GREEN ROAD CONCEPT

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German Technical Cooperation

SDC
Swiss Agency for Development and Cooperation

GREEN ROADS IN NEPAL

BEST PRACTICES REPORT

An innovative approach for rural transport infrastructure development in the Himalayas and other mountainous regions

IMPLEMENTATION TEAM
B. N. Acharya, R. Aryal,
B. Karmacharya and W. P. Meyer

COORDINATOR
Werner Paul Meyer

SECOND EDITION

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FOREWORD

Over the past twenty years much effort and many resources have been invested by the Swiss and German governments in the "integrated rural development approach" especially in mid-hill districts of Nepal. One of the lessons learned in these efforts was that, still, the need for basic infrastructure like rural roads persists. These investments are highly valued by the local people and have profound "ripple effects" towards economic development, far beyond the improvement of transport facilities along a narrow corridor.

In order to meet these aspirations, attention has been paid to how rural roads can be built in a socially responsible manner. The aptly named "Green Roads" have tried to combine low environmental impacts, local resource mobilisation and local employment generation as well as self-help capacity building. Road building is difficult in mountain regions, and the possibility for a catastrophic environmental impact is high. Moreover road building has a great potential to generate huge amounts of direct and indirect employment and thus has a major poverty alleviation effect. Finally, in Nepal, as elsewhere, local development by way of promoting self-help and capacity building is seen as an important strategy to sustain benefits.

This Green Road study was financed jointly by GTZ and SDC with a view to document what we consider a successful experience. Our objective was to compile and consolidate what has been learned in the Nepal Green Road efforts to date. Several steps towards implementation have been taken already. Many "key informants", who have been principally involved with Green Road applied research have been involved in the study itself. A number of meetings, seminars and workshops have been organised to share information and opinions. Earlier in 1998, a "State-of-the-Art" review of Green Roads was prepared for discussion. This and other documents are available with GTZ/SDC. This "Best Practices" report is however the culmination of these efforts.

It is hoped that this document is widely used by development practitioners in Nepal. In particular, those with an interest in rural poverty alleviation programmes or rural infrastructure development or self-help capacity building will be particularly interested in this approach. We hope that this document serves as a guideline for environment-friendly, participatory, low cost and labour-intensive road construction and as a spring-board for further action, particularly by international financial institutions and HMGN's new Department of Local Infrastructure and Agricultural Roads (DoLIDAR) within the Ministry of Local Development.

We are grateful to the study team for their participatory and appreciative work style, and timely presentation of results.

Klaus D. Lunau	Anton Hagen	Dietrich Stotz	Binod Shrestha
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GTZ	SDC	GTZ	GTZ

Kathmandu
May 1999

ACKNOWLEDGEMENTS

The compilation of this Best Practices Report in hand is the product of a series of efforts to compile the experiences made in selected rural Green Road projects supported by SDC and GTZ and the experiences of various persons directly involved. The outline and the basic principles of this report have been reviewed and consolidated by a wider group of people from various backgrounds during several workshops.

Warm appreciation and thanks are extended to Dr. Klaus D. Lunau, RDP/GTZ Programme Manager, Mr. Binod Shrestha, RDP/GTZ Deputy Programme Manager and Dr. Dietrich Stotz, GTZ Team Leader for RCIW/FfW Programme, who continuously supported the study team by actively accompanying in each step of the process. Special thanks are extended to Dr. Felix von Sury, SDC Resident Coordinator who co-sponsored the venture and Mr. Anton Hagen, SDC Deputy Resident Coordinator, who finalised the cooperation agreement as one of the first activities at the very beginning of his assignment in Nepal.

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The study team has been responsible for the preparation of the content outline and the write-up of the text. Special thanks go to Mr. Bed Nath Acharya, GTZ Consultant Engineering Advisor responsible for the Green Road Construction Programmes in DDP GDP and RDSPL, who contributed to this report by preparing Chapters 4 and 7. Similarly, special thanks go to Mr. Bijay Karmacharya, Senior Programme Coordinator (Engineering) RCIW/FfW, who drafted a part of Chapter 5, which was complemented by Mr. Rajendra Aryal, Programme Officer (Infrastructure), RDP/GTZ, who provided in addition a significant support in preparing the annexes as well as the day-to-day management and communication efforts among the numerous partners.

The present form of the report has been greatly facilitated by administrative support of Mr. Dinesh Shrestha, RDP/GTZ Administrator and his support team. Ms Sashi Rai, RDP Secretary, transformed large amounts of almost unreadable manuscripts into a typed form, Mr. Prem B. Shakya, AutoCad Draftsperson, digitised the drawings of the RTI consultant, and Mr. Purna Man Shrestha, Report Design and Printing Specialist designed the cover page and finalised the text layout.

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This report is dedicated to all the impoverished remote and isolated families living along the ridges and valleys of the Himalayan hills and desperately hoping for a better future and opportunities, which is very often initiated by better access through roads. May the Green Road Concept pave the way to open up the physical and psychological isolation and lead to break up the vicious circle of under-development by creation of new opportunities in the next century.

May 1999
Werner Paul Meyer
RDP/GTZ
Rural Transport Infrastructure Consultant

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ABBREVIATIONS AND ACRONYMS

AADT	Annual Average Daily Traffic
ADB	Asian Development Bank
amsl	above mean sea level
BEPRA	Best Practices Report
BCR	Benefit-Cost Ratio
B-S PASHP	Bhojpur-Sankhuwasabha Poverty Alleviation through Self-Help Promotion Project (MoLD/GTZ)
BMZ	German Federal Ministry for Cooperation and Development
ca	circa (around)
cap	per capita (per head)
CBS	Central Bureau of Statistics
CBO	Community-Based Organisation
CDO	Chief District Officer
DDC	District Development Committee
DDP	Dhading District Development Project (MoLD/GTZ)
DEM	German Mark
DoLIDAR	Department for Local Infrastructure and Agricultural Roads, MoLD
DoR	Department of Roads (MoWT)
DR	District Road
DRCC	District Road Coordination Committee
DSC (WM)	Dept. of Soil Conservation (and Watershed Management) (MoF)
DTMP	District Transport Master Plan
EIA	Environmental Impact Assessment
EPA	Environmental Protection Act
FfW	Food for Work Programme of the WFP
FYN	Financial Year in Nepal (from Mid July to Mid July)
GDP	Gorkha District Development Project (MoLD/GTZ)
GRECO	Green Road Concept
GTZ	Deutsche Gesellschaft für Technische Zusammenarbeit, GmbH, Eschborn, Germany, i.e., German Technical Cooperation (INGO)
Helvetas	Swiss Association for International Cooperation, Zürich (INGO)

hh	household
HMGN	His Majesty's Government of Nepal
ICIMOD	International Centre for Integrated Mountain Development, Kathmandu
IEE	Initial Environmental Examination
IHDP	Integrated Hill Development Project (HMG/SATA)
INGO(s)	International Non-Governmental Organisation(s)
IRDP	Integrated Rural Development Programme
IRs	Indian Rupee(s)
km	Kilometre
LDO	Local Development Officer (MoLD)
LJRP	Lamosangu-Jiri Road Project (MoWT/SDC)
LNGO	Local Non-Governmental Organisation
LRCC	Local Road Coordination Committee
LRIP	Local Road Improvement Programme (Palpa DDC/PDP)
md	Man day (Person day)
MoF	Ministry of Finance
MoFSC	Ministry of Forest and Soil Conservation of HMGN
MoLD	Ministry of Local Development of HMGN
MoU	Memorandum of Understanding
MoWT	Ministry of Works and Transport of HMGN
MT	Main Trail
NGO	Non- Governmental Organisation
NPC	National Planning Commission of Nepal
NPV	Net Present Value
NRs	Nepali Rupee(s)
pd	per day
PDP	Palpa District Development Project (MoLD/Helvetas/GTZ), former TWP (3. phase)
PDR	Primary District Road
PIP	Priority Investment Plan (DoR, RMRP), 1997
PLRP	Pilot Labour-based District Road Rehabilitation and Maintenance Project (MoLD/UNDP/WB/Helvetas)
RCIW	Rural Community Infrastructure Works Programme (MoLD/ FfW, GTZ)
RDP	Rural Development Programme (MoLD/GTZ)

RDSPL	Rural Development Through Self-help Promotion, Lamjung (Project), (MoLD/GTZ)
RMRP	Road Maintenance and Rehabilitation Project (MoWT/WB/UNDP/SDC/DFID)
RRD	Regional Rural Development
RTI	Rural Transport Infrastructure
SATA	Swiss Association for Technical Assistance (joint representation of SDC and Helvetas in Nepal) until1986
SDC	Swiss Agency for Development and Cooperation, Swiss Government
SDR	Secondary District Road
SoAR	State-of-the-Art Report
TWP	Tinau Khola Watershed Development Project (DSCWM/Helvetas/GTZ), (1. and 2. phase 1979-88)
UC	User Committee
UG	User Group
UNDP	United Nations Development Programme
USD	U. S. Dollar
VDC	Village Development Committee
VR	Village Road
WB	The World Bank, Washington, D.C.
WFP	World Food Programme of the United Nations
ZoI	Zone of Influence

Applied Currency Unit Rates:

U. S. $ 1.00 = NRs. 65.00 (1998)

Indian Rs. 1.00 = NRs. 1.60 (Fixed Rate 1998)

GLOSSARY OF TERMS

AGRICULTURAL ROAD

An "agricultural road" is built for agricultural purposes. Typically they service irrigation systems, tea estates, or are constructed specially for the collection of sugar cane or other mono crops. The term “agricultural road” is frequently used in the Agriculture Perspective Plan in reference to local "all-weather" roads, but without further specifying the ownership and maintenance jurisdiction. A frequent problem with agricultural roads is poor maintenance due to unclear ownership.

CORPORATE ROAD

The term "corporate road" implies that the ownership of a road lies typically with an irrigation cooperative, a tea estate, a group of tourist hotel owners, etc., i.e., a public organisation or a commercial enterprise, who build and maintain a road, generally as its principle user. This term was introduced by the Pilot Labour-based Road Rehabilitation Project to provide an alternative ownership form, and hence better opportunity for maintenance.

DISTRICT ROAD

This is an official definition in Nepal set out by the MoWT/DoR (*vide* the Nepal Road Standard). It defines roads that are part of the Strategic Road Network and therefore come under the mandatory authority of DoR. The term “District Road” implies ownership by the DDC hence identifying whose responsibility maintenance is.

DISTRICT ROAD COORDINATION COMMITTEE (DRCC)

A District Road Coordination Committee (DRCC) is understood as part of the legislative "Infrastructure Committee" defined by the Decentralisation Act. It consists of political representatives of the District Council, and includes the main district-level stakeholders from the private sector (i.e. Transport Associations) as well as HMGN line agency representatives mandated to represent the various interests of a district in order to guide the preparation of a District Transport Master Plan (DTMP), facilitate the approval by the District Council and implement the DTMP in the district.

FAIR WEATHER ROAD

A fair weather Green Road is a road with a low initial investment and has an earthen or a gravelled surface. It is generally opened during dry season, i.e., during winter. The road is closed during monsoon, i.e., between July and September.

FEEDER ROAD

This is an official definition in Nepal set out by MoWT/DoR (*vide* the Nepal Road Standards). A “Feeder Road” is part of the Strategic Road Network, linking a District Headquarters or Zonal Headquarters with the national level highway grid. They are therefore feeder roads to highways, and thus the concept deviates slightly from the internationally understood term.

GREEN ROAD CONCEPT

The "Green Road Concept" is an approach. It refers to an environmentally sound, affordable (i.e. low-cost), participatory, technically appropriate, labour-based rural road or trail construction/maintenance methodology. The Green Road Concept focuses on conserving the delicate mountain ecology, in particular the protection of vegetation cover as means of soil conservation.

Local populations benefit from this approach. In the short-term, they gain off-farm employment opportunities during construction. In the medium-term the community obtains better access to the outside world and enjoys reduced transport costs for goods and people. In the long-term Green Roads provide improved public and private services and economic development because the community is less “cut off”.

Local communities (VDCs, CBOs, LNGOs, committees as well as DDCs) are supported in their decision making process in planning their road and trail networks as per HMGN's decentralisation policy and implementation efforts, and they shall contribute to the optimum extent using their central level budgets and local funds.

GREEN ROAD

A "Green Road" is one characterised by the construction methods described by the Green Road Concept. Usually a Green Road has a relatively low initial design standard in terms of surface treatment and curvature of horizontal alignment in order to keep costs low. In fact, a Green Road is a low-cost, low-volume, fair-weather earthen road. Green Roads initially are typically “Village Roads”, however they *are not* a new class of roads. They are generally well integrated into the environment, and often can hardly be seen from a distance. Greater emphasis is given to the selection of a smooth longitudinal alignment that allows for progressive upgrading as traffic increases.

LOCAL ROAD

These are generally roads within a local area neighbourhood of one or several VDCs. The term "local" is relative however, and depends on the point of view. From an international perspective, quite a major piece of infrastructure (like an airport) might also be considered "local". The relative point of view of the term often creates an ownership dilemma.

LOCAL ROAD COORDINATION COMMITTEE (LRCC)

A LRCC often takes the form of a "User Committee" following the Decentralisation Act. LRCCs coordinate planning, construction and maintenance for a specific road. They mediate between the local population, landowners and the construction (user) groups or contractors who are supervised by the technical support team (consultant). A main function of an LRCC is in conflict resolution. They consist of representatives of the VDCs, members of the DDC, and can also include members of main road users, such as local transporters' association. Following construction, the LRCC is expected to assume maintenance responsibilities in a manner similar to an irrigation system User Committee.

MAN DAY

A man day (md) or a person work day unit (pd, either by a man or a woman) consists of 8 working hours.

PHASED ROAD CONSTRUCTION

It is the method of construction of a new Green Road in four phases:

- Phase I: a trail along the future road alignment
- Phase II: a track created by the gradual widening of the trail
- Phase III: a road including retaining structures, water management structures and bioengineering
- Phase IV: road surface compaction and construction of road surface drainage system including bioengineering. (See Chapter 5 for more details)

ROAD

A road is a "way", with a defined alignment and a fixed centreline. It can be used by various standard types of four-wheeled vehicles such as passenger cars, tractors etc. A road can be further classified as “fair weather” or “all weather”. (See also definition of "Track")

ROAD FEASIBILITY AND VIABILITY STUDY

Its major objective is to analyse whether a road project is technically, environmentally and socially feasible (that is, achievable, attainable and workable). After selection of the most feasible road options, the economically most viable one is generally preferred.

RURAL ROAD

This is a very general, widely used term describing the general location of a road (besides urban roads). The weakness with this term is that ownership is not clarified.

SECTORAL ROAD CONSTRUCTION

To provide way to speed-up the comparably slow labour-based road construction method, a road can be divided into several sections, typically 10-20 km long, with relatively independent construction management units and sub-committees. The sectoral construction approach is feasible for labour-based projects where neither heavy equipment nor large quantities of construction material need to be transported to the construction site. (See Chapter 5 for more details.)

STAGED ROAD CONSTRUCTION

Implies the construction of a road in stages, with a view to the final product (say, a double-lane, bituminous road). Initially a smaller road might be built (say, a single-lane earthen road). As funds are available and traffic volume increases, the narrower road might be upgraded. (See Chapter 5 for further details)

STRATEGIC ROAD NETWORK

An officially defined term in Nepal by MoWT/DoR (*vide* the Nepal Road Standards). The network consists of National Highways and Feeder Roads. It is built, managed and maintained by the DoR.

TRACK

A track is a way with a partly fixed alignment, within a corridor that may change seasonally. It may be used by various types of standard four-wheel-drive vehicles or agricultural equipment (animal cart, tractor-trailer etc.) generally only during fair weather conditions. There are a large number of tracks in the Terai that provide access to almost all settlements during the dry season.

TRAIL

A trail is a way with a defined alignment, sometimes within a corridor, and mostly used by pedestrians. **Mule Trails** are used by mule caravans and have slightly higher width requirements compared with pedestrian trails.

Recently a new type of **Cycle Trail**, designed for use by bicycles and motorcycles, has emerged. Tourist areas like Pokhara already have specified such trails, and there is a considerable potential scope for such trails in remote areas for emergency services.

In the mid-hills and mountains, there is about 9,800 km of “Main Trails” with about 800 major trail bridges (DoR, 1997, Main Trail Bridge Statistics). These main trails often serve entire regions (several districts).

TYPES OF ROAD WORK

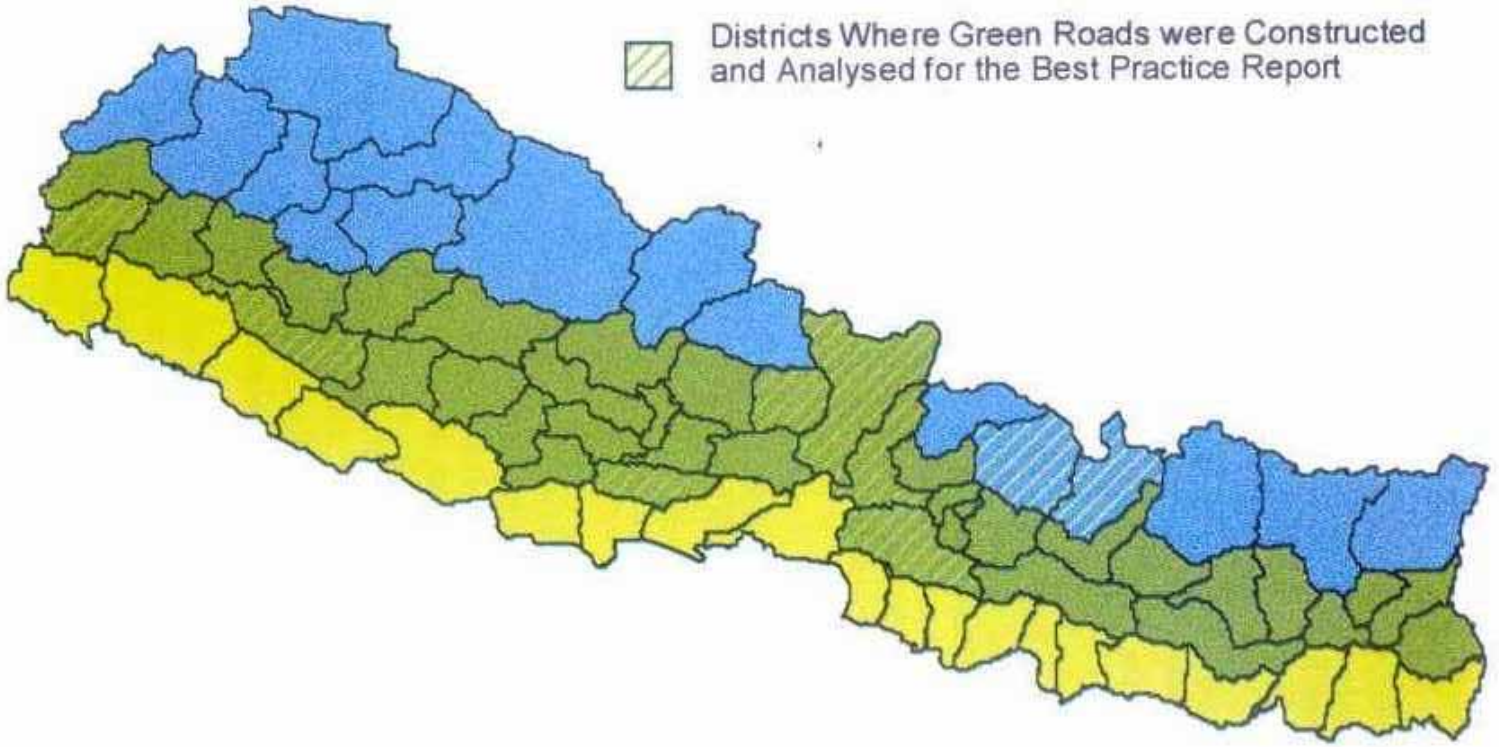
- **Construction:** Building of a new road or trail
- **Rehabilitation**: Rebuilding of an existing but defunct or written-off infrastructure into the initial new condition with the previous standard
- **Upgrading**: Bringing of an existing but usually over-utilised infrastructure to a higher standard with a higher performance
- **Maintenance:** Improvement or preservation of an existing road or trail in operational condition by various preventive and curative works, such as routine, periodic, seasonal, cyclic, and emergency maintenance works

VILLAGE ROAD

The official term "Village Road" as per Nepal Road Standards implies ownership by the respective VDCs with responsibility of maintenance and rehabilitation. However, neither the legal status of “Village Road” has yet been fully clarified nor the authority, responsibility and support from higher level authorities.

Administrative Map Showing Mountain, Hill and Terai Districts of Nepal

Green Area Showing Districts Where Green Road Concept is Most Appropriate



EXECUTIVE SUMMARY

CONTEXT AND BASIC PRINCIPLES

Rural mountain roads in Nepal have been slow to develop. Historically the country's interior was traversed by north-south trade routes linking Tibet with Nepal and India, and in the east-west direction by mail runner routes (Hulaki Bato). Even today, these traditional pathways remain important communication links for rural people.

Beginning on a larger scale in the 1960s motorable roads began to be developed to link Nepal's capital and some regional centres with India and Tibet. Despite much progress, Nepal remains one of the least accessible countries in South Asia with a total recorded road network of less than 14,000 kilometres or roughly 9 km of roads per 100 sq. km.

In this context work began in the 1980s to develop a road building technology that was appropriate for Nepal and that was environmentally sound for addressing the fragile mountain topography. Its goal was to conserve the delicate mountain ecology, and, in particular, to protect vegetation as means to prevent excessive soil erosion. Given Nepal's extreme poverty, the road building approach needed to use labour-based methods (to generate off-farm employment) and be affordable (i.e. low-cost). The resulting road was aptly described as a "Green Road".

By the late-1990s GTZ's and SDC's considerable experience made it possible to begin describing the best demonstrated practice for Green Roads by sharing certain basic principles:

1. Participatory Rural Road Network Planning

District transport master plans are a recommended first step. These combine local, district, regional and national level thinking into one document and force local decision-makers to recognise essential concepts, such as road ownership and guide them to identify needs and priorities as per available resources. A participatory (and simplified) methodology has been developed which district personnel can largely implement themselves. In this approach, decisions are made within the concerned district on the basis of a consensus, respecting the views of a broader number of stakeholders.

2. Preservation of the Fragile Mountain Environment

The Green Road technology has been developed as an approach to build mountain roads that cause minimum environmental damage in order to reduce future risks of road destruction by recurrent landslides or increased soil and water erosion. The approach is preventive, rather than curative and it avoids disruption of vegetation cover along the road corridor in the first place, rather than introducing expensive structures and re-planting measures later on. Re-utilisation of local material underlines the construction philosophy, in which excavated material is transformed into construction material (stone, gravel chips, topsoil, etc.). Mass balancing and controlled tipping of excess material is practised rather than bulldozing with uncontrolled waste disposal.

3. Optimisation of Supportive Natural Processes, Avoiding Destructive Natural Forces

Rather than fighting nature, it is used constructively. By properly aligning road corridors along south-west ridge routes, good sunlight can dry roads and avoid moist areas as well as frost-exposure. If earthwork is timed properly the monsoon can be a benefit to natural compaction, rather than a disaster. The Green Road approach calls for a phased construction method, which avoids management of large excavated mass and controlled natural compaction through the monsoon season that avoids the need for heavy equipment or costly manual compaction. Vegetation cover prevents excessive soil erosion and is developed on barren earth slopes. These plant roots act as effective sub-surface anchors to reduce landslips and landslides.

Destructive natural forces are avoided. Unlike the conventional road building approach which concentrates water in side drains, the Green Road approach aims at dispersed drainage system. The road cross-section itself slopes slightly outwards away from the mountain, so that water flows across. Problematic alignments are avoided. Again prevention is cheaper than cure, so a ridge road alignment is preferred that avoids gullies.

4. Promotion of Appropriate Labour-based Technology

Green Roads aim at finding an optimum balance of manual and mechanised work processes so that the result is highly labour-intensive. This is because labour-based methods in Nepal are currently the most economic. In addition, labour-based methods can be locally more sustainable if suitable construction techniques (such as simple structures, etc.) are applied using mainly local construction materials (excavated stone, chips, soil, plants etc.) and locally produced tools and simple equipment (i.e. wheelbarrows and drilling equipment, etc.) are used. In this sense the Green Road approach fits well into Nepal's interest in decentralisation: the Green Road technology opens the path for districts and villages to become more involved in road construction and consequent maintenance.

Emphasis is placed on useful field surveys that draw heavily on indigenous knowledge. Often Green Roads are based on traditional routes which local people are intimately familiar with. They know where the soil is soft, moist or slippery, where rock falls are dangerous and so on. These types of surveys reduce theoretical design inputs to a minimum. Simplified and standardised designs, drawings, and estimates and procedures are used to the maximum extent possible.

Roads are built in phases to avoid costly management of large excavated mass in fragile topography and to allow natural compaction to occur. In general a Green Road requires two monsoons to allow the road surface to settle. In order to speed construction, "sectoral" management in several sections lets work proceed all along the alignment rather than in a linear manner as conventional roads are built. This sectoral approach works because Green Roads do not require heavy equipment such as bulldozers (which have to start at the road head and push to the end). Finally, roads are built in a demand-driven and staged manner, responding to traffic needs. Thus, a Green Road starts modestly and expands as the economy along it grows. Green Roads optimally adapt road construction to the availability of funds, labour, and other self-help inputs and attempts to institute a functional and sustainable maintenance system.

5. Labour-based Construction Methods

A significant benefit of labour-based road construction methods is that they generate massive local employment opportunities, and, as well, recycle financial resources at the local level. Green Roads can be easily integrated into "poverty alleviation" programmes. Experience has shown that the construction of a Green Road requires about 12,000 person days per kilometre. In addition, road maintenance after completion requires about 200-300 person days per kilometre per year.

As these roads are ideally constructed (and maintained) in the agricultural slack season, they provide a significant amount of off-farm employment. Work processes are developed in a gender sensitive manner, so that women can be equitably involved in tasks that require other capacity than physical strength.

6. Performance-based Work Management

Conventional road building also uses a form of performance-based management: contractors bid on a project, and are paid on completion. Green Road management systems have adapted this same approach to locally managed and labour-based work gangs. Rather than paying workers at a fixed daily rate, they are paid on the basis of the quantum of work they accomplish. This provides a major incentive. In roads adopting this approach, work progress has been very fast.

Simplified small contract work assignments are used only for more complex structural works that require external construction material, mechanical equipment and specific professional experience (e.g. bridge construction etc.), or in less densely populated areas that lack local labour.

7. Decentralisation of Implementation, Decision-making and Road Ownership

Nepal's decentralisation evolution is supported with Green Roads. Ideally they are built with a delegation of authority and responsibility from the centre to the appropriate Village or District level. Green Roads are also supportive of emerging institutions like district-level "technical units". This technology can be easily adapted and used with little in the way of outside technical assistance. Planning and management of Green Roads has also proven to be suitable institution-building project for the "Local Road Coordination Committee" at the district level, made up of elected officials.

An absolute key to success for Green Roads is a clear definition of ownership. Many roads in Nepal are not perceived to be "locally owned", so they deteriorate gradually until they are useless or the central government comes to rescue them. With Green Roads, from the initial concept and request, the eventual ownership and responsibility for maintenance is reinforced. A Green Road only proceeds when local authorities (which may be the district, a VDC, a registered User Committee, or even a corporation) accept responsibility for road ownership and maintenance.

8. Integration of Local Circumstances into Implementation

Local employment generation is one of the key aspects of Green Road Concept. The construction period is aligned to the agricultural slack season. Women are encouraged to have active participation in decision-making as well as in construction works and are

equally paid as men. Children below 16 years of age are strictly prohibited to work; the same restriction applies to gambling and alcoholism at construction sites.

First-aid boxes are made available at construction sites. Treatment is done to the labourers at hospitals in case of serious injuries. Compensation is paid to the victim in case of physical disability during works and compensation is paid to the next of kin in case of death.

9. Promotion of Local Capacity Building and Self-help Efforts

A self-help mentality and local skill development are two positive side benefits of Green Roads. Experience has shown that investments in social mobilisation support (often provided by NGO workers) assist in the organisation process that is necessary to develop a feeling of ownership and involvement. Through the construction process investments are made in training at various levels. District officials are trained in Green Road technology principles, as well as in road network master planning. Local officials receive training on management aspects. Supervisors, group leaders and masons are trained, as are workers.

At another level, some Green Road projects have integrated savings and loan features into the project to make it a more holistic answer to the poverty alleviation efforts. Workers have been organised into savings and credit groups, and have contributed a small portion of their earnings into a revolving group fund. With the assistance of NGO social mobilisers, they have been able to leverage their earnings from Green Road construction into more sustainable, long-term income generating activities.

10. Low Costs, High Benefits

A high Benefit to Cost Ratio through improved road access by a large beneficiary population is achieved with Green Roads by accepting a lower road standard. Green Roads cost less. While other conventionally constructed mid-hills rural roads may have been much “better” in terms of design standards, they cost considerably more. However, the benefits they impart are also realised by the Green Roads.

Taking about 12,000 person days per kilometre estimate as a benchmark, the total labour costs for a Green Road amount to about NRs 800,000 per kilometre, which is about 65% of the total cost of the constructed road and the cost intake flows directly into the local rural economy.

Other qualitative factors such as improved access to public and private sector services, change in the psychology of people through mitigation of their isolation, and the ease of travel are important factors reducing rural remoteness, increasing quality of life and uplifting the economy.

11. Collective Financing and Transparency

Following other Green Road principles of decentralisation, self-help and local capacity building, Green Roads depend greatly on a high degree of local resource mobilisation. There are various local resources to mobilise. Land along the road alignment is a contribution-in-kind by landowners who benefit from greatly increased land values when the road is completed. Local construction materials such as stone, sand, soil, gravel and plants are available free of cost. In some Green Road projects, a requirement has been made for households to contribute voluntary labour. In other

projects, VDCs have made Green Road investments a major part of the Rural Self-help Programme (each VDC in Nepal receives a central government grant of NRs 500,000 per year, and a portion of this has been used to construct Green Roads). As well, district-level grants and donor contributions are routinely used to fund Green Roads.

Through experience it has been found that the most effective way to use these resources is for several stakeholders to pool their contributions, and manage them as one fund. Public awareness on the utilisation of funds is promoted via public audits and cost transparency. Labour payments are made in public and based on work measurements.

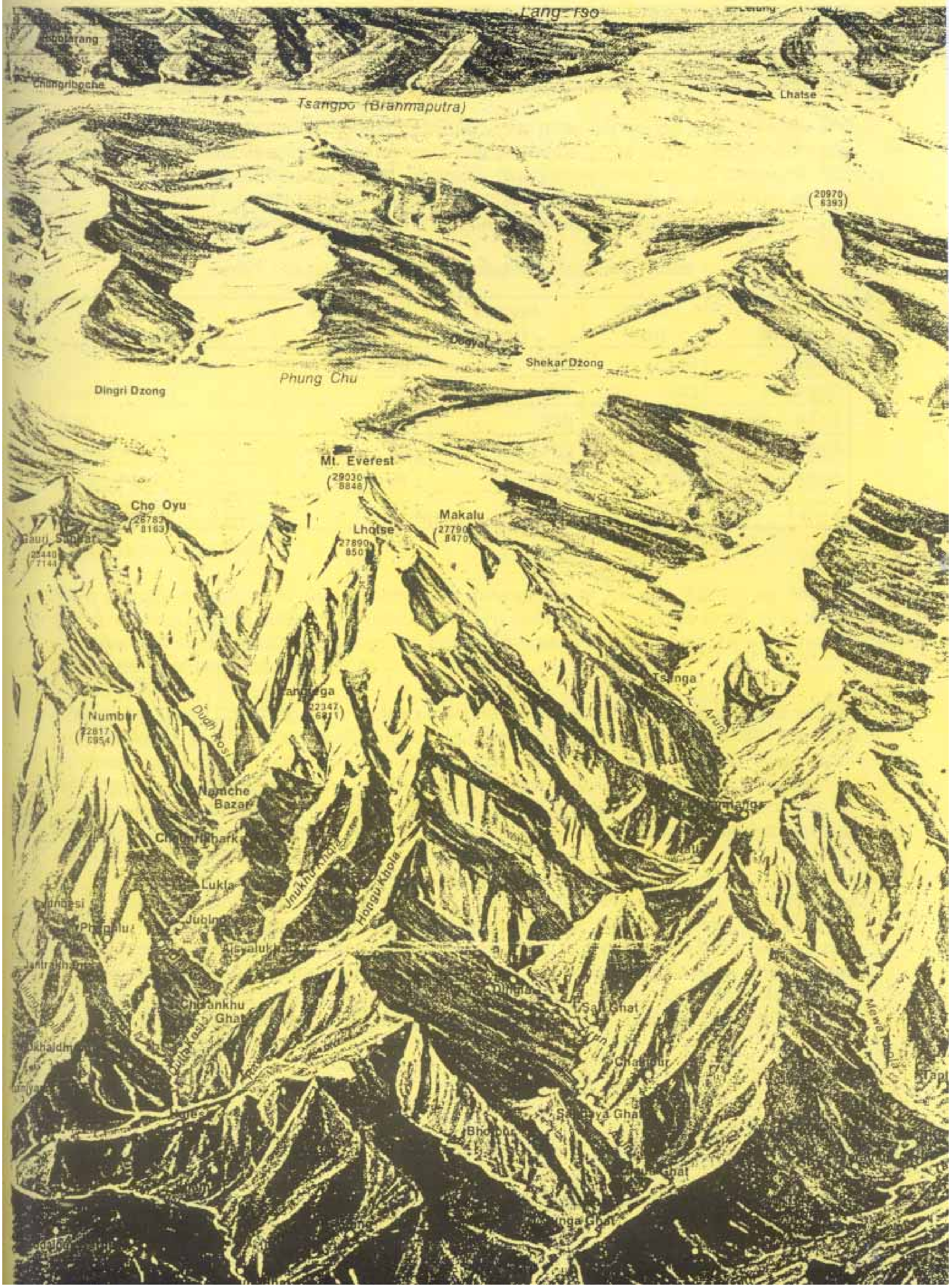
12. Sustainable Maintenance

Road maintenance is promoted through clear ownership and partly through local resource generation, and an explicit linkage between the road users and the road.

Along some Green Roads, transporters are charged a user service fee, or toll. Experience has shown that about 50% of routine and periodic maintenance costs can be financed in this manner, with the balance coming from the VDC/DDC annual grant funds.

Green Roads are generally closed during the monsoon to prevent excessive wear and tear of the road surface. Any earth road will degrade extremely fast if it is driven over in the rain. Again, prevention is cheaper than cure. Green Roads are not “all weather” roads, and can only be used about nine months out of twelve. During the District transport master planning process, the size of the network is scaled to what the district can afford to maintain.

Chapter – ONE



Tsangpo (Brahmaputra)
Lhatse
Dingri Dzong
Phung Chu
Shekar Dzong
Mt. Everest
Cho Oyu
Lhotse
Makalu
Lukla

1: INTRODUCTION

1.1 BACKGROUND

Worldwide, Nepal is a reputed tourist destination for mountaineering and trekking. The term "trekking" itself is associated – with many people – as synonymous with this Himalayan Kingdom together with "Mt. Everest", the highest mountain in the world. But while the prospect of trekking may attract a tourist perhaps once in a lifetime, for the majority of the rural population of Nepal, it is a daily time-consuming burden.

Table 1.1 Nepal Road Network, excluding Village-level Roads

Classification	Blacktop (km)	Gravel (km)	Earth (km)	Total (km)
National Highway	2205	324	376	2905
Feeder Road	651	591	593	1835
Sub Total	**2856**	**915**	**969**	**4740**
District Road	306	2039	4270	6615
Urban Road	911	522	435	1868
Grand Total	**4073**	**3476**	**5674**	**13223**

Source : *Draft Report NRS, 1998*

For a country of about 147,000 sq. km, with dimensions of roughly 900 km by 160 km and an estimated population of 22 million, Nepal's road density is quite small, only about 9 km per 100 sq. km with a coverage of about 6 km per 10,000 people. Nepal is hence one of the least accessible countries in South Asia.

