
			1	2	3	4	
R2:	Clean Culverts + Inlets and Outlets	As shown	5 rows/wd	3 rows/wd	1 wd/row	2 wd/row	Difficulty = Silt depth in culvert 1. Up to ¼ 2. ¼ to ½ 3. ½ to ¾ 4. Over ¾ Tasks for 600 dia.culverts with 6 rings
R3:	Clear debris from Bridges	m <sup>3</sup> /wd	0.5	2.5			Difficulty = type of work 1. Removing loose debris. 2. Excavating silt
R4:	Clean Mitre Drains	m <sup>3</sup> /wd	4.5	4.0	3.5		Difficulty = Soil condition 1. moist and loose 2. average 3. hard and dry
R5:	Clean Side Drains	m <sup>3</sup> /wd	4.5	4.0	3.5		Difficulty = Soil condition 1. moist and loose 2. average 3. hard and dry
R6:	Repair Scour Checks	No/wd	6				
R7:	Side Slope Repair	m <sup>3</sup> /wd	2.5	2.0	1.5		Difficulty = Soil condition 1. moist and loose 2. average 3. hard and dry
R8:	Repair of Shoulder	m <sup>3</sup> /wd	2.5	2.0	1.5		Difficulty = Soil condition 1. moist and loose 2. average 3. hard and dry
R9:	Patch Potholes	m <sup>3</sup> /wd	1.7	1.5	1.3		Difficulty = Soil condition 1. moist and loose 2. average 3. hard and dry
R10:	Fill Ruts in Carriageway	m <sup>3</sup> /wd	1.7	1.5	1.3		Difficulty = Soil condition 1. moist and loose 2. average 3. hard and dry
R11:	* Grub Edge of Carriageway	m/day	200				
R12:	* Reshape Carriageway	m/day	40	20			Difficulty = Soil condition 1. moist and loose 2. hard and dry
R13:	Grass Cutting and Bush Clearing	m <sup>2</sup> /day	300	200			Difficulty = Denseness of vegetation 1. Light 2. Dense
R14:	Grass Planting	m <sup>2</sup> /day	20				

\* All tasks measured in linear metres cover both sides of the road.

A full description of each of the above activities, including methods of measurement and payment can be found in Chapter 4. Chapter 4 also describes in detail how the planning process is carried out after a road condition inventory has been completed.

### Periodic Maintenance

Periodic road maintenance works involve activities such as reshaping of the road surface, re-gravelling and repair or reconstruction of damaged drainage structures. Such works could be organised the same way as rehabilitation and new construction works either by force account or contract works carried out by small-scale private contractors (with a limited amount of equipment).

Task rates for such works would be calculated and organised in the same way as road construction works.

**(iii) Tools for Maintenance Works****Periodic Maintenance**

The main activities defined as periodic maintenance consists of major repairs on drainage systems, rehabilitation of road camber and regravelling. As can be seen, these work activities are quite similar to rehabilitation and new construction works, so, depending on the magnitude of the road deterioration, periodic maintenance works would require the same type of tools as prescribed for construction works.

**Routine Maintenance**

Required tools and equipment for routine maintenance consist of (i) tools for the workers and (ii) inspection transport for the road authorities.

Hand tools normally consist of the following items:



- hoe
- sharpening file
- spade
- bush knife
- shovel
- wheelbarrow
- pickaxe
- hand rammer
- spreader

A major item in a routine maintenance setup is the regular inspection and supervision of works as well as the timely payment of the petty contractors and/or lengthmen. To carry out these activities successfully, the maintenance organisation must possess proper means to travel along the roads and meet with the lengthmen and/or contractors. Depending on the length of travel, supervision personnel needs to be equipped with bicycles, motorcycles or inspection cars.

One recent experience with routine maintenance of rural roads in Cambodia, is that by engaging petty contractors rather than lengthmen, the amount of time required for supervision and payment of works can be considerably reduced, since it is then no longer necessary to deal with each individual worker. This also reduces the amount of logistical support required by the Client.

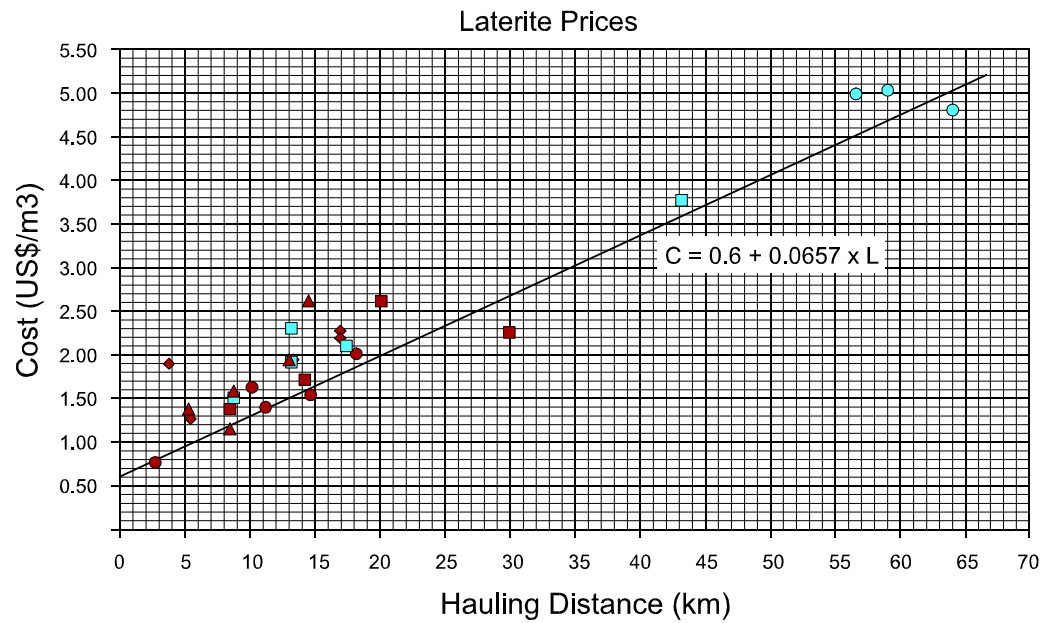
**(iv) Laterite Supply**

Some routine maintenance activities require additional supplies of laterite gravel, which are stockpiled at regular intervals along the road.

Due to the long hauling distances to obtain good quality laterite, this is in most cases carried out by hiring a local contractor who uses 10 - 15 cubic metre dump trucks. Contracts for the supply of laterite is carried out according to the same procedures as for road construction works.

Based on the Project contracts register, it has been possible to present a prognosis of the cost of supplying laterite to the road works sites. The graph presented below, shows that there is a linear relation between the unit cost (i.e. US\$ per cubic metre) and the hauling distance from the quarry to the road works site. Furthermore, it shows that a competitive market rate for laterite supply is at a cost of US\$ 0.60 (which represents the excavation and loading activity) plus 6.57 cents per kilometre hauling distance.





It should be noted that these are market prices and not based on any calculations of true costs, which can only be determined from the real investment cost of the equipment, depreciation, operation and maintenance, etc. However, since this work is carried out by contract, the above graph describing actual market prices is more relevant and may further assist in establishing reasonable cost estimates for laterite supply.

### 3.8 Reporting and Monitoring

The central objective of a maintenance reporting system is to provide programme management with an effective tool for monitoring work progress against the approved plan.

The reporting system will consist of several levels, starting at site level where the reports will contain the most detailed information. The following information should be provided in site reports:

Site Management Form						
Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday

- description of road,
- chainage of road section,
- activities carried out,
- targets for each activity,
- task rates used,
- workdays spent on each activity, and
- materials used.

At provincial level, the reports need to be less detailed, consisting of a summary of the information gathered from all the sites. The provincial reports would normally contain the following information:

- road names and numbers,
- total length of each road,
- total number of workers employed for each road,
- labour input for the maintenance of the main features (culverts, drains, carriage way, road reserve), and
- total workdays per kilometre.

A complete monitoring system for routine maintenance using petty contractors is described in detail in Chapter 5.

Periodic maintenance works would normally be reported using the same system and procedures as applied for road construction works.

Reports on urgent maintenance should record:

- description of road and location of site,
- date when work was executed,
- description of work and progress,
- workdays spent, and
- materials used.

Once this information has been checked and analysed, it should be used for (i) updating the road condition inventories and (ii) to improve and if necessary revise the general planning figures used by the road maintenance organisation.



# Chapter 4

## Contracts Management

### 4.1 Overview

#### General Description

**R**outine maintenance of low traffic rural roads is a widely dispersed activity, requiring small resource inputs over a large number of widely separated points. For this reason, this activity is well suited for manual labour. The amount of work needed to keep a length of road in good condition depends on several factors, such as type of road surface, traffic volume (number, type and size of vehicles), the severity of climatic conditions, especially rain fall, type of soil; the susceptibility of the terrain and road gradients to erosion, and the presence of bush and vegetation. Under average conditions, experience show that an input of 10 work days per month should cover the routine maintenance works of a 1 km road section, with traffic of about 25 to 100 vehicles per day.

Traditionally, routine road maintenance has been organised according to the lengthman system, which is based on assigning one person to take care of a section of approximately 1 km. This is the most common approach to maintenance when using labour-based work methods. The lengthman system has proven effective also in Cambodia, however, one of it's drawbacks is that it requires intensive supervision.

One way of solving the issue of effective supervision is to introduce petty contractors, basically consisting of a group of lengthmen which are assigned to a longer road section (5 to 15 km). Instead of entering into a contract with each lengthman, a maintenance contract covering a longer road section is awarded to a local petty contractor employing 5 to 15 persons. This reduces administrative procedures, as well as delegating direct supervision of each of the workers to the contractor. The responsibility of the Government Maintenance Inspector's is then limited to supervising and instructing the leader of the petty contractor.

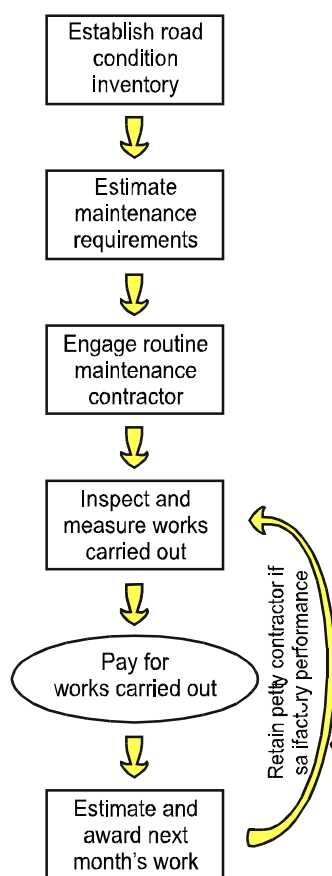
This system allows for a payment system based on performance rather than attendance, since contracts are based on specific work tasks and unit rates, rather than the attendance of the maintenance workers.

