USAID/NEPAL

FINAL PROJECT EVALUATION REPORT

LANDSLIDE AND SOIL STABILIZATION PROJECT

FAR WESTERN HILLS ROAD

DHANGARHI TO DADELDHURA

NEPAL

USAID PROJECT NO. 367-0138

by

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December 1983

Kathmandu

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EXECUTIVE SUMMARY

This is the final review for the Landslide and Soil Stabilization Project (LSS) done on the Far Western Hills Road between 1979 and 1982 under USAID/Nepal Project No.367-0138. The review team consisted of a Geotechnical Engineer specializing in highways, a Soil Scientist with highway experience and a Rural Economist.

The team concludes that the project goal of providing an operable all weather road was met. The structures in general were built as planned, and to high quality.

The DOR is not, at this point, prepared to assume responsibility for ongoing operation and maintenance of the road at the standard to which it was constructed. The equipment is worn out and they are not organized, budgeted or trained to keep the road functional except during the dry seasons.

The revegetation component was generally unsuccessful. The two nurseries were well designed and executed but the transplanting program failed because of site erosion, incorrect species selection, and a variety of other reasons. Future work should concentrate on grasses rather than trees, and on facilitating natural regeneration. Any future revegetation project leader should be more highly qualified than was the case in LSS.

The road has become a part of the environment and is relied upon by the people. Several important statistical indicators vary directly with distance from the road. Alternative forms of transport in the road corridor have largely disappeared as porters have turned to other work. Events which unexpectedly close the road, as the Sept. 11 and 12, 1983 storm, cause shortages of key items, such as salt, and drastic price rises for available supplies.

Financial procedures developed to expedite transfers of funds for LSS were successful and have been adapted to other AID/HMG projects since FY 1982/83.

The people of the area appreciate the road and realize that it is a major benefit to them. During the original WHR construction (1969-79) they were well aware of AID involvement. However, during LSS, AID personnel were not highly visible along the project and so the people seem to have accepted that AID is not presently involved.

INTRODUCTION AND PROJECT HISTORY

The Far Western Hills Road (WHR) extending some 135 km. from Dhangarhi to Dadeldhura was built under USAID Project No.367-0210 between 1969 and December 1979 when the project was closed. The selection of this project in 1969 is curious because it still is not connected to the remainder of Nepal, except through India, and because the terrain and geologic situation are among the most difficult ever seen by the writers.

During the construction period extensive landslide problems developed throughout most of the 110 km north of Godawari. Dr. Eugene Kojan, then of the US Forest Service, an Engineering Geologist with extensive landslide experience, was brought in to recommend solutions to the problems. His report dated June 21, 1978, was severely critical of most of the decisions made in locating and building the road. He recommended solutions in general terms and Mr. Tej Mathur, a Geotechnical Engineer of Indian birth, now a US citizen and also employed by the US Forest Service, spent several weeks in the field translating Kojan's recommendations into site specific design items. His report was completed in May 1979.

The Landslide and Soil Stabilization Project (LSS) was developed on the basis of Mathur's plans and estimates. It was funded as USAID Project No.367-0138 and the agreement

was signed on November 29, 1979. The initial US obligation was to be NRs. 28,257,375.41 (US$ 2,374,569.36) of which NRs 13,669,750.41 (US$ 1,148,718.52) was carried forward from the WHR Project. The HMG/N contribution was estimated at NRs. 9,419,500. The final AID expenditure was NRs. 27,746,135.44 which was 1.84% below the estimate. The final HMG/N contribution was NRs. 8,833,797.22 which was 1.85% below the estimate.

The principal objective of the LSS was to "ensure that DOR assumes operational responsibility for an operable all weather road without significant environmental problems". (Project Memo of 2/28/80, J.P. Guedet to File).

As it was in November 1979, the WHR was not an operable all weather road and if turned over to HMG at that point without further assistance might have been substantially abandoned.

Under the grant agreement, all work was to be done by Nepali engineers and contractors with a minimum of U.S. technical involvement beyond the Kojan and Mathur studies. There was a modest component for training of Nepali Engineers in certain special techniques which was funded separately under the Trail Suspension Bridge Project No. 367-0119.

A Nepali Consulting Engineer was to be retained to supervise construction work under the project. AID was to fund semi-annual reviews by an Engineering Geologist beginning in May 1980. Presumably this was to be either Kojan or Mathur. None of these reviews was ever made and the Nepali Consulting Engineer was not retained.

A former Peace Corps Volunteer, David Reed, was employed as an Environmental Technician and given responsibility for the revegetation effort which was aimed at reducing erosion and siltation and ultimately to help stabilize the landslides by moderating water movements. Mr. Reed had some academic background in biological science but was by no means a soil scientist or agronomist. He made a very sincere effort and attained some success, but he was constrained by his lack of specialized training.