Already by 1959, Toni Hagen, a Swiss geologist who had walked several times across the remote areas of Nepal, mentioned in his report to the United Nations that the poor transport system was one of the main bottlenecks that would slow down rural development. His proposal was to improve the accessibility of rural communities by concentrating on upgrading foot trails and suspension bridges across major streams. In the longer term, he foresaw the need to construct both motorable roads and ropeways, and to improve air services.

Since 1959 considerable development of the national level highway system[1] has occurred. Along the Southern Terai, an approximately 1000 km long blacktopped double-lane all-weather road from the Eastern border to the Far Western regions has been constructed. This main east-west link has been connected with the capital, Kathmandu. India has been linked with China, via Kathmandu, across the Himalayas through Tibet. Most secondary cities in the Terai and many in the mid-mountains are also linked with this system.

[1] In Nepal, called the "Strategic Road Network".

Most rural settlements in the flat Terai have already a seasonal motorable access for trucks or tractor-trailers during the dry winter season. A wide network of motorable roads and tracks exists which is assumed to be several thousand kilometres (about 3000 – 6000 km) in addition, but has never been statistically recorded.

But the rural mountain areas, in contrast, still remain quite remote. In the past, several major Trans-Himalayan trade routes consisting of major foot trails existed for seasonal barter trade between India, Nepal and Tibet. With the occupation of Tibet by the Chinese, this trade has stopped and this trade network has fallen into disuse. A majority of Nepal's population still walks for hours and days to reach the nearest service centre to meet their basic needs.

Besides the extensive efforts to construct a basic highway network, several unique rural road construction efforts have emerged from a series of integrated regional rural development programmes (IRDPs) in Nepal's mid-hills during the last two decades. These rural road programmes have been technically and financially supported by the German and Swiss governments. Roads often became a backbone of these development efforts, despite the fact that they were not in the initial focus of the project.

During the late 1970s, the Lamosangu-Jiri Road Project[2] began as one of the first rural road projects within the context of the Integrated Hill Development Project (IHDP) in Sindhupalchowk and Dolakha Districts. Its design paid particular attention to having a minimal negative environmental impact.

In the western hills of Nepal in the mid 1980s, the Local Road Improvement Programme[3] was included into the Tinau Khola Watershed Development Project (TWP), later re-named Palpa District Development Project (PDP). There a relatively innovative local road construction concept was developed which journalists later described as the **"Green Road Concept"**.

Experiences with these projects were later utilised as basis to further expand rural road construction in the Dhading District Development Project (DDP)[4]. Learning from these experiences, the emerging "Green Road Concept" was applied and gradually improved in road construction programmes in the adjoining district development projects of Gorkha (1996-ongoing) and Lamjung (1997-ongoing). The United Nations World Food Programme[5] together with GTZ's Food for Work (FfW) Programme is now also directly promoting the concept in about twenty districts through its Rural Community Infrastructure Works Programme (RCIW) from 1995 onwards.

Many of these initiatives have been implemented over the last twenty years under the umbrella of HMG Nepal, mainly through what is now called the Ministry of Local Development (MoLD). These efforts have been made with substantial financial and technical assistance by the German and Swiss governments (BMZ and SDC, respectively) together with their implementing support agencies (GTZ and Helvetas). Local district administrations where the roads have been built have also been greatly involved.

In this context, a “Green Road” is one that is environmentally sound, built using participatory, labour-based methods, affordable (i.e. low-cost) and technically

2 LJRP was implemented between 1975 and 1984.

3 LRIP was implemented over ten years, 1986-1996.

4 The Green Roads under Dhading Development Programme were implemented between 1987 and 1997.

5 WFP provided Food for Work (FfW) to a large amount of external labourers during the Lamosangu-Jiri road construction period, an early involvement with “Green Roads” that is now almost forgotten.

appropriate. Its goal is to conserve the delicate mountain ecology, and, in particular, to protect and further strengthen vegetation as means to prevent excessive soil erosion. As Green Road construction is labour-based, the local rural population draws direct short-term benefits from the approach through off-farm employment generation. In mid-term, the improved motorable access to remote areas provide better public and private services as well as reduce the transport costs, which stimulates the rural economy significantly and creates new income generating opportunities.

1.2 OBJECTIVES

This “Green Roads study” had several objectives:

- First, an objective was to collect information about a selected sample of Green Roads in Dandeldhura, Dhading, Dolakha, Gorkha, Kavre, Lamjung, Makwanpur, Palpa and Surkhet districts to document their experiences with the technology. This phase of the study would synthesise secondary data, complement it with site visits to the roads themselves, so that the information could be compiled into a “State-of-the-Art” review.

- Second, with this State-of-the-Art review in place, a team of experts would analyse, discuss, assess and synthesise these various observations and experiences, extracting the most successful elements to further define the best demonstrated practices for the technology, and to express these as the "Green Road Concept".

- Finally, in order to promote further the technology among the concerned stakeholders and agencies, this Best Practices documentation in hand would be widely disseminated. A training concept proposal would be made about how the technology could actually be disseminated among its potential users.

1.3 GOAL AND OBJECTIVES OF GREEN ROADS

More generally, the goal of promoting Green Roads in Nepal is to significantly improve access for a majority of the rural population to service, market and trading centres within the coming decade, thereby reducing transport costs and time for both people and goods, which constitutes a crucial precondition for rural economic development.

The following objectives for Green Road investments needed in order to achieve this goal are:

- Development of a rural road and trail network designed to meet the minimum traffic requirements for districts, in order to reduce transportation costs;
- Involvement of local authorities and stakeholder communities from the preparation phase onwards, thus supporting HMGN's decentralisation efforts in the road sector while promoting a sense of local-level road ownership in view of maintenance;
- Use of an environment-friendly road construction and maintenance technology that preserves the natural environment, its agricultural potential and its natural resources against excessive erosion;

- Optimum use of locally available resources in terms of labour, material and finances; and
- Generation of short-term, off-farm employment opportunities using labour-based road construction and maintenance techniques.

1.4 ORGANISATION OF THE REPORT

This report follows the same logic of the basic principles, which describe the Green Road Concept as being a mix of technology, organisational and institutional issues. However, this report does not attempt to be a cookbook.

This first chapter has provided a basic introduction. It is followed in Chapter 2 by a short discussion of the Green Road context, and the basic principles that define the concept.

Next begins the main discussion of the technology itself:

- Chapter 3 summarises the district-based rural road network planning approach as a major preparatory step for construction and maintenance of the various road networks defined at the ownership level of the respective networks.
- Chapter 4 explains the major implementation arrangements for the construction and management of such roads.
- Chapter 5 deals with the technology, techniques and methods proposed to construct and maintain the roads.
- Chapter 6 discusses the economic justification for the construction of new roads using Green Road technologies.
- Chapter 7 looks at maintenance and rehabilitation issues, and lastly
- Chapter 8 proposes areas for further improvement of the concept.

The document is complemented by a series of annexes further explaining and detailing the approach.

Photo 3800/13 - Palpa 1996
Typical Green Road Alignment of the Arebhanjyang – Rampur Road

Photo 2242/36 – Palpa, March 1996
Rural Passenger Transport along
Harthok – Chahara Road

Chapter - TWO

Suri Dobhan
Chankhu
Jhyaku
Pikhuti Bazar
Kot Khola
Khimti Khola
Nagdana
Jiri
(Valley Bazar)
Shyama
Shivalaya
Patashe La
Malidanda
2250
Manedanda
Bazar
Those
Chipchipe
(Mirge)
Bhater Chour
Chyama
Betali
Kalapani
19
13
Namadi
Kirnetar
Jamune
Sikaral
Khimtibesi
Pharpu
Jyamire
Ghyangdanda
Kartike
Ahaldanda
Nagidanda
Likhu Khola

2 : CONTEXT AND BASIC PRINCIPLES

2.1 A CULTURAL ANALOGY

People living in the remote Himalayas have their own rhythm and way of thinking. If they are to be actively involved in abstract activities like road surveying, planning before construction and preventive maintenance, these ideas need to be explained and placed in context. Experience has shown that such explanations using the mythology of the region helps to express abstract terms and activities.

In the Hindu mythology, "GOD" stands for the trilogy of the major elementary energies in continuous challenge to each other:

G Generation -- or Creation -- personified by Brahma and symbolising road planning and construction

O Operation personified by Vishnu and his incarnations, and symbolising road operation and maintenance

D Destruction personified by Shiva or Maheshwor, and symbolising control of road degeneration by natural agents such as water or traffic

This trilogy is observed in the life cycle of rural roads. In the Himalayas, the natural challenge against the elements of GOD are relatively very intensive as compared to roads built in the Alps, the Andes or Rocky Mountains.

In Nepal and the Himalayas:

G, representing the phase of planning and construction, is particularly intensive given self-help efforts of the local population that need to be linked with appropriate technical and organisational support. **O**, representing the road life cycle, in the Himalayas is relatively short life due to the extraordinarily strong degenerating forces of **D**. Road operation can be extended by:

- making optimum use of knowledge, symbolised by Brahma
- with improved attention to operation and maintenance, symbolised by Vishnu, and
- avoiding a direct confrontation with the destructive forces symbolised by Shiva

2.2 CONTEXT OF PHYSICAL ENVIRONMENT

Geologists describe the Himalayas as a very active zone due to the gradual drift of the south Asian continent towards the Tibetan plateau. As a consequence, the Himalayas grow by about 1cm per year, about ten times more than the Alps.

In addition to this physical movement, the Himalayas form a climatic barrier between the Indian monsoon and the Tibetan continental climates. Monsoon clouds along the Himalayas create extraordinary amounts of rainfall that results in excessive sheet erosion. Rain water causes torrential rivers to scour the slopes, making them more fragile particularly nearby riverbeds. A relatively dense subtropical natural vegetation cover tends to protect slopes from excessive sheet erosion, and dense rooting systems protect slopes from subsurface gliding by landslides of the moist slopes.

The Green Road Concept responds to these natural forces in the Himalayan mid-hills by:

- carefully selecting an optimum road alignment that avoids erosion-prone areas (such as rivers and fragile slope areas) in favour of ridge road alignments;
- avoiding any unnecessary damage to the existing vegetation cover during construction, particularly that directly above and below the road alignment;
- using bioengineering as an effective preventive technique to actively cover and protect exposed slope areas with plant cover to reduce the effects of sheet erosion, and taking advantage of plant roots to reinforce against land slipping and sliding of moist slope layers;
- careful, gradual formation of the road platform as a "terrace", and its road slopes, through a phase-wise widening process that allows natural stabilisation;
- actually taking advantage of heavy monsoon rains to promote controlled natural compaction and settlement of back-filled material; and
- using flexible, or "soft", retaining structures that are less prone to failure due to often unpredictable unstable foundations and slopes.

2.3 SOCIO-CULTURAL, HISTORIC AND POLITICAL ENVIRONMENT

Historically, human settlements in the middle Himalayan ranges of Nepal were characterised by popular migrations from the north-east by Tibeto-Burmese ethnic groups such as the Gurung, Limbu, Magar, Rai, Sherpa and Tamang who settled predominantly along the ridges in communities organised initially to exploit slash-and-burn agricultural opportunities.

From the Indian subcontinent, as a consequence of the Mogul invasion, Indo-Aryan ethnic groups such as the Brahmin, Chhetri, Damai, Kami, Sarki and Thakuri entered Nepal from south-west, settling predominantly in the fertile plains along the rivers to make use of the irrigated rice agriculture possibilities there. The Newar, one of the Nepal's oldest multi-cultural ethnic groups, settled in the fertile Kathmandu valley, and later expanded into the mid-mountains. Besides developing highly sophisticated rice irrigation agriculture, they dealt predominantly with trade and manufacturing, and created dense urban multi-story settlements with trading and storing facilities.

The migration of Nepal's mountain and mid-hill population to the Terai is a recent phenomenon over the last thirty years. It was made possible by the great reduction in the incidence of malaria there. Migration of the rural population towards the relatively

new peri-urban areas is a more recent phenomenon, still occurring in just the last twenty years.

North-south trade routes across the Himalayas were set up to promote barter trade of such staples as salt for food grains. As well, users moved their pack animal caravans to low-lying southern regions during the harsh winter season.

East-west routes historically were "strategic" ways radiating out from Kathmandu, partly along the mid-hills ridges, or the "Mahabharat Lek". These routes also crossed the Terai plains, linking secondary trading centres, and reaching as far as Kangra in Indian Himanchal Pradesh. These east-west routes known as "Hulaki Bato", or mail runner ways, are still in use by pedestrians, who continuously request that they be included as the public road network expands.

Decentralisation trends in the 1990s have intensified the political debate about how to further develop the road network. The process of decentralisation pushes the mandate for local level roads to the districts (DDCs) and to the villages (VDCs) in support of their efforts. At the same time, the centre is increasingly channelling funds for rural infrastructure to these local levels.

The term Green Roads (in Nepali, “Harit Sadak”) arose in the national debate following the popular urge to build roads in more environmentally friendly ways, and to allocate more resources to local efforts to build rural roads that serve remote communities.

At the same time in Nepal, the trend towards democratisation has resulted in a strong popular demand for more programmes aimed at opening-up the relatively densely populated, though isolated and therefore more disadvantaged mid-hills regions of the country. Democratisation or the local involvement of people in decision-making has resulted in the need to consider poverty reduction through employment generation activities as well. Green Roads respond to this sentiment, as its technology is labour-based.

2.4 BASIC PRINCIPLES

As a means to describe the Green Road Concept, a set of “basic principles” has been compiled. These are described below. In the chapters that follow, these descriptions are elaborated upon.

Political and Strategic Principle

1. Participatory rural road network planning

   In order to combine the local, district, regional and national level efforts to improve rural access, the District Transport Master Plan (DTMP) is prepared that includes the views of the local level through a participatory planning process. Decisions are made in a bottom-up manner through political consensus.

Environmental Principles

2. Preservation of the fragile mountain environment

   Damage to the fragile mountain environment shall be minimised in order to reduce future risks of road destruction by recurrent landslides or increased soil

and water erosion through protection of the vegetation cover within the road corridor. Preventive measures are cheaper than curative ones. Recycling of locally excavated material is stressed and transformed into construction material (stone, gravel chips, topsoil, etc.). Mass balancing approaches and controlled tipping are used rather than excavation and dumping resulting into mass wasting.

3. Optimum utilisation of supportive natural processes and avoidance of destructive natural forces

   Vegetation cover is used to prevent excessive soil erosion, so as plant roots are used as sub-surface anchors against landslips and landslides. Solar radiation is used to dry roads and minimise frost-exposure on the road surface through the selection of south-west oriented road slopes. Monsoon rainwater is used for controlled natural self-compaction.

   Excessive gully erosion caused by concentrated water from mountainside drains is avoided wherever possible through a dispersed road surface drainage concept (i.e. outward-oriented cross-falls). However, proper water management structures are used wherever the need exists. Road alignments are avoided near erosive torrential rivers destabilising nearby slopes.

Technological and Technical Principles

4. Promotion of appropriate labour-based technology

   Appropriate labour-based technologies (i.e. an optimum mix of manual and mechanised work) are promoted and such technologies are assisted by engineers who are familiar with Green Road Concept. Suitable construction techniques (such as soft structures, etc.) are applied by using mainly local construction materials (excavated stone, chips, soil, plants, etc.) and locally produced tools and low-cost intermediate equipment where possible (i.e. suitable wheelbarrows and appropriate drilling equipment, etc.).

   Emphasis is placed on field surveys that draw on indigenous knowledge for alignment identification, reducing theoretical design inputs through the application of simplified and standardised drawings and estimates. “Phased-“, “staged-“, and “sectoral” construction methods are applied, which optimally adapt the road construction to the availability of funds, labour, and other self-help inputs.

5. Application of labour-intensive road construction methods

   Since off-farm employment opportunities are very rare in the rural areas, labour-intensive road construction methods (mainly manual work) are adopted rather than capital-intensive technologies (such as bulldozers) to generate local employment opportunities and to recycle financial resources at local level as “poverty alleviation” measure.

Organisational Principle

6. Performance- based work assignment methods

   Green Road Concept emphasises on performance-based local (user) group employment systems. Simplified small contract work assignments are acceptable for more complex structural works that require external construction material,

mechanical equipment and specific professional experience (e.g. bridge construction etc.), or in less densely populated areas those lack local labour.

Institutional and Administrative Principle

7. Decentralised decision-making concerning planning, construction and road ownership

   HMGN's decentralisation efforts are supported through the delegation of authority and responsibility from the centre to the appropriate District or Village level. National democratisation processes are supported through clarification in the division of roles between national and local Legislative, Executive, Judicial and Implementing partners of a road project. “Local Road Coordination Committees” are established to act as mechanism for local conflict resolution. The land provided by the landowners is compensated indirectly by higher land values following road construction. Careful initial clarification of road ownership by DDC, VDC and other public institutions is an important basis for ensuring compensation of construction damage and for the development of a sustainable maintenance system.

Social and Socio-economic Principles

8. Integration of local circumstances into implementation

   Emphasis on generation of local employment opportunities is very essential. The construction period is aligned to the local agricultural slack season. Appropriate gender roles in labour employment and equal payment conditions are applied. Child labour is prevented through supervision by the Local Road Coordination Committees.

9. Self-help promotion and local capacity building

   Self-help and local skill development are promoted through social mobilisation support and local capacity building. Experience shows that trained local human resources often provide a most valuable source of local manpower for neighbouring road projects, as well as for later maintenance, rehabilitation and upgrading works.

Economic Principle

10. High benefit cost ratio and transport cost reduction

    A high benefit to cost ratio is realised through improved road access for a large beneficiary population and relatively smaller initial investment costs by accepting a lower road standard. Other qualitative factors such as improved access to public and private services and the ease of travel are important factors reducing rural isolation, remoteness, and improving quality of life and socio-economic living standards.

Financial and Fiscal Principles

11. Collective financing and public audit

    Resources of several stakeholders are pooled. Public awareness on the utilisation of funds and cost transparency is promoted via public audits (i.e., providing

necessary information on project plans, budgets, expenditures to the local people) that complement the official audit.

12. Sustainable maintenance

Green Road Concept emphasises road maintenance as the responsibility of the road owner. Roads are closed during the monsoon to prevent excessive vehicular destruction of the surface (e.g., formation of deep rills). Funds for road maintenance are provided by resource pooling and matching of local and central funds, such as road tolls and user fees agreed among the legislative and executive partners at the beginning of the project, and budgets from higher levels, as long as there is no national fuel tax.

Photo 3400/25 - Dhading 1998
View of a typical Green Road showing revegetated road slopes in steep section along the Bhimdunga – Lamidanda road

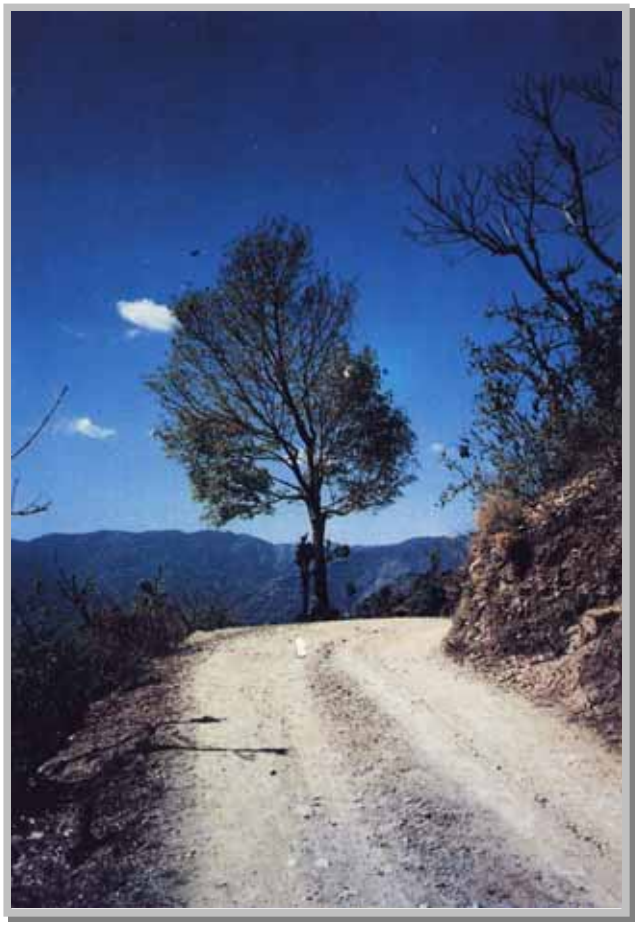


Photo 4817/30 – Palpa, March 1997
Stablised Green Road at Lakuridanda along the Arebhanjyang – Rampur road. The tree was planted at the start of LRIP road works

Chapter - THREE

3: PLANNING

3.1 BACKGROUND

Rural road networks in Nepal are generally based on traditional trail networks, which themselves have historical origins as ancient trading routes, as royal pathways ("Hulaki Bato") or as local village connections that link communities to fields or temples, or sources of water, firewood or fodder.

Trails are still the basis of communication for most rural people. People travel on foot for hours or days to meet their relatives, obtain basic services, consult a doctor or government official, or to trade. Family members carry commodities by hand. Porters carry bulk goods. Sometimes the goods are transported by mule caravans. Since rural people still travel quite frequently, they are reminded regularly of their isolation.

3.2 THE PRESENT TRAFFIC CONDITION

With new roads and changing road-heads, main trading routes and trail networks are in a regular state of flux. Local people have a "mind map" from their own perspective of the transport network based on their own experience and perceptions on needs. Although they might be intimately familiar with the immediate network, their knowledge depends on their work, and the distance and frequency of travel.

Good local level planning depends on this indigenous knowledge. However, the more people are actively involved in planning, the more time and technical assistance are required to come to widely accepted results. Sometimes unnecessary expectations are raised which can not be met, resulting into frustration.

Currently many local communities are eager to improve their local transport networks. Today, more than ever before, the means to make these improvements are possible with the annual VDC budget of NRs 500,000 (about USD 7700) combined with traditional voluntary work contributions. A major problem in planning is that communities have limited skills with road prioritisation and professional road alignment selection. Often roads are built without technical support simply upgrading traditional foot trails. These trails are generally rather straight, short but steep and avoid critical portions that cannot be managed with local technology (such as steep cliffs, river or gorge crossings, etc.). For roads, such trail alignments are inappropriate.

On the other hand, one failure of modern local level transport planning is that they are too often prepared by external planners, from a central point of view, using almost only secondary data from central statistics data bases and line agencies. This results in a well expressed document that is "hollow". Often the resulting plan is neither known, understood, discussed, debated nor approved by local stakeholders, and therefore is not a valid decision-making basis. In other words, a plan produced with only expert knowledge may not be optimal either.

A key element of a District Transport Master Plan (DTMP) is a participatory approach that follows certain basic planning principles. The preparation of a DTMP constitutes a

most important basis for the development of an optimum district level road network, and synchronises efforts of various partners involved in road networking. However, Green Roads can be built with clear justifications (economic, environmental and social) before a DTMP is prepared and approved.

3.3 GOALS AND OBJECTIVES OF THE PLANNING APPROACH

Basic Goal

District transport planning aims at improving access to rural areas in order to reduce transportation costs and time.

Objectives

While reaching this overall goal, several intermediate objectives are important to consider:

- One of the driving forces behind the plan must be to facilitate agricultural or industrial development.
- The methodology behind the master plan preparation should be systematic enough to take logical and transparent decisions.
- The resulting plan must efficiently allocate and utilise scarce resources available for transportation infrastructure; decisions taken should be strategic.
- At the same time, techniques used need to be simple enough to enable the plan preparation by DDC's technical staff who are generally inexperienced in regional planning.
- The plan must be prepared within a politically acceptable time frame (say in less than a year)

Roles of the Key Actors

Four key actors are involved in the process:

1. **Legislative:** The legislative body of the DDC – its District Road Coordination Committee (DRCC) consisting of representatives of various political parties beside elected DDC Chairperson, Vice-chairperson and Members-- are continuously informed about the planning process, and shall be the final decision-makers concerning the plan.
2. **Executive:** The executive body of the DDC – a complementary committee consisting of representatives of HMGN's line agencies and civil servants in DDC -- carry out the planning and provide options to the DRCC to aid its decision making, but this body does not itself approve the plan.
3. **Judicial**: The judiciary body of the DDC ensures lawful planning and implementation and resolves conflicts through mutual understanding. Coordination efforts by Chief District Officer (CDO) can significantly help resolve the conflicts at the local level itself, which otherwise could involve long delays over the court litigation.
4. **Implementing:** The implementing body – a District Road Transport Unit (DRTU) consisting of DDC Engineer, Overseers and Sub-overseers – carry out the

preparation of the plan. An external technical assistance may be required to train and support the DRTU in its planning task, and to facilitate a transparent decision making through well organised planning meetings of the DRCC.

District-level Decision-making and Implementation of Decisions in a Democratic Environment with Balance of Powers

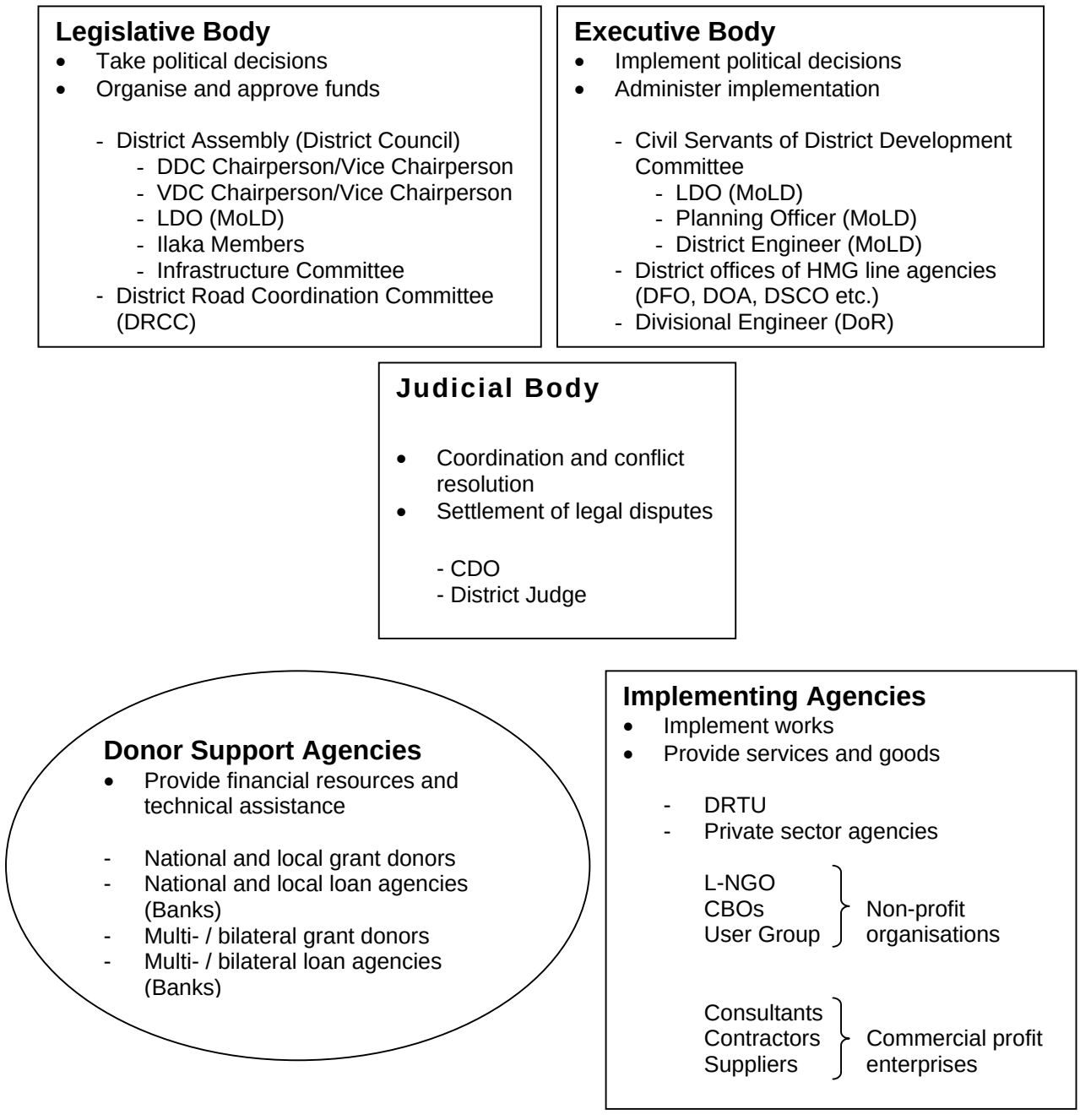


Fig 3.1 : District Transport Master Plan (DTMP) Organisation

3.4 MAJOR STEPS

Step 1: District Level Need Assessment and Basic Decision-making on Preparation of a District Transport Master Plan (DTMP)

- Formation of informal initiative groups
- Carrying out of debate and communication on need within the DDC
- Assessment of necessary inputs and steps required for the preparation of DTMP resulting into a basic agreement among partners in the form of a Memorandum of Understanding (MoU)
- Setting out of each partner's contribution as well as a decision-making process

Step 2: Institution and Capacity Building at District Level

- Formation of a Legislative Committee, called a District Roads Sub-committee or a District Road Coordination Committee (DRCC) out of the District Infrastructure Development Committee (DIDC) that is existing within the DDC as per DDC Act
- Formation of an Executive Committee comprising of representatives of all relevant HMGN's line agencies and civil servants of DDC
- Provision of official mandates to take decisions during the preparation of DTMP
- Ratification of MoU by all active partners and DDC
- Formation of District Road Technical Unit (DRTU) comprising of DDC's technical staff
- Arrangement of competent staff within the DDC to undertake the planning process or hiring of a consultant/consulting firm to assist DDC with regard to preparation of DTMP

Step 3: Collection of Relevant Secondary Transport Information

- Collection of available documents, maps and statistical data (by DRTU or Consultant) from central level agencies, such as NPC, CBS, MoLD or any other relevant agencies
- Collection of available data and information by contacting regional level agencies, neighbouring DDCs, HMGN line agencies in the district and other relevant agencies (NGOs, CBOs, etc.)
- Compilation of collected information into a state-of-the-art accessibility document with a district transport information base map

Step 4: Collection of Requests for Future Road and Trail Network and Discussion

- Division of the district into 4 to 6 geographical transport regions consisting of Constituencies or Ilakas in order to discuss the future road network
- Organisation of "Transport Planning Workshop" in each of the regions involving all major stakeholders such as Members of Parliament (MP), Ilaka and VDC representatives, representatives of major political parties, representatives of NGOs, CBOs, religious organisations and private sector groups etc.
- Discussion on the existing road and trail network, and future plans for new roads and trails keeping in view the available financial resources
- Preparation of an inventory of existing road and trail network and compilation of a request list of new roads and trails

Step 5: Field Verification of Critical Alignments

- Verification of all important but critical alignments by field visits through the technical staff together with local representatives
- Identification and verification of alternative options

Step 6: Political Decision Making on Selection Criteria to be Applied for the Road and Trail Network

- Organisation of a district level workshop for the Legislative Committee to decide and approve the criteria and weights for road classification and network prioritisation

Step 7: Systematic Road Evaluation and Preparation of the District Transport Network

- Mapping of the district road and trail network by using existing and planned national level transport network (i.e., strategic road network consisting of highways and feeder roads, airports, trail bridges etc.) in such a manner that clearly defines the present and future ownership and responsibility for maintenance as well as short-, medium- and long-term road network needs of the district
- Further refining of the prepared network considering important transport nodal points, market and service centres, agricultural pockets, and possible future agro-industrial as well as other industrial areas
- Preparation of draft DTMP and distribution to MoLD and other relevant agencies for comments and suggestions with a request to reply within 30 days

Step 8: Presentation of the Draft DTMP and Discussion

- Organisation of a meeting with Legislative and Executive Committee members
- Presentation of the draft DTMP comprising of road classification and prioritisation with short-, mid-, and long-term perspectives at the meeting
- Discussion on the draft DTMP
- Political decision-making on the draft DTMP with necessary amendments
- Revision of the draft and updating by incorporating all decisions made during the meeting
- Finalisation of the DTMP report with all necessary maps

Step 9: Presentation of the Final DTMP and Approval

- Presentation of the final DTMP at District Council (Assembly)
- Approval of the DTMP by District Council
- Translation of the DTMP report in Nepali
- Printing and distribution of the report to all major stakeholders involved at local, regional and national level

Step 10: Implementation of the DTMP (during the first 5 Years)

- Implementation of the approved DTMP by DRTU, headed by District Road Engineer
- Monitoring of the works by LDO as coordinator of Executive Committee
- Organisation of regular meetings for the members of the Legislative Committee for information and discussion on the progress of the work (such meetings can be organised immediately after monsoon, during working season, at the end of the Fiscal Year, etc.)

Step 11: Revision and Updating of the DTMP

- Evaluation of the progress of implementation of the DTMP after 5 years by the DRCC
- Reporting of the progress to the District Council to make necessary decisions (e.g. for budget allocations, etc.)
- Amendments in the DTMP, if necessary

Photo 2503/2 – Palpa 1998
Arebhanjyang – Rampur road, rural transport of goods by light vehicles and trucks

Photo 1201/28- Dhading, Oct. 1994
Bhimdunga-Lamidanda road transport of vegetables to market by Jeep

Photo 2697/2 – Palpa, June 1996
Inauguration and handing over of the Harthok – Chahara road to Palpa DDC creating Ownership

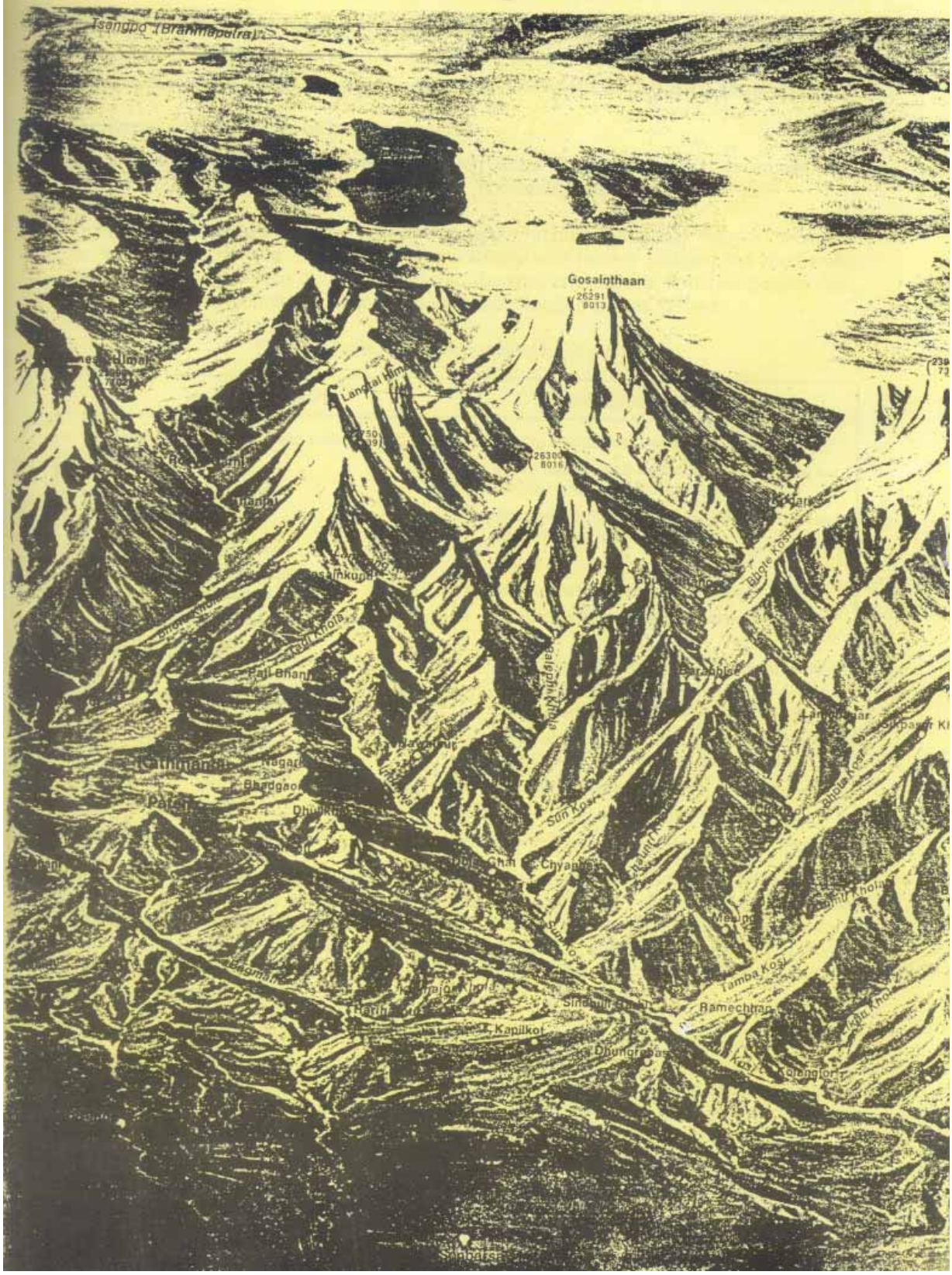
Photo 4436/12-
Achham, Oct. 1998
Constituency level DTMP
Planning workshop in
Magalsen

(Photo : SIDeF)

Photo 0399/32-
Palpa, Dec. 1997
Initial DTMP
Information meeting

Photo 4817/18 –
Palpa, 1997
Collection of
information at typical
rural retail shop
along the Banstari –
Jhadewa road

Chapter - FOUR



4 : IMPLEMENTATION ARRANGEMENTS

4.1 ORGANISATION AND MANAGEMENT

Technical and Social Mobilisation Support

For the success in implementing the Green Road Concept, support is crucial. This support would consist of technical and social mobilisation assistance.