MRD has thus developed a set of appropriate contracts procedures for routine maintenance works. The contracts have an average value of US\$ 50 to 250:- and due to their small size, are based on a simplified set of documents which allows for speedy and simple procedures for estimating works, awarding the maintenance contracts and inspecting and paying for works carried out, as shown in the following chapters.

The contracts are prepared, managed and paid for by the Provincial Department of Rural Development, once workplans and funding have been approved by central authorities.

Petty contractors are recruited from the vicinity of the road, in nearby villages, preferably from labour who have previously participated in the construction phase of the road. Workers previously employed as Gangleaders should be encouraged to start as maintenance contractors.

Equipment, consisting of simple hand-tools, needs to be provided to the contractors, thereby eliminating any prior requirement for investment capital. The contractor is then responsible for the proper caretaking and maintenance of the tools, and is expected to return the tools upon completion of works.



The management procedure for routine maintenance contracts is summarised in the adjacent figure. Basically, it starts with the Provincial Maintenance Inspector carrying out a road condition survey. Based on this survey, a workplan for road maintenance is prepared. This workplan (i) forms the basis for the cost estimates used when submitting an RSA (Request for Sub-project Approval) and (ii) is eventually used as the detailed instruction to the petty contractors.

Based on the volume and distribution of work, an appropriate number of petty contractors are recruited to carry out the work. The Client and the contractor agrees on a time schedule for the execution of the works and at agreed intervals, the works completed are inspected and paid for.

Especially during the rainy season, it is important that the roads are frequently inspected to ensure that drainage system is operation properly, thereby (i) avoiding that damages to the road body, and (ii) if any erosion is occurring, these problems are rectified at an early stage limiting the damages.

For the purpose of monitoring works as well as overseeing the condition of the road, it would be practical to issue petty contracts which require on average one month to complete.

If the petty contractor have carried out the works to according to the agreed time schedule and to agreed quality standards, the contractor is awarded new works when and as required.

Section 4.2 defines the various maintenance works activities, how they are measured and paid for. Section 4.3 describes the exact use of the various documents as listed above, how they are prepared, by whom, filing and approval procedures, etc. Finally, samples of the above documents have been included in Section 4.3.

## 4.2 Activity Descriptions

In order to achieve a uniform system of contracts management, the following section attempts to standardise the contents of each of the maintenance activities mentioned in the petty contracts.

It is also important to specify the exact method and unit of measurement of completed works before a contract is signed with the contractor. This may avoid any contention which may occur during measurement and payment of completed works.

Finally, by standardising the units and methods of measurement, the quality of monitoring of productivity and cost norms are improved, which in the next turn, provides improved planning figures when estimating future maintenance works.

For the above reasons, it is strongly recommended that all quantities used during the planning of maintenance works as well as during contracts award and payment follow the standardised descriptions and utilising the units of measurement as provided in the follow sections.

### R1 General Inspection and Removing Obstructions

#### Description of Work

This activity includes an inspection of the complete length of the road section covered by the contract, to ensure that no critical damages or obstructions exists. If critical damages have occurred, this needs to be reported immediately to the PDRD through the nearest District Office.

Objects, such as fallen trees, rocks, boulders or bushes, which are blocking the carriage way or the drainage system should be removed and disposed of safely at a distance sufficiently far away from the road and its drainage system to avoid reappearing as an obstruction and damage to the road.

Removal of soils due to erosion and silting should not be covered by this activity.

#### Measurement and Payment

The payment for inspection shall be made as a lump sum payment payable only once, based on a certain number of site visits estimated by the Maintenance Inspector:

Inspection of Road	5 km per workday
--------------------	------------------

Removal of obstructions when they occur should be paid according to rates per cubic metre of materials disposed, at the following task rate:

Removal of Obstructions	0.5 m <sup>3</sup> per workday
-------------------------	--------------------------------

## R2 Clean Culverts, Inlets and Outfalls

### Description of Work

This activity includes the removal of all silt, debris and other foreign matter from inside the culvert at the area of the wing walls. Inlet and outlet ditches at a minimum distance of 10 metres from the wing walls, or as instructed by the Maintenance Overseer, shall also be cleared of vegetation, silt and loose debris. Grass should be cut leaving the roots to provide soil erosion protection. All debris and other materials shall be removed well clear of the road and the drainage system to prevent it from being washed back into the drains.

A long handled shovel may be provided to excavate material from the culvert pipes.

On completion of this work, the culvert, including the inlet and outlet drains, shall allow for free and unhindered flow of water.

### Measurement and Payment

Payment shall be made based on the amount of materials blocking each of the culverts and will be measured by the degree of which the culvert pipes are blocked.

The following task rates are recommended for single, double and triple pipe culverts using 0.6 m and 1.0 m diameter culvert rings:

Diameter	Task Difficulty - Silt depth in culvert				Tasks cover culverts with up to 6 rings (6m pipes)
	Up to ¼	¼ to ½	½ to ¾	Over ¾	
600 mm	5 rows/day	3 rows/day	1 row/day	2 days/row	
1000 mm	2 rows/day	1 row/day	2 days/row	3 days/row	

If the culvert pipe is longer than 6 metres, new tasks should be calculated using the above rates for 6 metre pipes as the basis for the calculations.

Similarly, if other diameter pipes are used, new rates need to be calculated based on the new internal area of the culvert pipe.

### R3 Clear Debris from Bridges

#### Description of Work

The work shall consist of clearing of all silt, debris and other foreign matter from the structure, its abutments and piers and for a minimum distance of 25 metres both upstream and downstream thereby allowing water to flow freely and unhindered.

All debris and other materials shall be removed well clear of the river and the drainage system to prevent it from being washed back and once again obstructing the river flow.

#### Measurement and Payment

Payment shall be made based on the volume of materials removed, at the following task rates:

Removing loose debris such as boulders, branches, etc.	0.5 m <sup>3</sup> /wd
Excavating and removing silt	2.5 m <sup>3</sup> /wd

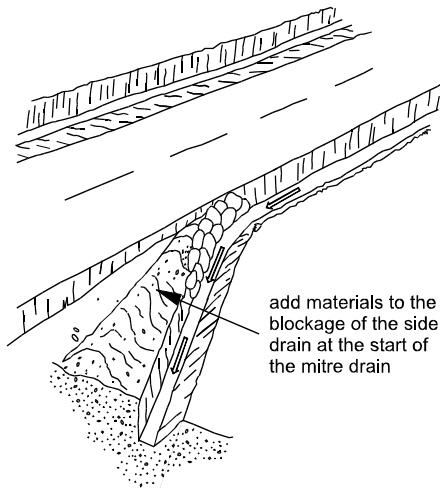


**R4 Clean Mitre Drains**

**Description of Work**

Mitre drains secure the exit of water from the side drains and needs to be kept clean at all times in order for the other components of the drainage system to function properly.

Mitre drains are normally excavated and maintained to the same standards as the side drains. Their capacity should at the least be similar to the side drains. To avoid causing erosion at the discharge point, mitre drains should be provided as often as possible so that the accumulated water volume in each drain is not too high. Wherever possible, they should be located at intervals of 30 metres along the road alignment. Additional mitre drains may be installed where necessary at the direction of the Maintenance Overseer.



Some of the excavated soils shall be used to block the downhill side of the drain to ensure that the water flows into the mitre drain. The remaining excess soils should be disposed well away from the drainage system, thereby avoiding excavated soils and debris to re-enter the drains.

Where the road is situated on a hill side, a catchwater drain may have been constructed above the road. These drains shall be cleaned and any erosion repaired under this activity using the same work methods, measurement and payment.

**Measurement and Payment**

Works shall be measured on the basis of cubic metres of materials removed. The normal task rates applied per cubic metre are as follows:

Task Difficulty			tasks relate to drained ditches without any standing water
moist and loose soils	average soil conditions	hard and dry soils	
4.5 m <sup>3</sup> /wd	4.0 m <sup>3</sup> /wd	3.5 m <sup>3</sup> /wd	

When constructed to the standard design used for side drains (ref Section 3.3) the above task rates can determined on the basis of linear metres of drains and required excavation depth (i.e. degree of silting).

Silt Depth	moist and loose soils	average soil conditions	hard and dry soils
10 cm	65 m/wd	57 m/wd	50 m/wd
15 cm	38 m/wd	33 m/wd	29 m/wd
20 cm	25 m/wd	22 m/wd	19 m/wd

## R5 Clean Side Drains

### Description of Work

Where the side drains are established to the correct depth and profile with grass cover and no erosion, only grass cutting is required (Activity R13).

Where the ditch has silted more than 10 cm in depth, the vegetation and silt must be removed to the original depth and profile (with the exception of the areas close to scour checks where silting is normal).

Profile boards and line levels are used to re-establish the correct depths of the ditches. Also make sure that the ditch achieves a smooth longitudinal slope at the desired gradient. A ditch template can be used as an additional tool to confirm that the drain is excavated to its original depth and profile.

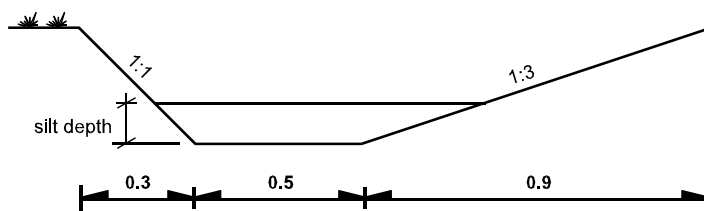
All debris and other materials from the side drain must be removed well clear of the road and drainage system to prevent it being washed back.

### Measurement and Payment

Measurement and payment of works shall be made based on the amount of materials blocking the drains.

Works shall be measured on the basis of cubic metres of materials removed. The normal task rate applied per cubic metre is as follows:

Task Difficulty			tasks relate to drained ditches without any standing water
moist and loose soils	average soil conditions	hard and dry soils	
4.5 m <sup>3</sup> /wd	4.0 m <sup>3</sup> /wd	3.5 m <sup>3</sup> /wd	



When applying the standard design for side drains, the above task rates can be determined on the basis of linear metres of drains and required excavation depth (i.e. degree of silting).

Silt Depth	moist and loose soils	average soil conditions	hard and dry soils
10 cm	65 m/wd	57 m/wd	50 m/wd
15 cm	38 m/wd	33 m/wd	29 m/wd
20 cm	25 m/wd	22 m/wd	19 m/wd

## R6 Repair of Scour Checks

### Description of Work

In addition to mitre drains, the instalment of scour checks provide an efficient method for reducing soil erosion in side drains. Scour checks are produced at a frequency based on the longitudinal gradient of the drain. This relation is shown in the following table. Scour checks should not be constructed on roads with gradients less than 4%. This will encourage too much silting of the side drain and lead to damages of the road body.