The project was terminated and declared complete on schedule on July 15, 1982. It was substantially on the budget target, as was indicated previously.

No previous project reviews have been conducted. There is a file consisting of thirteen trip reports, each one several pages in length, which adequately describe the progress of the work (Appendix).

An unfortunate event occurred on September 11 and 12, 1983 when a storm of unusual intensity, even for the monsoon season, struck the area. The rain gauge at Dadeldhura recorded 216 mm of rainfall, 800 % of normal and the heaviest single rain in 14 years of record at that station. At Godavari, the other end of the road, 232 mm of rain fell in the period showing that the storm was uniformly distributed over the project. Due to this storm, the month of September is also the wettest in 14 years of record at Dadeldhura.

Several people lost their lives and a great amount of damage was done, including reactivation of many slides thought to be controlled by the LSS works. There is no estimate of the return frequency of this kind of storm since weather data in Nepal do not go back in time far enough to allow meaningful computation. It may well have been a 50 to 100 year event. It seems safe to assume, however, that a storm of this magnitude is highly unlikely to occur as often as one time in the economic analysis period of a given road project. Thus the LSS works were subjected to conditions exceeding the design parameters and where damaged, should not be judged solely on the basis of this one event. The timing of the storm, just after formal termination of the LSS project is an unfortunate coincidence.

This team was charged with the review of the LSS project, not of the earlier WHR project. However, it was asked to investigate certain aspects basic to the road itself, particularly the impact of the road on the people and their society.

Three separate, free standing reports are combined in this package. The engineering aspects are reported by Geotechnical Engineer Martin Everitt who was primarily interested in whether the LSS works were built in substantial compliance with Kojan's concepts and Mathur's designs. Everitt also examined the equipment, organization, and budgeting in place for routine operation and maintenance of the facility, based on his knowledge of similar organizations in the U.S.

Soil Scientist Paul Winkelaar reports on the revegetation component of the project and its relationship to the overall objectives of the LSS. He also presents a reconnaissance report on the major soil categories found along the corridor with some data which will be useful for future maintenance efforts.

Tek Bahadur Thapa, a Rural Economist, studied the broader implications of the WHR and its impact on the people of the area extending for several kilometers on each side of the route. In so doing he interviewed many people and the data compiled in these interviews is included in his report.

Many of these data are numerical facts which individually do not support particular conclusions, but in total, clearly show that the WHR has become an important part of local life.

METHODOLOGY

This evaluation used an unusual methodology. The group decided early that the three disciplines represented had relatively small areas in common. Thus it was decided that each would function independently, though generally in a group with frequent discussion and exchange of ideas. In the field Everitt and Winkelaar stayed together throughout, each observing the facilities from his own viewpoint and discussing them frequently. Thapa was in the same area but collecting his own data.

In preparing this report, each principal wrote a free standing report which complements but does not overlap the other two. Any of the three reports is intended to be read separately by persons interested only in that material, without the necessity of studying the total, fairly lengthy, paper.

The principal conclusions are stated in the Executive Summary. These address the five broad questions posed in the PASA (Appendix). Each report has a number of specific recommendations in it and these are directed to the Engineer or Manager who must act on individual portions of the total study.

This presentation is somewhat different from the usual format. The authors feel that it is a useful and convenient presentation. The multi-disciplinary team approach has worked well and has permitted each member of the group to present his own ideas as forcefully as he felt was necessary. The team members suggest that this approach should be used in future such efforts where there is little occasion for overlapping of subject areas.

PERSONNEL AND ACKNOWLEDGEMENTS

The review team consisted of the following members:

Martin C. Everitt, Geotechnical Engineer, Arvada, Colo.
Tek Bahadur Thapa, Consultant Economist, Kathmandu
Paul Winkelaar, Soil Scientist, USDA Forest Service,
Wasatch National Forest, Salt Lake City, Utah.

The following individuals also participated in the field trip:

Birendra B. Deoja, Engineer, DOR/HMG
George E. Lewis, Acting Deputy Director, AID
Hari P. Pokhrel, Program Assistant, AID

Mr. Deoja had been Project Engineer during a portion of the WHR construction. His accurate personal recollection of construction details and decisions, as well as his ability to locate particular spots where surveys have not survived, was an important contribution to the team. His knowledge saved many hours of study and work.

George Lewis provided a valuable insight into the interaction of AID with DOR, and this team. He was also most helpful in explaining some of AID's organizational considerations and other background data which the team would have otherwise lacked.