A principle behind technical support is that these technicians would live and work with the local people on-site. They would work directly with people building the road rather than preparing elaborate detailed drawings, designs and reports that few people read. The nature of the technical and social mobilisation support are as follows:

Table 4.1 Types of support required for Green Roads

Technical Support	Social Mobilisation Support
• preparation of the district transport master plan (DTMP) • road alignment selection • surveys, designs and report • training materials • inputs to district decision making • training to Naikes, labour groups, masons, supervisors, User Committee members etc. • arranging local supplies and services • construction supervision • site office and store management • work measurement, valuation and certification for labour payment • quality certification • progress monitoring and reporting • preventive maintenance	• initiating dialogues and meetings. • playing catalytic role in maintaining political balance and bringing consensus in decision making • communication with politicians, the User Committee and the general population • training • assistance to UC to mobilise local people • assistance to UC to ensure the social welfare of the labourers • assistance to make decisions and other aspects of the programme transparent • witness labour payment work • helping labour groups generate group savings and undertake revolving income generating activities • secretarial assistance to the UC

Technical support can be provided by a local engineering consultancy firm that has engineers, overseers, sub-overseers, senior supervisors and social mobilisers experienced in Green Road approach. Alternatively, non-governmental organisations can be recruited if they have sufficient technical staff. Technical support for a single Green Road is provided either by an engineering consultancy firm or by an NGO but it is not mixed between the two.

Technical support is provided during the construction period only, and ceases once the road is complete. Supervision of maintenance work, for example, is a local (UC, VDC, DDC) responsibility. While support may be extended to help institute a proper maintenance system by training and systems development, it is important to avoid dependency on technical support for these recurrent activities.

In cases where local leadership is active and capable, providing social mobilisation support is not necessary. Where local leadership is capable of managing most activities themselves (largely with their own resources), injecting outside social mobilisation crowds out local initiative. In these cases only technical support is provided for alignment selection, surveys and training. Usually only one technician and a couple of senior supervisors are required. At present, expertise of Green Road mainly lies with professionals of few donors and consultants, and therefore HMGN line agencies cannot provide necessary technical support.

Overall an engineer or overseer, not the social mobiliser hold site responsibility. While the site in-charge and the social mobiliser work in close co-operation, the latter is responsible to the former.

To optimise the work of the technical support team, suitable work schedules and other arrangements such as site office and store are established in the middle of each 10 km construction sector. During the monsoon season (June-October) work stops, except for bioengineering and preventive maintenance. Necessary surveys designs, planning, training and annual leave of staff can be arranged during this off period. Please refer to table 4.4 for more information.

The following preconditions are to be met prior to start of a Green Road Project:

- all partners (DDC, VDC, MoLD and district political parties) agree to adopt Green Road principles;
- local people construct the road using labour-intensive methods;
- local representatives form a User Committee which takes responsibility of construction and future maintenance (including local resource generation);
- MoLD and DDC agree to recognise this User Committee as an autonomous body, and empower it to make suitable policies regarding the raising of local resources;
- the DDC and VDC agree to provide resources to the UC to meet future maintenance and rehabilitation costs; and
- the DDC agrees to provide its technical manpower for the future maintenance and rehabilitation requirements.

Management Support

Apart from technical and social mobilisation support, a sound management support is needed from project management side. A schematic illustration of activities in its project cycle is shown in Figure 4.2. Figure 4.1 gives a typical Green Road sector constriction organisation chart.

Twelve different types of major management activities are necessary, consisting of:

- Recruitment of local consultants (or NGOs) to provide technical support and supervision,
- Procurement and supply of "imported" tools (those that cannot be locally made), construction materials and survey equipment and other logistics support,
- Arrangement of meetings, workshops and review meetings,
- Work planning and monitoring,
- Management of the store and record keeping,
- Site work management,
- Coordination at different levels, and between different partners,
- Measurement of works, labour wage payments and record keeping,
- Physical and financial progress monitoring,
- Treatment of injured workers, and compensation for death or injuries,
- Land or property compensation; and
- Technical and financial auditing.

Management practices differ depending upon size, nature and partners of the project. There are in general four different types of Green Road projects:

- VDC-level projects supported by the DDC;
- larger DDC-level projects supported by MoLD;
- bilateral donor/INGO supported projects; and
- international lending institution supported projects.

With respect to the complexity of the four different types of Green Roads, best management practices (or a range of best practices) that apply to each are given in Annex E).

Lean Management Technology

A Green Road approach follows a process, rather than fixed programme. It builds the capacity of local people and institutions as much as possible, rather than using complex and sophisticated expertise. It looks for innovative alternatives rather than conventional, structured practices. It uses "soft line", socially congenial technology rather than hard line engineering practices. In this sense, Green Roads use a form of lean management technology. It avoids unnecessary overheads and middlemen's profits. The savings on these flow back to the local people. Workers are the farmers living adjacent to the road corridor and work in the agriculture off-season. Please refer to Table 4.2 for comparison of Green Roads and the conventional contract approach.

Table 4.2 Green Roads and the conventional contract approach comparison

Green Roads	Conventional Contracts
User Committees comprising of local people have overall authority in planning, construction and maintenance	Contractors of various levels have authority and responsibility for the works; local people may be involved, mostly as labourers
Policies are made by the representatives of local people in accordance with their need	Policies are made by outsiders, and may not be in accordance with the needs of local people
Investment made on roads goes directly to the local people through off-farm employment generation	Major part of the investment goes to outsiders
Low-cost construction	Construction can become expensive
Labour-intensive methods are used, rather than heavy equipment	Capital-intensive methods, including explosives
Ownership at local level, which helps sustainable maintenance	Ownership by government (or nobody) thus sustainable maintenance system compromised
Construction work is started at various places simultaneously (sectoral construction)	Construction work is generally started from the road head and is gradually progressed into the interior area
Maintenance carried out locally as and when needed	If funds are available, maintenance carried out as per HMGN norms, depending on priorities
High emphasis on transparency, and labour records are kept transparent	Local people are generally not informed about costs and procedures
Road construction synchronised with agricultural cycle to involve local people in off-farm employment	Construction dependent on budget release and appointment of contractors, factors that are not related to season or labour availability
Overheads are kept low	Contractors hire local contractors, who hire further sub-contractors, and each level keeps a margin of profit and overheads
Official and public auditing are done	Only official auditing is done

Performance Based Work Assignment

There are two main work assignment systems used in Nepal (Please refer to Table 4.3):

- labour payment without competitive bidding
- assigning contractors (i.e. with competitive bidding)

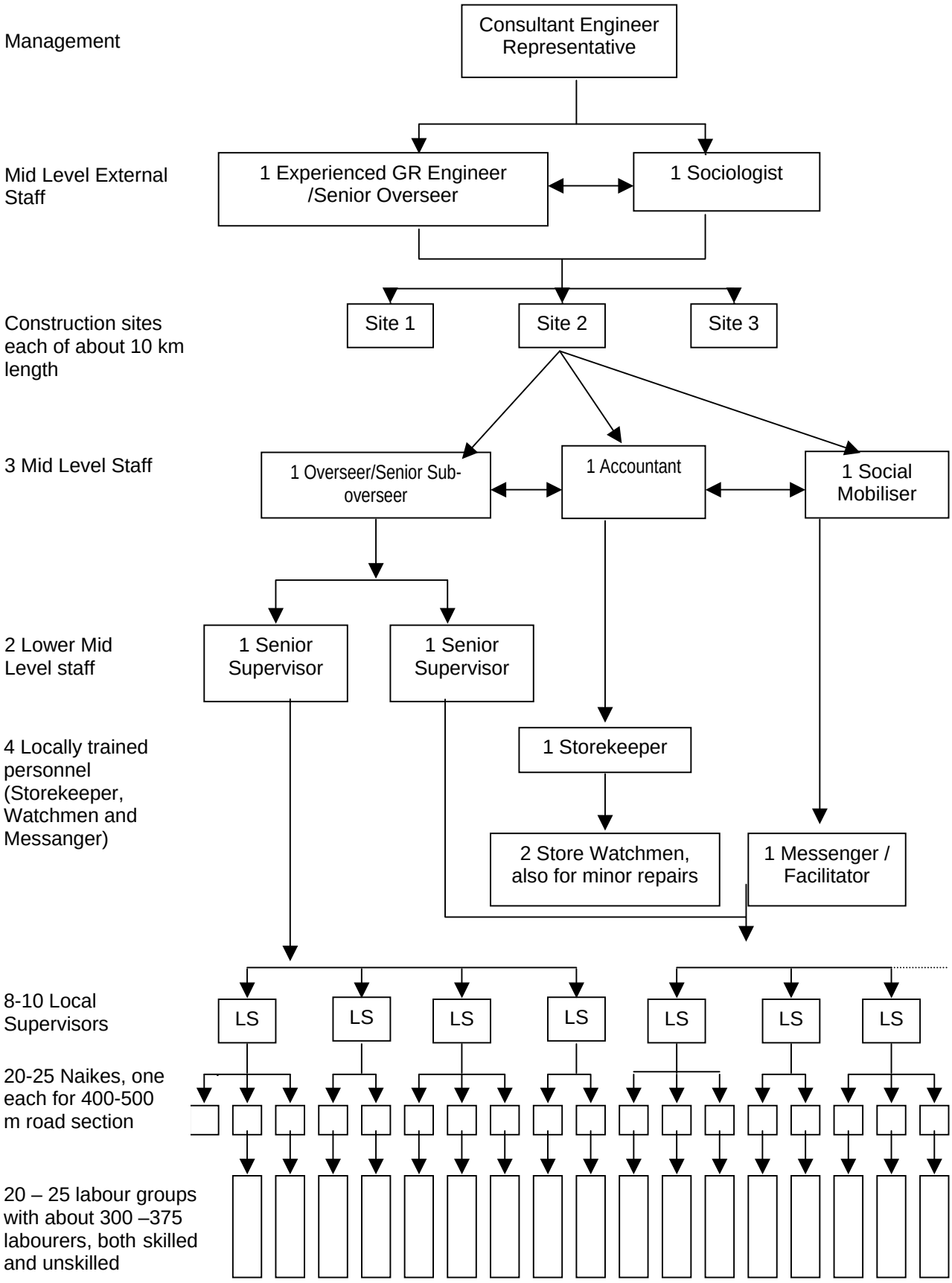
The first approach (labour payment without competitive bidding) can be further divided into three methods, namely a muster-roll system, a lump-sum piecework system, and payments based on work measurement and valuation. Valuation is based on approved unit rates.

Work assignment methods emphasise performance-based payment, in areas with a high level of self-help motivation. A muster-roll approach is appropriate when high levels of supervision are available, quality is particularly important, and in situations where time is not a constraint. Labour payment systems based upon work measurement and valuation is appropriate in larger scale programmes where fast progress is required and where an objective is poverty alleviation or employment generation. Labour payments based on work measurement and valuation are also preferred where an objective is to provide high incentives for local capacity and institution building.

Following the lines of the Green Road Concept, the conventional contract system is not desired generally. Only in cases of more complex structural works requiring external construction materials or equipment that require specific professional experience (such as bridge building), or in areas where literally the local labour pool is non-existent is the conventional contract system acceptable. Small contracts can be awarded either with or without a pre-qualification of contractors.

Table 4.3 Different Systems of Assignment of Works

Work Assignment System	Experienced Advantage (+)	Experienced Disadvantage (-)	Findings
A. Payment system without bidding a. Muster-roll	+ Very simple administration + Usually high work quality + No need of quantity measurement survey + Less technical staff required + Local labour employment + Gender issue addressed	- Difficult to control work quantity - Strong self-help motivation is required for quality & quantity work output - Slow work progress - More labour supervision is required for work output	Muster-roll system is appropriate for quality works without time constraints such as action research, or direct user implied programmes etc.
b. Lump-sum Piece Work	+ No need of regular quantity survey & supervision + Relatively fast progress + Local labour employment + Gender issue addressed	- Regular quality control needed	Appropriate for smaller time bound works
c. Work Measurement - HMG norms*/district rate** - HMG norms/adjusted rate*** - Adjusted norms***/district rate - Adjusted norms/adjusted rate ** HMG norms of analysis of rates* *** Official district rate of the daily wage of an unskilled labourer (annually approved by each DDC)* **** Approved payment by the committee*	+ Local labour employment + Relatively fast work progress + Financial motivation for higher work outputs for labours	- Intensive quantity survey required - More technical supervision is required for quality work output - Higher chances for quality compromise - HMG norms & district rate results in expensive labour payment	Payment system based upon work measurement is appropriate for: • Large programmes where speedy progress is required • Large scale poverty alleviation through local employment generation • High incentive for local capacity building including local institution building
B. System with Competitive Bidding a. Small contracts with pre-qualification of contractors b. Small contracts without pre-qualification of contractors	+ Good for technically more sophisticated works such as small bridges, culverts etc. + Guided by established system + Good for works including delivery of construction materials and special equipment	- Intensive supervision - TA is required - More complex administration - Lengthy administrative process - higher chances of malpractice - Local labour rarely used - Women discriminated - Inflexible towards environmental care - Child labour problem	Small contract system is appropriate for specialised or more sophisticated works including procurement of materials



N.B.: Typical length of a construction site = 10 km and 400 - 500 m stretch for each labour group

Fig. 4.1 Typical Green Road Sector Construction Organisation Chart

Organisational Set-up

A typical set-up of a construction site of 10 km sector that follows the Green Road approach is illustrated in the organisation chart presented in Fig. 4.1. This system of site organisation of labour has proved successful for supervision and quality control.

Typical Working Period

Table 4.4 Typical Working Period

Labourers	Work is undertaken only for about six months of the year and for about 150 working days. • Higher altitude areas : The best off-farm working period avoiding the monsoon season and winter are: Oct-Nov (2 months) and Feb-May (4 months). • Lower altitude areas : The appropriate working period to avoid the farming season, monsoon and prickly heat is: Nov-April (6 months) In the monsoon period only bioengineering activities and preventive maintenance work are undertaken.
Technical Team	June-Oct : Planning, reporting, surveys and annual leave Oct-May : Field work at the site for the lower altitude areas Jan-Feb : Site work in low altitudes or preparatory works at higher altitude areas

Store and Site Management

Store Management

Experience has shown that the technical team most effectively provides store management in internationally supported projects. In cases where the project is being carried out using only local resources (VDC/DDC), User Committee members also manage storekeeping with a view to minimising costs. Storekeepers are trained to repair light equipment, such as wheelbarrows, and for providing first aid. Local blacksmiths sharpen tools like axes, sickles, crowbars, picks, chisels and spades at an agreed rate per piece.

In order to ensure transparency, a record is kept of all materials, tools, and stationery entering and leaving the store using a double entry system. All the tools and materials of the store are inventoried at least once every year, and tools requiring replacement and repairs are identified. The typical types and list of labour-based tools and equipment is given in Annex F.

Site Management System

The first stages of a Green Road project can often be carried out exclusively with voluntary labour during the first year. Each household is asked to provide a similar voluntary labour input. Labourers are provided khaja (a light snack) and khana (full meals) is provided as an allowance only if they require staying at the site itself.

As the project expands and increases in complexity, voluntary labour may no longer be sufficient. Volunteers are not sought for rock cutting, wall construction and finishing work which is undertaken by paid groups only.

Work is assigned to labour groups composed of 10-15 persons headed by a trained leader called in Nepal a “Naike”. Each labour group also consists of trained masons. Naikes and masons are selected by the User Committee and are trained within the scope of the project. Local supervisors are trained and employed temporarily at the rate of one supervisor per 2-3 labour groups. Local supervisor training is carried out after the first stage track is completed, setting out the alignment of the Green Road. A senior supervisor (or an overseer) experienced in the Green Road technology oversees three local supervisors. These local and senior supervisors provide day-to-day and hour-by-hour supervision, and ensure quality control. Technician (engineer or overseers) visits the construction site at least once per day. A social mobiliser supports to bring smooth work progress. Please refer to Figure 4.1 for details.

During Naike, mason and local supervisor training, a demonstration road section is constructed to illustrate the Green Road Concept practically.

Work organisation is coordinated by the User Committee (UC), which meets regularly at least once every month and more during the road construction season. The entire UC assembly meets frequently per year, just prior to road construction season, and as necessary to identify labour groups. All decisions are recorded and circulated. Labour attendance records are also kept in a transparent manner.

Site offices and stores are established and equipped for reasonable comfort and safety of the technical staff, to enable them to live and work with the local people without tension. Particular technicians are teamed with senior and local supervisors to work at every stage of planning and preparation. Technicians visit the site at least once per day, and provide road engineering guidance and motivation to fulfil Green Road technical, social and environmental standards. All teams are also trained in work uniformity, so that the various sectors of the road are measured, evaluated and paid in a similar manner.

Technicians and UC members identify what tools and materials are at hand with labour groups, and arrange additional supplies as necessary. Unnecessary procurement delays are avoided by making purchases through the donor or UC. One set of tools is provided to the labour groups soon after the work order is given. Broken or defective tools are replaced with the permission of supervisors. Tools loaned to labourers are returned before the labour wage payment bill is paid. Naikes are responsible for the loss of tools. The cost of the lost tools is recovered from the responsible labourers. Local labourers are requested to bring at least one tool of their own, as a self-help contribution-in-kind.

One UC member remains constantly at the site during road construction to help solve problems of a social nature. This local official can also arrange the purchase or transportation of local materials.

A social mobiliser also remains constantly at the site in support of the User Committee member. In addition, the social mobiliser’s role is to maintain a communication linkage with the general public.

Technician or supervisors prepare the daily progress report. Naikes take daily attendance of the labour groups, which are verified by the site supervisors.

The consulting engineer constantly follows-up with the donor or the UC to arrange supplies or to solve specific problems. The UC also follows up with the donor, the DDC/VDC to ensure that promised funds are forthcoming. A petty cash fund to purchase local materials and services at the site level is managed by the UC or the consultant.

4.2 INSTITUTIONAL

Decentralised Institutional Arrangement

Green Roads are best implemented in a decentralised manner. This means that overall authority and responsibility for planning, construction and maintenance is given to the User Committee. Institutions like VDC, DDC, MoLD and donors assist and support by providing resources or technical advice. Different local and regional political voices are also accommodated in the planning, decision making and User Committee formation process.

The DDC and VDC Acts of HMG provide the legal basis for the formation of the User Committees. Under these Acts both the DDCs and VDCs are empowered to form and approve the User Committees, and specifying tasks for them to perform. Political balancing is attempted in forming the User Committees, and in the process, representatives of political parties with no representation in the DDC or VDC can also be nominated as UC members.

The User Committee can also be formed in different tiers, if necessary. For example a VDC can constitute a User Committee for a VDC road programme under the chairmanship of a person it considers the best. A User Committee can further form sub-committees for specific tasks (such as materials or tool procurement, monitoring etc.) or sub-committees (or User Group) at ward or community level. The sub-committees will be responsible to the User Committee that in turn will be responsible to the VDC. This arrangement works best for a VDC-type road where the project is confined to a single VDC.

Similarly a DDC can constitute a User Committee for DDC-level road. If there is more than one road committee in the district, the DDC can also form a district road co-ordination committee (DRCC) to coordinate. This type of arrangement works best for DDC-type road spanning several VDCs, or road programmes supported by donors working closely with the DDC. The User Committees of such projects can also form VDC wise sub-committees for providing management support and such sub-committees become responsible to the specific road User Committee.

Another method of forming a User Committee is a three tier User Committee, which is suitable for a DDC-type road supported with resources from several sources (DDC, MoLD, VDCs and donors) termed as "single basket system". To manage a “single basket” type of UC, strong social mobilisation support becomes crucial.

Three tiers are created as follows:

Main Committee formed by an assembly of users and mandated by DDC, which also elects a chairman, vice-chairman, secretary and treasurer and other members.

- Coordination Committee at VDC level headed by the VDC chairman. Other members are the VDC vice-chairman and representatives of the main political parties of the VDC.
- Mobilisation Committee at ward level headed by the ward president. Other members are the representatives from political parties, representatives of other social groups such as mothers, youth, forest User Group, income generation groups or other social mobilisation groups in the ward.

In this arrangement the VDC chairpersons are made the ex-officio members with specific numbers of representatives from the main political parties. A legal basis for this type of arrangement is required through the approval of the DDC. The User Committee is also made autonomous by registering it at the district administration office as a local NGO, for which the User Committee develops its own constitution specifying all the necessary provisions and requires recommendation of the DDC.

Different Partners, their Roles and Responsibilities

The roles and responsibilities of the different partners involved in a Green Road project are well defined. They include:

- Labour groups
- User Committees
- District/Village Development Committees (DDC/VDCs)
- Private Engineering Consultant or NGO
- Donor

Table 4.5 Roles and Responsibilities of Different Partners

Labour groups	Undertake road construction and maintenance while developing a self-help culture. Once completed, the road is maintained through local resource generation. These local people protect encroachment on the right-of-way, and treat the road as their own.
User Committees	Have the overall responsibility for organising construction and maintenance. They meet periodically, enact necessary rules and regulations and enforce them. The UCs identify local supervisors, Naikes, masons and labour groups for training. Members coordinate with the DDC, the consultant, farmer's group, politicians, officials etc. They make available the land necessary and monitor progress.
DDC/VDCs	Provide official approval for the project and User Committees. They carry out policy coordination for the institutionalisation of a maintenance system based on local resource generation and undertake monitoring. The DDC/VDCs may provide resources and technical support. They may help solve site specific problems, if requested, and arrange payment to the labour groups and suppliers on the basis of certification of the consultant.
Consultant/NGO	Provides the technical and social mobilisation support.
Donor	Enters into contract agreement with local institutions and co-operating partners for the technical or financial support to the construction project. It selects, commissions and supervises a local consultant and/or supplies for technical support. It may control management of funds and undertake independent evaluation and monitoring.

4.3 ADMINISTRATIVE

Forms, Formats and Procedures

Forms and Formats

For rapid mobilisation of paid labour for construction, assessment and valuation of completed work, and for arranging labour payment in a transparent manner, a set of forms and formats may be used for Green Road site management. (See Annex H for a summary of these.)

Work Norms

HMGN work norms are heavily inflated, in some cases, and are under-valued in others. For the Green Road approach, they are inappropriate given the participatory nature of the technology. In analysing unit rates for different work items, four different possibilities exist:

- HMG norms and official district wage rates
- HMG norms and adjusted district wage rates
- Adjusted HMG norms and official district wage rates
- Adjusted HMG norms and adjusted district wage rates

If HMGN norms and official district wage rates are used for labour payment, the costs can generally come out to be higher than minimum possible costs of construction. Thus unit rates need to be analysed with either HMGN norms or the district wage rate needs to be adjusted. Additionally, HMGN norms segregate skilled and unskilled labour, which may create complication for Green Road construction. As most Green Road work items do not require specialised skills and their participatory nature provides training when new skills are required, the distinction between skilled and unskilled labour becomes meaningless.

Any adjustment requires the prior agreement of either MoLD or DDC. The adjustment of HMGN norms is recommended for twenty main items of work that are frequently encountered in Green Roads which influence the road construction costs the most. For other items, HMGN norms are acceptable. Recommended specifications are given in Annex G.

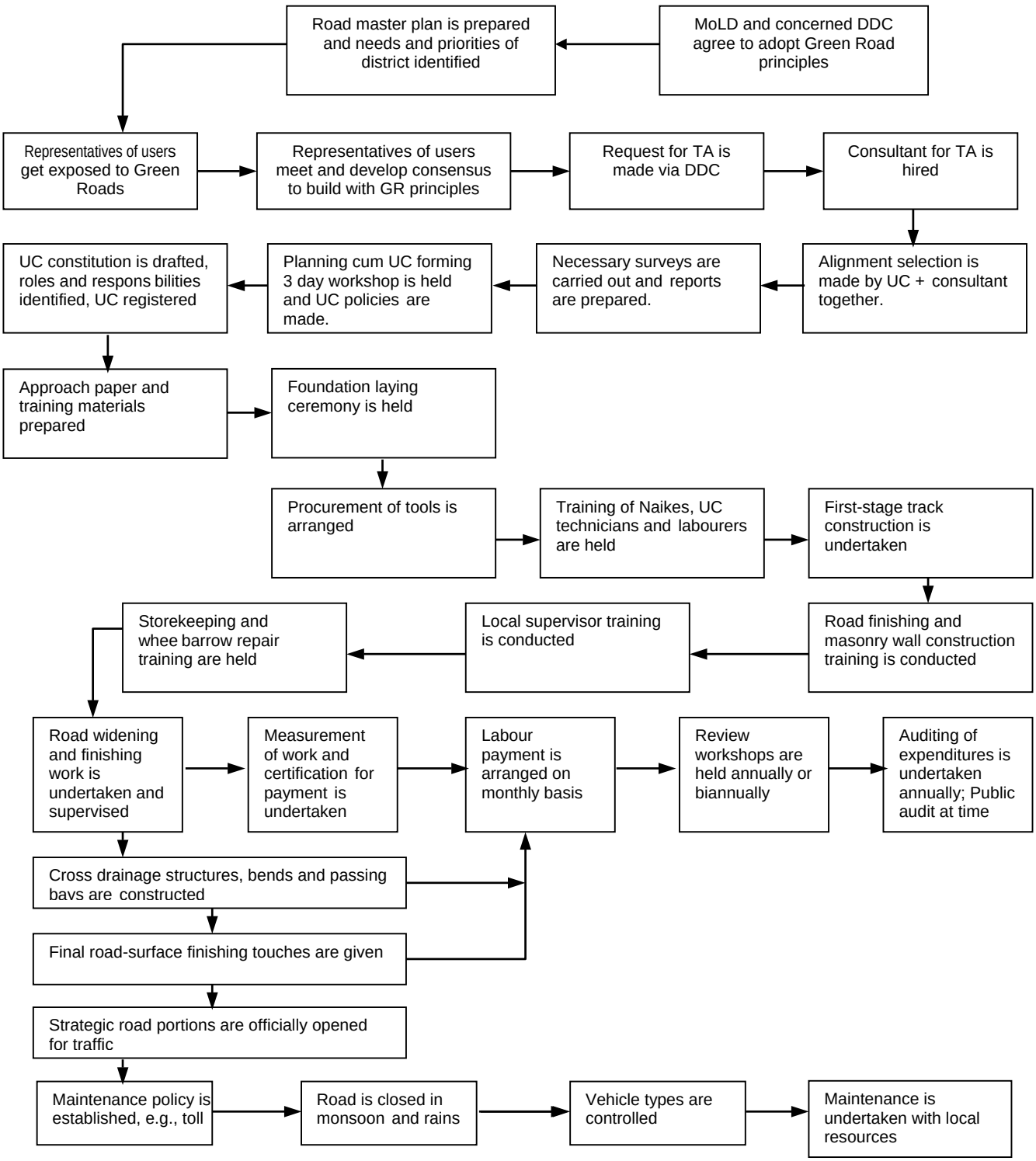


Fig. 4.2 Schematic Illustration of Green Road Programme Activities

Procedure for Measurement, Certification and Labour Payment

The UC decides the number of labour groups to be deployed in a particular construction season. At each site, the store is inventoried, and required tools and construction materials are procured and supplied.

UC members inform local households of their responsibilities. A mobilisation meeting at the ward level is held. Members pledge to take responsibility for construction and maintenance of the portions of the road entrusted to them, and this pledge is formalised the signing of a binding document.

About ten to fifteen persons form one labour group. The group selects a leader, called the “Naike”. Next, the group applies to User Committee to register the group and to obtain training for the Naike.

UC collects the applications and compiles them. UC also prioritises training with the help of technicians. The technician (engineer or overseer) and the social mobiliser provide a six-day training programme for the selected persons, and provide a certificate of training. Only after receiving such training, is a person regarded as qualified for leading a group. Such training is given only once per person.

The UC meets after the Naike Training, and decides the work priority for groups. When making decisions about the division of work, groups are ideally provided work in their own local ward. The technician has the authority to distribute work along any section as required.

The technician calls groups in turn for training on basic Green Road construction principles and other issues. Labour groups are provided one-day training provided by the concerned Naike, supervisor appointed by the technician and the social mobiliser. Several groups can be combined for training to improve efficiency.

After completion, trained members are asked to pledge that they will contribute to the maintenance system set-up by their UC. The pledge is for routine as well as for the incidental maintenance. The members sign their pledge. This pledge states that they consider the road as their own, and will maintain it by providing the necessary voluntary labour in case maintenance funds are not available.

All the labours (including the Naike) are paid equally. There is no difference in wages between skilled and unskilled local labour for manual work. Here the philosophy is that local people provide whatever skills they have for constructing their own road. A Naike is the “first among equals” within the group, with a similar status to the other members of the group. The Naike does not receive any special benefits, and has to work similarly to other members while leading at the same time.

The technician distributes work to the group by specifying the road sector and the work needed to be done in that portion. The labour groups assigned are able to work on the site at any time that suits them (from dawn to dusk). Work assignments are made so that the groups will have approximately similar amounts, so that they can finish within a period of one month. The supervisor inspects daily attendance. The technician, based on the supervisor’s recommendations, prepares the monthly progress report in accordance with the forms provided, and consolidates it in a format which is submitted to the project management monthly.

In order not to disrupt agriculture work, the bulk of road construction work is undertaken during the off-farm season. Smaller groups may be deployed even during the agriculture season for preventive maintenance, re-vegetation and bioengineering measures, or for completing special priority tasks.

Labour groups keep daily attendance using a muster roll form, and submit this to the technician. The site supervisor, the technician and the social mobiliser closely supervise work progress, and can suspend an assignment given to an "incompetent" group if necessary.

Technical supervision is provided as necessary, and the technical team remains at the site working side-by-side with the groups. After completing the assignment, the group requests the technician to inspect and take measurements. If the group has not finished, or if mistakes are observed, the technician specifies what needs to be done. After the technician is satisfied, the measurement of work performed by the group is undertaken by filling a measurement book. Only those items of works specified are measured.

The technician together with the concerned UC Chairperson collects all the recommended bills. The technician measures the completed work and prepares final bills (for each labourer and the total completed works) utilising the work measurement book and specified unit rates. Thereafter the technician recommends the UC Chairperson to forward the final bill to DDC Chairperson and LDO for payment. The LDO together with DDC Chairperson verifies the bills and prepares the cheques. The LDO finally sends DDC accountant to the work site to pay to the labour groups. The accountant witnessed by UC members, the technician and social mobiliser makes payments. The labour group members sign a receipt. Payments are done on regular paydays.

After the completion of work sector, the technician provides a new assignment to the group. In some cases, labourers might deposit a portion of their earnings into a group saving account in their village. They are then able to take loans from the account for various income generation activities. If this social mobilisation approach is used, the role of the social mobiliser becomes crucial, yet such a system multiplies the poverty alleviation impact of the Green Road approach considerably. Rules and regulations regarding group saving schemes are developed jointly by the labourers and the social mobiliser (or motivators) supporting them.

4.4 SOCIAL

Social Mobilisation Support

Self-help promotion is provided by social mobilisation support. "Social Mobilisers" are recruited by the consultant or NGO whose assignment includes group mobilisation tasks or additional work if portions of wages are pooled into savings and loan fund at the group level.

As an expression of self-help, local people and institutions contribute the following:

- voluntary labour is contributed as a contribution-in-kind for a fixed number of days per household per year in the off-farm season;

- land for road is contributed and obtained free of cost;
- local construction materials (stone, gravel, sand, soil and planting materials) are other forms of contribution-in-kind;
- participants bring at least one tool with them to work; and
- representatives serve on committees without salary, although they may receive allowances to meet expenses.

Main district political leaders also participate in mass campaigns in which they jointly visit communities, and address the constituents to support the programme of Green Road policies.

Self-help Local Level Capacity Building

A focus of Green Roads is on local capacity building. Training efforts are integrated into the construction work. Experience has shown that trained people often provide an invaluable source of human resources for the neighbouring districts and subsequent road or other infrastructure projects, as well as for later maintenance, rehabilitation and upgrading works. Table 5.1 (Chapter 5, page 62) provides a summary of types of different training, for different stakeholders, appropriate to Green Roads.

Gender Issues

This approach does not discriminate against women in either work or wages, and instead encourages their involvement in the committees and training. Policies that require a certain involvement of women workers (25-50%) have been experimented with, and it is found that they work. Sometimes separate women groups, women Naikes, and women local supervisors make this kind of involvement socially more acceptable.

The approach also recognises areas of work where women perform better than men, and encourages women to be involved in those areas more than in others. For example, women are better in transporting stone, sand, gravel, planting materials etc. in dokos. As well, they are better at the collection, transportation, supply and planting of materials, excavation using spades, and assisting masons with wall construction.

Green Road projects also recognise that wages paid to women are not wasted on drinking and gambling, but spent on family care instead.

Child Labour Issues

A Green Road management system discourages employment of children below 16 years of age in several ways. Registering labour groups, specifying individual labour members and their ages in advance controls it. Children working at the site are asked to return home by the supervisors or UC members. Education discouraging child employment is built into various Green Road training curricula as well as during the orientation of Naikes. Groups found to use child labour are cautioned or warned.

Campaign against Alcohol Drinking and Gambling

In Green Roads a large part of the investment (65%-75%) goes towards labour payments, and so the cash flows directly to the people. Labourers earning NRs 30,000 (about $440) in a single season is not common, and this is a large sum of money for most rural people in Nepal. If precautionary measures are not taken, these earnings can result in social evils such as drinking, gambling, and extravagant spending on consumption. Drinking and gambling are forbidden at construction sites and labour camps.

Group Saving and Income Generation

A system of group savings and income generation has been promoted in some Green Road sites. This kind of component can be best managed by an experienced NGO.

Labourers are organised into income generation groups, and social awareness training is provided. The group members are asked to contribute a percentage of their earning for deposit into a group saving account. Members of the group can then take short-term loans from this account for individual income-earning projects, subject to approval by the group. Interest on the loan is “revolved” back into the saving fund. Further the group, with the support and guidance of the NGO motivator supervising the programme fixes priorities and policies of utilising the fund. This motivator plays a catalytic role until the group becomes capable to manage the scheme itself.