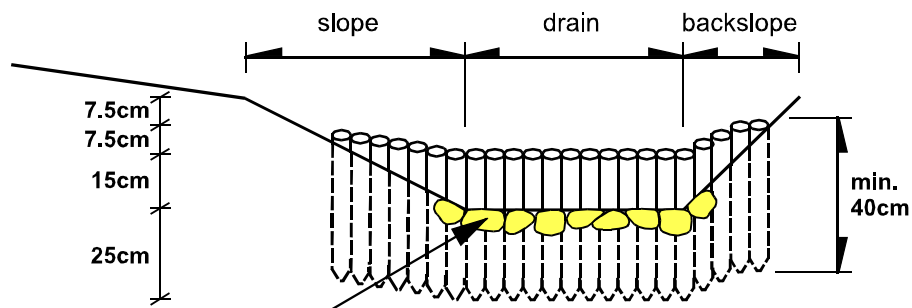
Road Gradient [%]	Scour Check Interval [m]
4	not required
5	20
6	15
7	10
8	8
9	7
10	6

During periods of heavy rains, it is important to ensure that all the scour checks are in good working order. This includes replacing scour checks which are washed away as well as repairing damaged ones.

After the basic scour check has been constructed, an apron shall be built immediately downstream using stones. Ensure that the stones have sufficient size to avoid them being washed away. The apron will stop any scouring below the scour check.

Grass sods shall be placed against the upstream face of the scour check to prevent water from seeping through scour check and to encourage the silting behind the scour check. The long term objective is to establish a complete grass cover over the silted scour checks to stabilise them.

The basic measurements for constructing a scour check is illustrated in the figure below:



apron of stones below the scour check with a length of appr. 40 cm

### Measurement and Payment

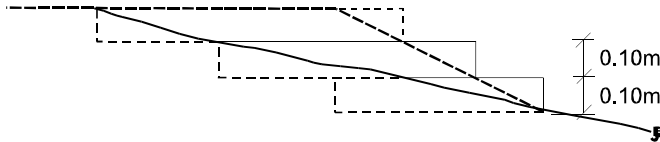
Measurement of works is based on the number of scour checks which needs to be replaced or repaired, at the following task rate:

Repair of scour checks	6 (no.) per workday
------------------------	---------------------

## R7 Side Slope Repair

### Description of Work

This activity includes the excavation of soils to establish a proper bench on to which new soils are added. Soils are then excavated from nearby borrow pits and placed in layers not thicker than 0.10 metres and compacted with hand rammers at optimal



moisture content. After final shaping of the slope, it is covered by grass to prevent future soil erosion (covered by a separate activity).

### Measurement and Payment

Measurement and payment of works are based on the volume of soils added to the side slopes, at the following task rates:

Task Difficulty		
moist and loose soils	average soil conditions	hard and dry soils
2.5 m <sup>3</sup> /wd	2.0 m <sup>3</sup> /wd	1.5 m <sup>3</sup> /wd

## R8 Repair of Shoulder and Grass Planting

### Description of Work

Erosion gullies can be formed by water running over the edge of the carriageway and road shoulders. These gullies shall be filled and properly compacted using laterite gravel. Erosion gullies on the side slope can be repaired using soils borrowed from the adjacent areas next to the road.

Although no vegetation shall be allowed on the carriageway, grass should be established on the sloping shoulders to protect against erosion. After repairing shoulders, it is important that the repaired slide slope is immediately covered with grass turfing.

### Measurement and Payment

Measurement and payment of works are based on the volume of soils added to the shoulders and side slopes, at the following task rates:

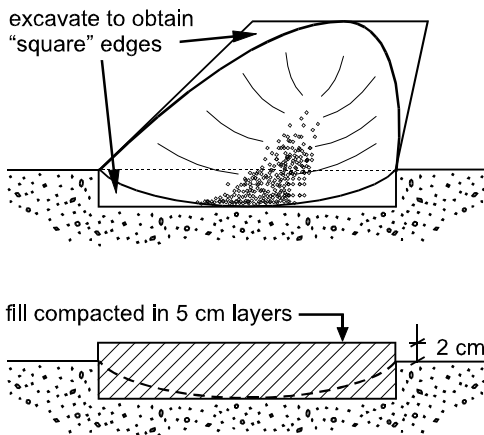
Task Difficulty		
moist and loose soils	average soil conditions	hard and dry soils
2.5 m <sup>3</sup> /wd	2.0 m <sup>3</sup> /wd	1.5 m <sup>3</sup> /wd

**R9 Patch Potholes in Carriageway**

Potholes collect rainwater on the road surface and restrict it from draining off to the side of the road. Combined with traffic, this stagnant water accelerates the wear of the road surface and finally if this water penetrates the road surface layer, it reduces the bearing strength of the road base.

**Description of Work**

The area to be filled shall be excavated with squared off edges and to a minimum depth equal to the lowest point of the pot hole or until firm and compacted materials are reached.



The excavated material together with other approved filling material shall be mixed together, watered and placed back into the excavated hole and compacted using hand rammers. Make sure that there is no water in the pothole when it is filled. If the pothole is deep the materials should be filled and compacted in layers not thicker than 5 centimetres. Compaction is carried out using hand rammers.

The surface level of the filled hole, after compaction shall be a minimum of two centimetres higher than the adjacent pavement surface level.

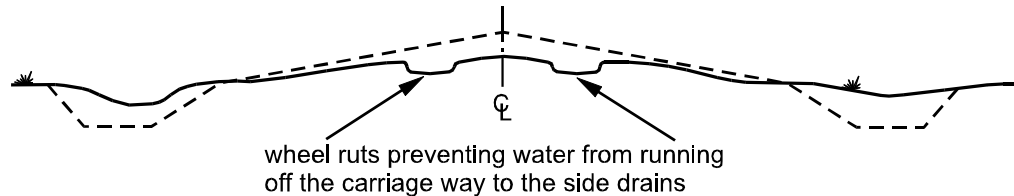
**Measurement and Payment**

Measurement and payment of works are based on the volume of soils added to the potholes, at the following tasks:

Task Difficulty – Hauling Distance to Laterite		
Up to 100 m	100 m – 300 m	more than 300 m
1.7 m <sup>3</sup> /wd	1.5 m <sup>3</sup> /wd	1.3 m <sup>3</sup> /wd

## R10 Fill Ruts in Carriageway

Ruts are caused by vehicles that keep on passing in the same tracks made by vehicles before them. The weight of the vehicles and their speed push surface material to the sides of the road. This process eventually deforms the cross section and the camber of the road surface. The ruts obstruct the water from exiting the surface. The stagnant water accelerates the wear of the surface when subject to passing traffic.



### Description of Work

This work normally comprises of raking excess materials from the road shoulder back on to the carriageway where ruts have been formed.

In cases of more severe rutting, it may be necessary to bring in additional laterite gravel to compensate for the gravel loss. In such cases the ruts should be treated using the same work methods as when filling potholes. The ruts should then be excavated to form vertical edges and the fill materials need to be placed, watered and compacted in layers. When using hand rammers for compaction, the thickness of each layer should not exceed 5 centimetres.

### Measurement and Payment

If this activity only involves raking excess material from the road shoulders onto the road carriageway, the work is measured on the basis of length of the road section to be improved, at the following task rates:

Repairing Ruts using Material from the Shoulders: 50m/wd

When additional material is imported, applying the same methods as for pothole patching, measurement and payment of works are based on the volume of soils added to the ruts, at the following rates:

Task Difficulty – Hauling Distance to Laterite		
Up to 100 m	100 m – 300 m	more than 300 m
1.7 m <sup>3</sup> /wd	1.5 m <sup>3</sup> /wd	1.3 m <sup>3</sup> /wd

### R11 Grub Edge of Carriageway

Grass growing on the edge of the carriageway can prevent rainwater from draining off the road surface. It can also start growing into the carriageway.

#### Description of Work

Grass and roots shall be removed from the carriageway. A string line showing the exact position of the start of the side slope provides a good guidance when removing grass and grubbing the shoulders. Debris should be removed well away from the road to avoid the removed material being washed into the drainage system.

#### Measurement and Payment

The work is measured on the basis of length of the road shoulder improved, at the following task rate:

Grubbing of Road Shoulders:	200 m/wd
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### R12 Reshape Carriageway

In time, the camber of the carriageway is reduced due to the action of traffic and weather.

#### Description of Work

The camber should be rebuilt by redistributing material from the edge of the carriageway to the crown of the road. To achieve the correct levels, it is required that the works are set out using pegs and strings and re-establishing the correct camber using line levels.

Light reshaping of the carriageway is normally carried out relying entirely on excess materials from the road side. After placing the materials, they should be compacted at optimal moisture content.



#### Measurement and Payment

The work is measured on the basis of length of the road shoulder improved, at the following task rate:

Task Difficulty	
moist and loose soils	hard and dry soils
40 m/wd	20 m/wd



## R13 Grass Cutting and Bush Clearing

### Description of Work

Clearing shall consist of the removal of grass, bushes, other vegetation, rubbish and all other superfluous material including the disposal of all material resulting from the works.

The work shall comprise of the cutting (not scarifying) of all grass and bush on both sides of the roadway and for the entire width between the pavement edge and the top of the road side drain back-slope. All vegetation shall be cut to a height not exceeding five centimetres. Where road side drainage exists on one side of the roadway only, grass and bush cutting on the fill slope shall extend for a minimum distance of 2.5 metre from the pavement edge adjacent to the embankment slope. Where no road side drains exist, i.e. on road embankments, cutting shall extend from the pavement edge to the foot of the embankment or to the paddy water level on both sides of the roadway.

All bushes and branches hanging over the road, shoulders, side drains, mitre drains and traffic signs shall be cut down and disposed of safely.

When tree seedlings have newly been planted, it is important that they are not damaged when clearing grass and bush around the seedlings. Furthermore, when the seedlings are young, vegetation close to the trees shall be removed to allow the trees good growing conditions.

Finally, trimming of planted trees shall be included in this activity on a regular basis to ensure that they develop into healthy shapes and which do not interfere with the road traffic.

### Measurement and Payment

The unit of measurement for clearing is square metres (m<sup>2</sup>). The quantity shall be taken as the area in square meters designated by the Overseer, and cleared in accordance with these specifications.

Appropriate task rates are as follows:

Task Difficulty - Density of Vegetation	
Light	Dense
300 m <sup>2</sup> /wd	200 m <sup>2</sup> /wd

**R14 Grass Planting****Description of Work**

This work shall consist of furnishing turf and sods as required and planting them to give a healthy stable covering of grass which will maintain its growth in any weather and prevent erosion of the material in which it is planted.

Grass shall be of species native to Cambodia, harmless and inoffensive to persons and animals and not of a kind recognised as a nuisance to agriculture. It shall be free of disease and noxious weeds, deep rooted and sufficiently rapid growing and spreading to give a complete cover over the planted area.

The term "grass" embraces turf and sods and, if the Overseer permits, may include plants of other types capable of giving effective erosion protection.

Sodding or turfing shall be done by planting sods or turf to give continuous cover over the whole area. They shall be planted with their root system substantially undamaged, well buried in firm material, and packed around with moist earth in which they have grown.

Grass shall be planted at such a time and the work shall be done in such a way that at the time of the final inspection all areas to be grassed are substantially covered with healthy, well established, firmly rooted grass and the planted area is free from erosion channels.

Surfaces to be planted shall be trimmed in such a way that the ground surface after planting shall be as shown on the standard drawings.

If required the Contractor shall maintain the grass at his expense until the issuance of the Payment Certificate. Maintenance shall consist of watering, preserving, protecting and replacing grass and such other work as may be necessary to keep it in a satisfactory condition to prevent erosion and to present a dense and uniform appearance.

**Measurement and Payment**

The quantity measured for payment shall be the number of square metres (m<sup>2</sup>) of turfed or sodded surface. An appropriate task rate is as follows:

Grass Planting :	20 m <sup>2</sup> /wd
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### 4.3 Standard Contract Documents

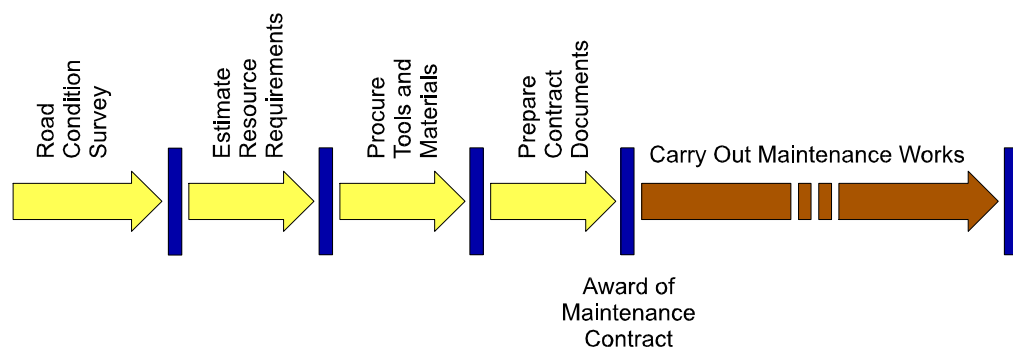
#### Overview

In order to streamline and standardise the various stages of the road maintenance management system, a set of standard documents have been developed to establish uniform practices for all routine road maintenance works. Contracts documents for routine road maintenance works comprise of:

- Labour-based Routine Road Maintenance Agreement
- Annex A Duties and Responsibilities of the Contractor
- Annex B Workplan Road Maintenance
- Activity Schedule and Payment Certificate

As a general rule, the preparation and management of routine maintenance contracts is the responsibility of the Maintenance Inspector in each province. Before a contract is awarded, all estimates of quantities, task rates and unit rates should be verified and checked by the Provincial Engineer and the PIC Field Engineer. Once the contracts have been found in good order, the contracts agreement are signed by the petty contractor, the Provincial Project Manager and the PIC Field Engineer.

Also for these contracts, it is important that a time schedule is prepared and agreed with the Provincial Engineer, for the entire process of contracts preparation and award, thus ensuring that the works are carried out at the correct time and that the necessary tools and material is available before commencement of works.



## Labour-based Routine Road Maintenance Agreement

**Purpose:** The Form of Agreement provides the standard contract to be used when awarding a contract to a petty contractor for routine road maintenance. It should be noted that this standard contract should only be used for routine maintenance. When contracting out periodic maintenance, the procedures established for contracts management of road construction works should be applied.

**Responsibility:** The Province Maintenance Overseer is responsible for preparing the contract documents for routine road maintenance including the Agreement. It should be checked by the Provincial Engineer together with the other contract documents to ensure that they have each been completed accurately, as well as being consistent with each other.

**Timing:** A new Agreement is prepared every time a new petty contractor is recruited. When a contract is renewed in the case of contractor being awarded additional works, this agreement remains effective. In such cases, only the annexes of the contract need to be revised.

**Procedure:** The Agreement is the most essential part of the contract documents, and needs to be duly filled out and signed for all routine road maintenance works where petty contractors are engaged.

The detailed information pertaining to a specific contract, which is prepared in advance of announcement of bids, are as follows:

**Contract No:** Establish a unique contract number for each contract. This number will be used as a reference for all related contract documents, correspondence and accounting activities.

**Date:** Enter the date of the contract issue.

**Province:** Enter the name of the Province where the works will be carried out.

**Contractor:** Enter the full company name for which this contract is being awarded.

**Location:** Enter the location of the road maintenance works, the start chainage and end chainage, and name of commune(s) and village(s) close to the road.

After the above information has been entered and checked by the Provincial Engineer, the Agreement is signed by the following parties:

**Approval:** The Form of Agreement shall be signed by an authorised representative of the Contractor and the Provincial Project Manager in witness of the PIC Field Engineer.

**Filing:** The Agreement forms an essential part of the Contract, and needs to be filed since it is used as justification for payments of works, and finally is subject to the annual audit.



Kingdom of Cambodia  
Ministry of Rural Development  
**Rural Infrastructure Improvement Project**  
ADB Loan No. 1385 - CAM (SF)



## LABOUR-BASED ROUTINE ROAD MAINTENANCE AGREEMENT

Contract No: .....

This Agreement, dated ....., between the Provincial Department of Rural Development (hereinafter referred to as PDRD) in ..... Province and ....., (hereinafter referred to as the Contractor) covers routine maintenance activities on Road Number ..... from Chainage ..... to Chainage ..... in the District of ....., near the village/commune of ....., as shown in the attached map.

The Contractor, having received basic training from the Provincial Department of Rural Development, willingly agrees to complete the work on the assigned road according to the work plan as described in Annex B and to undertake the duties and responsibilities as described in Annex A. In consideration of the work undertaken, payment will be made in accordance with details also described in Annex A.

All necessary hand tools as scheduled in Annex A will be provided through PDRD. It is the responsibility of the Contractor to ensure their security and good repair. Handle replacements shall be the responsibility of the Contractor.

Signed: ..... Date: .....  
(Contractor)

Signed: ..... Date: .....  
(Field Engineer, Project Implementation Consultant)

Signed: ..... Date: .....  
(Provincial Project Manager)

## Annex A to the Routine Road Maintenance Agreement

- Purpose:** This form provides a summary of the duties and responsibilities of the two parties to the petty contract agreement. It also includes the exact number and type of tools issued to the petty contractor. It should be noted that in the clause defining the duties of the contractor, it is referred to the Road Maintenance Management Manual for the detailed description of the work activities. That implies that this manual actually forms part of all the petty contract agreements in terms of how works are carried out and finally how they are measured and paid for.
- Responsibility:** The Province Maintenance Overseer is responsible for preparing the contract documents for routine road maintenance including Annex A. It should be checked by the Provincial Engineer together with the other contract documents to ensure that they have each been completed accurately, as well as being consistent with each other.
- Timing:** Annex A needs to be prepared every time a new petty contractor is engaged. When a contract is renewed in the case of contractor being awarded additional works, the agreement remains effective and if no additional equipment is issued, the previous Annex A remains valid. In case the contractor is issued additional equipment or returns some of the tools previously issued, then a new copy of Annex A should be issued.
- Procedure:** Annex A forms part of the contract documents, and needs to be duly filled out and signed for all routine road maintenance works where petty contractors are engaged.
- It mainly consists of a standard text which needs no modification from one contract to another. The only information to be entered is the exact number and type of tools issued to the petty contractor
- Approval:** After the above information has been entered and checked by the Provincial Engineer, a copy of the Annex is issued to the contractor when signing the contract agreement.
- Filing:** This Annex is part of the Contract, and therefore needs to be filed for the purpose of (i) overall monitoring of tools and (ii) finally to be subject to the annual audit.

## ANNEX A

### Duties and Responsibilities of the Contractor

The contractor will be responsible for the routine maintenance of the road as defined in Annex B, and in accordance to the work methods prescribed in the RIIP Road Maintenance Management manual.

The contractor shall be able to plan his/her work to suit other commitments that he/she may have, without affecting the performance of the duties and responsibilities under this contract. As long as the minimum acceptable standards of maintenance are achieved, working hours and working days are flexible. Contractors from adjoining road sections may join together in the interests of efficiency or safety. The contractor must however be available on assigned inspection days and pay days. These days will be agreed with the Maintenance Overseer.

The contractor will be issued a set of hand tools at the commencement of the contract, and he/she will be expected to maintain these hand tools, handles, etc. and to take all reasonable precautions against damage or loss. Hand tools, which are worn out through normal use will be replaced by the Client upon production of the item originally issued. All items of hand tools are to be returned to the Maintenance Overseer when, for any reason this contract is terminated.

List of hand tools issued:

- Wheel barrow	.....pc
- Shovel	.....pc
- Hoe	.....pc
- Pickaxe	.....pc
- Axe	.....pc
- Bush knife	.....pc
- Rake	.....pc
- Watering can	.....pc
- Hand rammer	.....pc
- Basket	.....pc

### Payment of Works

The contractor's payment of works is based on the monthly work input as estimated and agreed upon in Annex B which will be remunerated in cash at the value of 4000 Riel per work day. Payment shall be strictly performance based.

If the Overseer decides that the contractor is not carrying out the work to the required standard, then (if warnings are not effective) he/she shall report the matter to the Provincial Engineer who will have the authority to withhold the payment from the contractor concerned. Depending upon the circumstances, a written warning letter may be given to the contractor explaining the reason for the withholding of payment. A note will also be made on the payment certificate of the amount deducted and the reason of it. The relevant road section will be re-inspected the following month and if the standard of works is satisfactory, the contractor will resume full payment (but not back payment) of his/her entitlement. If the standard of work remains unsatisfactory then the contractor may be dismissed and a replacement appointed.

## Workplan Road Maintenance - Annex B

- Purpose:** This form provides the details of the quantities and location of the routine road maintenance works to be carried out under a petty contract agreement.
- Responsibility:** The Province Maintenance Overseer is responsible for preparing the contract documents for routine road maintenance including Annex B. It should be checked by the Provincial Engineer together with the other contract documents to ensure that they have each been completed accurately, as well as being consistent with each other.
- Timing:** Annex B needs to be prepared every time a new petty contractor is engaged. When a contract is renewed in the case of contractor being awarded additional works, the agreement remains effective and the previous Annex B can be replaced with a new version detailing the additional works.
- Procedure:** Annex B forms part of the contract documents, and needs to be duly filled out and signed for all routine road maintenance works where petty contractors are engaged.
- This routine maintenance workplan consists of two parts. The right hand side of the form allows works to be specified at a certain chainage along the road (location). This information at various locations along the road line is then summarised in terms of work activity, quantities and work days in the columns in the left hand side of the form. If the contract covers a road section longer than two kilometres, it is necessary to utilise several copies of this form.
- Chainage:** Start by marking the exact chainage where maintenance works are located and which will be covered in each maintenance contract agreement.
- Activity:** Select the appropriate work activities which will be included in the contract. Please note that all activities have been described in detail in the Road Maintenance Management manual. It is strongly recommended that this standard is applied in all contracts in order to streamline measurements and payment of works.
- Unit:** Enter the appropriate unit of measurement. A standard unit of measurement is prescribed in the Road Maintenance Management manual. This unit is also used for payment purposes.
- Quantity:** The exact quantity is based on the total sum of the various quantities of work identified along the road line and entered into the form according to its exact location (chainage).
- Task Rate:** Depending on the difficulty of the works, estimate a task rate for each work activity. Guidelines on task rates are provided in the Road Maintenance Management manual.
- Work Days:** The number of work days required for each work activity is calculated by dividing the task rate with the quantity of works.
- Approval:** After the above information has been entered and checked by the Provincial Engineer, a copy of Annex B is issued to the contractor when signing the contract agreement. It needs to be signed by the Provincial Engineer and the petty contractor.
- Filing:** Annex B forms part of the Contract, and therefore needs to be filed together with the Contract Agreement to be used for (i) overall supervision of works and (ii) finally to be subject to the annual audit.