Insurance of the Labourers

Green Road projects have provided a form of health and safety insurance to labourers through first aid boxes placed at the site level. It contains essential medicines and bandages. Seriously injured workers are treated at the health post or hospital. The labour group insures that the injured worker is paid equally as the other labour members for the duration of treatment at the hospital and recovery period. A particularly risky type of work is where one worker holds a chisel by hand, and another hits the chisel with sledgehammer. Special locally made equipment such as bamboo pliers and hand gloves can reduce the risk with this kind of work.

Compensation in case of permanent physical disability is paid, and compensation to the next of kin occurs in case of death arising from an injury. In case of death of a labourer while performing duty, the next of kin of the deceased is in addition paid a fixed amount for performing the last rites and the amount of compensation is fixed by the User Committee or the donor supporting the project.

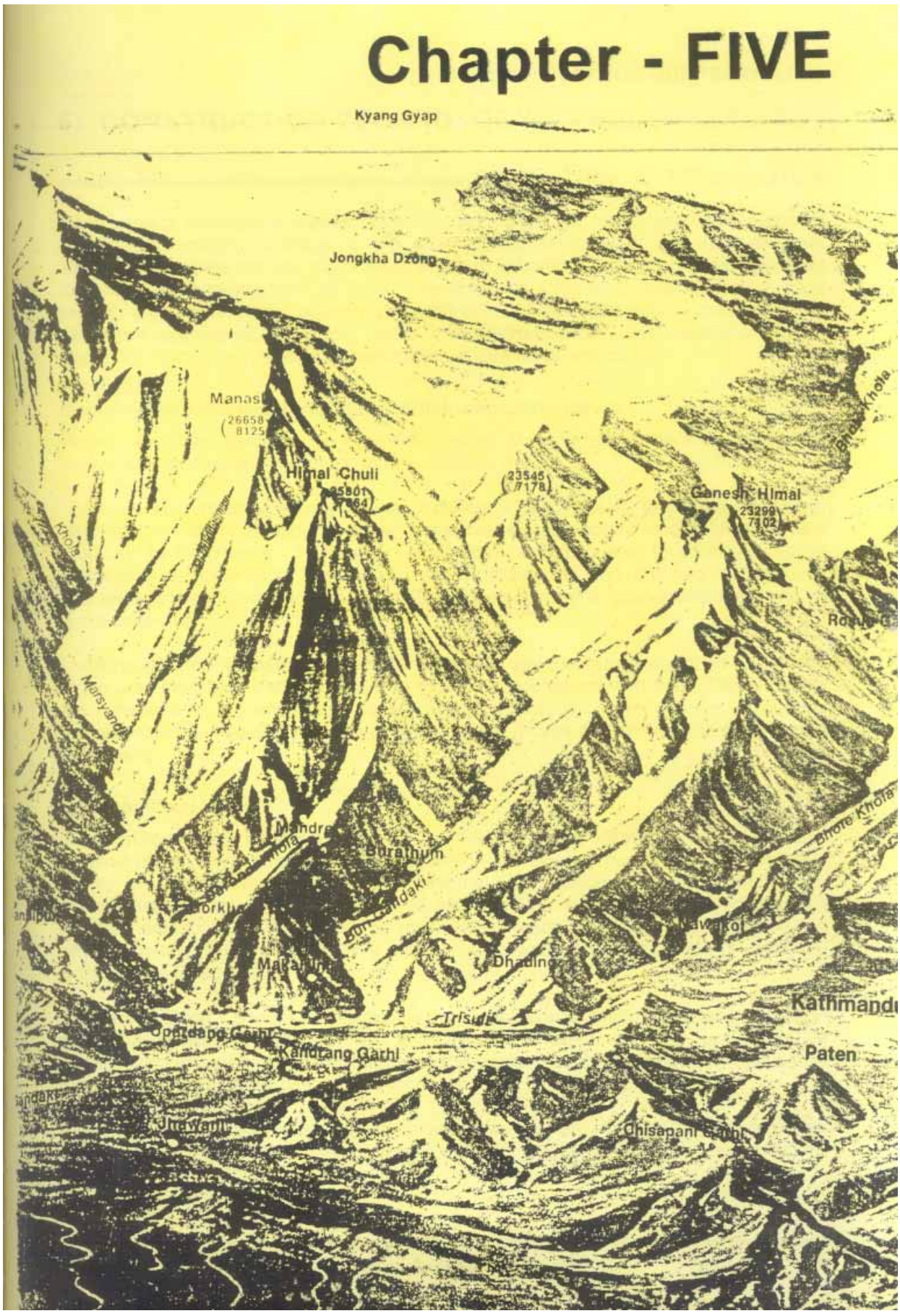
Management takes the utmost precautions for safety of the labourers and pedestrians. In high-risk areas, labourers are provided safety helmets and safety belts. In areas where pedestrians or labourers may be hit by falling stones, other precautions are taken for their safety.

Photo 2912/3 – Gorkha, Feb. 1998
Site administration done using forms and formats for the Benighat – Aarughat road

Photo 2901/31 – Gorkha, Feb. 1998
Heaps of original terrain left for work measurement for performance based work arrangements

Photo 0622/24 – Gorkha, Dec. 1997
Store management of wheelbarrows at the construction sites

Chapter - FIVE



5: CONSTRUCTION TECHNOLOGY

5.1 ROAD PROJECT PREPARATION

Good project preparation makes implementation easy. As the Green Road Concept focuses on minimum damage to the environment, selection of the most optimum alignment becomes the first major step, which is followed by other activities. Following the major recommendations by DTMP mentioned in Chapter 3, major steps in road project preparation are: alignment identification, field verification, comparison of alternative alignments, economic, social and environmental study, selection of best alignment, and survey, design and estimation of quantities and costs.

Identification and Field Verification of Alternative Alignments

Proper alignment selection is essential. Technical expertise, experience and local knowledge are required in order to get an optimum result.

Thorough field reconnaissance by an experienced engineer is the basis for proper alignment selection. Existing documents and maps -- especially topographical sheets produced by Department of Survey -- are also the basic resources for identifying viable and alternative alignments. These maps help in defining the start, end and control points and alignment corridor. Intensive desk study does not result in proper alignment and so is not necessary.

Local people are involved right from the alignment selection stage and their knowledge of the area from their lifetimes is utilised through consultations with them. These people are consulted as key informants during alignment selection. Their genuine aspirations are respected, but vested interests of individuals or groups are excluded through proper judgement.

Environmental Study

The Environmental Protection Act (EPA) 1996 of Nepal provides the basic legal framework for environmental considerations in developing rural transport networks. Under this framework, an Initial Environmental Examination (IEE) or Environmental Impact Assessment (EIA) is required to ascertain the acceptability of a project from an environmental point of view. Green Roads are in fact rural roads, generally localised and small in nature, but are obviously a part of the network. Therefore they fall under the scope of the EPA.

The Green Road Concept envisages environmental conservation from the preparation stage. Major environmental damage is anticipated while constructing rural roads. Of particular concern are principal disturbances at fragile mountain slopes that could cause landslides and soil erosion during the monsoon.

Since the concept incorporates environmental aspects right from the beginning, proper preparation is probably the most promising mitigation measure in itself. A few questions arise:

Are the relatively time- and resource-intensive preparation and approval procedures justifiable for each single rural road project? And, if yes, who bears the cost? If the project is donor-funded there will be a provision to finance such studies. But, today in Nepal, rural road projects are generally constructed by DDC and VDCs using local resources. This level would find objections in funding such studies. If funding is ensured by HMGN, the *Social And Environmental Monitoring and Evaluation System for Agricultural and Rural Roads*, proposed by the Department of Local Infrastructure Development and Agricultural Roads (DoLIDAR) of MoLD, can also be considered for Green Roads.

Selection of an Optimum Alignment

Selection of an optimum alignment should be based on a comparative analysis of various alternatives. Selection has to be done professionally. Costs and benefits, environmental risks and hazards and the ideas from local people become the major criteria for selection of an optimum alignment.

Simple Clues for Selecting a Technically Optimum Alignment

a) Prefer ridge alignment to the valley bottom one. The advantages of the ridge alignment over the valley alignment are as follows:
   - Since the cross slopes at the ridge are moderate, constructing ridge alignments become relatively easy
   - Water management is less a problem with ridge alignment as no large cross drainage structures and bridges are required
   - Ridge alignments are relatively cheap because of less water management structures
   - Ridge alignment generally covers more settlements and directly serves the people

b) Avoid riverbank alignment as far as possible, as it is very often influenced by river scouring.

c) Locate the road centreline near the level of natural mountain slope (Refer Fig. 5.1).

d) Prefer south or south-west facing slopes to north or north-east facing slopes to avoid moist areas and frost.

e) Avoid critical areas such as landslide-zones, rock falls, vertical cliffs, geological faults etc.

f) Avoid weak soil and swampy areas that require large number of structures.

g) Avoid serpentine type of switchbacks as far as possible.

h) Avoid areas that may invite encounters with natural forces such as areas having potential for flood damage, fragile slopes, etc.

i) Include knowledge of local people particularly to identify fragile areas, temporary water sources and natural drainage systems.

j) Avoid paddy fields for minimising water management problems.

k) Avoid agricultural lands as far as possible in order to avoid land disputes and compensation problems.

l) Select alignments along borderlines of forests or pasture lands and agricultural fields wherever possible.

Road Survey, Design and Estimates

The Green Road approach is for the mountain districts in Nepal, where the traffic volumes are low. Such Green Roads are generally constructed by people's participation, where sophisticated survey and detailed design works are not so essential. In fact, detailed desk design work consumes a lot of time and energy, and usually ends up with voluminous reports that are hardly used during construction. Therefore, Green Roads emphasise only minimal survey and design essential for technical and official purposes. To guide technicians in the field, typical designs for retaining structures as well as water management structures prepared beforehand are used. Most important is that the road follows a smooth longitudinal gradient with an average of 7% and a maximum of 12%. The horizontal alignment generally follows the natural contour, but can be gradually improved in major rehabilitation works later on.

After selecting the optimum alignment, the minimum requirement for a technical survey works is the following:

- Longitudinal alignment setting is done with "Abney level" or levelling instrument, staff and measuring tapes.
- Road Centreline Pegs are fixed at intervals of 25m, and the cross slope at each peg point is measured.
- Bench Marks are established at intervals of 500m, and Reference Points are located at the rates of 4 per km.
- A more detailed survey by using Theodolite is carried out only at critical sections, such as gullies, hairpin bends (switchbacks) etc. which could include contour mapping.
- A local plant availability survey is conducted at certain intervals to identify suitable plants, which could be later used for bioengineering purposes.
- A land-use survey (forest, agricultural land, pasture land, rock cliffs, etc.) and a soil survey (earth, gravel, rock, conglomerate, etc.) are carried out.

Simple and robust survey instruments are to be used for survey and construction supervision works. Some of the most essential instruments are listed here as follows:

- Measurement tapes of different lengths (5m, 30m, 50m, 100m, etc.)
- Ranging Rods
- Abney Level
- Magnetic Compass
- Clinometer
- Camera
- Binocular
- Engineering Level with horizontal compass and circle
- Cross Staffs
- Plumb bobs
- Theodolite for specialised survey works at critical sites such as at switchbacks, landslide prone zones, steep rocky portions, gullies, settlement areas
- Pipe water level (5 m transparent pipe)
- Wooden triangle frames to fix the road surface (camber, slopes, cross section of drainage, etc.)

A typical Design Report would consists of the following:

- Longitudinal Profile of the road alignment (1:1000 Horizontal and 1:100 Vertical)
- Horizontal plan of the road on an existing topographical map (1:25000 or 1:50000)
- Cross Sections at given intervals and typical cross sections of varying mountain slopes (Refer to Annex D)
- Detailed Cross Sections at critical areas including layout plan in contour maps, if necessary, specially at switchbacks
- Typical type designs of structural works, such as retaining walls and water management structures
- Estimate of quantity and cost of different work items, preferably for each construction phase, and finally number of skilled and unskilled labour person days required (Please refer to Annex G for work specifications and work norms)
- Quantity and cost of construction materials to be procured from outside (cement, gabion wires, etc.)
- Quantity of tools and equipment to be procured from outside (wheelbarrows, shovels, crowbars, etc.)

Road Standards

Please refer to Annex B for proposed Green Road standards.

Appropriate road standards are those which guarantee safe traffic movement and minimise construction and maintenance costs. Green Road standards are necessary to make roads affordable while addressing the country's economic capability for extension of rural road network. To minimise construction and maintenance costs, the following practices are favourable:

- Unnecessary road width that creates large amounts of soil excavation creates disposal problems and allows accumulation of surface run-off thereby causing erosion must be avoided.
- Natural road surface run-off distribution is maintained by providing a 7% outward slope on road surface, and mountainside drains are constructed only in the areas with excess water from the mountainside.
- Steep longitudinal gradient is avoided and maintained at reasonable level (in average 5%).
- Switchbacks and steep curves are avoided, but if essential they are properly designed and built with necessary water management structures.

A Green Road is a fair weather road and is generally closed during monsoon, i.e., from July to September. In Nepal monsoon is the peak season for agricultural activities. Therefore, the seasonal closure of the road has very limited negative impacts due to the following reasons:

- the active rural population works in the field and rarely has any time to travel
- transportation of agricultural inputs, such as fertiliser is generally done before monsoon
- even the all weather roads are also temporarily closed during monsoon due to landslides, floods, etc.
- people are somehow reluctant to travel during rain as flooded causeways and rivers could sometimes turn travel into unpredictable risks
- there are generally no significant cash crops to be transported to the cities during monsoon (except few perishable cash crops such as vegetables); roads bringing vegetables to larger cities could be always upgraded to all weather bituminous road if properly justified

The Green Road standards are more or less in line with DoR's single lane earthen road standards and also more or less follow DoR's staged construction approach as explained in Chapter 5.3.

5.2 ENVIRONMENTAL CONSERVATION

Due to the extreme fragility of the mountains and the heavy monsoon rainfall pattern, washouts and failures caused by erosion and landslides are common in Nepal. This has made road construction a challenging task. If proper preventive technology and precautions are not applied, unmanageable problems are encountered that must be cured with huge costs. Construction practices such as cut-and-throw and box cutting pose a great risk to the road slopes and to the environment. The situation is further aggravated when the districts and villages opt for bulldozing alignments across mountain slopes. Such practices have often resulted into massive destruction of environment and wastage of resources resulting into accelerated pace of degradation of the environment and raised questions on sustenance of poor and marginal rural economy.

Massive cutting of the mountain slopes and disposal of cut material down hill in an uncontrolled manner, blasting of rocks in large quantities thereby shaking the whole geological sub-structure and sub-surface drainage system, and improper water management all result in intensive soil loss from accelerated erosion and landslides. Effective establishment of roads in the mountains must consider how this human-induced damage to the environment can be minimised. The Green Road Concept has answers to these environmental problems in road construction.

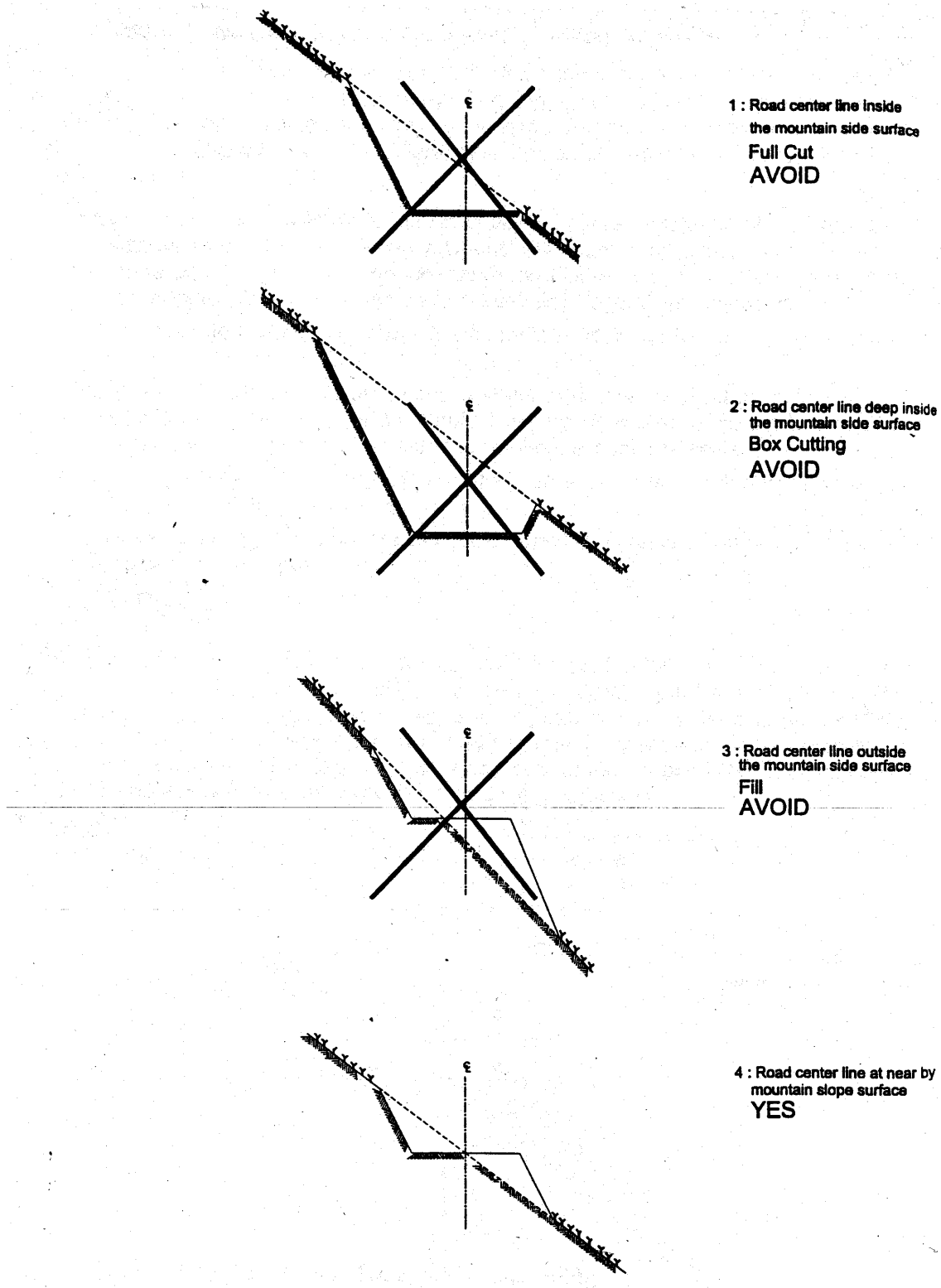


Fig. 5.1 : Road Alignment Selection

Minimisation of Slope Cutting and Preservation of Vegetative Cover

Construction of road on a natural mountain slope involves slope cutting that can be compared to an injury on human body. The bigger the injury, the greater are the treatment costs and the time necessary for healing. Therefore the Green Road Concept tries to inflict minimum injury to the natural mountain slope that can be cured fast by self-healing process.

Vegetation cover acts as a "skin" to the slope body. Fast re-vegetation of exposed earth surface acts as an ointment to the injury. Utmost attention to the conservation of natural vegetation is paid in order to reduce future problems and this adopts preventive measures for causing minimum damage to the existing vegetative cover, such as:

- Bush clearing is done only within the formation width, not to the edge of the right-of-way.
- Uncontrolled disposal of excavated material downhill the road is prohibited, but instead, mass balancing and controlled tipping of excess excavated material is practised. Toe walls are constructed to withhold excess materials.
- Felling of trees (approval of which is required form District Forest Office) even in the middle of the road is done only in the last phase just before vehicles begin to ply.
- Suitable planting materials are extracted during the construction works and used for bioengineering purposes.

Mass Balancing

Mass balancing is the most crucial – as well as the most fundamental -- principle in the Green Road Concept, yet, technically, it is the most difficult one to achieve properly. Mass balancing poses pragmatic problems in implementation if there is no sufficient technical supervision and improper labour management. In addition, non-availability of appropriate tools and materials, lack of funds and proper supervision, and improper technical know-how further influence mass balancing negatively.

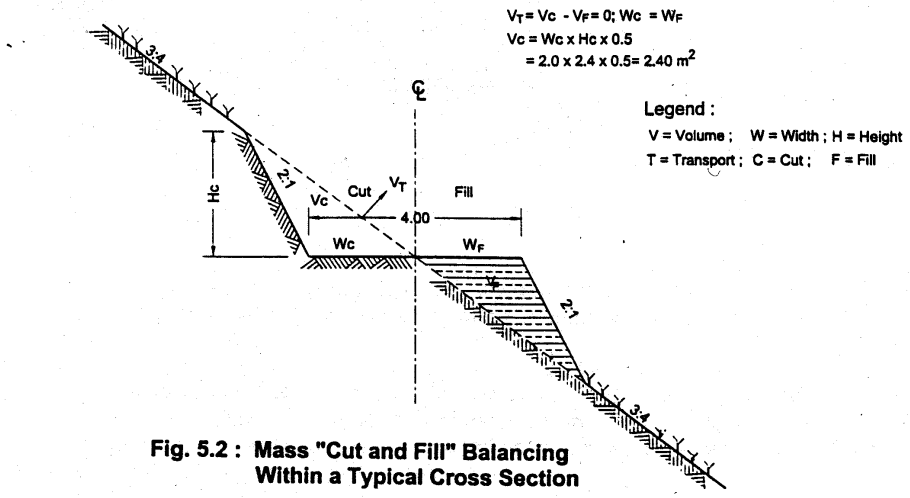


Fig. 5.2 : Mass "Cut and Fill" Balancing Within a Typical Cross Section

Fig. 5.2 : Mass "Cut and Fill" Balancing Within a Typical Cross Section

The conventional road construction practice of developing the road width by full cutting and throwing the excavated material downhill, referred to as mass wasting, causes great damage to the vegetation cover. The barren soil creates excessive soil erosion and gully formation. Figure 5.3 shows the conventional construction practice for a hill slope of 3:4, where the cut volume is approximately 9.6 cubic meter per meter of road length. This earth volume alone is more than enough to cause unaffordable environmental damage through inundation of large parts of mountain slope. In addition to the large cut volume, the cut height is also larger than the road width, which causes excessive risks of slope failure.

The Green Road Concept on the other hand, attempts to balance the volume of cut and fill and prevent mass wasting. This technique is referred to as mass balancing as illustrated in figure 5.2. For controlling the wastage of fill volume, dry stone or gabion retaining structures are built on the valley side. In this way construction of road can be made possible without wasting even a single particle of soil. However, the fill material needs time for monsoon assisted self-compaction. For making self-compaction more effective, vehicles are not allowed to ply on the road at least one year after completion.

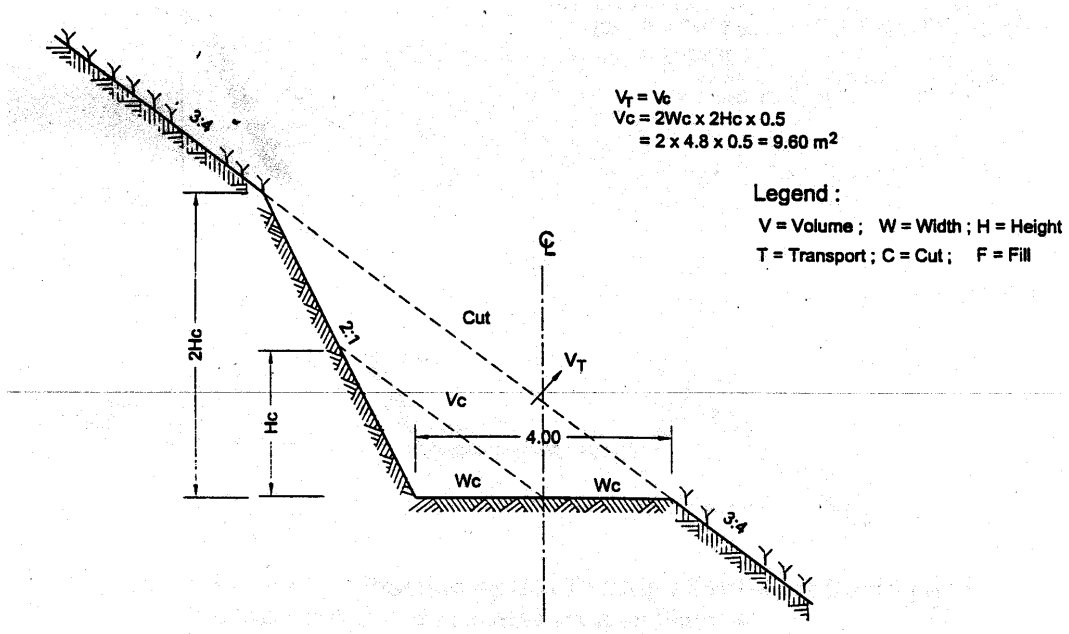


Fig. 5.3 : "Cut and throw" Conventional Construction Practice by Full Cutting : Earthwork Cutting and Transportation of Excavated Excess Material

In the cut-and-fill method, the cut slope height becomes half as smaller as compared to cut and throw approach, thereby making the cut slope much more stable and safe. In addition, the Green Road is developed in phases, which helps manage the excavated material easily without posing any environmental hazard. Refer to section 5.3 for a fuller discussion of the phased construction approach.

Mass balancing is not just a two-dimensional issue, but extends to three dimensions. It is therefore not always possible within the cross section alone to achieve mass balancing. Sometimes the excess soil has also to be used somewhere along the longitudinal alignment. Transportation of soil mass sometimes can be a major item for obtaining optimum mass balancing, which is best done by using pneumatic wheelbarrows. Excess excavated material can be properly disposed off at specified tipping sites and gullies. Necessary passing bays and switchbacks can be developed by using such excess materials.

Locating the road centreline of a Green Road is a very important technical consideration. If the centreline is not properly located it may result in massive box cutting. Figure 5.4 below shows a sample volume of box cutting being as high as 22 cubic meter per meter of road length in an improperly selected alignment. Box cutting can be avoided (or at least minimised) by shifting the road centreline to the extent of the allowable horizontal curve radius. The Green Road Concept tries to avoid box cutting to the extent possible.

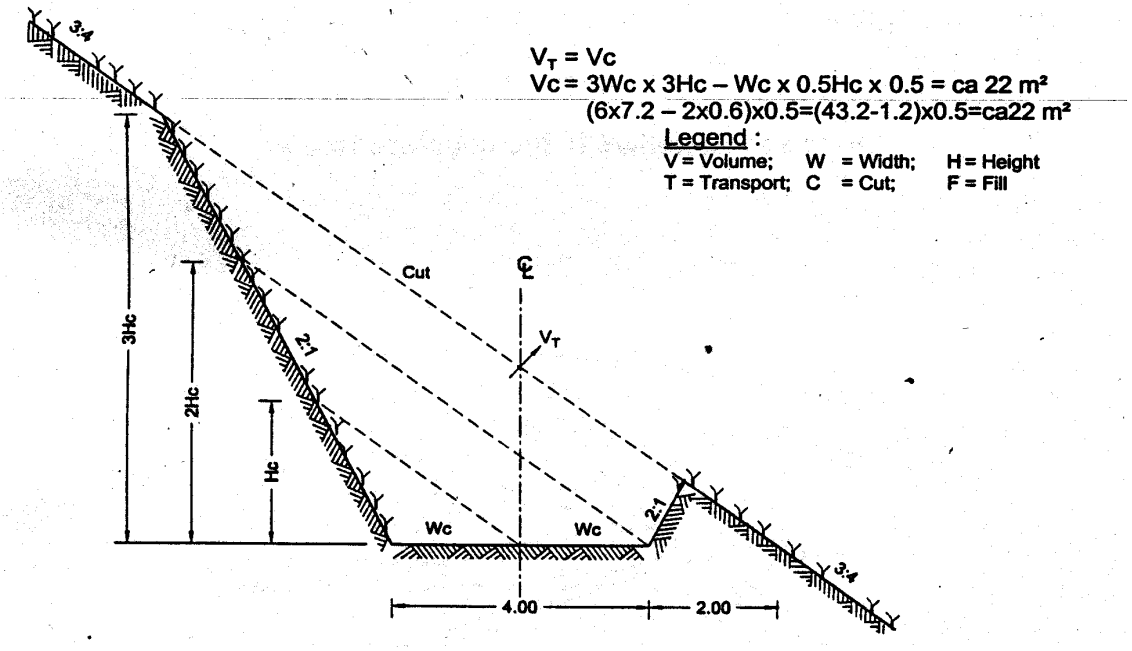


Fig. 5.4 : Construction Practice by Box Cutting : Earthwork Cutting and Transportation of Excavated Excess Material

Re-use of Excavated Material as Construction Materials

All excavated material is considered as potential construction material and is thus re-used. The idea is to produce minimum wastage and minimum damage to the environment.

Excavated stone blocks, for instance, are stockpiled at the time of collection and re-used for constructing stone structures such as dry stone walls in the later phase. If these stones are rolled down the hill at the time of excavation, existing natural resources are wasted. Later, at the time of need, significant amount of financial resources is required to procure the same, which was once wasted.

Chapter 5.4 deals with this topic in more detail.

Bioengineering

Bioengineering is the use of live plants for engineering purposes to reduce slope instability and soil erosion. Green Road Concept incorporates bioengineering as one of the important tools of environmental conservation. Use of vegetative measures is in accordance with engineering principles and serves to prevent damage caused to the environment. In fact, growth of vegetation is a dynamic process rather than an inert one. Vegetation tends to become stronger over time with its extended root systems that help stabilise the slopes.

The climate of mid-mountains in Nepal favours rapid vegetation growth. There are three further benefits of vegetation:

- environmental improvement: a cover of vegetation of pioneer plants encourages other plants and animals to live and develop further on the slope;
- limiting the lateral extent of instability: the rooting system of trees can interrupt shear planes and stop them spreading further in the current phase of active instability; and
- plants can provide useful products such as roofing thatch, fruit and firewood.

Green Road Concept adopts bioengineering as a preventive measure rather than a curative one. In order to incorporate bioengineering in road construction, it needs to be built into the project preparation stage. A plant availability survey has to be done simultaneously with the road alignment survey. Having known the indigenous plant already at survey stage, provisions have to be made for nursery as well as collection of plants, cuttings, seeds etc. A taskforce is formed for plantation works during monsoon period when plants, cutting and seeds thrive most efficiently. Planting cuttings and seeds alone does not ensure survival of these vegetative measures, however. A provision should also be made for preserving these plants.

The local people are generally quite familiar with the different locally available plant species. A labour-intensive bioengineering approach is thus adopted for Green Road construction, which include incorporation of such readily available indigenous skills and knowledge at the local level. Women are found to be well skilled in plantation works. Local farmers are encouraged to establish nurseries by providing them required technical advice and support, by which they can make additional income. Bioengineering measures are to be started simultaneously with the road construction activities from Phase 3, as explained in Chapter 5.3.

Proper Water Management

Construction of roads in Nepal is always a battle against water. Proper water management is one of the major means of environmental conservation. In order to make rural mountain road sustainable, a proper water management system has to be adopted. The causes of water induced problems in the road alignment has to be carefully understood.

Water collected and concentrated on the road surface can become a major threat to earth roads. Dispersed water management is therefore a fundamental technique in Green Road engineering that avoids collection and concentration of water along the road surface. An important feature of water management is that mountainside drains are generally not provided. Experience has shown that these drains are usually blocked during monsoon anyway, when they are needed the most. Once these drains are blocked, water flowing down the drain finds its way out to the road surface, thereby causing major damage to the road. In order to resolve this problem Green Road Concept has developed an entirely different (and passive) approach of water management. Along a Green Road, rainwater is dispersed towards the valley side from the place of rainfall itself and is not allowed to collect to the extent possible. Mountainside drains are constructed only at sections with excess water from the mountainside, at steep road sections and at switchbacks.

The following measures are taken for water management of Green Roads

- The road surface is generally provided with a 5 % outward slope so that the surface run-off flows out of the road surface downhill. Where longitudinal gradient is more than 5%, small and shallow diagonal drains across the road can be provided to drain out the water from road surface.
- diagonal surface drains are provided at certain intervals.
- At places where longitudinal gradients are more than 7%, rainwater cannot flow out of the road surface. Mountainside drains are to be provided at such places and are to be directed safely towards nearby cross drainage structures or a gully. Construction of check dams further strengthens natural gullies.
- At places where longitudinal gradient is as high as 10-12%, it might be essential to do spot gravelling or stone soling. Rills are formed otherwise, which could cause heavy damage to the road. At switchbacks, 5% inward slope is provided and water is collected in a mountain drain, which is then passed across the road at an appropriate place through a pipe culvert or dry stone causeway.
- Mountain drains are provided at places such as paddy fields, moist areas and natural spring water sources, which are often active during monsoon and dry out during winter.
- While setting out a serpentine road alignment, switchbacks are located one above another in such a way that water diverted from the road uphill does not fall on the road segment downhill as shown in Fig. 5.5.
- Catch drains, sub-surface drains and French drains are constructed at required places.

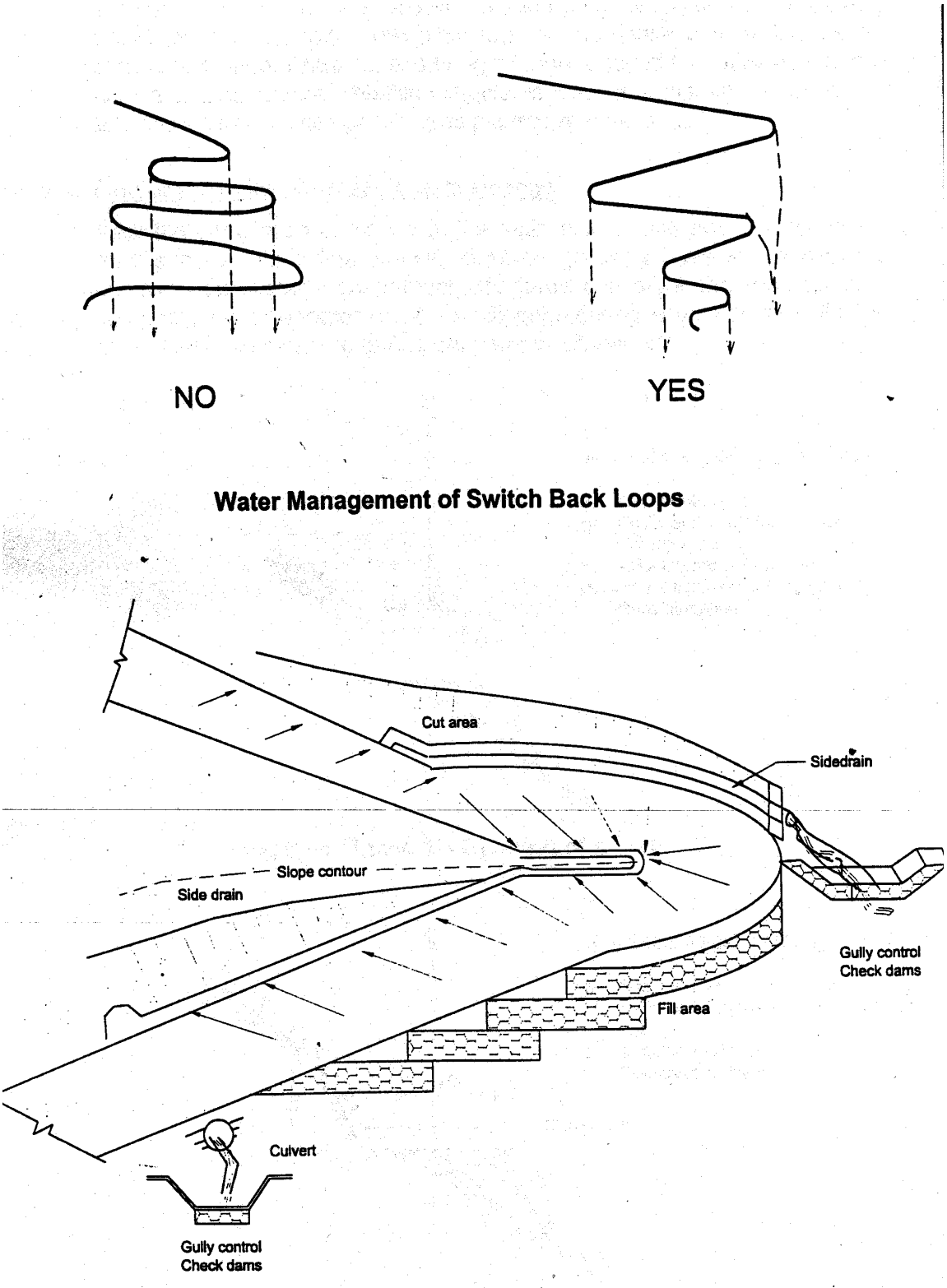


Fig. 5.5 : Location of Serpentine-type Switchbacks to avoid gully erosion

5.3 PHASED CONSTRUCTION

Phased Construction Introduction

Once road project preparation activities are completed, actual road construction can begin.

The Green Road Concept envisages a "phased construction" approach. This term refers to a method of constructing a road in different phases. The main objectives of the phased construction are to:

- conserve the fragile mountain slope by minimising the risk of landslides and soil erosion
- build a consensus on the selected road alignment among local people and relevant stakeholders by having interaction
- identify critical sections and make necessary adjustments if required
- assess the natural resources available (e.g., soil, stones, plants, etc.) for re-utilisation in construction works

The first phase refers to the opening of a trail, followed by a gradual widening of the trail into a track, and finally the completion of a road to the required engineering standards. The different construction phases are briefly mentioned in the following paragraphs. Annex D deals with the different phases in more detail.

Different Phases of Construction

Phase 1: Opening of a Trail

The main task under this phase is to open a trail along the identified alignment. Its average width is 1.25m. The major objective of the trail opening is to demonstrate the alignment setting to all relevant stakeholders and local people and to develop a consensus on it. Opening of trail gives enough room for necessary adjustments on finalisation of alignment and location of required structures.

Phase 2: Gradual Widening to a Track

The main task under this phase is to construct a non-motorable track along the finally fixed alignment. The average width of the track is 2.5m.

One should not forget that Phase 1 and Phase 2 can be done in the same construction year, and do not necessarily require two consecutive years. Also, where the slope is gentle, Phase one can be replaced with Phase 2.

Phase 3: Road Construction

This phase is started after allowing natural compaction of the track over the period of one monsoon. The main task of this phase is to widen the track, constructed under Phase 2, and bring it to the required Green Road standards, construction of required retaining structures and water management structures, and application of bioengineering as preventive measure.

Phase 4: Finalisation of the Road and Bioengineering

After the completion of Phase 3, the main task of this phase is to bring the road surface into a final shape, complete passing bays where necessary, complete the water management structures and allow the road for natural compaction over another monsoon. Bioengineering is also done at this point as a preventive measure during early monsoon period.

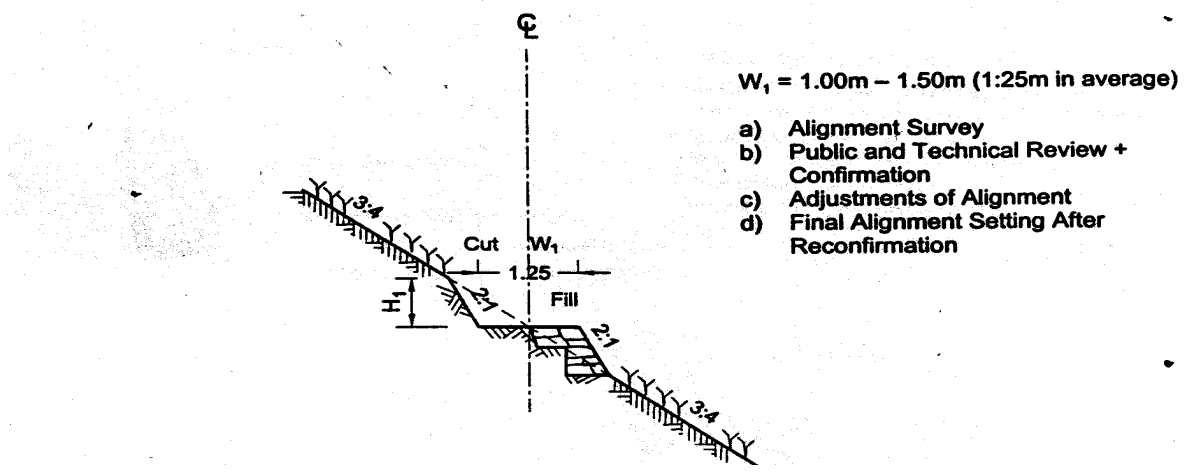


Fig 5.6 : Phase 1 – Opening Of A Trail

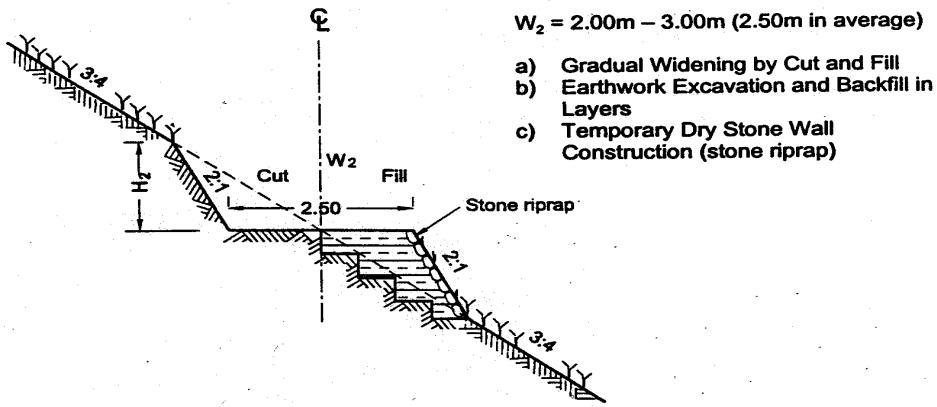


Fig 5.7 : Phase 2 – Gradual Widening to a Track

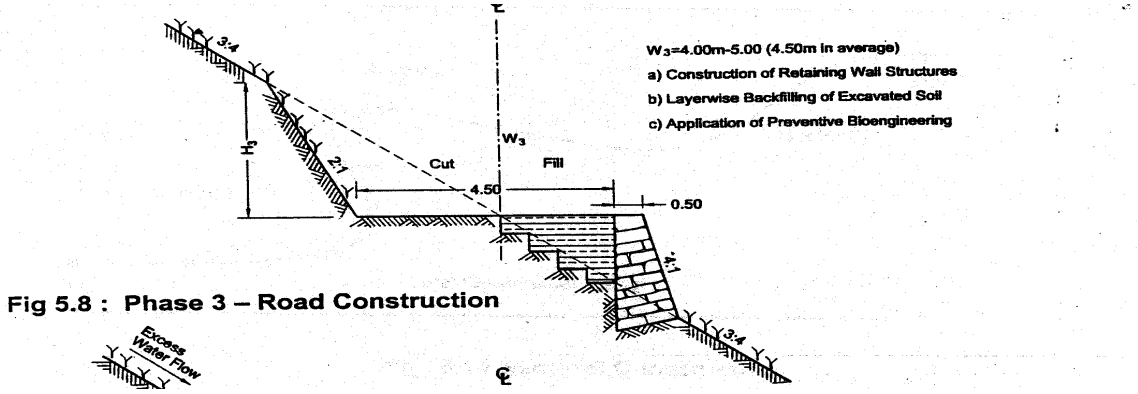


Fig 5.8 : Phase 3 – Road Construction

Fig 5.8 : Phase 3 – Road Construction

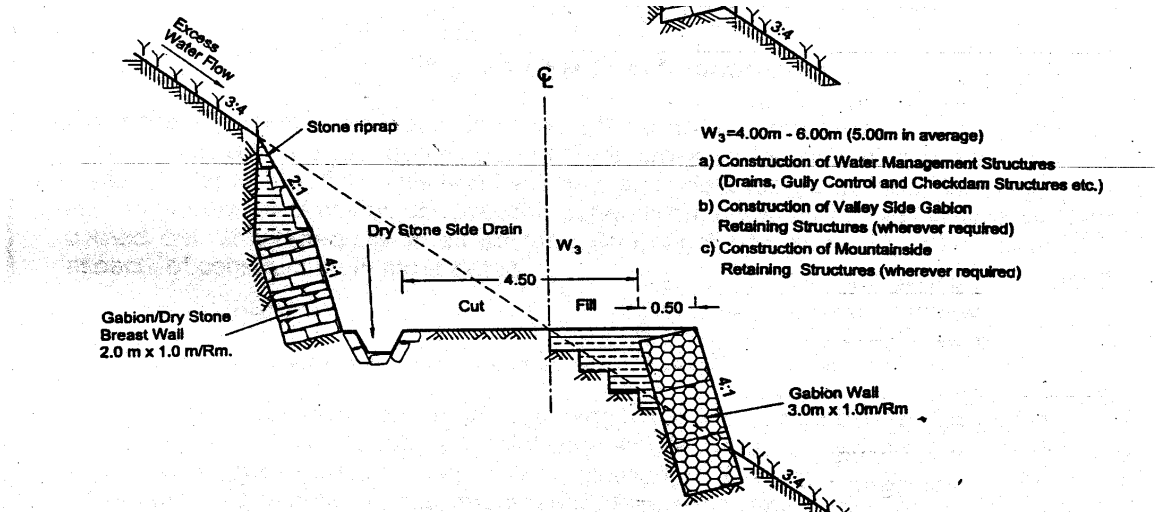


FIG 5.9 : PHASE 3 – ROAD CONSTRUCTION IN SITUATION WITH EXCESS WATER FROM MOUNTAINSIDE

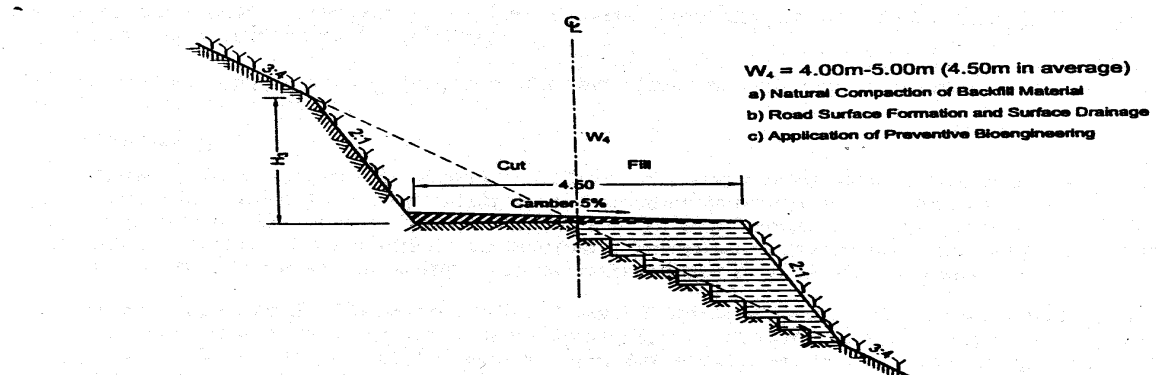


FIG 5.10 : PHASE 4 - ROAD FINALISATION WORKS AND BIOENGINEERING

Staged Construction

Green Roads are the roads constructed for initial low traffic volume with available limited funds. However, while constructing Green Roads, the concept of *Staged Construction* is applied. This means a longer-term vision so that Green Roads can be gradually upgraded from a fair-weather earthen road to an all-weather bituminous road if:

- the traffic volume increases and the existing Green Roads are not in position to accommodate the increased traffic volume;
- the resources needed for construction and maintenance of the road are available; and
- later stages of construction are also carried out in accordance with the Green Road principles (e.g., no bulldozing).

The decisions to upgrade the particular Green Road will be made based on a consensus reached among local people and all relevant stakeholders. Relevant studies (economic, environmental, and social) will be required to sufficiently justify the need for upgrading.

Proposed development stages -- which are to be successively implemented upon fulfilment of the aforementioned criteria -- are more or less in line with *DoR's concept of Staged Construction*, and are as follows:

Stage I: Fair-weather Earthen Road is the first construction stage -- a low-cost, low-volume, fair-weather, single-lane earthen Green Road, with necessary bypasses.

Stage II: Gravel Road is the second stage of construction designed to a higher volume of traffic. The road geometrics are improved, the surface is gravelled and the cross-sections are improved by widening as well as by providing better retaining and water management structures.

Stage III: All-weather Bituminous Road is the final stage of construction. The road is finally brought to all-weather road with bituminous surface with further improved curves, culverts and bridges, and better provision of retaining and water management structures.

Sectoral Construction

There is always a question about construction speed with Green Roads. There are people who still feel that Green Roads take long time to complete and allow vehicles to ply. However, experiences in several districts have shown that impressive construction speed can be achieved if the roads are constructed along various sectors simultaneously (Refer to Fig. 5.11). There are three major factors that govern the construction speed:

- enough funds should be available for construction and disbursement of these funds should be timely
- the team providing engineering and social services should be well experienced in Green Road construction management

- sufficient labour groups should be available and they should be properly mobilised

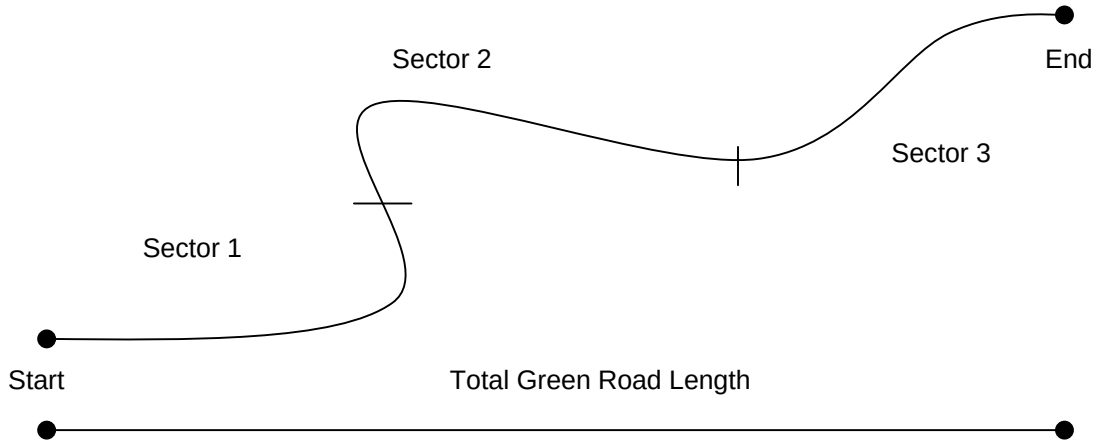


Fig. 5.11 Sectoral Construction

Once the alignment is finalised, the road will be divided into sectors of about 10 km. In each sector, a technical support team will be provided for executing the works in each sector (Refer to Fig. 4.1). This team will be responsible for group formation, organisation and management of works, construction supervision, monitoring, and training. Works are carried out simultaneously in all sectors. Chapter 4 has dealt with the organisational aspects of construction in more detail.

5.4 CONSTRUCTION METHODS

Green Roads require neither high technological skills, nor high level technology. As a matter of fact, these roads are relatively simple, and do not require sophisticated academic degrees of engineering skill or knowledge. They do require good professional experience, organisational and managerial experience, and a general understanding of the Green Road Concept. These roads slightly differ from conventional road construction practices. It becomes very important to understand what the methods of Green Road construction are, and how Green Roads are constructed to meet the required engineering standards and quality.

Some of the *additional elements* of Green Road construction method are described in the following paragraphs.

1. Training

Green Road Concept follows a rather demand-driven and bottom-up approach. In order to make this approach work, proper training to all relevant actors is very important. Different types of training are required for different levels of stakeholders. The training component comprises theoretical as well as on-the-job training. Classroom training is to be carried out in a closed session.

More importantly, "Demonstration Road Sections" are to be constructed specifically for on-the-job training activities. Training is provided on all major aspects of the Green Road construction technology, for instance, mass balancing, rock cutting, construction of soft retaining and water management structures, preventive bio-engineering measures, etc.

It has always to be remembered that the training activities are to be carried out during slack construction period, i.e., mostly during the monsoon. Moreover, it is always to be remembered that the Green Road Concept envisages a gender-balanced approach, and thus strongly supports equal involvement of both men and women in decision-making as well as construction activities. It is therefore very essential to integrate gender issues in the training of local level politicians, members of the User Groups and User Committees, representatives of major political parties as well as other relevant stakeholders.

The various types of training are described in Table 5.1 in brief.

2. Labour-based Construction

Generally labour-based construction methods are used. Local labour has always been one of the largest resources in many developing countries. The International Labour Organisation (ILO) recommends opting for labour-intensive construction approach in countries with a daily wage of US$5 or less. In the mid-hills of Nepal, where the daily labour wage is about US$1, labour-intensive construction methods are undoubtedly the most economic choice.

Local labour resource is under-utilised during the agriculture slack period from October to May. Many farmers living in the mid-hills in Nepal need to supplement their income during this period often with seasonal migration to the Nepal Terai or India. These human resources can be properly utilised if the local people are mobilised for construction activities during off-farm season. The major advantages that can be achieved by labour-intensive method are:

- Local people can get additional income generating opportunities, which is a step towards poverty alleviation for them. Experiences have shown that by adopting labour-intensive construction methods, about 65% of the total expenditures on road construction can go to the local people in the form of labour payments.
- Skills learned by the local people during construction can be later utilised for road maintenance activities and other similar infrastructure works.
- Labour is mostly employed from the nearby villages along road corridor up to two hours walking distance. By employing the people from the nearby areas, the need for accommodation decreases, as many of them can return back to their respective homes after finishing the works. However, safe encamping facilities are to be provided for those who need to stay there. Special care should be provided to the women labour groups.

Table 5.1 Types of Training for Different Stakeholders

	Stake Holders	Objectives	Type of Training and duration	Appropriate Period
1.	Policy makers at district level (e.g. DDC Chairperson, Vice-Chairperson, Members, Leaders of major political parties, LDO, Planning Officer, District Engineer, Members of Parliament)	To help policy makers and local politicians understand and accept the Green Road Concept	• 3-days exposure visit to an ongoing Green Road project in other districts excluding travel time • A one-day workshop at district headquarters dealing with various issues on Green Road including gender	Prior to initiating any dialogue with the district on Green Road Concept
2.	Technicians such as Engineers and Overseers, and Supervisors and Social mobilisers who are directly responsible for Green Road construction in districts	To train on planning, survey, design and implementation aspects of Green Roads in accordance with the Green Road Concept	• One-week classroom training • 3-days training on various aspects at a demonstration road section • One-year apprenticeship under a qualified senior Green Road engineer	• Classroom training prior to going to field • Demonstration road sections during all phases of construction
3.	Users Representatives (such as VDC Chairperson and Vice Chairperson, Ward Presidents, Representatives of major political parties and other influential people located in the zone of influence of a Green Road programme)	• To help the participants understand the Green Road Concept • To develop a common political understanding • To identify the available resources • To develop suitable plans and policies • To formulate the approach for implementation • To get the commitments to construct and maintain the road • To form and empower User Committees	• A three-days workshop at district headquarters dealing with various issues on Green Road including gender • Subsequent workshops are held at least annually for reviewing progress	• First workshop after the survey design and cost estimate report is prepared. • Subsequent workshops in October of each year prior to starting of next construction season
4.	Members of User Committees, accountants, senior supervisors and other support staff	To make the primary road programme implementers understand their roles, responsibilities, and the methodologies and procedures of Green Road Concept in detail	• A two-days seminar is held • A two-days training at the Demonstration Road Section	Prior to beginning of road construction
5.	Labour Group Leaders (Naikes), who can read and write	To make Naikes understand the basic Green Road Concept and able to apply it	A six-days on-the-job training with two hours of theory class followed by Green Road construction exercise along a Demonstration Road Section	Prior to beginning of road construction but after road alignment is finalised and User Committee is empowered
6.	Masons (masons need not be literate)	To ensure good quality road works	A six-days on-the-job training along the Demonstration Road Section	After the first phase track is built and before proper road structure and finishing task is begun
7.	Local supervisors	• To prepare qualified local manpower for other rural road construction projects • To transfer know-how to the local level for future road network development	• A two-weeks on-the-job training with everyday two hour theory class followed by Green Road construction exercise along the Demonstration Road Section • One-year supervision work as trainees before they are accepted as full fledged local supervisors	Prior to beginning of road construction
8.	Labourers	To make local labourers understand their roles, and the method of work valuation and payment system	A half-day training by the Naikes, Social Mobiliser and Senior Supervisors	Prior to assignment of task to a labour group
9.	Training of public or the users at large	To make local people understand what Green Road means	Asking the local people to have observation on demonstration road sections any time	Preferably during Naike and Mason training

3. Rock Cutting Techniques

Unlike conventional road construction practices, the Green Road Concept does not support blasting of rocks, as hard rocks are not often encountered in the mid-hills of Nepal. However, places where hard rocks such as granites are encountered, there might not be any other alternative choice. In such cases, contracts are made with professional licensed blasters (e.g. within DoR).

Blasting can disturb the fragile mountain slope stability, on the one hand, and the natural sub-surface water drainage system on the other. Blasting therefore increases the risks of landslides tremendously during the monsoon. Many landslides are developed along the road at the sections where blasting was done during construction.

Rock cutting is actually one of the time consuming and expensive tasks encountered in road construction. Many person-days of labour could be spent for rock cutting. The Green Road Concept opts for optimum rock-cutting techniques. Selection of the most appropriate method is always tricky and challenging. The suitable methods of rock cutting have been experienced as follows:

- **Chiselling and Hammering**

  For soft rocks such as sandstone and schist, which crumble generally into pieces, cutting can be done manually by chiselling and hammering. Kingpin chisel would be the most appropriate chisel for this purpose. Chiselling and hammering can be done also for some of the medium rocks.

- **Heating and Breaking**

  Medium rocks such as limestone and dolomite can be broken down into pieces by heating and breaking. Rocks are heated by using fire woods or old vehicle tires. After heating for a few hours water is poured on it, which will develop cracks on the rock. Simple tools such as frog and feather, crowbar, chisel and hammer can be used for finally breaking rocks.

- **Drilling and Breaking**

  Hard rocks like granite and gneiss can be broken down into pieces by drilling and breaking, as chiselling would be very slow and difficult. A suitable mechanised drilling machine can be used for drilling the holes. As mentioned above, simple tools such as frog and feather, crowbar, chisel and hammer can be used for developing cracks in the rock and eventually breaking it.

Please refer to Annex F for rock breaking tools.

4. Haulage and Transportation of Excavated Materials

Haulage and transportation of construction materials is one of the most important (and time consuming) road construction activities. Better management could increase construction speed as well as efficiency. The methods generally adopted for the transportation of materials in Green Road construction are as follows:

Manual Haulage

- *Dokos* and *Thunses* (carrying baskets very often used in the mid-hills of Nepal*)*, which are knitted locally by using bamboo or Nigalo wickers
- Barrows, made locally out of leather
- Jute bags*,* which are available at the local market and generally used for rice transportation

Haulage by Wheelbarrows

Wheelbarrows with pneumatic tyres are mostly used for the transportation of soil and stones. It has been experienced that wheelbarrows with steel or hard rubber tires are found to be inefficient. Properly constructed pneumatic wheelbarrows are robust, easy to operate and maintain and they can speed up the construction works. These are found to be very efficient for transportation of soil and stone up to 100 m distance. Several workshops in Kathmandu and Terai manufacture proper wheelbarrows.

Transportation by Vehicles

Transportation of stones can be done by using tractor-trailers in accessible areas. These are low-cost type of construction equipment and thus can be recommended particularly for transportation of stone and gravel in larger quantities over distances of more than 100 m. Various models of tractors, mostly used for agricultural purposes, are available in the market, and trailers suitable for labour-based loading and tipping are also produced locally in Nepal. Low-loading type of trailers are recommended for Green Roads. Assessment has to be made on tractors and trailers based on the budget available for construction.

5. Construction Material

A re-utilisation of locally available natural resources obtained from excavation is strongly recommended. This form of re-utilisation of material is economic and environment-friendly, however, it needs proper know-how and management skills. Excavated soil, rocks, and topsoil and vegetation are the primary construction materials for Green Roads, as:

- Excavated soil can be used for horizontal as well as longitudinal as well as horizontal back-filling works (i.e., mass balancing). Excess soil is used for widening the roads at passing zones, gullies and switchbacks.
- Stone can be used for construction of dry stone masonry walls and gabion walls, and water management structures. The stones obtained from excavation are to be stacked along the road and re-used later for these structures.
- Gravel can be used for spot surface improvement of critical (steep, moist etc.) road sections.
- Vegetation and topsoil can be used for turfing and re-vegetation of the hill slopes.

Local people are generally familiar with the use of locally available resources. Optimum use of their skills and knowledge not only makes the road construction cheaper, but also makes the road more easily maintainable. The Green Road Concept thus envisages the use of locally available indigenous skills and knowledge. Use of steel, cement and concrete are discouraged to the greatest extent possible: these materials must be imported and transported to the site, and specialised workmanship is required for constructing the structures out of these materials.

6. Use of Flexible Retaining and Cross Drainage Structures

Construction of flexible soft structures compared to the conventional hard structures such as cement concrete is promoted, as foundation of such structures can adjust themselves to the instability of the mountain slope. These soft structures can be listed as follows:

- dry stone masonry retaining wall up to maximum 3.0 m height;
- gabion retaining wall up to maximum 15.0 m height;
- composite walls with gabion walls at bottom and dry stone wall at top;
- gabion check dams for gully control works;
- dry stone masonry side drains;
- catch drains and French drains for road slope drainage;
- dry stone causeways with stone soling;
- dry stone rip rap (or stone pitching) for slope protection;
- dry stone skipper culverts (truncated culverts);
- hume pipe culverts as cross drainage structure in combination with dry stone walls; and,
- vented floodway with hume pipes.

Flexible soft structures are preferred over the concrete structures because, they are:

- comparatively cheap, as locally available materials and skills are used
- relatively easy to construct, as locally trained workmanship can be developed
- relatively easy to maintain, as the local manpower can use the skills learned during construction for the maintenance works

Construction of such structures not only retains the construction expenditures in the local area, but also enhances the skills of the local people. However, for constructing hume pipes for cross drainage structures, either the construction materials, such as cement, reinforcement bars and required form works need to be brought from outside for casting the hume pipes or readily available pipes are to be brought from outside depending upon the quantity and situation. If the hume pipes are casted in-situ, skilled labourers will also be required for casting these hume pipes.

7. Natural Compaction

Use of natural rain for compaction purposes is recommended. With Green Roads, mechanised compaction equipment is not required. Construction activities are carried out during the dry season and the road is allowed to settle down over the monsoon period after each construction phase. Monsoon rains compact and stabilise the fill material. This process makes optimum use of available natural forces that makes the road cost-effective. However, manual compaction methods, such as ramming can be applied, if

- critical road sections are encountered
- speedy construction is needed
- enough funds are available

Ramming is also required if a strong foundation is needed for retaining structures.

8. Tools and Equipment

Green Road Concept supports the promotion and use of locally available tools, primarily agricultural tools, suited to the labourers for their day-to-day works and environment. Appropriate hand tools are used. Simple tools, such as spade, axes etc., can also be purchased from local blacksmiths (expanding their market). Other tools, such as good quality shovels, picks etc. can be procured from local markets. The tools must be of good quality and be supplied in sufficient quantity to achieve speedy construction and maximum efficiency in construction works. Appropriate and robust pneumatic wheelbarrows are required for transporting the construction materials. With a few exceptions, it is strongly recommended not to import any equipment from abroad, as such imports require foreign currency, which are generally not available at district level.

Please refer to Annex F for more details on tool and equipment generally required for Green Road construction.

Photo 2503/10 – Palpa, March 1997
Labour intensive earth work excavation, Aarebhanjyang – Rampur road

Photo 1128/24 – Lamjung, May 1998
Construction of stone wall and work measurement along Karaputar – Salme Bhanjyang road

Photo 2474/37 – Syangja, 1997
Construction of gabion wall on the Naudanda – Karkinetta road

Photo 3319/23 – Surkhet, May 1998
Plantation works for bioengineering by women group along the Ratanangla – Dharmapokhara road

Photo 4817/7 – Palpa, March 1996
Bio-engineering slope stabilisation with Agave along the Banstari – Jhadewa road

Photo 3802/6 – Palpa, Oct. 1997
Fully established former critical site along the Aarebhanjyang – Rampur Road. Where was the problem?

Photo 3319/20 –
Surkhet, May 1998
Rock cutting by using hammer, frog and feather along the Ratanangla – Dharmapokhara road

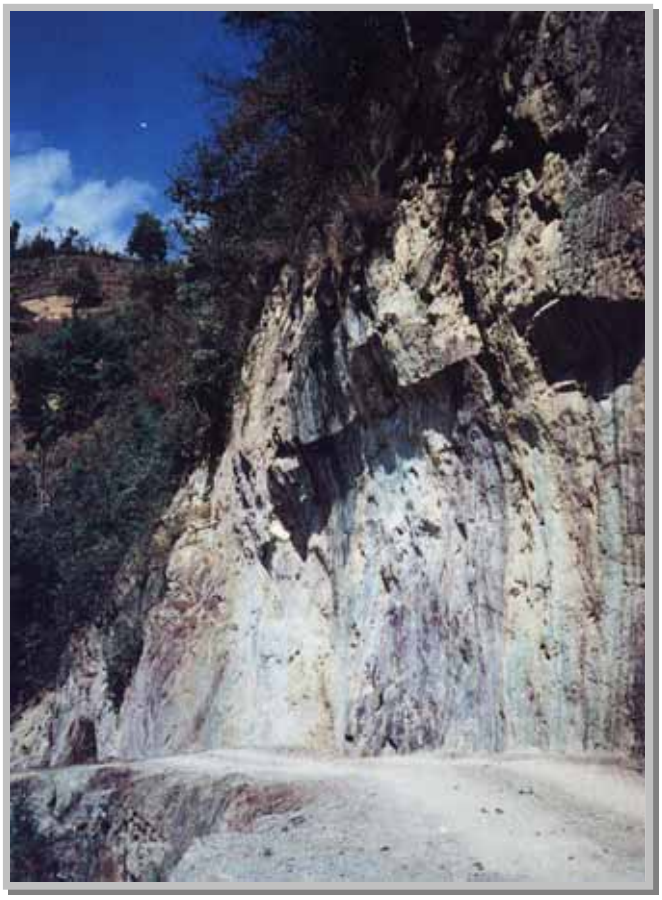


Photo 4820/26 –
Palpa March 1996
Manual rock cutting of steep and rocky portion along the Aarebhanjyang – Rampur road

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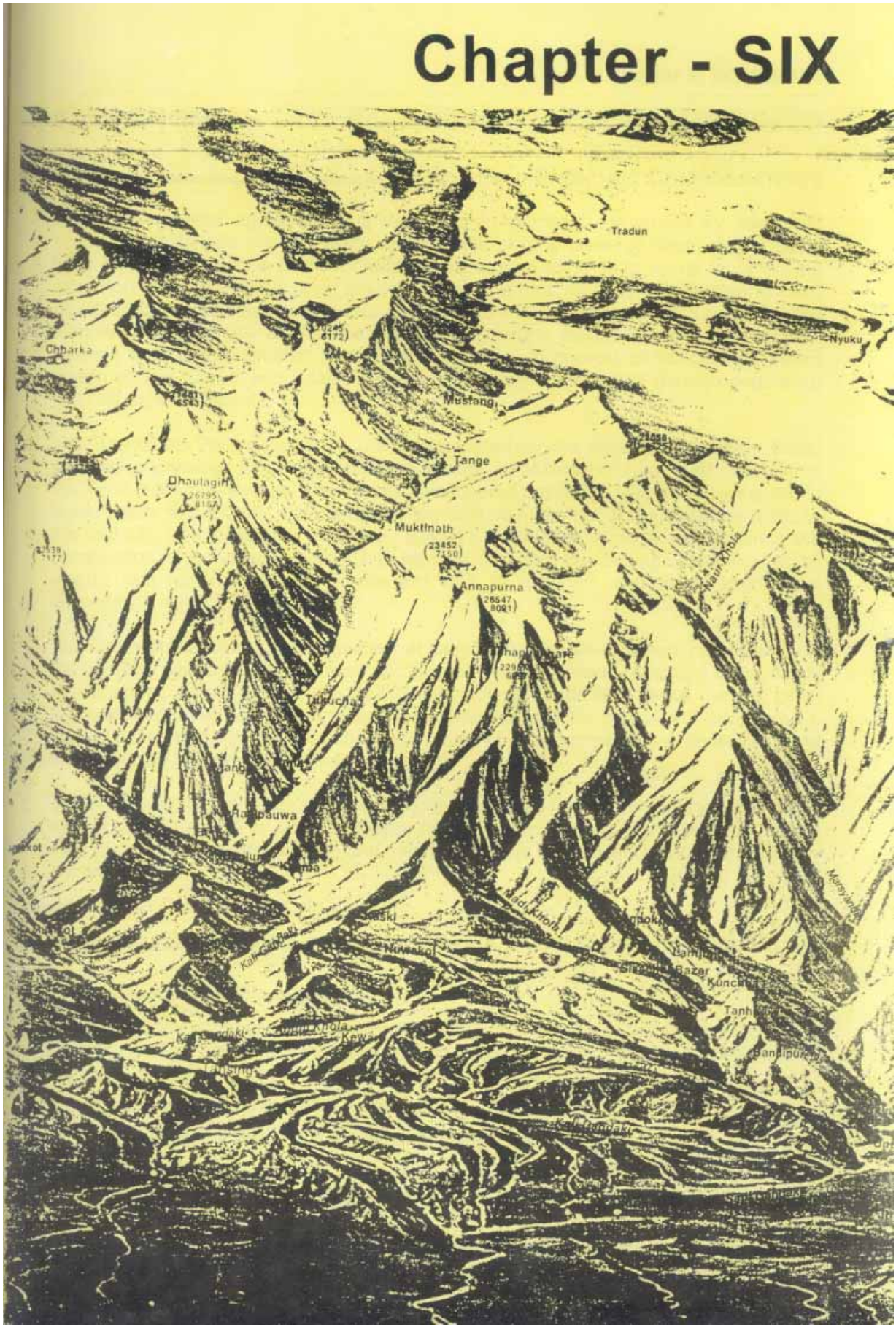
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Tukuche
Ranipauwa
Kagbeni
Kali Gandaki
Nuwakot
Bandipur
Kunchha
Tanhu
Kali Gandaki

6: ECONOMICS

6.1 OVERALL ECONOMIC CONSIDERATIONS

There is a general agreement that rural road investments are crucial for integrated economic, social and environmental development of rural areas of Nepal. At the same time, there are vigorous political debates. Issues like whether to invest more on the extension of national roads or on the development of rural roads and trail networks have aroused strong debates. Some other related issues are: whether to construct a limited number of high quality all weather but expensive rural roads, or more low-cost fair-weather rural roads; whether to expand the rural road network of the fertile Terai or construct new rural Green Roads in the more poverty-stricken (but densely populated) mid-hills areas of Nepal.

The Agriculture Perspective Plan (APP), supported by the Asian Development Bank, strongly emphasises its priority on the expansion of all-weather rural road networks in the Terai plain. Interestingly, the Priority Investment Plan (PIP), supported by the World Bank, points to the utility of constructing low-cost, fair-weather and all-weather roads in the mid-hills and mountains of Nepal. HMGN's Ninth Plan strongly recommends the construction of low-cost rural roads in its rural transport development strategy, which ensure that national transport costs are kept to minimum and the environmental degradation is minimised.

The Green Road Concept emerged out of integrated rural development programmes in the mid-hills where the lack of road access was felt as a major constraint to economic development. Green Roads are in fact "pioneering" roads into these remote, often impoverished areas that nevertheless have some potential for agricultural development. The concept also emphasises the importance of local employment generation and strengthening of local capabilities.

In this chapter, typical costs for Green Roads calculated from documents are compared with potential benefits in order to assess the economic justification. In addition, typical systems of Resource Mobilisation and means to ensure transparency and cost efficiency are presented.