### Workplan Road Maintenance - Annex B

Province ..... District: .....  
 Road Name: ..... Total Length ..... km

ACTIVITY	Unit	Qty	Task Rate	Work Days																				
					1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9		
Pothole filling																								
Fill ruts in carriageway																								
Laterite collecting																								
Soil filling thin laterite																								
Reshape carriage way both side																								
Clean culvert pipes																								
Slope Repairing																								
Shoulder Repairing																								
Bush/grass clearing																								
Drain clearing	Right																							
Repair side drain erosion																								
Grass planting																								
Repair scour check																								
Slope Repairing																								
Shoulder Repairing																								
Bush/grass clearing																								
Drain clearing	Left																							
Repair side drain erosion																								
Grass planting																								
Repair scour check																								
Total																								

Date: .....  
 Prepared by: .....

Date: .....  
 Signature of Contractor: .....

## Activity Schedule and Payment Certificate

- Purpose:** The purpose of this form is (i) to provide a summary of all the works included in a maintenance contract and (ii) to certify payments of completed works for which a contractor has requested payments. The Activity Schedule is based on the Workplan in Annex B of the contract, and any previous payments made under the contract.
- Responsibility:** The Maintenance Overseer is responsible for preparing the Activity Schedule and Payment Certificate. It should be checked by the Provincial Engineer to ensure that all quantities of work have been correctly entered ensuring that it is consistent with the road maintenance contract.
- Timing:** The Activity Schedule needs to be prepared every time a new petty contractor is engaged. When a contract is renewed in the case of contractor being awarded additional works, the agreement remains effective only revising the workplan and preparing a new Activity Schedule for the additional works.
- Procedure:** The Activity Schedule forms part of the contract documents, and needs to be duly filled out and signed for all routine road maintenance works where petty contractors are engaged.
- This Activity Schedule and Payment Certificate consists of two parts. The left hand section of the form summarises the works as detailed in the Workplan (Annex B). This information is summarised in terms of estimated quantities, task rates, work days and amount of payment for each work activity. When works have been completed and are due for payment, the right hand section of the form is utilised for processing payments.
- At first, enter basic data relating to the contract, i.e. Province, Road Section, Contract Number, Name of Contractor, and agreed commencement and completion dates.
- No.:** The first column relates to the code number of each work activity as established in the Road Maintenance Management manual.
- Activity:** Enter the work activities as included in the contract. Please note that all activities have been described in detail in the Road Maintenance Management manual. It is strongly recommended that this standard is applied in all contracts in order to streamline measurements and payment of works.
- Planned:**
- Quantity:** The exact quantity is based on the total sum of the various quantities of work as detailed in the Workplan.
- Task Rate:** Enter the estimated task rate for each work activity from the Workplan. Guidelines on task rates are provided in the Road Maintenance Management manual.
- Work Days:** The number of work days required for each work activity is calculated by dividing the task rate with the quantity of works.
- Amount:** Based on the number of work days planned and the current standard wage rate for unskilled labour, the amount to be paid for each work activity is calculated.
- Contingency:** In order to cater for unforeseen works, or works which may be required due to damages occurring during the contract period, a 15 percent allowance may be included in the

maintenance contract. It should be noted that this allowance shall be used for specific additional work and only be used upon prior written instructions from the Maintenance Overseer. If no written instructions are issued during the course of the contract to utilise the contingencies, then this amount will be withheld.

**Supervision:** The contractor is allowed to add 15 percent to cover the costs of supervision of works, profits and other miscellaneous expenses.

**Total Contract Value:** The total contract value is the total sum of all work activities, plus contingencies and supervision.

**Actual:**

**Quantity:** At the end of the contract period, works covered by the contract are inspected by the Maintenance Overseer. Works which have been completed to the correct quality standards are then measured and entered into the Activity Schedule and Payment Certificate. Quantities should be measured using the standard units and method as prescribed in the Road Maintenance Management manual.

**Work Days:** Based on the actually measured quantities and the originally agreed task rate, the number of work days is calculated for each activity.

**Amount:** The amount due for payment for each measured activity is calculated based on the measured quantity and the current daily wage rate.

**Remarks:** Any remarks in regards to the planned or actually carried out work activities can be entered into the last column or referred to here.

**Contingency:** If any, the actual contingency works shall be measured and paid for according to the written instructions given prior to commencing additional works not prescribed in the above quantified activities. If no prior instruction were issued, there shall be no payment of contingencies.

**Supervision:** Actual supervision costs is then calculated on the basis of the total of actual work carried out.

**Approval:** Once the above planned information has been entered, these figures should be checked by the Provincial Engineer, agreed with the Contractor, verified by the PIC Field Engineer and approved by the Provincial Project Manager. A copy of the Activity Schedule is issued to the contractor when signing the contract agreement.

When the same form is used as a payment certificate at the end of the contract period, it needs to be signed by the Maintenance Overseer who inspected the works. At the same time as inspecting the works, the Contractor shall sign the form upon acceptance of the measurements. Finally, the Provincial Engineer needs to certify the calculations, the PIC Field Engineer shall verify the payment and finally the Provincial Project Manager needs to approve that payments are issued to the contractor.

**Filing:** The Activity Schedule and Payment Certificate forms part of the Contract, and therefore needs to be filed together with the Contract Agreement to be used for (i) overall supervision and payment of works and (ii) finally to be subject to the annual audit.



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**Activity Schedule and Payment Certificate**

Province: .....

Road Section: .....

Contract No: .....

Name of Contractor: .....

Period from: ..... to .....

No	Activity	Planned				Actual			Remarks
		Qty	Task Rate	WD	Amount	Qty	WD	Amount	
	Contingency 15%								
<b>Total:</b>									
Supervision 15%									
Total Contract Value						Supervision 15%			
						Due for Payment:			

Prepared by: _____ <div style="text-align: center; margin-left: 100px;">Maintenance Overseer</div> Checked by: _____ <div style="text-align: center; margin-left: 100px;">Provincial Engineer</div> Agreed by: _____ <div style="text-align: center; margin-left: 100px;">Contractor</div> Verified: _____ <div style="text-align: center; margin-left: 100px;">Field Engineer, Project Implementation Consultant</div> Approved: _____ <div style="text-align: center; margin-left: 100px;">Provincial Project Manager</div>	Inspected: _____ <div style="text-align: center; margin-left: 100px;">Maintenance Overseer</div> Certified: _____ <div style="text-align: center; margin-left: 100px;">Provincial Engineer</div> Accepted: _____ <div style="text-align: center; margin-left: 100px;">Contractor</div> Verified: _____ <div style="text-align: center; margin-left: 100px;">Project Implementation Consultant</div> Approved: _____ <div style="text-align: center; margin-left: 100px;">Provincial Project Manager</div>
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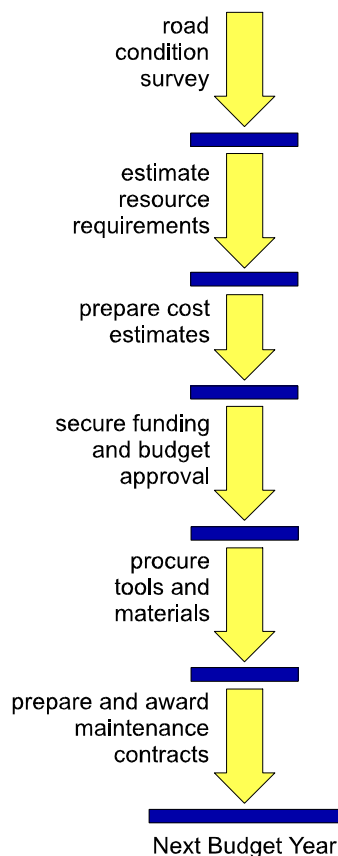
# Chapter 5

## Planning and Reporting

### 5.1 Planning and Estimating Works

#### General Description

As mentioned earlier in Chapter 3, there are several stages of preparatory work before a routine maintenance works programme can commence. The figure below show the sequence of preparatory activities which needs to be timed properly in advance in order to secure that the road maintenance works take place when it is planned for.



At first, it is necessary to establish what the maintenance requirements consist of. All maintenance planning is based on field surveys where the actual condition of the road is established in detail. Based on the damages observed, work estimated are entered into the Routine Road Maintenance Inventory form according to its location and at what time of the year it is most appropriate to carry the works.

Some work activities will require the supply of additional laterite gravel which needs to be stockpiled at regular intervals along the road. Hand tools needs to be replenished, and if the network under maintenance is expanded, then additional tools needs to be purchased.

The above mentioned resources, including the hiring of petty contractors to carry out the works, require that funding has been approved well in advance of the works commencement. The detailed budget is presented in the Annual Maintenance Requirements form.

Once the budget has been secured, detailed work plans needs to be prepared for each road using time location and bar charts. It is only when all these activities have been completed that the hiring of road maintenance contractors can take place.

Finally, it should be stressed that the maintenance plan needs to be carefully monitored and compared to the real needs of the road network during the course of the year. Unforeseen damages are likely to occur which may require revisions of the original plan.

The remaining part of this section, describes in detail how and when to use these forms, including their purpose, who is responsible for their preparation and procedures for approval and filing.