6.2 THE COST OF GREEN ROADS

Green Road Construction Costs

Calculation and comparison of construction costs on the basis of actual implementation experience is very complex because they depend on a variety of influencing factors such as:

- the selected road standard (width, surface treatments, etc.)
- the selected alignment, the number of bridges and structures
- the terrain and soil condition (mountains slope inclination, rock, etc.)
- the employment system of the labourers and their motivation

- the labourer's daily wage
- the quality of the technical supervision
- the political and local interventions

In order to compare the construction costs of Green Roads with other roads of a similar standard, an equal delineation of cost items is required. Different road projects define different cost items. As well, the construction periods of the different road projects differ and require annual cost adjustments. Even after extensive inquiries about post-construction costs for similar roads built by the DoR, this study determined that no officially accepted data has been prepared up to now.

The calculation and comparison of construction costs on the basis of actual implementation costs are also difficult because the cost accounting frameworks vary so much. Only the Lamosangu-Jiri Road Project compiled an elaborate summary of its costs. However, its road standard is considerably above a typical Green Road.

Based on a series of cost analysis mainly of the Palpa and Dhading Roads, the following key data of construction costs have been retrieved. The costs are based on a labour input of 12,000 person-days per kilometre, which constitutes the major expenditure. This includes the costs for local material excavation, collection, separation, haulage, storage and controlled disposal besides the construction of structures. A daily wage rate of NRs 65/day (1998 prices) has been applied which constitutes typical average District Daily Wages used in Hill and Mountain Districts.

Table 6.1 Construction Costs for a Fair-weather Earth Road applying the Green Road Concept

Particulars	Construction Cost (%)	Construction Cost (NRs ,000 per km)	(US$ per km)
Labour costs	65%	780	12,000
Construction material	15%	180	2,770
Tools and Equipment and Transport costs	10%	120	1,850
Construction Supervision, social mobilisation overhead	10%	120	1,850
Construction Costs	100%	1200	18,470
Construction Cost Range	+/- 66%	+/- 800	+/-12,300

Labour Costs (local)

The labour costs are based on a labour input of 12,000 person-days per kilometre, which constitutes the major expenditure. This includes the costs for local material excavation, collection, separation, haulage, storage and controlled disposal besides the construction of structures. A daily wage rate of NRs 65/day (1998 prices) has been applied which constitutes typical average District Daily Wages used in Hill and Mountain Districts.

In many Green Road projects significant local contributions were made in the form of "Shramadan", a traditional self-help system with contributions of free labour voluntarily by the local households. Often, the costs of labour were reduced due to this contribution. The amount of labour input includes these free voluntary labour contributions.

Construction Materials (imported)

The costs for construction material consist of imported materials, which have to be procured: mainly gabion wire, concrete pipes and or a small amount of cement for culvert structures.

Tools, Equipment and Transportation

The costs for tools, equipment and transportation include local procurement and maintenance of tools, national-level procurement of wheelbarrows, in some cases trailers etc. produced in Nepal and very few imported equipment such as highly efficient mechanical hand-held drilling equipment. In areas lacking of stones, gravel or sand for construction, material transport costs to be carried by hired local tractor-trailer sets are often incurred in the added value of the material at the respective site.

Construction Supervision and Social Mobilisation

For the relatively intensive construction supervision (see chapter 5) through qualified national consultant experienced in the supervision of labour-based works combined with the services for the social mobilisation (see chapter 4), an overhead of typically about 10% has been calculated, which may be seen relatively high, but is fair in view of the overall low unit construction costs.

Additional Costs for Initial Road Engineering and Project Document Preparation

From previous Green Road experiences, detailed surveys, designs and estimate quantity and costs of a project can be considered at about 5% of the construction cost of the road, estimated at NRs. 60,000/km. Unit costs are higher because of the relatively low construction costs, and assume a minimum of 10 km length. The costs may differ considerably depending on the expectations of the executive agencies. If multilateral donors are involved, a higher standard for project documentation is expected than if a district or a village constructs its own road.

Additional Costs for Land Compensation

Land compensation costs are generally not included since land has to be provided free by the landowners as a contribution-in-kind and preliminary condition for the road's construction. This is applied as long as no tax for the considerably increased land value is collected from the landowners nearby the road. In general, the land for a road has to be compensated by the future owner of the road. Donor agencies consider the legal land provision as an important contribution from the local partner, HMGN, the DDC or VDCs with organisational support from the UC or LRCC. It is recommended that in hardship cases (e.g. loss of more than 50% of land of a poor farmer), compensation needs to be made with land exchanged from within the community. Financial compensation provided by donors has often created wrong expectations and additional legal cases (e.g. LJRP).

Additional Costs for Training at Local Level

Costs for local-level training and social mobilisation, as well as public audits, have to be considered. These direct costs are not included in conventional rural road construction programmes. However the advantages are manifold as the gained skill and know-how can be used for the maintenance and other infrastructure and road construction works. Training costs in the Green Road construction programmes are estimated at about 5% of total construction cost. NRs. 67,300/km has been calculated for training based on actual expenditures in the Palpa, Dhading and Gorkha experiences.

Table 6.2 Summary of Estimated Training Costs

	Headings	(NRs/km)
1.	Exposure of district policy makers to the Green Road Concept	2,400
2.	Planning and review workshops	17,000
3.	Training-of-Trainers and Social Mobilisers	1,500
4.	Training of Naikes, masons and supervisors	44,000
5.	Wheelbarrow maintenance training	800
6.	Storekeeping and accounting training	1,600
	Total Costs for Training	67,300

Source: *B.N. Acharya, GTZ Engineer, 14-12-98.*

Maintenance Cost

Maintenance costs of the Palpa roads were reviewed to estimate the maintenance costs for typical Green Roads. They are based on the average labour need of 187 per day per km ranging about 150 to 200 per day per km (see table 6.3). Consequently the annual maintenance costs required to keep the road in a good condition was found to be between 1 - 2% of total construction cost, which matches with international standards.

Table 6.3 Maintenance Cost of Green Roads in Palpa District (1998)

	Roads (Palpa)	**Actual Costs ***		
		Labour (pd/km)	Expenditure (NRs./km/yr)	(NRs/km/year)
1.	Arebhanjyang - Rampur	196	8,203	12,300
2.	Banstari – Jhadewa	143	8,402	12,600
3.	Harthok - Chhahara	188	8,552	12,900
	Weighted Average	187	8,352	12,500

*1998 Price adjusted by Price index (CBS)
Source: *LRIP, Palpa Roads, H.P. Sharma/W. P. Meyer, 7 Sept. 1998.*

Rehabilitation Costs

Rehabilitation works have been carried out on existing but defunct road sections along the Palpa roads. The works included landslide clearing and stabilisation works, retaining wall structures, soil conservation, water management and bioengineering works. When rehabilitation costs in Palpa were reviewed (see Table 6.4), per kilometre costs were ranging between NRs. 55,000 - 135,000, or roughly about 10% of the construction costs. The term "rehabilitation" has been defined in the Glossary under Types of Roadwork.

Table 6.4: Rehabilitation Costs of Green Roads (1998)

	Roads (Palpa)	Rehabilitation Costs		
		Rehabilitation work (km)	Labour (pd/km)	(NRs/km/year)
1.	Arebhanjyang - Rampur Road	21	1,583	135,100
2.	Banstari - Jhadewa Road	12	1,815	128,100
3.	Harthok - Chhahara Road	16	603	55,400
	Weighted Average		1,320	107,400

* 1998 price adjusted by Price Index (CBS)
Source: *LRIP, Palpa Roads, H.P. Sharma, W. P. Meyer, Sept. 1998.*

6.3 BENEFITS FROM GREEN ROAD CONSTRUCTION

Identification of Benefits

The calculation of quantifiable benefits of remote areas by vehicle transport on new low-cost volume Green Roads replacing the traditional traffic by porters and animals is relatively complex and depends on a number of assessed data, which can vary considerably. Analysing different calculation models, the one applied for PIP was found one of the most updated and adequate. New road access brings fundamental changes in the types and level of economic activities overtime and a relocation of population into fast growing settlements along the nearby road corridor, which leads to the establishment of new commercial centres.

Up to now, the economic benefits of Green Roads have not been systematically analysed in detail, particularly the benefits have not been calculated as means for justifications, because these roads were considered as backbones of rural hill development.

Applying the measures of the economic benefit calculation of the PIP, the following quantifiable and non-quantifiable benefits of a new Green Road were identified:

Quantifiable Benefits

Following four types of quantifiable benefits from Green Road projects are identified.

I. Transport Cost Savings

The transport cost savings or "Road user benefit" is the difference between in transport costs with, and without the road. In the mid-hills of Nepal, the cost of freight transportation is equivalent to the cost of either human or animal porterage. The cost of passenger transport (i.e. pedestrian travel) is the cost of the time and expenses of walking. When a new road is built, transport costs change to become vehicle operating costs and passenger time costs. The comparison is applied to the normal traffic only. The benefit to the additional trips generated after the construction of the road is valued at half those of normal traffic.

II. Producer Surplus Benefit

This benefit is the net value of increased production as a result of improved access to the area served by a new road. "Net value" of increased production is the value of the output minus the cost of producing it, and transporting it to a market. This benefit can occur in any area of economic activity, but, in general, the benefit is considered in terms of agricultural production and often referred to as agricultural development benefits. The producer surplus benefit is considered only when the present access to the area served by the new road is constrained and the transport costs are high.

The economic benefit of a road over a 20 year life-span deducting the maintenance cost have been calculated in Fig. 6.1. Other quantifiable benefits were not included in the PIP calculation model of the economic benefits.

III. Appreciation of Land Values

As soon as a road is planned or comes under construction, land values in the adjacent areas increase by many folds, particularly in potential commercial areas. Land speculation starts by increased selling and buying. Landowners of land within the road corridor benefit greatly and this is why they mostly agree to provide land for the new road. Along the Dhadingbesi – Sallyantar road, land values per ropani jumped to NRs. 150,000 – 250,000 from a pre-road value of less than NRs. 10,000.

IV. Local Employment Generation during the construction phase

This means that about 12,000 person days of labour are required to construct one kilometre of road. About 65% of the construction costs are paid to the labourers over three years. As well, local people will continue to benefit in future maintenance work.

(Assessment based on the methodology of the PIP, 1997)

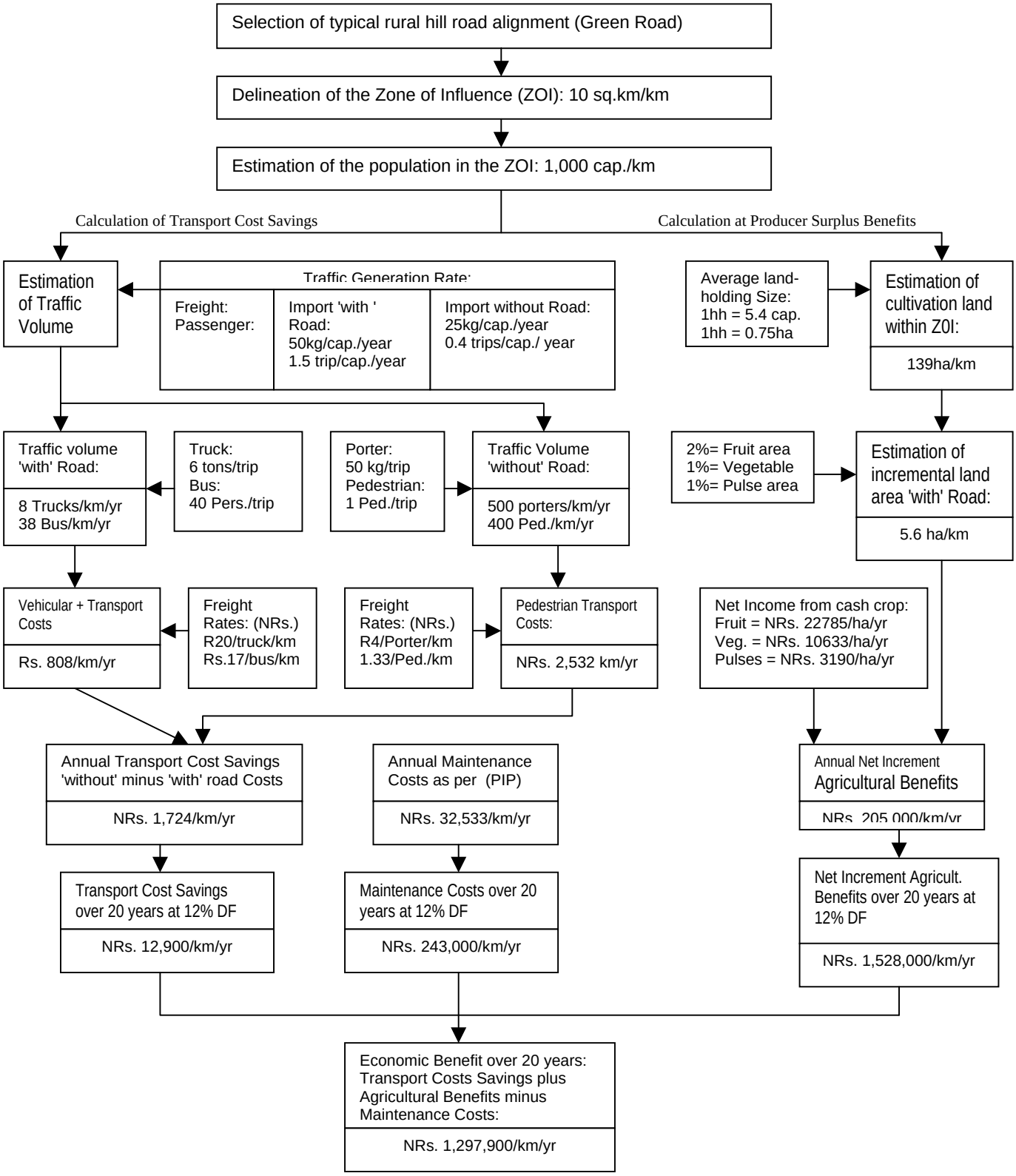


Fig. 6.1 Estimation of Economic Benefits

Non-quantifiable Benefits

There are a number of direct as well as indirect social benefits, which cannot be as easily quantified and calculated in terms of money. These are:

- Faster, easier and cheaper access to markets and goods providing new options for perishable products.
- Faster and easier access to public and private services such as education, health, government offices, saving and credit banks, etc.
- More frequent visits of extension workers into remote areas within and beyond the zone of influence.
- Longer stay of professionals, officers, teachers, doctors, etc. to their rural duty areas as a result of easier access to their homes and markets, leading to a higher quality of education, health status, etc.
- Wider selection and more reliable supply of consumer goods.
- Awakening of the rural population out of psychological isolation and remoteness into connection with the outside world.
- Access provision for other rural infrastructure works, such as irrigation schemes, water supply, electricity lines and hydropower stations, etc.
- Generation of new agro-industrial income opportunities generating off-farm employment.

6.4 ECONOMIC JUSTIFICATION

Background

In planning rural road programmes, executing agencies are often faced with a large number of proposals, often more than can be entertained within their budget constraints. Funding agencies increasingly look towards economic, social and environmental impacts in order to assist in a rational evaluation and screening to ensure an optimum viable selection.

a. Economic Viability of Green Roads

Under the prevailing conditions defined in the previous two chapters, the economic viability of a typical Green Road in the mid-hills has been assessed by three different indicators.

The Benefit Cost Ratio (BCR)

The BCR compares the present value of the benefit stream with the cost stream by forming a quotient, each discounted at the same rate of 10% – 12%. In general, a road project is considered as economically viable if the benefit-cost ratio is above 1.

Benefit of an average Green Road = NRs. 1,298 Mio.
Cost of an average Green Road = NRs. 1.030 Mio.
BCR = EB/EC = 1.26 or >1

The Net Present Value (NPV)

The NPV compares again the benefit stream with the cost stream by forming a subtraction, each discounted at the same rate of 10% - 12%. In general, a road project is considered as economically viable if the subtract is positive (>0).

NPV = EB - EC = NRs. 0.26 Mio.

The Internal Rate of Return (IRR)

The IRR represents the rate of return, at economic prices that would be achieved on all expenditures (costs) of the project. The IRR is calculated by using the net benefit stream obtained by subtracting the year-by-year costs from the year-by-year benefit. In general a rural road is considered as economically viable if the rate is at least 12%. The IRR of typical Green Road is:

IRR = 15%

Among the three above mentioned criteria the IRR is considered the best indicator to review the potential economic performance.

b. Environmental Viability of Green Roads

Under the prevailing planning method and particularly environment-friendly and labour-based construction techniques, Green Roads are screened according to the following criteria:

- Selection of the road alignment in geological and topographic area; aesthetic impacts; risk of slope failure, land slides, accelerated erosion
- Applied construction methods and planned construction supervision, no blasting, etc.
- Ecological degradation, encroachment into undisturbed forest areas, ecologically fragile high mountain areas, disturbance of wild life
- Disruption of natural drainage System in watersheds
- Effects on drinking water quality, air and noise pollution
- Damage to sensitive archaeological, historic, religious and cultural sites and monuments

c. Social Viability of Green Roads

Important social issues have to be addressed in order to assess the social viability of roads. Again the institutional set up of the Green Road Concept is adhered to optimise the benefits for the local population and minimise the negative impacts. The main criteria are:

- local employment generation and correct income distribution, equal employment rules for men and women, child labour restriction, promotion of local savings
- Improved access to education, health, and social, commercial and governmental facilities
- Resolution of hardship cases due to the encroachment of private farm land by the road

Testing the Overall Viability of Green Roads

The most economically viable road may not be the best from an overall perspective that needs to be assessed considering the economic, environmental and social viability. When comparing roads, this is done by comparing different roads or alternative road alignments, the different viability criteria are weighted and assessed. When a District Transport Master Plan is prepared for a district, all the proposed roads are screened within this frame. For specific road alignment similar road alternatives can be screened by focusing on the economic viability using the main results of NPV, which should be positive, and the IRR which should by greater than the discounted rate (2%).

6.5 RESOURCE MOBILISATION

Background

Different systems of resource mobilisation for Green Road construction and maintenance were developed and gradually improved from project to project. The same applies for the fund flow schemes. Overall, one can observe a start with a centralised, rather donor-driven approach (LJRP) in the late 1970s towards increasingly decentralised resource mobilisation and fund flow schemes. For the construction of a new Green Road, often several funding sources have been utilised, partly provided by various central and local level agencies, which resulted that the DDC would build annually a section of perhaps 1-2 km, the DoR would continue building about the same, and the VDCs would add another stretch by a mix of voluntary labour and the use of their VDC budget. The result is generally quite unsatisfactory ending up in an incomplete work resulting in a lack of co-ordination and absence of future local ownership over the road.

A solution to this often observed problem in recent years seems to be the pooling of the financial resources together into one “basket” or in other words, the creation of a “Road Fund” for a specific road to be managed by the future road owner, i.e. the DDC, a LRCC, etc.

Green Roads were initially launched to a large extent with financial and technical support from bilateral donors, but local and district level resources are increasingly made available. In order to meet the need to extend the rural road network significantly within a satisfactory time frame, additional external financial resources are required. For the development of a sustainable road maintenance funding system, the creation of a matching fund by collecting resources from local, district and central level seems to be a promising direction. The collection of user taxes was and will have to be the main source for maintenance funding and a key question is which form of tax is the most suitable and acceptable by the public and can be collected in a cost effective way. The world wide experience shows that the financing of the road network through a central level road fund created by collecting fuel tax is the most viable long-term solution.

Village (VDC) Level

- Annual "Build Our Village Ourselves (BOVO)" fund
- Shramadan (traditional free labour contribution by each household)
- Local taxes
- Direct support funds from donor agencies

Constituency Area (Electoral areas of the Member of Parliament)

- Annual fund received by the Member of Parliament for rural development works

District (DDC) Level

- Annual budgets for rural roads and trails from MoLD
- Funds from the collection of various user fees and taxes by the district
- Direct support grant funds from donor agencies

Central Level (HMG)

- Rural road and trail projects implemented by MoLD
- Rural road bridges and trail bridge projects implemented by the DoR Divisions or central level DoR
- Loans granted to HMGN for Rural Road Projects
- Grant aid provided to HMGN for rural road projects, generally by bilateral donors

Fund Flow Schemes of Selected Green Roads for Construction and Maintenance

Lamosangu – Jiri Road Project (1974-84)

For construction, the fund flow went from SDC to MoF to MoWT/DoR to the contractors and finally to the labourers and suppliers. In the second phase SDC and DoR funds were managed by a joint co-management office, which shortened the fund flow considerably. In general one can observe that the financial system was highly centralised without any involvement of the district or local level organisations, which is characteristic for “Strategic Roads” owned by the DoR.

Accordingly, the maintenance is organised through DoR, which established a Divisional Office in Charikot using central level funding.

Local Road Improvement Programme in Palpa District (1985-96)

For the rehabilitation of defunct existing road sections, project funds from the Soil Conservation Section (DSCWM) of the Tinau Watershed Project (TWP) were mainly utilised.

For the construction of new road sections, DDC and direct District Support Funds of TWP were used flowing from SDC/GTZ to TWP to a special account of the DDC and from there directly to the labourers with supervision of TWP representatives (Helvetas, East Consult). Construction material (gabion wire) and tools (wheelbarrow) were directly procured by TWP. The consultant (East Consult) managed an additional "Action Research" fund for special works. For maintenance, initially the LRCCs of each road were to contribute funds, topped up with a matching fund of the TWP. With the growing length of the roads, their status changed gradually into district level roads.

To finance maintenance, tax collection barriers were erected and the DDC collected road user taxes with a matching fund from PDP, which phased out in 1996. Since then, the DDC awards tax collection contracts for each road. These taxes contribute around 30 to 50% of the maintenance costs and the rest is funded by the respective DDC budget from MoLD.

Dhading Roads Programme (1988 – 1996)

For construction, the resources were provided to a large extent by Dhading Development Programme (DDP) of GTZ via MoLD to the DDC. The project office was supported by a DDP technical support team, which supervised also the fund flow from the DDC to the road committees and to each particular labourer.

The local resource mobilisation for maintenance was and is handled in a similar manner to Palpa. Dhading managed to collect significant taxes for stone collection (quarrying) for the supply of stone construction material to the Kathmandu valley.

Gorkha Road Programme (1996 – ongoing)

The resources for construction are provided by the Gorkha Development Project (GDP) of GTZ. Through a resolution with the DDC, the GDP transferred the resources directly to a national level NGO (SAMAGRA) who are in charge to pay the labourers based on group-wise work performance measurements prepared by the technical supervision consultant (B. N. Acharya).

In order to generate a sustainable maintenance fund, various sources were conceived. The DDC, each directly linked VDC and each neighbouring VDC was requested to annually contribute a fixed amount into the Maintenance Fund. However, the fund collection has been hampered by the interruption of the construction.

Hulaki Bhanjyang – Chainpur Road, Dhading District (1994 –1996)

This is a typical village road constructed as a local initiative with own resources and only limited technical assistance by the DDP. A well-defined local resource mobilisation was developed. The main resources were finances from the annual Build Our Village Ourselves (BOVO) budget of MoLD provided to the Chainpur VDC, and voluntary labour contributions from each benefiting household. The financial resources were divided according to the road length to each ward, a sub-division of a VDC. For maintenance, funds are collected by a toll tax and other local taxes and contributions.

Local Road Programme in Lamjung (1996 – on-going)

The funds for construction are pooled into a “Single Basket” from DDC (MoLD) and VDC annual budgets, and donor grants managed by local “User Committees” (UC), with approval for its operation from the LDO. The UCs were formed and facilitated by a local NGO and its legal status authorises it to manage the fund. This approach is similar to resource management of drinking water and irrigation scheme managed by UCs.

Local Roads of RCIW/FfW in Various Districts (1996 – ongoing)

For rural road construction, food resources of the WFP and financial resources of MoLD are channelled to the DDCs, which is in charge to distribute the resources to VDCs and user groups or local self-help groups. With the technical assistance of GTZ, emphasis is put on more transparency on the resource utilisation through public audit.

The experiences from these projects resulted in the following major recommendations:

Resource Mobilisation for New Construction

- For construction of a road the different financial, food, material and human resources should be pooled together into a “Single Basket”, also called a "Road Fund".
- The executing organisation of a road project should be responsible to the future owner of the road.
- Full financial transparency of the income and expenditure needs to be ensured to all contributing partners to further ensure their commitments.

Fund Flow Scheme for New Construction

- The fund flow system should be kept as simple as possible, but still transparent. The authority on the financial transactions needs to be carefully balanced out to avoid misuse or allegations of misuse.
- Since more than 65% of the costs are labour payments, the full and correct payment to each labour according to the group work performance needs to be ensured by well-organised labour payment days with public audit.
- To ensure full transparency towards the local population and the future road owner, a public audit system needs to be included besides the official audit system.
- The procurement of construction material and appropriate tools and equipment needs to be cost-effective and timely. The introduction of sophisticated administrative procurement procedures in a rather uncontrolled market system has not shown expected results and has often created serious delays of delivery. A combined team of administrators, engineers and committee members should be entrusted with procurement to ensure timely delivery, procured quantity and quality and market oriented prices. Donors may consider the direct delivery of construction material (i.e. gabion wire, appropriate wheelbarrows) if they are in a position to do so.

Resource Mobilisation for Maintenance

- In general, the concept of Matching Fund contributions by higher authorities should be promoted for maintenance to stimulate local resource mobilisation, i.e. the higher authority or a donor agency may provide a definite ratio as a topping-up of the collected resources. The future road owner shall propose a convincing resource mobilisation scheme, i.e. DDC or LRCC may have existing taxation schemes. In many hill areas, there are traditional "Shramadan" (labour donation) systems, which can be effectively utilised for village road maintenance within a VDC.
- DDCs, VDCs and LRCCs have several options to raise funds for maintenance: the collection of road User Fees by a tax barrier directly or by awarding annual contracts. The amount collected from such user fees should cover 50% of the maintenance costs. A DDC may carefully choose the amount of their roads to avoid an overburden of maintenance duties within the budget available.

Fund Flow Scheme for Maintenance

- Experience has shown that the road owner shall use the maintenance fund by employing local teams for after monsoon and routine maintenance for road sections of about 5 km. The maintenance work can be contracted out to interested local maintenance teams applying for works.
- For urgently needed post monsoon maintenance works, the roads need separate maintenance funds independent from the release of HMGN budgets in order to overcome the chronic problem of late availability of the annual HMGN budgets.

6.6 PUBLIC AUDITING

The concept of an "audit" implies an examination of accounts for the purposes of independently verifying financial transactions. It can also be used in the sense of examining the quality and timing of work, the nature of outputs etc. to ensure that agreements were met. "Public" is added to the concept to denote the interest of the general public in information about how public funds are used.

The concept of public auditing is relatively new in Nepal. However, some elements of public auditing have already been used in the Green Road projects in Palpa, Dhading, Gorkha and Lamjung on an experimental basis. Formal public auditing was first started in the Churiya Development Project supported by GTZ in 1993 where Food for Work was used as a drought relief activity in Saptari. VDCs were involved in the process, monitored by the DDC.

This experiment was a success. GTZ has begun to apply the system in its FfW and Rural Development Programmes. The experiences obtained from different agencies suggest that in publicly audited projects:

- funds are used more effectively;
- construction, maintenance and rehabilitation costs are reduced; and
- the distribution of benefits is more transparent and equitable.

Public Audit Proposal

There must be norms and standards against which the performance of Green Roads is assured in order to effectively apply public auditing. The proposed public audit system shall consist the following elements and principles:

i) There shall be no compromise with regard to quality of work, as defined by Green Road standards.

ii) Local Road Coordination Committee (LRCC) or user committee (UC) shall be nominated to apply public auditing procedures.

iii) Written records of all official decisions and transactions shall be recorded and be made open to public inspection. An official project book shall be kept at the site in which all decisions are recorded (see photo 0446/29).

iv) All financial transactions and procedural activities shall be carried out in a transparent manner, and any interested person shall obtain full financial information and have open access to the records mentioned in (iii) above.

v) Work quality and financial transactions shall be subjected to periodic random verification (audit).

vi) Irregularity or deviation from the set project standards such as resource misappropriation, or reduction of work quality and quantity, shall be identified. The persons involved shall be held accountable for compensating the loss.

vii) Standard signboards (in Nepali and English) shall be erected at important points along the road. Such signboards shall contain key information regarding the name of project, road length, duration of work, estimated costs and financial contributions, number of workers, name of the user committee responsible for work execution, and the name of national and international agencies, NGOs or INGOs involved in the project. Signboards shall also contain the labour rates and the payment dates are scheduled to be made (see photo 2507/17).

viii) There shall be at least one public hearing organised annually at the beginning of the construction season, and another upon the completion of the works at the end of the working season. During the first public hearing, an introduction to the project shall be made, a list of stakeholders shall be developed, and the possible impacts of the project on the community shall be discussed. During this introductory meeting, the rights and responsibilities of the community shall be agreed. The estimated cost of project shall be discussed thoroughly. In the final hearing, an actual expense shall be discussed with an auditor detailing the expenditures of the project. A description of the status of completed project, and role of community in the future with regard to the project shall be presented and discussed.

Photo 4817/23 – Palpa, March 1996
Road user fee collection barrier at the Aarebhanjyang – Rampur road

Photo 2913/16 – Palpa, Feb. 1998
Road user rates for Aarebhanjyang – Rampur road:

Bus, Truck:	100.-
Tractor:	90.-
Mini bus & Mini truck:	80.-
Jeep:	60.-

Photo 3320/21 – Dhading, April 1998
Road user rates for Bhimdunga – Lamidanda road:

Bus, Mini truck:	50.-
Tractor/Minibus:	40.-
Passenger Jeep:	25.-
Private Jeep:	20.-
Taxi, Car, Tempo:	20.-
Motorcycle:	5.-

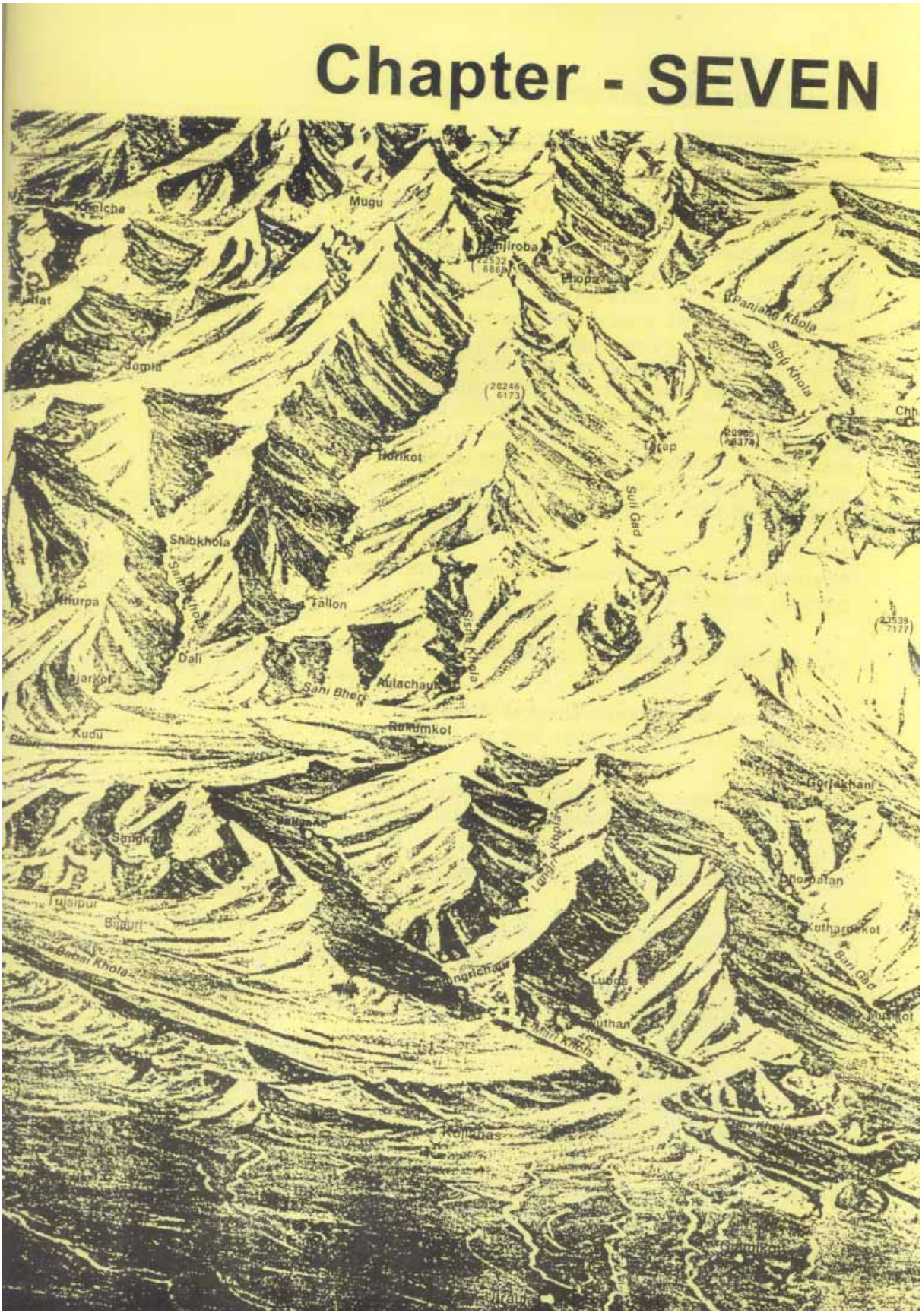
Photo 2507/17 – Dec. 1998
RCIW/FfW-Model signboard to inform the local population on the road project (in Nepali)

Photo 4260/32 – Kavre, April 1998
User committee meeting at the Nayagaon – Thulochaur road

Photo 0446/29 –

RCIW – public project book in which all major decisions of meetings are recorded and to which all people have access

Chapter - SEVEN



7: MAINTENANCE AND REHABILITATION

7.1 OPERATION AND MAINTENANCE

The main agent that contributes to road deterioration is water. Monsoon rain causes soil erosion, landslides, torrents and floods and moisture converts solid dry soil into plastic material. A second agent is the traffic using the road. The traffic volume, its type and load, and traffic period influence the degree of road deterioration. Moreover, there is a general tendency of overloading the vehicles, thus damaging road surfaces very highly. A third factor is people. Deforestation and inappropriate agriculture within the road corridor accelerates soil erosion. Land disputes and conflicts between irrigation system and road drainage, location of unprotected drinking water pipes and diversion of open channels towards the road, the destruction of road slope vegetation from overgrazing of livestock, uncontrolled mining of red soil, or quarrying of gravel and stone collection from the road slopes, or even the careless disposal or deposition of earth and other construction materials by nearby house builders all contribute to road deterioration. These agents of road deterioration also work jointly.

The Green Road Concept emphasises on preventive measures, promoting sustainable operation and maintenance, rather than curative steps, and begins from the planning stage of the road and includes the following considerations:

- ownership for the road is to be well defined, since the owner shall be fully responsible for maintenance
- DDCs', VDCs' or UCs' capacity to maintain its roads is not over-stretched or mis-matched considering the need within its road network, and its capacity and priorities are identified
- road alignments are selected by avoiding areas requiring high maintenance (such as landslide prone area, paddy fields, rock falls, marshy soil, area with natural spring etc.) as far as possible
- when planning any road, the maintenance concept for that road is integrated in the planning stage
- a district's policy makers and User Committees pledge their commitment to maintenance using resources that they themselves generate

Minimisation of Maintenance Requirements

Road deterioration cannot be stopped, but can be minimised. With minimal regular maintenance requirements, the upkeep of the road can become affordable to a community. Several main policies contribute to the minimisation of maintenance:

- seasonal closure of the road during monsoon, as the road surface would be wet and be very prone to rill formation
- banning of heavy vehicles (with heavy axle loads including overloaded vehicles) which contribute to deep rill formation in the earthen road surfaces
- education to road users about avoidable factors that contribute to rapid road deterioration

- initiation of dialogues with farmers to reach mutually acceptable solutions about issues like irrigation for agricultural purposes and water management with road drainage management
- execution of proper and timely maintenance while the damage is still manageable at low cost.