## Routine Road Maintenance Inventory

- Purpose:** This form provides the details of the quantities of road maintenance work required, the location of works and finally the appropriate timing when to carry it out.
- Responsibility:** The Province Maintenance Overseer is responsible for preparing the Maintenance Inventory. It should be checked and approved by the Provincial Engineer to ensure that it has been prepared accurately.
- Timing:** The Maintenance Inventory needs to be prepared every year for each road which is placed under maintenance. It needs to be completed well in advance of commencing works thereby allowing sufficient time for securing necessary funding and recruiting petty contractors to carry out the works.
- Procedure:** The Maintenance Inventory is the basic estimate of works required along the road line. The form allows works to be specified at a certain chainage along the road (location). This information at various locations along the road line is then summarised in terms of labour inputs, quantities of laterite gravel and other envisaged costs in the columns at the corresponding chainage. Normally, it is necessary to use several forms to cover an entire road.
- At first, enter basic data relating to the road, i.e. Province, Name and Number Code for the road section.
- Chainage:** Mark the exact chainage where maintenance works will be required. Also indicate whether the road is situated on an embankment, or whether a cut to fill with side drains are utilised (ref. Remarks).
- Month:** Depending on the type of maintenance works, each activity should be scheduled for a specific time of the year (i.e. before after or during the rainy season). On some roads it may not be necessary to carry out any works during the dry season.
- Activity:** Select the appropriate work activities which will be required, and schedule them for the appropriate time of the year. Please note that all activities have been described in detail in the Road Maintenance Management manual. It is strongly recommended that this standard is applied in all contracts in order to streamline measurements and payment of works.
- Labour:** The number of work days required for each work activity along the road line is calculated by dividing the estimated task rate with the quantity of works observed.
- Laterite:** Certain work activities require an additional supply of laterite gravel. Estimate the exact quantity required for the entire year along the road line.
- Other:** Any additional estimated costs are included in this last column or referred to here.
- Total:** The totals of each column are added up at the bottom of the table.
- Approval:** After the above information has been prepared by the Maintenance Overseer and checked by the Provincial Engineer, the estimates and calculations are verified by the PIC Field Engineer.
- Filing:** The Maintenance Inventory should be filed in a designated file at the Provincial Office to be used for (i) overall budgeting of works and (ii) finally as a basis for detailed planning of works and preparation and award of petty contracts.

**Routine Road Maintenance Inventory**

Road Name and No:

Province:

Month	Chainage	0 1 2 3 4											
		Labour wd	Laterite m <sup>3</sup>	Other US\$	Labour wd	Laterite m <sup>3</sup>	Other US\$	Labour wd	Laterite m <sup>3</sup>	Other US\$	Labour wd	Laterite m <sup>3</sup>	Other US\$
Activity		Labour wd	Laterite m <sup>3</sup>	Other US\$	Labour wd	Laterite m <sup>3</sup>	Other US\$	Labour wd	Laterite m <sup>3</sup>	Other US\$	Labour wd	Laterite m <sup>3</sup>	Other US\$
Jan	Cut & Plant Grass (Nov+Dec)												
Feb	Clear Bush												
Mar	Repair Structures												
Apr	Reshape Carriageway & Fill Potholes												
May	Clean Structures & Reshape Carriageway												
Jun	Clean and Repair Drainage												
Jul	Repair Erosion & Plant Grass												
Aug	Clean Structures & Reshape Carriageway												
Sep	Clean & Repair Drainage												
Oct	Repair Erosion & Plant Grass												
Nov	Fill Potholes & Ruts												
Dec	Reshape Carriageway & Fill Potholes												
<b>Total</b>													
Remarks:		=====	Embankment	Verified by: _____ PIC Field Engineer									
		-----	Drains on both sides	Prepared by: _____ Maintenance Overseer									
		-----	Drains on one side	Approved by: _____ Provincial Engineer									
				Revision Date: _____									

## Annual Road Maintenance Requirements

- Purpose:** The purpose of this form is to establish the annual road maintenance budget for a province. It is based on the details of Road Maintenance Inventories prepared for each of the roads to be included in the provincial road maintenance programme.
- Responsibility:** The Province Maintenance Overseer is responsible for preparing the Annual Road Maintenance Requirements. It should be checked and approved by the Provincial Engineer to ensure that it has been prepared accurately.
- Timing:** The Annual Road Maintenance Requirements needS to be prepared every year. It needs to be completed well in advance of commencing works thereby allowing sufficient time for securing necessary funding and recruiting petty contractors to carry out the works.
- Procedure:** The Annual Road Maintenance Requirements provides the overall estimate of works required for all maintainable roads in a province, using petty contractors to carry out the works. Summarised information in terms of labour inputs, quantities of laterite gravel, tools requirements and other envisaged costs are entered for each road or road section.
- At first, enter basic data relating to the form, i.e. the name of the Province and the budget year.
- No:** Enter the Code given to each road or road section.
- Road Name:** Enter the names of each road or road section to be included in the maintenance programme.
- Length:** Provide the exact length of the road or road section which will be placed under maintenance.

### Workdays and Expenses:

- Labour:** The number of work days required for each road section is obtained from the totals in the Routine Road Maintenance Inventory.
- Contingency:** In order to cater for unforeseen works, or works which may be required due to damages occurring during the budget period, a 15 percent allowance may be included in the agreements with the petty contractors. It should be noted that this allowance shall be used for specific additional work and only be used upon prior written instructions from the Maintenance Overseer. If no written instructions are issued during the course of the contract to utilise the contingencies, then this amount will be withheld.
- Supervision:** The petty contractors are allowed to add 15 percent to cover the costs of supervision of works, profits and other miscellaneous expenses.
- Amount:** This column totals the cost of the labour employed by petty contractors, including contingencies and supervision.
- Laterite:**  
m<sup>3</sup>: Enter the total requirement for additional laterite gravel from the Routine Road Maintenance Inventory of each road.
- Hauling Distance:** Enter the estimated hauling distance for the supply of laterite gravel to each road section.



- Amount:** Based on the hauling distance, enter the estimated cost of supplying laterite contractors. It is strongly recommended that average unit rates presented in Chapter 3 of the Road Maintenance Management Manual is utilised as a basis for this cost estimate.
- Tools:** Enter the costs of purchasing sufficient tools for each road section.
- Other:** Any additional estimated costs are included in this column or referred to here.
- Total:** Calculate to the total cost of the petty contractors, laterite supply, tools and other expenses for each road section.
- Province Total:** Calculate to the total cost of each of the sub-items, i.e. the labour inputs and costs, quantity and cost of laterite, tools and other expenses for all the roads covered by the maintenance programme.
- Approval:** After the above information has been prepared by the Maintenance Overseer and checked by the Provincial Engineer, the estimates and calculations are verified by the PIC Field Engineer.
- Filing:** The Annual Road Maintenance Requirements should be filed in a designated file at the Provincial Office to be used for (i) overall budgeting of works and (ii) finally as a basis for detailed planning of works and preparation and award of petty contracts.

**Annual Road Maintenance - All Provinces**

The same form is also used for summarising the road maintenance programme in all provinces. This is done by entering the totals of each province (from the Annual Road Maintenance Requirements forms), rather than for each road, as shown in the below excerpts of the form:

**Annual Road Maintenance - All Provinces**

For year .....

Province	Length (km)	Workdays and Expenses (WD/US\$)				Laterite			Tools US\$
		Labour (wd)	Contingency 15% (wd)	Supervision 15% (US\$)	Amount (US\$)	m <sup>3</sup>	Hauling Distance km	Amount US\$	
Takeo									
Kandal									
Kampot									
Kampong Cham									
Prey Veng									
Svay Rieng									
<b>Province Total:</b>									

### Annual Road Maintenance Requirements

Province:

For year .....

No	Road Name	Length (km)	Workdays and Expenses (WD/US\$)			m <sup>3</sup>	Laterite		Tools US\$	Other US\$	Total US\$	Remarks
			Labour (wd)	Contingency 15% (wd)	Supervision 15% (US\$)		Amount (US\$)	Hauling Distance km				
<b>Province Total:</b>												

Date:.....  
Prepared by:

Date:.....  
Checked by:

Date:.....  
Verified by:

Maintenance Overseer

Provincial Engineer

PIC Field Engineer

## Tools Request for Routine Maintenance

- Purpose:** The purpose of this form is to ensure that tools are acquired in good time before routine maintenance is planned for a certain road. This form, when prepared, provides a detailed estimate of the tools required to equip a number of petty contractors engaged to carry out routine maintenance. Since these tools will be on loan to the contractors, this information forms part of the overall tools inventory management of the Provincial Implementation Unit.
- Responsibility:** The Maintenance Overseer is responsible for preparing the Tools Request for Routine Maintenance. It is checked for accuracy and approved by the Provincial Engineer.
- Timing:** The Tools Request form is normally prepared when (i) new petty contractors are engaged and need to be issued hand tools, or (ii) already engaged contractors require additional hand tools.
- Procedure:** The request form is normally prepared for issuing tools to several petty contractors. If tools need to be purchased, it is important to carry out a price survey, in order to obtain good quality tools at competitive prices.
- At the top of the form, enter the name of the Province and the name of the road where the maintenance works will be carried out.
- No.** The first column, allows for a numbering of all the tools required. The purpose of this number is merely to assist the Overseer in making sure all tools have been included in the request form.
- Item Description:** Enter the type of tools required. Although some standard tools have already been entered into this column, these items can be changed as and when required.
- Quantity:** Enter the total quantity of each tool required. These amounts should not only cover the demands of one petty contractor, but can also cater for a group of contractor (i.e. for an entire road).
- Price per Unit:** If tools are purchased from outside, use the latest price estimate or quote available. If tools are drawn from the provincial store, then apply the unit price which was used when these tools were purchased.
- Amount:** Enter the total cost for each tool required, based on the quantity and the unit price.
- Remarks:** Any remarks relating to the request of a particular tool can be entered into the last column or referred to here.
- Approval:** The Tools Request is checked and approved by the Provincial Engineer.
- Filing:** The Tools Request forms are reconciled with the petty contract agreements to ensure that tools requested actually are used for its intended purpose. The Tools Request forms should be stored in a designated file at Province headquarters for later inventory monitoring and audits



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### Tools Request for Routine Maintenance

Province:

Road Name:

No.	Item Description	Qty.	Price per Unit (US\$)	Amount (US\$)	Remarks
1	Wheel barrow				
2	Shovel with handle				
3	Hoe with handle				
4	Pickaxe with handle				
5	Axe				
6	Bush knife				
7	Spreader with handle				
8	Watering can				
9	Hand rammer with handle				
10	Plastic basket				
11	Spade				
12	Other				
	Total:				

Date: .....

Date: .....

Requested by:

Approved by:

\_\_\_\_\_  
Maintenance Overseer

\_\_\_\_\_  
Provincial Engineer

## 5.2 Reporting Work Outputs

### General Description

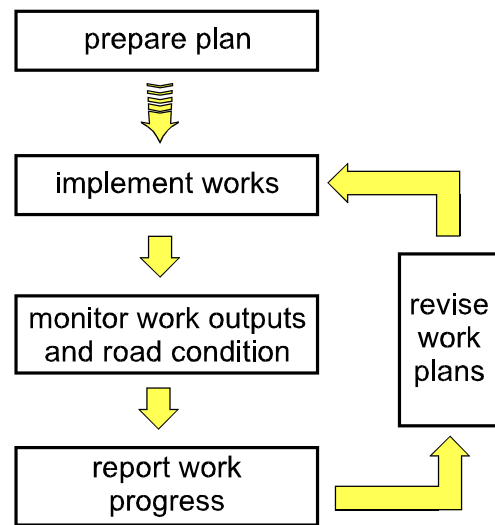
**R**eporting work outputs is necessary in order to (i) validate that work plans are adhered to and (ii) measure to what extent the planned progress is achieved. As demonstrated in the following section, reporting is closely interlinked into the planning process. Based on monitoring of works, the reported outputs and costs of works, plans are revised on a regular basis, thereby ensuring that the original purpose and effect of the works carried out are obtained.

A basic concept in road maintenance is to conserve the road at its original performance standards to which it was originally constructed.

In order to achieve this objective, there is a continuous demand for monitoring and reporting of the maintenance works carried out and how this work effects the quality of the road.

The most effective interventions will always vary according to the changing weather conditions and volume of traffic. Therefore, by continuously updating road maintenance work plans based on the actual work outputs and the current condition of the road, the road authorities will be more effective in protecting the original investments when the road was first constructed.

The following section describes a complete reporting and monitoring system for routine maintenance of rural roads using labour-based work methods carried out by petty contractors.



## Monthly Maintenance Outputs and Expenditure

- Purpose:** The purpose of this form is to monitor the outputs and expenditure by all petty contractors engaged on routine road maintenance in a province. It is based on the details of Activity Schedule and Payment Certificates prepared for each of the contractors.
- Responsibility:** The Province Maintenance Overseer is responsible for preparing the Monthly Maintenance Outputs and Expenditure. It should be checked and approved by the Provincial Engineer to ensure that it has been prepared accurately.
- Timing:** The Monthly Maintenance Outputs and Expenditure needs to be prepared every month. It needs to be prepared on time so it can be used as the basis for the reporting of all maintenance works summary for the entire programme at the end of each month.
- Procedure:** The Monthly Maintenance Outputs and Expenditure provides a summarised performance report for each petty contractor and the amounts of payments issued. For this reason, it effectively acts as a contracts register for the maintenance contractors.
- At first, enter basic data relating to the form, i.e. the name of the Province and the month.
- No:** Enter the Code given to each road or road section.
- Road Name:** Enter the names of each road or road section included in the maintenance programme.
- Length:** Provide the exact length of the road or road section which has been placed under routine maintenance.
- Contractor:** Enter the names of the petty contractors engaged on each road or road section.
- Cumulative Last Month:** From the report of the previous month, enter the total number of workdays and payments made to each of the contractors.
- This month:** Enter this month's work outputs, labour input (including contingencies, if utilised) and the payments issued for each petty contractor.
- Total:** Add this month's figures to the cumulative figures of last month to provide the total labour inputs and payments made this financial year.
- Sub-total:** Total the figures from all petty contractors engaged on each road, thereby showing the total labour inputs and maintenance costs for each road under maintenance.
- Province Total:** Add together all the sub-totals for each road to obtain the total labour inputs and payments issued for routine maintenance in the entire province.
- Approval:** After the above information has been prepared by the Maintenance Overseer, the estimates and calculations are checked by the Provincial Engineer.
- Filing:** The Monthly Maintenance Outputs and Expenditure should be filed in a designated file at the Provincial Office to be used for overall cost monitoring of works. A copy should be submitted to central headquarters as part of the monthly reporting from the provinces.



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**Monthly Maintenance Outputs and Expenditure**

Province:

Month:

No	Road Name	Total Length km	Contractor	Cum. Last Month		This Month		Total	
				Labour wd	Amount Paid US\$	Labour wd	Amount Paid US\$	Labour wd	Amount Paid US\$
Sub Total:									
Sub total:									
Sub total:									
Sub total:									
Sub total:									
Province Total:									

Date:.....

Date:.....

Prepared by:

Checked by:

\_\_\_\_\_  
Maintenance Overseer

\_\_\_\_\_  
Provincial Engineer

## Routine Maintenance Employment and Expenditure

- Purpose:** The purpose of this form is to monitor the outputs and expenditure for routine road maintenance works in all provinces. It is based on the details of Monthly Maintenance Outputs and Expenditure reports prepared in each of the provinces.
- Responsibility:** The Maintenance Engineer is responsible for preparing the Routine Maintenance Employment and Expenditure. It should be checked and approved by the Planning and Monitoring Engineer to ensure that it has been prepared accurately.
- Timing:** The Routine Maintenance Employment and Expenditure needs to be prepared every month.
- Procedure:** The Routine Maintenance Employment and Expenditure report provides a summarised performance report for each province on the inputs of labour, tools and materials, and the related amounts of payments issued.
- At first, enter basic data relating to the form, i.e. the month reported.
- Province:** Enter the names of each province included in the maintenance programme.
- Length:** Provide the exact length of roads which has been placed under routine maintenance in each province.
- Workdays and Costs:** Enter the labour input, in terms of number of workdays and costs. In the first column under this header, enter the cumulative total from last month's report. Enter this month's figures in the second column and the cumulative total in the last column.
- Laterite:** Provide laterite supply in cubic metres as well as in costs up to the previous month, this month and total up to date.
- Tools:** Tools acquisitions can be found from the tools request forms. Enter the total costs of tools purchased for routine maintenance purposes up to the previous month, this month and cumulative total to date.
- Other:** In the same manner, enter any other costs incurred for routine maintenance in each of the provinces.
- Grand total:** Total the figures from all the provinces, thereby showing the total labour input and maintenance costs for each province.
- Approval:** After the above information has been prepared by the Planning and Monitoring Engineer, the calculations are checked by the Project Implementation Consultant.
- Filing:** The Routine Maintenance Employment and Expenditure reports should be filed in a designated file at central headquarters to be used for overall cost monitoring of works.



**Routine Maintenance Employment and Expenditure  
Summary of all Provinces for the Month of .....**

Province	Length km	Workdays and Costs (wd/US\$)			Laterite (m <sup>3</sup> /US\$)			Tools (US\$)			Other (US\$)			Grand Total	
		Cum.to last month	This month	Cum. Total	Cum.to last month	This month	Cum. Total	Cum.to last month	This month	Cum. Total	Cum.to last month	This month	Cum. Total	This month US\$	Cum. Total US\$
Takeo															
Kandal															
Kampong Cham															
Kampot															
Prey Veng															
Svay Rieng															
<b>Grand Total (wd/US\$)</b>															

Date:.....

Prepared by:

\_\_\_\_\_  
Planning and Monitoring Engineer

Date:.....

Checked by:

\_\_\_\_\_  
Project Implementation Consultant

## Workplan and Monthly Report

- Purpose:** The purpose of this form is to (i) present in detail the programmed level of works for each road under maintenance, and (ii) report labour inputs as compared to the planned work programme.
- Responsibility:** The Province Maintenance Overseer is responsible for preparing this plan. It should be prepared before the beginning of the financial year and regularly updated based on monitoring of works and the current condition of the road network.
- Timing:** Actual labour inputs are entered into the chart on a monthly basis.
- Procedure:** The report form basically consist of two charts. At the top of the form a bar chart presents the labour inputs for each of the roads placed under routine maintenance. In addition the report presents a linear chart showing the cumulative total of planned and actual labour utilised for routine road maintenance in the province.
- Enter basic data relating to the report, i.e. name of Province and Revision Date.
- No:** Enter the Code given to each road or road section.
- Road Name:** Enter the names of each road or road section included in the maintenance programme.
- Length:** Provide the exact length of the road or road section which has been placed under routine maintenance.
- Labour:** Enter the total planned labour input for each of the roads where maintenance is planned. Once work commences, enter the actual total workdays used in the row below the planned figure.
- Month:** Distribute the planned total labour input over the months for which maintenance is planned. A bar chart is created showing which months there will be maintenance works on each of the roads.
- After commencement of works, the actual labour input is entered on a monthly basis into the form for comparison with the planned figures.
- Total Length:** The total length of all roads in the province which are placed under maintenance is calculated on the basis of the length of each road entered into the workplan.
- Total Workdays:** The total workdays planned for each month, covering all roads, is entered at the bottom of the chart. As works proceeds the actual total workdays is entered in to the row below the planned figures.
- Workdays:** The planned and actual cumulative labour input is calculated from the above monthly inputs.
- wd Graph:** Finally, the cumulative planned and actual labour inputs are presented in a line graph, using the months as the horisontal axis and the number of workdays as the vertical axis. One line graph is prepared for planned works and a dotted line is constructed to present the actual labour input.
- Approval:** After the above information has been prepared by the Maintenance Overseer, the estimates and calculations are checked by the Provincial Engineer.
- Filing:** The Workplan should be filed in a designated file at the Provincial Office to be used for overall progress monitoring of works. A copy should be submitted to central headquarters as part of the monthly reporting from the provinces.

Kingdom of Cambodia Ministry of Rural Development		WORKPLAN/MONTHLY REPORT 1999												Rural Infrastructure Improvement Project ADB Loan No. 1385-CAM(SF)		
No.	Road Name	Length km	Labour wd	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	wd Graph
	Samrong-Preykabas	22.4	Planned 2688 Actual 406	224 201	114 115	114 90	180	224	224	268	268	268	224	290	290	5000
	Samrong-RN3	2.5	Planned 240 Actual 37	20 15	10 12	10 10	16	20	20	24	24	24	20	26	26	
	Angtasoam-Angroka	4.0	Planned 480 Actual 63	40 20	20 25	20 18	32	40	40	48	48	48	40	52	52	5000
	Baty-Preykabas	5.0	Planned 600 Actual 82	50 40	25 22	25 20	40	50	50	60	60	60	50	65	65	
	Mangkolmeanlak-Tropangleat	10.5	Planned 1260 Actual 180	105 90	53 40	53 50	84	105	105	126	126	126	105	136	136	4000
	<b>TOTAL (km)</b>	44.4														
	<b>Total workdays</b>		Planned 5,268 Actual 366	439 366	222 214	222 188	352	439	439	526	526	526	439	569	569	
	<b>Workdays</b>		Planned Cumulative 439 Actual Cumulative 366	1,674 366	1,235 580	1,235 768										
Legend:			Checked by: _____												PROVINCE: Takeo	
Planned: _____			Prepared by: _____												REVISION:	
Actual: - - - - -			Maintenance Overseer: _____												Provincial Engineer: _____	

## Workplan and Monthly Report - All Provinces

- Purpose:** The purpose of this form is to (i) present a summary of the programmed level of maintenance works, and (ii) report labour inputs and expenditure as compared to the planned work programme in all provinces.
- Responsibility:** The Planning and Monitoring Engineer is responsible for preparing this plan. It should be prepared before the beginning of the financial year and regularly updated based on monitoring of works and the current condition of the road network.
- Timing:** Actual labour inputs and expenditure are entered into the chart on a monthly basis.
- Procedure:** The report form basically consist of two charts. At the top of the form a bar chart presents the labour inputs for each of the provinces included in the routine maintenance programme. As an overlay, a linear chart shows the cumulative total of planned and actual labour utilised for all provinces.
- The second chart presents the planned monthly expenditure as well as actually incurred costs for each of the provinces.
- First Chart:**
- Province:** Enter the names of each province included in the maintenance programme.
- Length:** Provide the total length of the roads which is placed under routine maintenance in each of the provinces.
- Labour:** Enter the total planned labour input for each of the provinces. These figures are obtained from the Annual Road Maintenance Requirements reports and the provincial workplans for routine maintenance.
- Month:** Transfer the total labour inputs for each province from the provincial workplans. A bar chart is created showing which months there will be maintenance works on each of the provinces.
- Total Length:** The total length of all roads in the programme is calculated on the basis of the length of roads in each province.
- Total Workdays:** The total workdays planned for each month, covering all provinces, is entered at the bottom of the first chart. As works proceeds the actual total workdays is entered in to the row below the planned figures.
- Cumulative:** The planned and actual cumulative labour input is calculated from the above monthly inputs.
- wd Graph:** Finally, the cumulative planned and actual labour inputs are presented in a line graph, using the months as the horisontal axis and the number of workdays as the vertical axis. One line graph is prepared for planned works and a dotted line is constructed to present the actual labour input.