Mitigation Measures

1. Controlling Road Use During Rainy Season

   Low-volume earth roads can be damaged to a large extent that can lead towards tremendous maintenance costs when the vehicles are allowed to ply during monsoon. As the road surface is mainly earthen, it becomes slippery during rain and also becomes unsafe to drive. It is thus recommended to close the road during the rainy season. Just this measure alone helps to minimise maintenance tremendously. Road closure is achieved by installing a gate and a watchman, and forbidding the passage of vehicles during the monsoon for about 3 months (from July to September).

   Road closure only works if users understand the reasons for it, and accept these. One compromise could be to allow users to ply during the monsoon if they agree to pay for the damage caused. As earth roads deteriorate fast in the rain, in a very short time extremely heavy and unaffordable maintenance requirements are caused. Thus the best practice is either to stop using the road during this season, or to upgrade its surface by gravelling or even black topping.

2. Controlling Axle Weight

   Heavy axle loads as vehicle characteristics and the actual load determines damage rather than simply vehicle size. Large vehicles like the large trucks and buses often carrying heavy loads cause excessive damage to the earth road surface through deep rut formation. At the first (earthen surface) stage of a Green Road, they need to be limited from plying. As with monsoon closure, consultation is required with vehicle owners in order to educate them about the adverse consequences of using a Green Road with heavy loads. If users pay for the damage caused by inappropriate use of the road, then temporary road opening could be permitted for emergency purposes. Control is exercised by installing a gate and a watchman. Large vehicles can be controlled passively with a narrower road width.

3. User Education and Transparent Policies

   It has already been mentioned why a Green Road should not be used during the monsoon, and why heavy vehicles should not be allowed to ply. If users are made aware of the consequences of these issues, often problems can be avoided. Sometimes, however, mere education is not enough. Rules and regulations need to be framed and owners (e.g., Users Committees) can be empowered to enforce them. Fines can be imposed on violators of the policies, with these penalties reinvested in road maintenance. A dialogue with local transport associations is important with regard to it.

4. Dialogues with Farmers

   Dialogues with farmers are held in all Green Road programmes to the maximum extent possible so that those along the road corridor understand the technology. In areas where farmer's interests compete with the road, dialogues are aimed at finding mutually acceptable technical solutions, which minimise maintenance problems. For example, at places where the farmers need irrigation water and outlet (especially at rice fields), pipe culverts across the road are installed. During road construction, these are installed in the manner they want, if they pledge to maintain these pipes and ensure water does not drain along the road surface. Platforms and steps alongside the road are built in places where local people and farmers need them so that animals crossing the road cause minimum conflict with the traffic and minimum damage to the road.

5. Preventive Maintenance while the damage is still small

   Proper and timely maintenance is crucial. Best practice is to repair the damage while the problems are still small and manageable. Preventive maintenance generally reduces maintenance and rehabilitation costs significantly and increases the life span of a road. However, this needs a high level of commitment.

Main Types of Maintenance

- Routine Maintenance: Weekly, bi-weekly or monthly maintenance is carried out by local labourers in groups of say about 4 to 6 people to correct water drainage problems, obstructions caused by deep rills and pot holes, road structural damage, blocked side, cross and diagonal drains, and replanting. Palpa's experience shows the need for about 100 person days of labour per kilometre per year for routine maintenance.
- Post Monsoon (Periodic) Maintenance: Periodic maintenance is carried out following the monsoon under the supervision of a trained overseer or technician. Groups of about 10 people can be used for this maintenance as well. Issues here are the clearing of slumps and landslides, backfilling of rills and gullies created by heavy run-off, filling of major pot holes which obstruct traffic, repair of structures, re-cambering the outward cross slope, repair of the drains, and minor readjustment of the longitudinal gradients damaged by run-off or traffic. Spot gravelling or stone soling in slippery areas may be undertaken as well. Palpa's experience shows that periodic maintenance requires at least about 100 person days of labour per kilometre per year.
- Cyclic Maintenance: Cyclic maintenance should be carried out in cycles of about 5-7 years. However, this has been hardly ever practised in any Green Road programme so far.
- Emergency Maintenance: Emergency maintenance is carried out after extraordinary landslides. Important is the immediate establishment of the drainage system to avoid further damage.

Inputs Required for Maintenance

The major input required for rural road maintenance so far is local labour with appropriate tools and equipment (e.g., wheelbarrows). In some roads, a tractor-trailer set was hired on daily basis for removal and safe disposal of landslides, backfilling of rills, and for spot improvement works, such as at deep ruts, damaged retaining structures, etc.

The Palpa experience shows that for routine and periodic maintenance, 150 – 200 person days of labour are required per kilometre provided that the road is closed during monsoon (Refer to Chapter 6 for maintenance costs), which is equivalent to about NRs. 20,000.00 at current stage. That means about 50% of total input (at least 100 person days) is required per kilometre for post-monsoon maintenance and about the same is required for routine maintenance. Damage caused by the vehicles during the monsoon is not included in these figures, and is generally considerable and often higher than the costs for routine and periodic maintenance.

The necessary inputs depend also significantly on the working institution and applied labour payment system.

Maintenance Organisation

Experience has shown that the labourers in Nepal do not generally like working alone, but rather prefer working in groups. The labourers have felt lonely while working and in some areas, they have even argued on being attacked by wild animals. Therefore, the internationally propagated "Lengthman" system needs adjustments.

In Green Roads, special local Road Maintenance Teams comprising of 4-6 labourers headed by a local supervisor (Naike) are generally formed and employed for a specific road section of about 5 km. In case of voluntary labour contribution, additional groups can be involved for post-monsoon maintenance works, which can also be combined with the traditional system of "Shramadan" (voluntary labour) during the Dashain festival in September/October. In fact, the need for opening the road is very high for the safe movement of people and goods during Dashain.

For routine maintenance, a general practice is to use the muster roll system (daily attendance list). This method is simple in terms of administrative procedures. However, experience has shown that desired quantity of work cannot be achieved sometimes and it becomes simply costly. Therefore, performance-based sample maintenance work contracts need to be worked out specifying various individual tasks. Works can be contracted out to local work groups, which were already trained during the construction period.

Sustainable Maintenance Funding

The biggest challenge in Nepal for rural road maintenance is the institution of a sustainable maintenance programme and clearly defined road ownership. Sustainable maintenance requires right policies, sufficient knowledge and awareness

about the resources required and money as well as clear road ownership that defines responsibility for maintenance.

Sources of resources for road maintenance differ according to the ownership category.

- For the roads that the VDC owns, Rural Self-help Programme grants from MoLD, voluntary labour and tolls on vehicles are often sufficient for routine and periodic maintenance costs. VDC, DDC and MoLD contributions continue to be necessary in the case of emergency and cyclic maintenance.

- For roads owned by User Committees empowered as autonomous NGOs (the Lamjung experience) funds are contributed by the DDC and VDCs, from tolls and fixed voluntary labour contribution from each user household. "Voluntary labour" is extremely important resource in maintenance in the short term. In the longer run, the presence of the road changes the economic framework in the region itself, and at this point the local economy starts to pay for the maintenance.

- DDC roads can be maintained with DDC block grants received from MoLD, and tolls on vehicles. These are often sufficient to fund for routine and periodic maintenance. Often toll taxes are collected by DDC through the appointment of a contractor (through competitive bidding) who collects the tolls for a profit. Experience has shown that these tolls are only sufficient to meet 50% of the cost with the balance from DDC sources.

7.2 REHABILITATION AND UPGRADING

Rehabilitation

The issue of rehabilitation of a Green Road becomes relevant at the end of the economic life of the road, i.e., after about 20 years, provided there exists a properly functioning maintenance management system and a traffic volume as planned.

In Palpa district, the initial involvement consisted of rehabilitation of the first existing but defunct and poorly constructed road sections in all three LRIP alignments. The main works executed were stabilisation of critical landslides, repair of water management structures, repair of damaged retaining structures, widening of critical curves and smoothening of longitudinal gradient.

Though a Green Road may look different after 20 years, rehabilitation works can be considered as similar to any other roads. Rehabilitation works could consist of construction of retaining structures, resurfacing of worn out road surface sections (deep ruts), complementary plantation works and trimming works if required. The work input required for rehabilitation works has been assessed in Chapter 6.2.

Along several initial Green Roads, it can be observed that the traffic volume has increased very fast and beyond the expectations. The main reason is opening of new branch roads that helped increase the movement of goods and people from other

previously inaccessible areas. As the function of a road changes from an "access" to a "link road", the traffic volume increases.

Upgrading

In cases with a fast increasing traffic volume and a large amount of through traffic, a fair weather, earthen road may need a reclassification and upgrading to a higher standard. As the traffic on such roads begins to increase, the need for upgrading arises.

If the longitudinal alignment is carefully selected (smooth gradient), the initial road alignment can be maintained also during upgrading. This shall significantly reduce the costs and avoid complicated land compensation issues, as upgrading could further increase the land price, landowners would definitely expect compensation for their lands. The original horizontal alignment following the contours would need improvements while smoothening the curves and widening. Excavated material can be transported and re-utilised for widening and back filling. Excess materials can be disposed by controlled tipping.

Labour-based work methods are to be efficiently applied for upgrading a Green Road. Appropriate intermediate equipment, such as tractor-towed trailers, graders, rollers are to be used to minimise the costs. As per the availability of funds, and existing traffic volume, road surface shall be upgraded to gravelled surface or to blacktop surface

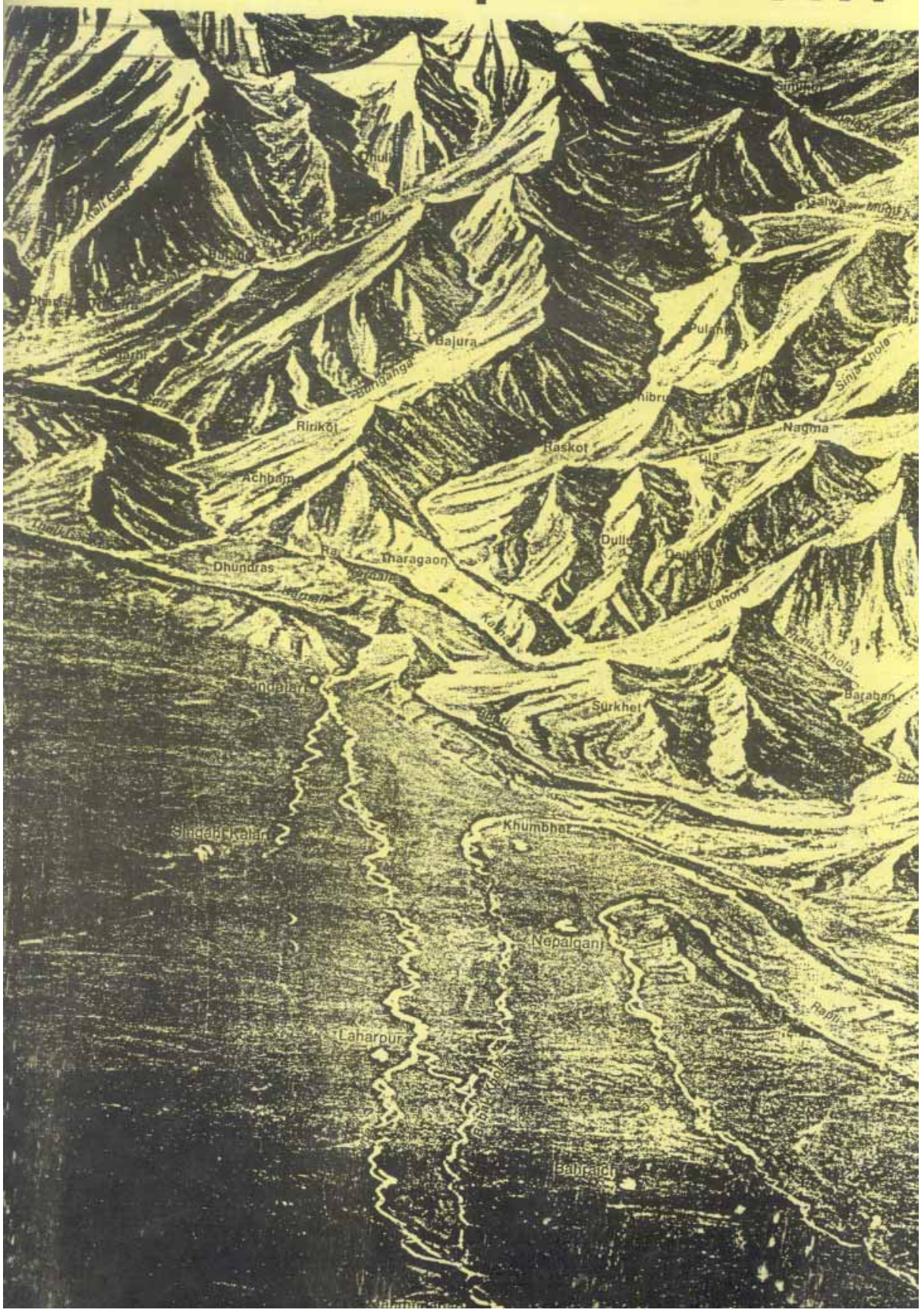
At the time of upgrading, the ownership of the road may also require a redefinition. For example, a VDC-level road may be upgraded to a DDC-road, or a DDC-road may be taken over by the Department of Roads, requiring higher standards such as side drains or double lane width. Changing the standard may also inflate the maintenance requirement dramatically.

Photo 4817/5 –
Palpa, March 1996
Post-monsoon maintenance works along the Banstari – Jhadewa road

Photo 3744/36 –
Dolakha, April 1998
Spot improvement by stone soling

Photo 6992/13 –
Dhading, 1995
Clearing of a landslide along the Bhimdhunga – Lamidanda road

Chapter - EIGHT



8: FURTHER CONCEPTUAL REQUIREMENTS

Although the Green Road Concept has been developed to a considerable degree through experience and action research, there continues the need to further refine the approach particularly in institutional, managerial and technical aspects as well as the questions regarding construction and maintenance.

Institutional

- In order to reach the local governments in all 75 districts, the Green Road Concept needs to be institutionally embraced by HMGN and its respective line agencies (such as MoLD and its Department of Local Infrastructure and Agricultural Roads).

- The concept of road ownership needs further clarification from an administrative perspective, with legal authority (and consequential responsibility) placed with DDC, VDC and corporate roads. These legal aspects are still largely unexplored. Consequences and opportunities for road-owning organisations such as irrigation, community forestry User Groups or cooperatives need to be further developed in the spirit of decentralisation.

- Critical aspects of land provision and compensation for new roads and collection of value-added tax in terms of cash or kind (land) in order to compensate landowners losing their lands due to road as per provision made in the Constitution of Nepal need to be studied more. A legalised form of land compensation for hardship cases where a substantial proportion of landholding is expropriated to build a road needs to be developed relatively soon.

- In order to disseminate know-how and further develop the labour-based technology through applied research, the continuation of the Labour-based Training Centre in Butwal should be considered. Its focus would be the provision of training in districts and specific road project sites, but also training to national and local level consulting firms in order to disseminate the Green Road Concept and ensure the quality of works.

- A simple monitoring system needs to be developed to evaluate the work performance of User Group, contractors, technicians (engineers and overseers), and supervisors in order to ensure and improve the quality of works on one hand and make them qualify for further similar works in future on the other. However, such evaluation system should avoid any new "institutional barrier" or "insider favouritism".

- A sustainable financing mechanism with a long-term perspective needs to be developed for rural road maintenance at central level by considering fuel charges that could replace cost and time-consuming toll collection system.

Managerial

- The efficiency of labour-intensive works can be further improved by combining labour with some low-cost and preferably locally produced equipment. However, the scope for this can be explored by analysing typical jobs systematically.

- Developing new forms of specialised private small contractors with semi-mechanised equipment and materials focusing on the delivery of cost-effective complementary services (such as building small bridges or culverts) would be useful. These tasks are not really appropriate for low-skilled User Groups to attempt.

Technical

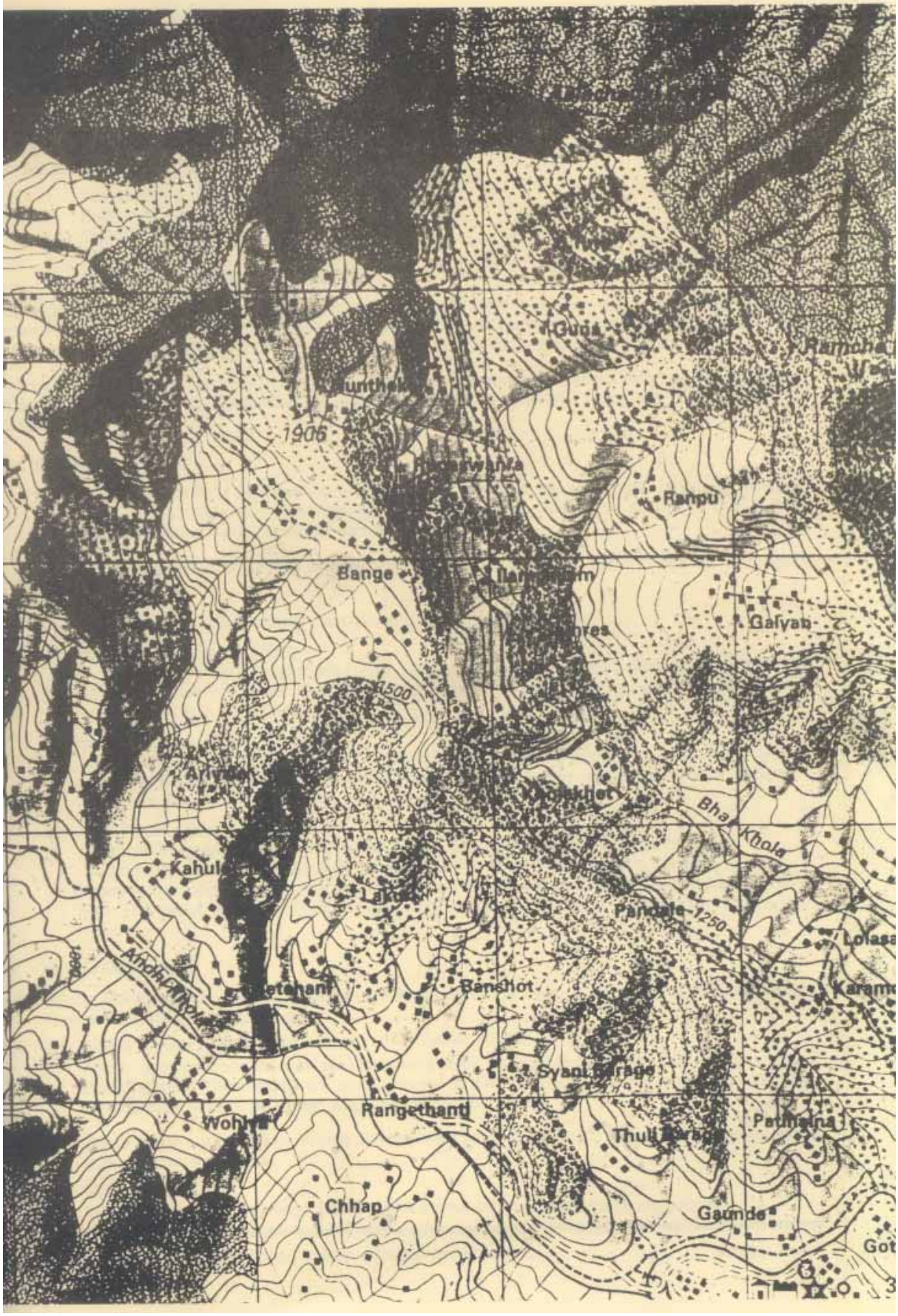
- Dust pollution problems of earth and gravel roads in settlement and market areas can be reduced by appropriate low-cost treatment methods, such as soil-lime or soil-cement binding processes, stone soling, spot gravelling etc.

- Work tasks could be further analysed with an aim towards improving productivity. Workers could be consulted about how their tasks could be simplified. Certain tasks may have a potential for semi-mechanisation to increase output.

- Improved locally produced and ergonomically adjusted hand tools need to be developed so that blacksmiths and artisans can produce and maintain these items.

- Low-cost appropriate techniques and equipment for mountain road construction could be further developed. Needs include techniques to improve rock cutting and stone breaking and tractor-towed trailers with short-turning radiuses for longer distance material transport. Other tractor-towed implements such as dead-weight rollers (including sheep-foot rollers) for compaction, graders and levellers for maintenance work have large potential to increase the efficiency of labour-based technology.

ANNEXES


Guna
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Rangethanti
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Chhap
Gaunde

Annex - A

Classification of Rural Green Roads

The Road Classification (Second Revision) 2050 of DoR/MoWT provides five classes of roads in Nepal, as per the classification by DoR. These are:

1. National Highways (NH)
2. Feeder Roads (FR)
3. District Roads (DR)
4. Urban Roads (UR)
5. Village Roads (VR)

Rural Green Road obviously falls within the classification of DoR. However, the Green Road considers "road ownership" as the major element for classification, as road ownership actually defines the authority, and the roles and responsibilities of the road undertaking agency for maintenance works.

Rural Green Roads are classified according to their functions under the District Roads (DR) and Village Roads (VR). The following definitions are suggested for the DR and VR, which are in line with DoR's definitions.

1. District Roads (DR)

District roads are defined as those roads within the district which serve primarily by providing access to abutting land carrying little or no through movement. These roads give access to one or more villages to the nearest market or higher classes of roads.

These roads are owned by District Development Committee (DDC) and serve the district for its traffic requirements.

District Roads are more specifically classified into three different groups:

1.1 Primary District Roads (PDR)
These roads are the arterial roads linking several Village Development Committees (VDC), and main trading centres of the district to higher classes of roads with through movement. Typical length of a PDR is 10 to 40 km.

1.2 Secondary District Roads (SDR)
These roads are linking two or more villages (VDCs), connecting commercial and market centres within the district, and providing access to abutting land to the higher classes of roads. Typical length of a SDR is 5 to 20 km.

1.3 Main Trails including Tracks (MT)
These are trails and tracks for the movement of people and goods within one or several neighbouring districts in north-south or east-west directions. Mules are also generally used for transportation of goods in many districts (See definition as per DoR, Suspension Bridge Division, Main Trail Statistics, 1997). Typical length of these trails is 10 to 50 km and sometimes even more.

2. Village Roads (VR)

Village Roads include short non-through roads linking single villages directly to the District Roads. They are classified into two groups:

2.1 Village Access Roads (VAR)
These roads give access to villages to several settlements up to 2 villages (VDCs) to the nearest District Roads. These roads are often linked with the existing district trail network on the other sides and generally have a road length of 1 to 10 km.

These roads are owned by Village Development Committee (VDC) and serve the village for its traffic requirements.

2.2 Village Trails (VT)
Village Trails serve the village and its wards for the non-motorable traffic requirements.

Annex B

Design Standards for "Green Roads"

S. No.	Design Parameters	Unit	Recommended values for		Remarks
			Village Road (VR)	District Road (DR)	
1	Annual Average Daily Traffic	AADT	20	40	
2	Design Speed	kmph	20	30	
3	Number of traffic lane	no	1	1	
4	Maximum vehicle loading capacity Axle load (2 wheels)	ton	6	8	Design vehicles are: Light bus, Light truck and Tractor Trailer
5	Right of Way	m	30	30	15 m on either side
6	Formation width	m	4.00	4.50	
7	Additional width in curves with radius below 20 m	m	2.00	2.00	
8	Carriageway width	m	3.00	3.00	
9	Total shoulder width (both sides)	m	1.00	1.50	can be exceptionally reduced in short sections upto 20 m
10	Maximum average longitudinal gradient	%	7	7	
11	Maximum longitudinal gradient	%	12	12	Special surface treatment and side drains are required
12	Maximum length of the sections above 7% gradient	m	300	300	
13	Camber / outward cross slopes	%	5	5	camber shall be provided only in the places where longitudinal gradient of the road is more than 7%. For longitudinal gradient less than 7% an outward cross slope of 5% towards the valley side shall be provided.
14	Minimum horizontal curve radius	m	12.5	12.5	
15	Minimum horizontal curve radius in hairpin bend	m	10	10	
16	Average number of bypasses	no./km	2	3	
17	Size of the bypasses (length x breadth)	mxm	20 x 2	30 x 2	Located at sites visible for the drivers to stop for safe passage of vehicles
18	Minimum culvert size (diameter)	mm	600	600	
19	Opening period of the road for vehicular traffic	month	8	9	Fair weather road

Characteristic features of the green road:

1 Road suitable to mountain terrain
2 Fair weather road, i.e., road opened to the traffic for 8 - 9 months and closed during the monsoon rains
3 Road with fixed center line
4 Pavement surface is earthen with spot gravelling at places wherever required
5 Road can be upgraded to gravel road when AADT increases
6 Short drains are provided only in those places where surplus accumulated run-off flows into the road from the maountain side viz. at paddy fields and slopes with springs as well as in cases where the longitudinal gradient of the road is more than 7% Such drains would discharge into the nearest causeways, pipe culverts or cross drains.

Reference materials used:

1 Nepal Road standards 2027/2045 (HMG/MoWT/DoR)
2 Design Standards for Low-cost Feeder Roads August 1997 (HMG/MoWT/DoR)
3 Rural Road Construction in Nepal: Evaluation of Experiences from LJRP 1983 (HMG/SATA)
4 Final Report on the Implementation of TWP/PDP: Implementation Guidelines for Local Hill Roads 1996 (GTZ)

Annex C

Staged Construction

The methodology of Staged construction is an important tool to build roads which are initially constructed with a low-cost standard, but which can be upgraded in a compatible manner as soon as the traffic volume justifies additional inputs and funds are available. The method looks at design standards which need to be set in view of the final stage and design elements in which minimum initial investments can be made and gradual upgrade can be made as per need and availability of resources.

Similar to the *"Design Standards for low- trafficked Feeder Roads"* of the HMG/N DoR Departmental Policy, the following characteristics are suggested:

Road Development Stage 1	Construction of an **earth** road with a typical AADT of about 20
Road Development Stage 2	Construction of **gravel road** with improved curves, generally with a traffic volume of about 50 AADT and above
Road Development Stage 3	Construction of a **black top** (bituminous) road with improved curves and formation width, generally with a traffic volume of about 100 AADT and above

Compromises in terms of initially low- cost standards can be made in:

- the **horizontal road alignment** selection: Initially the road can be aligned along the natural contours of the mountain slope with very few exceptions where the minimum radius has to be maintained. The "narrow winding road" is mainly used by relatively slow- speed vehicles in which the passenger comfort is not strongly influenced by the vertical forces in driving curves
- the **road surface** treatment by building an **earth** road surface only generally with some spot gravelling in critical sites

Basically **no cost compromises** should be typically made in:

- **longitudinal alignment** selection: Roads with too steep road alignments need special and costly road surface treatment and road side drainage and cause problems to the prevailing vehicles. Such too steep road alignment sections often need costly realignment measures later on after initial investments have already been made. This frequent problem arises when a new road follows an initial trail alignment with a gradient suitable for pedestrian and animal users. Local teashop and landowners usually lobby strongly to retain the traffic flow nearby in view of their business. But in many cases, the road users complain later on about steep sections because of the potential road damage and accidental risks caused by the steep gradient. preventive measures regarding **erosion control** and potential landslide occurrences: All collected drainage water needs appropriate and often costly water management structures.

Annex D

Phased Construction Approach

Phased Construction in Mountain Slopes Between 5° and 55°

Phase 1: Opening of a Trail (Approximate Work Input 5%)

The major steps to be carried out in this phase to open up a trail and adjust the alignment:

a. Fixation of the identified alignment by pegging
b. Opening of a simple trail to clearly demonstrate the alignment
c. Technical review of the alignment by the site engineer in-charge in order to minimise earthwork and review the structural designs
d. Development of a consensus on the selected alignment among local people and relevant stakeholders
e. Making necessary adjustments if required
f. Finalisation of the alignment

Characteristic features of the trail are as follows:

Width:	$W_{1\,min}$ = 1.00 m
	$W_{1\,max}$ = 1.50 m
Average width:	$W_{1\,av.}$ = 1.25 m
Average cut slope height:	H_1 = 0.75 m

Phase 2: Gradual Widening to a Track (Approximate Work Input 25%)

The main task under this phase is to construct a non-motorable track along the finally fixed alignment. The major steps to be carried out in this phase are as follows:

a. Widening of the finalised alignment from Phase 1 by excavating the mountain side slope and depositing the excavated material within the cross-section of the alignment.
b. Scarifying of the top soil and excavating steps of about 0.60 m at the valley-side in order to ensure optimum horizontal backfill
c. Segregation and storage of the excavated material simultaneously as these materials can be re-used as construction material, for instance,
   - plants and top soil for revegetation of bare slopes
   - stones for construction of gabion walls, dry stone masonry walls and water management structures
   - gravel for spot gravelling at critical sections
   - remaining sand and fines for backfilling at valley-side
d. Construction of temporary dry stone walls for conserving the soil
e. Backfilling in horizontal layers with fine materials
f. Allowing the track for natural compaction by monsoon rain as well as movement of people and transportation of materials

Characteristic features of the track are as follows:

Width:	$W_{2\,min}$ = 2.00 m
	$W_{2\,max}$ = 3.00 m
Average Width:	$W_{2\,av.}$ = 2.50 m
Average cut slope height:	H_2 = 1.50 m

Phase 3: Road Construction (Approximate Work Input 40%)

This phase is to be started after allowing natural compaction of the track over the period of one monsoon.

The main task under this phase is to widen the track constructed under Phase 2 and bring it to the required green road standards. As this is the major activity towards bringing the road into the required engineering standards, there are some major steps to be followed. It is obvious that the height of cut is directly proportional to the mountain slope. The following paragraphs explain the major steps of widening and the differences with increased mountain slope. Please refer to the sketches in Annex D for more details.

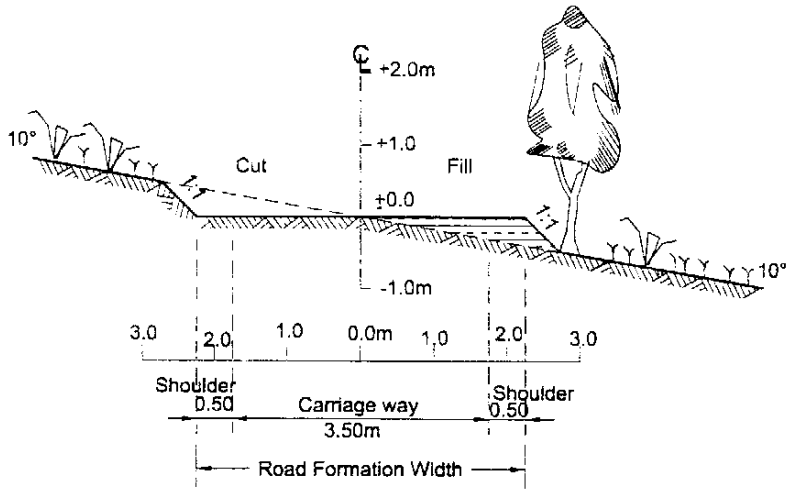
Major steps:

a. Widening of the track by excavating at the mountain side and depositing the excavated materials within the cross-section of the alignment
b. Excavation at the valley side in steps of about 0.60 m to ensure horizontal backfill
c. Segregation of the excavated material simultaneously as in Phase 2
d. Transportation of excess material to already defined sites for future re-use
e. Construction of dry stone walls for retaining backfill materials
f. Backfilling in horizontal layers with fine materials
g. Widening of the road to the required width for passing zones at specified places as per the green road standards
g. Allowing the road for natural compaction by monsoon rain as well as movement of people and transportation of materials; labour-based compaction methods can be adopted as per the need
h. Application of preventive bio-engineering measures for avoiding soil erosion and landslide

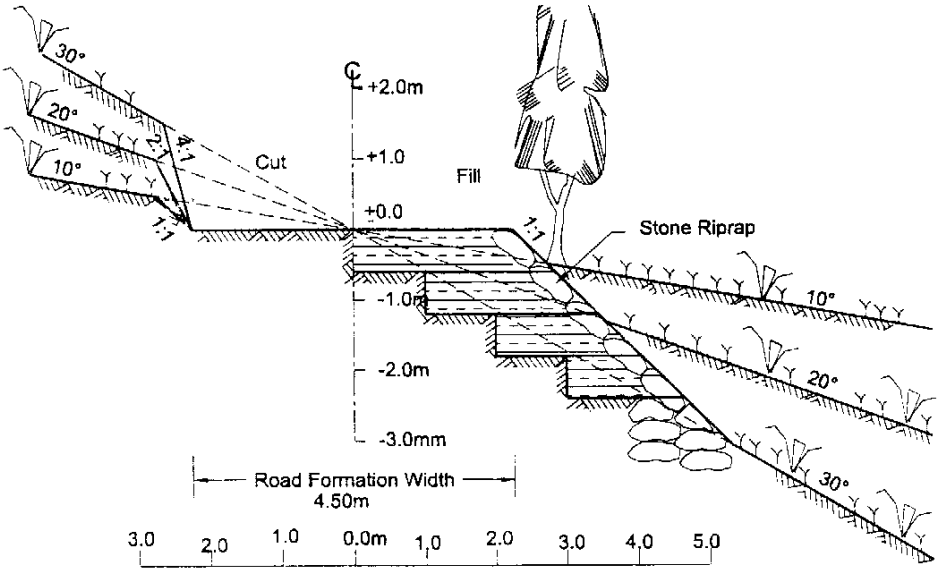
Characteristic features of the road:

Typical road width:	$W_{3\ min}$ = 4.00 m
	$W_{3\ max}$ = 5.00 m
Average road width:	$W_{3\ av.}$ = 4.50 m
Typical bypass width:	$W_{B\ av.}$ = 6.00 m
Road cut slope height:	H_3 = up to 2.00 m

Construction of fairly stable road sections in mountain slopes below 30 degrees (Cross slopes below 58%)



1. Hill slopes between 5° and 10° (cross slopes between 9% and 18%)

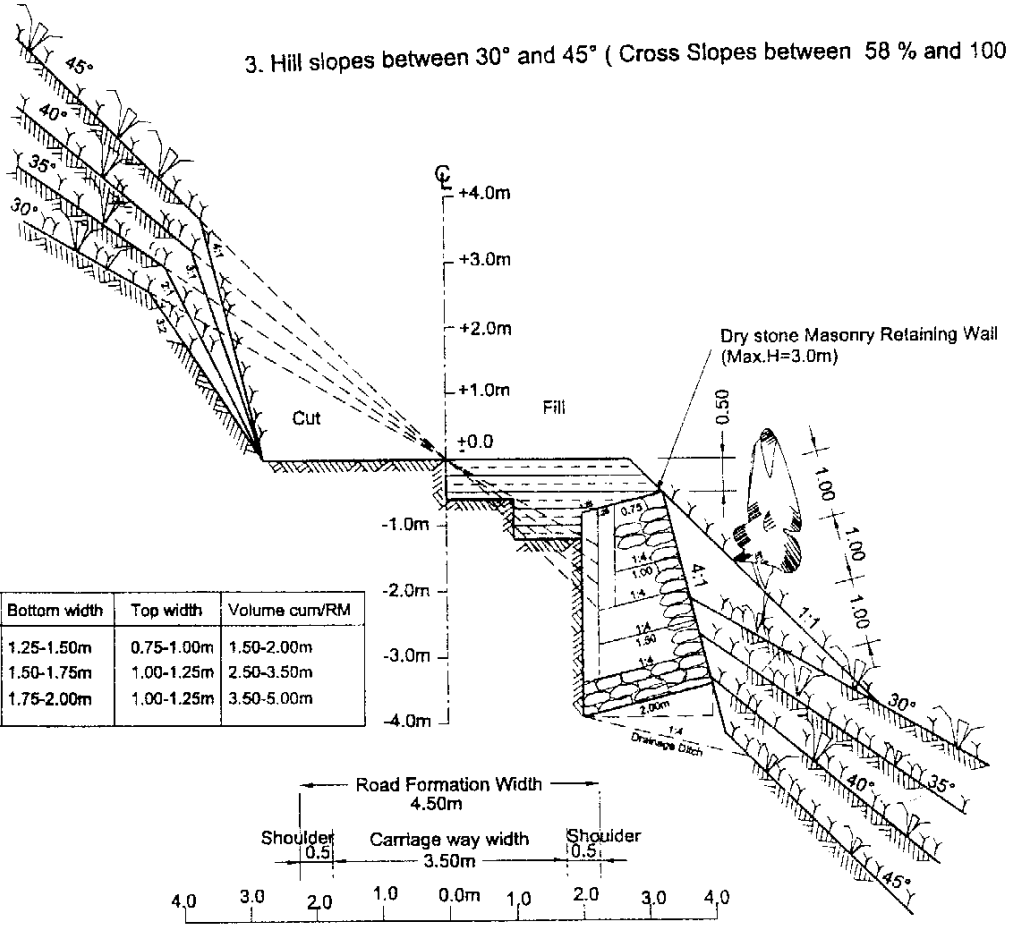


2. Hill slopes between 10° and 30° (cross slopes between 18 % and 58 %)

The Major steps for the construction are similar to 1 as explained above. The only difference is the road cut slope height H_3, which is up to 2.0 m.