**Second Chart:**

- Province:** Enter the name of the provinces where road maintenance expenditure is expected.
- Budget:** For each of these provinces, enter the total budget for road maintenance.
- US\$/km** Based on the province budget and the total length of roads included in the maintenance programme (ref. first chart), calculate the unit cost of road maintenance.
- Month:** Enter the projected monthly expenditure for each province. This information needs to be summarised from the Routine Road Maintenance Inventory forms.
- Total:** The total programme budget covering all provinces included in the programme is calculated on the basis of the budgets in each province. Check that this figure corresponds with the total in the Annual Road Maintenance Requirements report.
- Total Budget:** The total budget planned for each month, covering all provinces, is entered at the bottom of the second chart. As works proceeds the actual total expenditure is entered in to the row below the planned figures.
- Cumulative:** The planned and actual cumulative budget and actual expenditure are calculated from the above monthly figures.
- wd Graph:** Finally, the cumulative budget and actual expenditure are presented in a line graph, using the months as the horisontal axis and the costs as the vertical axis. One line graph is prepared for the budgeted costs and a dotted line is constructed to present the actual expenditure incurred for each month.
- Approval:** After the above information has been prepared by the Planning and Monitoring Engineer, the estimates and calculations are checked by the Project Implementation Consultant.
- Filing:** The Workplan should be filed in a designated file at the Headquarters to be used for overall progress monitoring of works progress and costs. Copies should be issued to each of the provinces as part of the feedback to the monthly reporting from the provinces.

Kingdom of Cambodia Ministry of Rural Development		Rural Infrastructure Improvement Project ADB Loan No. 1385-CAM(SF)												wd/US\$ Graph		
1999		WORKPLAN/MONTHLY REPORT ALL PROVINCES														
Province	Unit	Length	Labour wd	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	
Takeo	km	58.7	6,269	439	222	222	352	439	582	689	689	689	582	712	712	12,000
Kampot	km	14.9	1,363	110	33	33	52	64	149	154	149	149	149	154	167	10,000
Kandal	km	24.0	2,430	188	78	78	121	150	240	258	273	263	245	267	269	8,000
Kampong Cham	km	16.0	1,420	75	30	30	30	42	160	195	190	182	160	185	180	6,000
Prey Veng	km	4.6	552	50	23	23	23	46	46	46	46	56	56	67	54	4,000
Svay Rieng	km	5.0	600	110	25	25	25	40	50	50	50	50	50	56	69	2,000
<b>Total Length</b>	km	123.2														0
<b>Total Workdays</b>				972	417	411	603	781	1,227	1,373	1,357	1,349	1,242	1,441	1,461	
Planned			12,634													
Actual				0	611	567	382	861	1,100	1,080	869					
Planned Cumulative				972	1,389	1,800	2,403	3,184	4,411	5,784	7,141	8,490	9,732	11,173	12,634	
Actual Cumulative				0	611	1,178	1,560	2,421	3,521	4,601	5,470					
<b>US\$/km</b>																<b>US\$/1000</b>
Takeo	US\$	16,637.20	283.43	1054	305	305	7189	604	1191.2	1053	946	1146	826	1006	1012	28
Kampot	US\$	2,952.84	198.18	424.4	47	47	169.24	89	637.2	717.36	231	231	231	238	282	26
Kandal	US\$	6,431.06	267.96	484.5	108	108	1904	307	702.2	576	386	372	348	378	386	24
Kampong Cham	US\$	2,985.36	186.59	375.4	41	41	89.96	58	682	400	241	244	241	275	287	22
Prey Veng	US\$	1,202.75	261.47	295.5	40	32	248.25	63	63	63	77	77	77	92	75	20
Svay Rieng	US\$	2,243.10	448.62	1584.1	32	32	32	85	96	66	66	66	66	75	93	18
<b>Total</b>																
Planned		US\$	32,452.31	4,197.90	573.00	585.00	9,632.45	1,206.00	3,351.60	2,875.36	1,947.00	2,136.00	1,789.00	2,064.00	2,115.00	
Actual				0.00	2,520.40	687.51	462.35	1,075.97	13,706.05	1,336.29	1,039.65					
<b>Total Budget</b>				4,197.90	4770.9	5335.9	14968.35	16174.35	19525.95	22401.31	24348.31	26484.31	28273.31	30337.31	32452.31	
Planned Cumulative				0.00	2,520.40	3,207.91	3,670.26	4,746.23	18,442.28	19,778.57	20,818.22					
Actual Cumulative				0.00	2,520.40	3,207.91	3,670.26	4,746.23	18,442.28	19,778.57	20,818.22					
Prepared by:																
Checked by:																
Project Implementation Consultant																
Revision:																

## Tools Inventory for Routine Road Maintenance

**Purpose:** This form keeps track of all hand tools which has been issued to the petty contractors engaged to carry out routine road maintenance works. It records the type and amount of tools issued to the contractors. Since these tools are only on loan to the contractors, this information forms part of the overall tools inventory management of the Provincial Implementation Unit.

**Responsibility:** The Maintenance Overseer is responsible for maintaining the Tools Inventory for Road Routine Maintenance. It is regularly checked for accuracy by the Provincial Engineer and needs to be reconciled with the overall Tools Record of the PIU.

**Timing:** The Tools Inventory is normally updated on a monthly basis, in line with the procedures established for the PIU stores.

**Procedure:** Information regarding the issue of tools to contractors should be entered every time new contracts are awarded for routine road maintenance. On a monthly basis, this information should be checked with the contracts register to ensure that all petty contracts have been included.

At the top of the form, enter the name of the Province and current date.

**No.** The first column, allows for a numbering of all the engaged petty contractors. The purpose of this number is merely to assist the Overseer in making sure all contractors have been included in the report form.

**Name of Contractor:** Enter the name of each contractor which has been issued tools. Contractors which completed their works and returned the tools should be omitted from the list.

**Tools:** The following columns list the various standard tools issued. Finally, the column marked "Other Tools" allows for recording issuance of non-standard tools.

**Remarks:** Any remarks relating to the issuance of tools to a particular contractor can be entered into the last column or referred to here.

**Approval:** The Tools Inventory is checked and approved by the Provincial Engineer.

**Filing:** The Tools Inventory is reconciled at the end of the month with the overall tools monitoring of the Province (other road works and provincial stores).



Kingdom of Cambodia  
 Ministry of Rural Development  
**Rural Infrastructure Improvement Project**  
 ADB LOAN No. 1385- CAM (SF)



**Tools Inventory for Routine Road Maintenance**

Province: \_\_\_\_\_

Date:.....

No	Name of Contractor	Wheel barrow	Shovel	Hoc	Pickaxe	Axe	Bush Knife	Rake	Watering Can	Hand Rammer	Basket	Grass cutting knife	Spade	Other Tools	Remarks
<b>Total:</b>															

Date:.....

Date:.....

Prepared by:

Checked by:

\_\_\_\_\_   
 Maintenance Overseer

\_\_\_\_\_   
 Provincial Engineer





## Chapter 6

# Reference Literature

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Technical Manual - Labour Based Road Construction Methods, *Johannessen*, I.T. Transport, Phnom Penh July 1998

Contracts Management - Labour-based Road Construction Works, *Johannessen*, I.T. Transport Phnom Penh July 1999

Rural Road Maintenance Consultancy, Rural Infrastructure Improvement Project, I.T. Transport, Phnom Penh June 1998

Standard Contract Documents for Laterite Supply, Rural Infrastructure Improvement Project, *Johannessen*, I.T. Transport Phnom Penh 1998

Standard Contract Documents for Culvert and Bridge Works, Rural Infrastructure Improvement Project, *Johannessen*, I.T. Transport Phnom Penh 1998

Road Maintenance and the Use of Local Resources, *Edmonds* I.T. Transport, International Labour Organisation Phnom Penh 1996

Field Manual for Labour-based Road Supervisors, *Johannessen*, International Labour Organisation Cambodia, 1994

Labour-based Appropriate Technology Posters, Rural Infrastructure Improvement Project, I.T. Transport, Phnom Penh June 1998

UNDP/ILO Rural Feeder Road Maintenance Using Labour-based Technology - Short Training Course, International Labour Organisation Phnom Penh April 1994

Management and Monitoring Aid - MAMA, Rural Infrastructure Improvement Project, I.T. Transport, Phnom Penh 1999

Labour-based Road Construction and Maintenance Technology, *Johannessen*, National Polytechnic Institute, Laos September 1997

International Road Maintenance Handbooks, Transport and Research Laboratory, England

Strategy Document for a Labour-based Road Works Programme in Lao PDR, *Johannessen and Edmonds*, Laos December 1996

Road Maintenance Manual, Ministry of Public Works, Kenya, Intech Associates, November 1992

Appropriate Technology - Labour-based Roadworks Technical Manual, Volume II Road Maintenance, Intech Associates, International Labour Organisation, Tanzania May 1997

International Course for Engineers and Managers of Labour-based Road Construction and Maintenance Programmes, *Beusch and de Veen*, International Labour Office, Geneva 1991

Labour-based Construction Programs: A Practical Guide for Planning and Management, *Coukis et al*, World Bank, 1983

Training Videos for Labour-based Road Construction and Maintenance, International Labour Office Geneva 1991

Road Maintenance and Regravelling (ROMAR) using Labour-based Methods, *Andersson, Beusch and Miles*, International Labour Office 1996

Labour-based Technology - A Review of Current Practice: Report of Proceedings 2-6 March 1992, Mophale Hoek, Lesotho, CTP 129 International Labour Office, *Bosma and Johannessen*

Labour-based Contract Maintenance Programme: Orientation Course for District Engineers, Course Notes, ILO CTP 130, *Intech Beusch and Co.*, April 1993

Maintenance Management for District Engineers, TRL Overseas Road Notes, 1987