Construction of unstable road sections in mountain slopes between 30^0 and 45^0 degrees (Cross slopes between 58% and 100%)

3. Hill slopes between 30° and 45° (Cross Slopes between 58 % and 100 %)

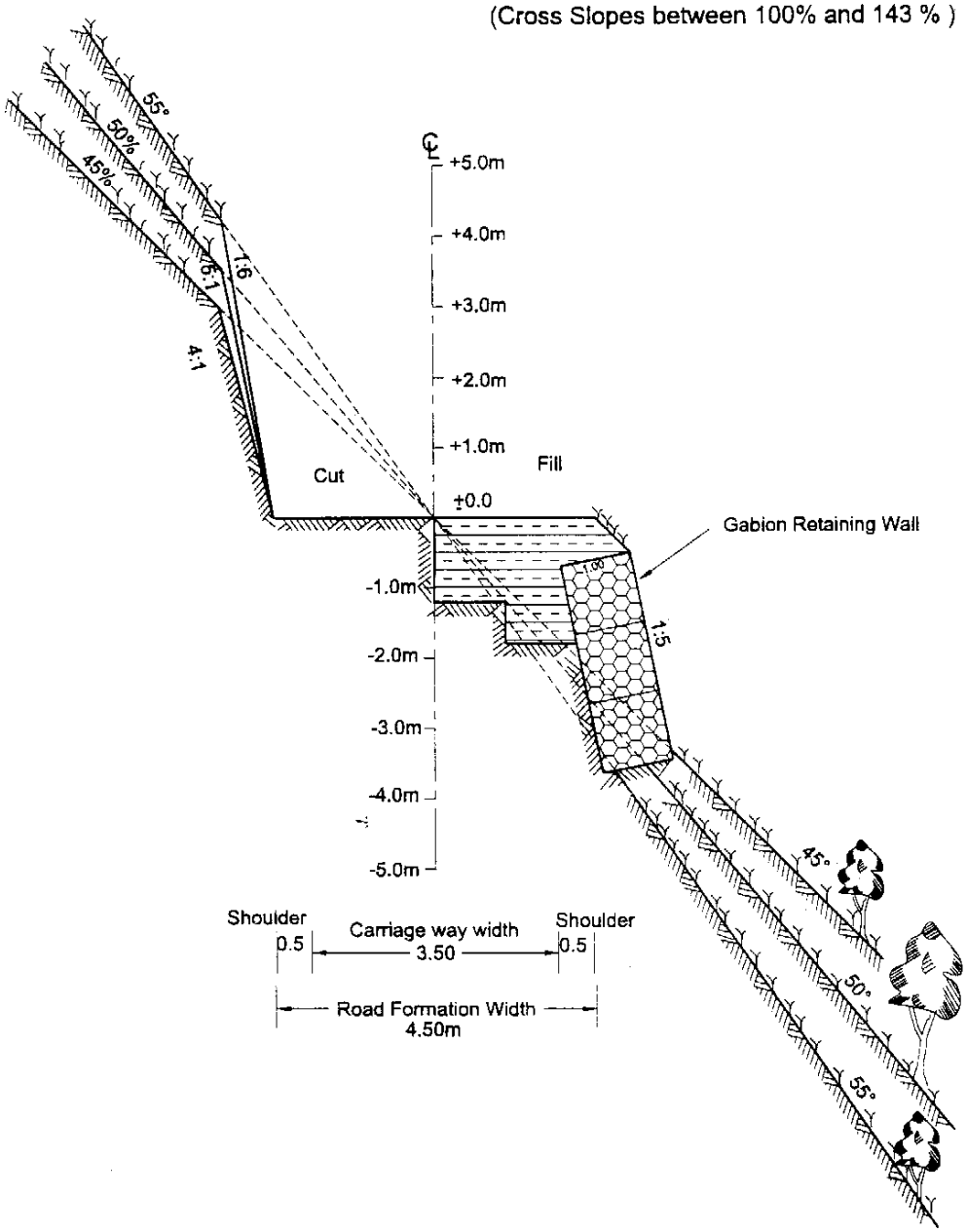


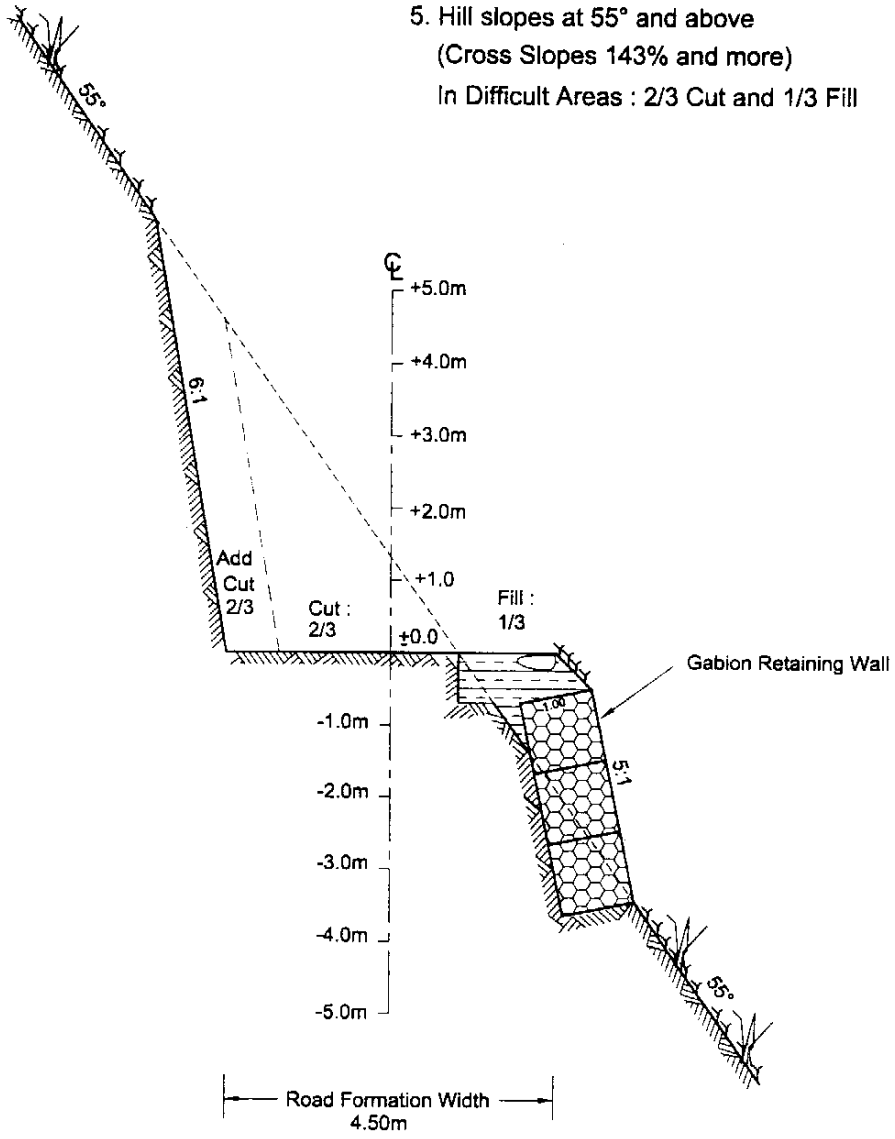
Hill Slope	Height of wall	Bottom width	Top width	Volume cum/RM
30°-35°	1.50-2.00m	1.25-1.50m	0.75-1.00m	1.50-2.00m
35°-40°	2.00-2.50m	1.50-1.75m	1.00-1.25m	2.50-3.50m
40°-45°	2.50-3.00m	1.75-2.00m	1.00-1.25m	3.50-5.00m

Construction of unstable and critical road sections with excess water flow and mountain slopes above 45 ^{0} degrees (Cross slopes above 100%)

The Major steps for the construction are similar to 1 and 2 as explained above. The only difference is the road cut slope height H_3, which is above 3.0 m.

4. Hill slopes between 45° and 55°
(Cross Slopes between 100% and 143 %)





Phase 4: <u>Water Management and Bioengineering (Approximate Work Input 30%)</u>

After the completion of Phase 3, the main task of this phase is to allow the road for natural compaction over a monsoon and give a final shape.

The major steps to be carried out in this phase are as follows:

a. Allowing natural compaction of the back filled material by monsoon water; labour-based compaction methods can be adopted as per the need
b. Formation of outward cross slope of 5% towards the valley side to drain the rain water
c. Construction of low-cost stone masonry side drains at longitudinal gradients of more than 7% and at switchbacks
d. Widening of loops at sharp bends
e. Application of preventive bio-engineering measures

Annex E

Management Support Best Practices

		Best Practices			
	Management Support	VDC supported by DDC	DDC supported by MoLD	Bilateral donor/INGO supported	International Lending Institutions (ILI)/ Multilateral supported
1	Hiring and supervision of local consultant or NGO for technical support	Consultant is hired for technical support (TS) by donors promoting GR concept TS is limited to provisions of one technician and two senior supervisors for one year and provision of training and tools	Consultant is hired for TS by donors promoting GR concept TS is for a full fledged technical team for tools and for training and imported materials	Donor/INGO hire and supervise consultant TS includes technical team, social mobilization, tools, training, imported materials and matching cash grants	Donor/INGO hire local consultant with concurrence of DDC and supervise It covers every thing including construction cost of GR
2	Procurement and supply of tools, construction materials, survey equipment and other logistics supports	Local UC procures tools unless donor provides as grant in kind Survey equipment are provided by consultant hired UC arranges its own logistics support Local people bring their own tools	Donor provides tools & materials as grants in kind Survey equipment are provided by consultant hired UC arranges its own logistics supports	Donor provides tools & materials as grants in kind Survey equipment and other logistics support are provided by donor	DDC and UC together procure tools and construction materials Donor provides the survey equipment and other logistics supports through consultant
3	Arrangement of meetings, workshops and review meetings	VDC or UC arranges and bears the costs	UC arranges but cost is borne by donor	DDC arranges it and cost is borne by donor	DDC arranges it and cost is borne by ILI
4	Work planning and monitoring	DDC or UC undertakes the task and bears costs	UC undertakes the task and bears the costs	DDC undertakes the task facilitated by consultant but costs are borne by donor	DDC arranges facilitated by consultant and costs are borne by donor through consultant
5	Management of the store and record keeping	VDC or UC undertakes the task and bears costs	UC undertakes the task and bears the cost as part of construction	Consultant undertakes the task and the cost is borne by donor as part of consultancy	Consultant undertakes the task on behalf of DDC and the cost is borne by donor as part of consultancy
6	Site work management	UC takes the responsibility	Consultant or NGO and UC jointly take responsibility	Consultant (or NGO) and UC jointly take responsibility	Consultant (or NGO) and UC jointly take responsibility

		Best Practices			
	Management Support	VDC supported by DDC	DDC supported by MoLD	Bilateral donor/INGO supported	International Lending Institutions (ILI)/ Multilateral supported
7	Co-ordination at different levels and between different partners	VDC co-ordinates between different political parties and UC DDC/MoLD co-ordinates between donor and VDC UC co-ordinates between wards and local people	UC co-ordinates between VDC and DDC Consultant co-ordinates between UC, VDC and people DDC/MoLD co-ordinates between donor and UC	DDC/MoLD co-ordinates between donor and UC Consultant co-ordinates between UC, VDC, DDC and people UC co-ordinates between consultant, VDC and people	DDC/MoLD co-ordinates between donor and UC Consultant co-ordinates between UC, VDC, DDC and people UC co-ordinates between DDC, consultant, VDC & people
8	Labor wage payment and record keeping	UC undertakes labor payment and UC/VDC keep records	UC undertakes labor payment and record keeping, assisted by consultant or NGO	Either donor/NGO or DDC undertakes labor payment and record keeping	DDC undertakes labor payment and record keeping
9	Physical and financial progress monitoring	Donor where donor involved DDC VDC	Donor DDC	Donor MLD or DDC	Donor MLD or DDC
10	Treatment of injured and compensations for death or injuries	UC arrange it with its own expenses	UC arranges it with its own expenses	DDC arranges it and pays out of donor support funds	DDC arranges it and pays out of ILI support funds
11	Compensation for land or property	People provide land free of cost and land compensation is not provided Effected households are compensated indirectly by providing employment in road program and by reconstructing the property Concerned VDC is overall responsible to provide land free of cost	Ditto	Ditto	Ditto
12	Technical and financial auditing	Mass meeting of users Internal auditing by DDC and external by HMG, auditor general office	Review meeting of user assembly Internal auditing by DDC and external by HMG, auditor general's office	Review meetings at DDC Appointment and approval of independent auditing by user assembly Special auditing as per donor/INGO policies and practices	Review meetings at DDC Internal auditing by DDC and external, by HMG-auditor general's office Special auditing as per ILI's policies and practices

Annex F

Labour-based Tools and Equipment

Approximate number of tools and equipment required for a typical green road construction site of 10 Km length during a period of 3 years for 25 labour groups with 15 labourers per group, i.e., 375 labourers

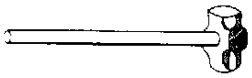
S. No.	Name of tools in English/Nepali	Approx. Weight per Piece (in kg)	Approx. Amount required per labour group (in no.)	Approx. Amount required per Site (in no.)
1	Aluminum water vessel 20 litre (Gagro)	2.75	1	25
2	Axe (Bancharo) local made	2.50	1	25
3	Bamboo wicker baskets (Doko or Thunse with Namlo)	2.0	18	450
4	Chisel (Chinno) Ring pin	2.00	4	100
5	Crowbar (medium) 1 1/8" dia	4.50	1	25
6	Crowbar (large Gal)	11.00	1	25
7	Crowbar (small Gal) 1"dia	7.20	1	25
8	Crowbars (extra 1/8") for chisel	9.50	2	50
9	First Aid kit box with medicines and bandages (boxes)	3.00	-	5 boxes
10	Frog and Feathers	0.50	3	75
11	Hammer (Ghan) large (10 lb)	4.50	1	25
12	Hammer (Ghan) small (5 lb)	2.27	1	25
13	Hammer (Ghan) medium (2 lb)	1.00	2	50
14	Large tarpolene sheet (Tripal)	2	-	20
15	Mason's hammer (Mairi)	1.00	4	100
16	Mason's nylon thread (3 mm dia.)	1	2	50
17	Nylon rope in coils of 40m (6mm dia.)	1.50	2	50
18	Pan (Karai)	1.70	2	50
19	Pick (Gainti Tata)	2.50	6	150
20	Pipe level (3" dia. polythene pipe 10 m long)	0.25	-	10
21	Plastic Mug	0.10	2	50
22	Pliers for gabion crates (Penchis)	0.8	-	5
23	Plumb bob (Ghanti)	0.25	2	50
24	Shovel (steel handle Indian kiwi)	2.40	6	150
25	Sickle (Ansu or Hansiya locally made)	1.50	1	25
26	Spade (prefer local made Kuto or Kodalo)	1.75	6	150
27	Spirit Level (Pani Level)	0.2	-	10
28	Tape (Phitta) 30 m	0.75	-	10
29	Tape (Phitta) 5 m	0.15	-	15
30	Terai Spade (Faruwa)	2.00	2	50
31	Trowel (Jyawal)	0.3	-	10
32	Wheelbarrow (Thela Gadi) pneumatic	25.00	2	50
33	Spares for wheel barrow at 20% of wheel-barrow cost (set)	5.00	-	-

Equipment

34	Calculator	0.5	-	5
35	Computer, printer and accessories	10	-	1
36	Drilling Machine with accessories	25	-	1

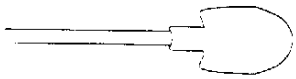
CROW BAR (GAL)

SLEDGE HAMMER (GHAN)

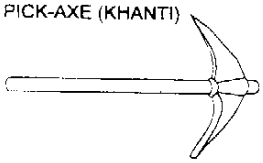


IRON PAN (KARAI)

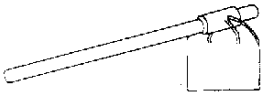
SHOVEL (BELCHA)



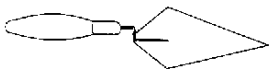
PICK-AXE (KHANTI)



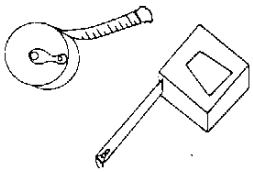
HOE or MATTOCK (PHORUWA)



TROWEL (KARNI)



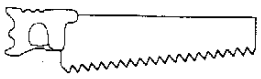
MEASURING TAPE (NAPNE FOOT)



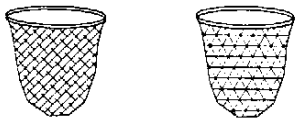
SPIRIT LEVEL (LEVEL)

PLUMB BOB (GHANTI)

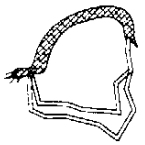
HAND SAW (KARAUTI)



BAMBOO BASKET (THUNCHE, DOKO)



TOMPLINE (NAMLO)



ROPE (DORI)

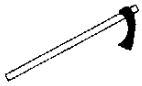
WATER LEVEL (PANI LEVEL)

SICKLE (HANSIYA, KHURPA)

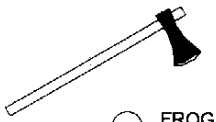
CHISEL (CHINO)

KHUKURI

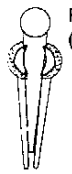
SPADE (KUTO)



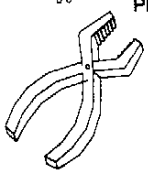
AXE (BANCHORO)

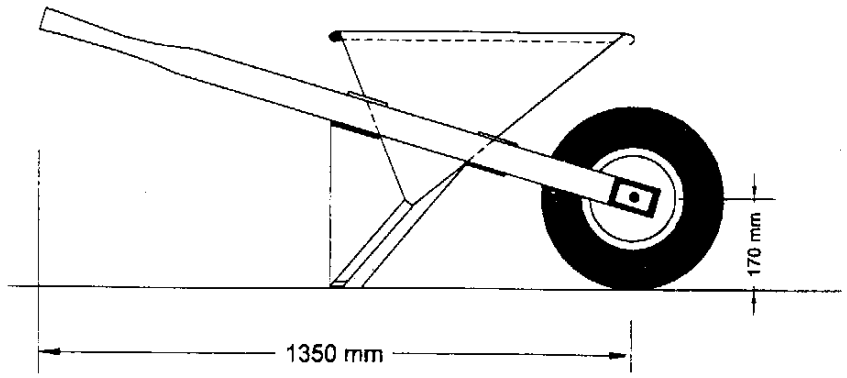


FROG & FEATHER
(DHUNGA FORNE CHHINO)

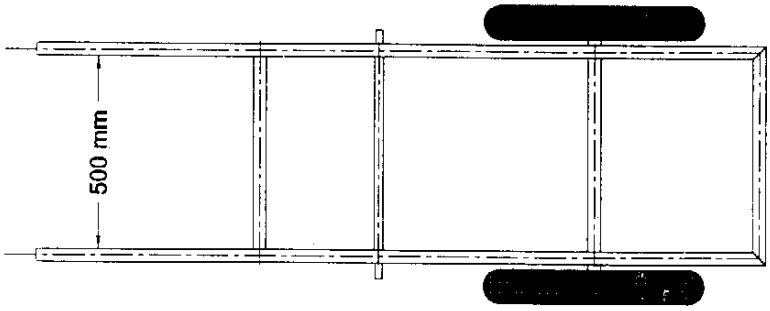


PLIERS (PENCHIS)

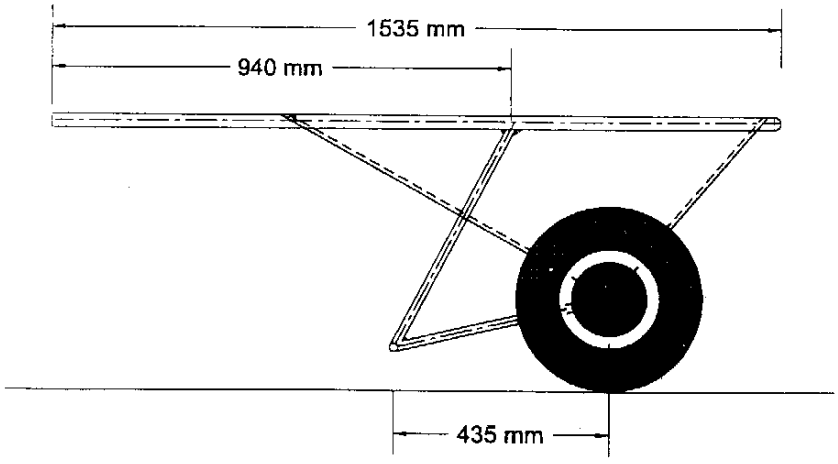




SIDE VIEW
WHEELBARROW (with single wheel)
Volume = 50 Litres



PLAN



SIDE VIEW
WHEELBARROW (with double wheels)
Volume = 100 Litres

Annex G

Green Roads Work Norms for Analysis of Rates

Activity No.	Description of Item	Unit	Labour		
			Category	Unit	Quantity
1.	**Bush clearing:** Clearing of dense bushes and shrubs and deposition at specified places into piles within a lead of 30 m	Sq.m.	Unskilled	Md	0.06
2.	**Earthwork in Excavation**				
a)	Earthwork in excavation in ordinary and stone mixed soil, separation, transportation and stockpiling of useful stones, gravel, topsoil and planting materials for re-use in road construction; transportation and deposition of excavated earth in layers by applying the principles of mass balancing within a lead of 10 meters	m^3	Unskilled	Md	0.70
b)	Earthwork in excavation in ordinary, stone mixed and hard soils without resorting to mass-balancing, transportation and proper deposition in layers	m^3	Unskilled	Md	0.40
c)	Earthwork in excavation in hard soils, soft rocks, gravel and excavation under water including gravel and boulders and separation, transportation and proper stockpiling of useful stones for re-use in road construction; transportation and disposition of the excavated materials at required places in layers within a lead of 10 meters by applying the principles of mass-balancing	m^3	Unskilled	Md	1.00
d)	Excavation in medium and hard rocks in large quantities manually with hand tools including heating and rapid cooling of rock blocks where necessary; Separation, transportation and stockpiling of useful stones for re-use in road construction; transportation and deposition of the other remaining materials in layers within a lead of 10 meters by applying the principles of mass-balancing	m^3	Unskilled	Md	5.00
e)	Very hard rock cutting in small quantities mainly with chiseling including separation, transportation and stockpiling of useful stones for re-use in road construction; transportation and deposition of the remaining materials in layers at specified places within a lead of 10 meters by applying the principles of mass-	m^3	Unskilled	Md	20.00
3.	**Material Collection and Stockpiling:** Surface collection/quarrying of stones including breaking of required size and neatly stockpiling into 'Chatta' within a haulage distance of 100 meters from the 'Chatta'	m^3	Unskilled	Md	1.40
4.	**Wall Construction:** Proper dry stone masonry and gabion masonry wall construction with semi-dressed stone into headers and stretchers and bond stones being surface collected or quarried including utilisation of stones obtained from earthwork excavation from within a lead of 30	m^3	Unskilled	Md	1.00
5.	**Back Filling:** Filling in retaining structures with rubble stones collected and transported from within a lead of 30 meters	m^3	Unskilled	Md	0.70
6.	**Stone Soling:** Stone soling with selected size 30 cm thick semi-dressed stone including tight packing and hammering of smaller stones in the joints (excluding collection and transportation of stone) at slippery hair-pin bends and depressed rills as well as for the construction of dry stone causeways	m^3	Skilled Unskilled	Md Md	1.00 2.00

Activity No.	Description of Item	Unit	Labour		
			Category	Unit	Quantity
7.	**Transportation Works**				
a)	Mainly horizontal and downhill transportation of construction materials like stone, sand, gravel and soil in wheelbarrows for every extra 30 m lead including loading and unloading (0.20 md-unskilled labour/m^3 of material)	m^3	Unskilled	Md	0.20
b)	Uphill transportation of stone, sand, soil and gravel carrying in the back mainly in Dokos or Thunses (wicker baskets) including loading for every 30m extra lead	m^3	Unskilled	Md	0.40
8.	**Surface finishing:** Final grading and surface finishing of the road (4.5m width) including back filling of rills and depressions with stone or gravel or mixed soil collected locally; levelling and formation of 5% outward slope of the road surface, re-establishing the longitudinal gradient where disturbed; revegetation of the outward edge with turfing, grass slips etc.	rm	Unskilled	Md	0.20
9.	**Spot gravelling:** Spot gravelling of 15cm thickness with supplied gravel including compaction of the gravel layer manually by hammering including transportation in wheelbarrows up to a distance of 30m	m^3	Unskilled	Md	0.40
10.	**Gabion works**				
a)	Supply of medium coated gabion wire (mesh wire #10SWG and selvedge wire #8SWG) in coils of weight not exceeding 50kg for fabricating gabion crates with mesh size of 20cm x 12cm (1 kg of total wire weight/2.25 sq. m of crate surface with selvedge wire at 10% of total weight)	kg			
b)	Cutting, rolling, bending and weaving and fabrication of gabion crates of different sizes:				
	Box size 3m x 1m x 1m		Skilled	Md	0.03
	Box size 2m x1m x 1m		Unskilled	Md	0.01
	Mat box size 3m x 3m x 0.5m				
	Wire cap size 3m x 1m x 0.5 m				
	With mesh size of 10cm x 12cm with #10SWG and border with #8 SWG selvedge wire	Sq.m.			
11.	**Bio-engineering and plantation works**				
a)	Supply of large size Ketuke, Nigalo, bamboo bush type plants at 60cm spacing for 100 plants	No.*	Unskilled	Md	3.20
	Planting of these plants	No.*	Unskilled	Md	0.44
b)	Supply of small size Ketuke or pine-apple shrub type plants with roots	No.*	Unskilled	Md	1.60
	Planting of these plants at 60 cm spacing for 100 plants	No.*	Unskilled	Md	0.44
c)	Supply of cuttings of Simali, Asuro, Dabdabe, Kapro hedge type of plants	No.*	Unskilled	Md	1.00
	Planting of these plants at 60 cm spacing/100 cuttings	No.*	Unskilled	Md	0.44
d)	Supply of grass root slips like Kans, Katrakhar, Salimbo, Prirre, Siru, Kharuki, Amriso etc.	Kg++	Unskilled	Md	
	Transplanting of these plants at 10 cm spacing with at least two stems of grass root slips per spot	Kg++	Unskilled	Md	1.60 2.00

P. S.: * For 100 plants ++ For 100 kg of grass root slips

Annex H

Summary of Contents of the Forms and Formats Suitable for Green Road Site Management

Form No.	Subject Matter of Form	Form's Main Contents	Form Addressed To	Form to be filled by	Remarks
1.	Letter pledge for providing labour for construction and maintenance as per UC decisions and policies	Four columns with headings on serial no, name of person or official, official designation and signature (numerous rows).	UC Chairman	Workshop participants and all persons receiving training	Pledgers agree also undertake maintenance of specified road sections even with voluntary labour in case of no available fund.
2.	Letter request for registration of labour group and for training of Naike (or mason)	Six columns and 20 rows with headings on serial no., name of labour, age, father's name, grandfather's name, signature.	UC Chairman (or VDC Coordinator)	Labour group members	Up to 20 persons of 16 years or older can register a group specifying Naike (or masons).
3.	Recommendation for Naike training	Three columns and up to 10 rows with headings on serial no., priority orders, name of person nominated for Naike.	UC Chairman	VDC Coordinator	
4.	Request for providing Naike or mason training	Two columns and up to 20 rows with headings on serial no and name of person selected for training	Chief technician responsible for providing training designated by donor	UC Chairman or designated UC official	UC meeting decides persons to be provided training selection is based upon a criterion.
5.	Certificate of training of Naike (or mason)	Name of programme, DDC, place of training, name of trainee and his address, signature of technician providing training and date.	—	Technician is responsible for providing training.	—
6.	Application for work assignment by a labour group through Naike.	Name and address of the Naike and five columns on serial no, name of labourers, father's name, grandfather's name and signature and twenty rows.	Site Incharge overseeing construction	Naike and labour group	Only trained Naike and labour group can apply. The form can also accompany a pledge similar to form no.1.
7.	Work Order Form	Contains work order no. and information of place where work is assigned and the particulars of the group provided with the work order.	—	The work order is given by the site in charge by filling the form, ticking and signing the items of works to be performed in the presence of the witness UC member who also counter signs.	Form contains serial no with boxes to be ticked, description of works to be performed, unit and unit rates of the works that will be paid. The backside of the form contains the guidelines and other particulars for filling the form by the site in charge.

Form No.	Subject Matter of Form	Form's Main Contents	Form Addressed To	Form to be filled by	Remarks
8.	Daily work progress report	Contains work progress report specifying site name and chainage, labour nos. and brief work description, particulars of people present at site from UC, NGO, Consultant and other sides and other particulars.	Site Incharge	Form is filled by site supervisor.	Form also tries to identify problems and attempts to find solution, main decisions of meetings, name of visitors and main advises given.
9.	Daily attendance record of workers	Form contains 35 columns and 20 rows with serial no, name of worker, 32 box columns for attendance ticking and last column stating no of days worked by each labourer.	Is submitted to UC, via site in charge with forms 9 and 10 & 7	Daily record keeping is done by Naike, which is verified by supervisor.	The daily attendance record is submitted to UC for labour payment together with work measurement and certified bill.
10.	Accomplished work measurement form	The form contains 8 columns and 21 rows, with headings, serial no, description of work, nos., length, width height, quantity and remarks.	Is submitted to UC with form 9 and forms 10 and 7	Site Incharge measures and fills the form witnessed by Naike and UC member.	The form in its heading specifies work order no., particulars of site, particulars of group etc.
11.	Value of accomplished work and recommendation for labour payment (priced bill of quantities)	The form contains 7 columns and 15 rows with headings, serial no., description of work, unit, quantity, rate, amount and remarks.	Is submitted to UC with forms 9, 10 and 7	Site Incharge fills form on the basis of form no. 10 and 7.	The form's heading contains recommendation no, particulars of site, particulars of group etc. and bottom of the form contains a request and recommendation to UC for labour payment.
12.	Request for labour payment	The form contains 7 columns and 20 rows with headings, serial no., name of Naike, VDC ward and village of Naike, technician's recommendation no., amount of money to pay to labour groups.	Is submitted either by consultant's overall in charge to UC or by UC to the LDO as the case may be	Form is filled either by consultant's overall in charge or by authorized UC member.	Bottom of the form contains total amount and particulars of person requesting for labour payment.
13.	Receipt form (to be signed by labourers receiving payment)	The form contains five columns and 20 rows with headings, serial no., name of labourer, total number of days worked, amount received by labourers and signature of the labourer.	Is addressed to either the LDO or the UC Chairman responsible for labour payment	The accountant of LDO or UC or the UC member responsible for labour payment fills up the form and obtains signature of each and every labourer paid.	Top of the form contains particulars of site and labour group and bottom contains signature of witnesses, witnessing the labour payment.

Annex I

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Werner Paul Meyer; M. Eng.; currently Rural Transport Infrastructure Consultant with the Regional Rural Development Projects of the German Technical Cooperation GTZ Nepal; since 1985 active in the Rural Mountain Road Sector, initially with the Local Road Improvement Programme of the Tinau Watershed Project in Palpa, start-up support of the Green Roads in Dhading, from 1994 onwards management of Technical Assistance of the Pilot Labour-based District Road Rehabilitation and Maintenance Project in 4 Districts in Western Nepal.

A brief historical review of the rural road sector in Nepal

The history of road construction in Nepal is closely linked with international assistance since the very beginning which began only about four decades ago. It started in 1953 with the construction of the Tribhuvan Rajpath by the Indian Army linking the Indian border with Nepal's capital city Kathmandu. About eleven further major North-South trunks followed from the 1960's onwards with support of the Chinese, Indian, American, Swiss and British Governments. The construction of the Mahendra Rajmarg (East – West Highway) stretching over 1000 km in the flat Terai was started in the late 60'ies linking for the first time East- and West Nepal with the Central part. It is now in its final stage of completion. In 1998, the National-level Highway and Feeder Road Network consisted of about 4740 km of roads and is managed by the Department of Roads. His Majesty's Government of Nepal, supported by the main donor agencies, has given considerable importance to develop a national-level road network linking district headquarters and other economically important areas.

Under increased political pressure of the parliament in the early 1990's, the Government feels a commitment to connect all 75 districts with motorable Feeder roads in view of social justice and fulfilment of the basic needs. A growing concern from bilateral donors as well as multilateral loan partners is that the rate of return on road transport investment is significantly lower in Nepal than in other similar countries. Some major reasons are the increased construction and maintenance costs partly due to the difficult mountain topography and the monsoon. Solutions are required to meet both concerns of providing increased access to the still remote rural areas as well as reducing the unit costs of road construction, rehabilitation and maintenance.

In general, roads in Nepal have been built without sufficient conservation of the fragile Himalayan mountain ecosystem and attention to environmental aspects. Though some donor supported roads were built already in the early 1980's with environmental protection measures, they have been considered as too expensive for replication in a wider scale. The construction of local rural roads through local governments with people's participation has been practised already since about two decades. Self-help construction is rapidly increasing since the democratisation and allocation of funds to each Village Development Committee and implementation through User Groups in popular political movements BOVO (Build Our Village Ourselves). Such rural roads are cheap, but are mostly built without adequate planning, lack of technical support and construction supervision. Environmental aspects have been considered during construction. These roads are often not in operation after one or two rainy seasons.

Based on the first experiences of a more conservation-oriented road construction of the Swiss supported Lamosangu-Jiri Road in the early 1980's, a new type of mountain road construction focusing on environment-friendly ways was gradually developed that was suitable for the Nepal mid-mountains. The approach was further developed from 1985 onwards by rehabilitating defunct tracks and building a new type of rural low-cost, low-volume roads using participatory and labor-based methods in the Palpa District. The Local Road Improvement Programme (LRIP) was implemented by the District with the Tinau Watershed Project / later Palpa Development Programme with technical and financial assistance of Helvetas and GTZ.

With some further adjustments, the new rural road construction approach was transferred to Dhading in the frame of Dhading Development Project (DDP). With further modifications the then called "Green Road Concept" was introduced in 1988 in the GTZ- supported DDP along two roads and later on replicated and improved in the Regional Rural Development Programmes of Gorkha, Lamjung and Sankhuwasabha. Since the mid 1990's, the Rural Community Infrastructure Work Programme (RCIW) supported by UN World Food Programme and with technical support of GTZ adopted the concept in a wider number of local roads in over 20 districts. More than 300 km of Green Roads have been built in various Districts and currently a considerable amount are under construction.

This Best Practices Report in hand summarises the experiences and lessons learnt of a selected number of rural mountain roads built as Green Roads by applying the "Green Road Concept".