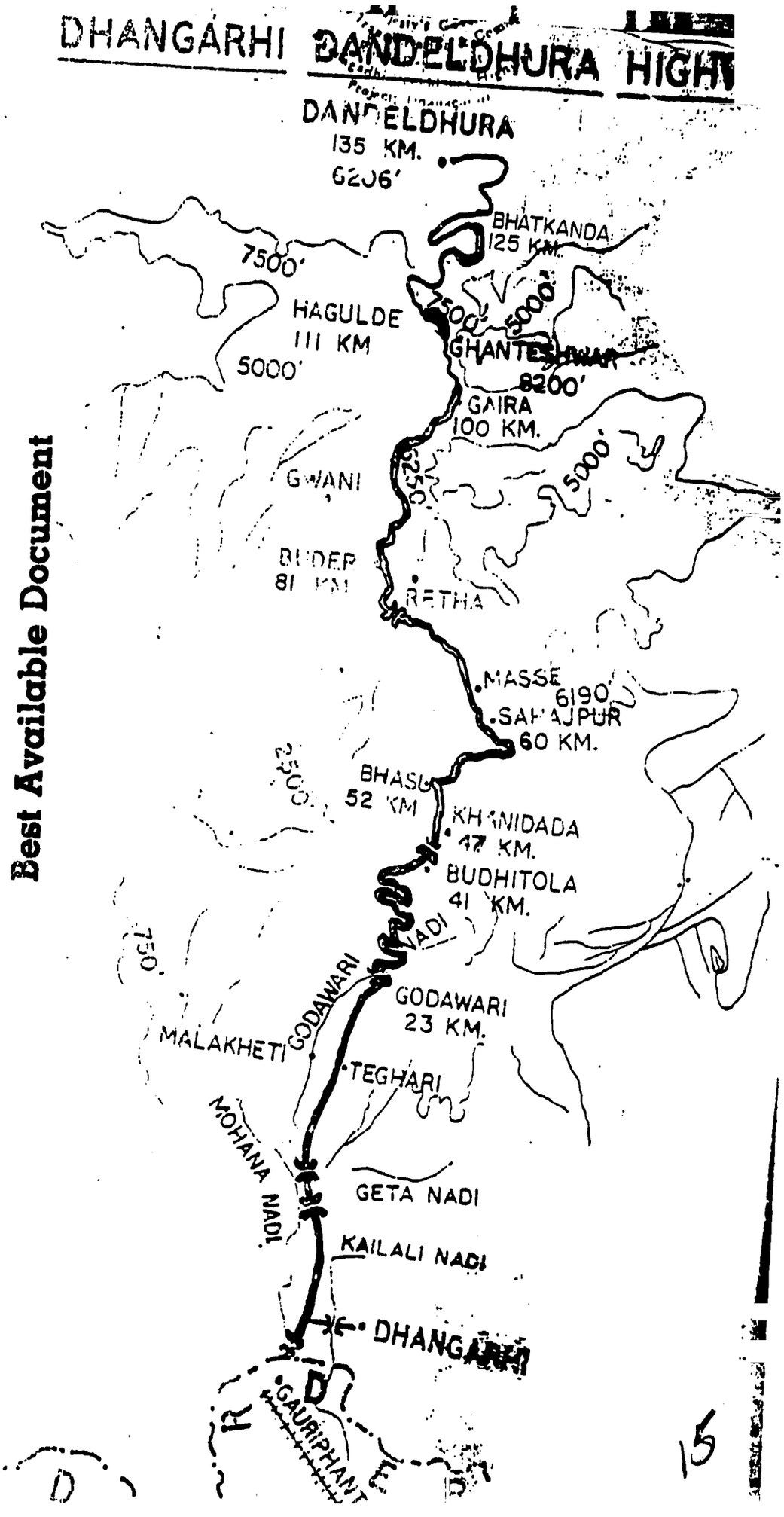
H.P. Pokhrel handled all of the logistics of the field trip with tireless energy and flawless attention to detail. His knowledge of people, titles and functions, as well as the inner workings of the LSS Project are invaluable. In addition he was a valuable assistant in the collection of Mr. Winkelaar's soil samples.

Itinerary

10/29/83	Depart Kathmandu by Government Auto via Lucknow, India.
10/31/83	Arrive Godavari DOR Camp.
11/1/83	Interviews in the Dhangarhi and Godavari area
11/2/83	Travel to Bhatkanda by Govt. Auto and foot.
11/3/83	Travel to Dadeldhura by Nepal Govt. Auto. Conduct interviews and return to Bhatkanda on foot inspecting LSS works and recent damage.
11/4/83	Travel to Budar by foot and Govt. Auto inspecting LSS works en route.
11/5/83	Inspect LSS works, Gaira to Budar.
11/6/83	Inspect LSS works, Budar to Godavari.
11/7/83	Travel by RNAC from Dhangarhi to Kathmandu.

Note: From 11/3 to 11/9 T.B. Thapa operated separately but in the same area as the remainder of the team. He returned to Kathmandu on November 9, 1983.

DHANGARHI DANDELDHURA HIGH



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REPORT OF ENGINEERING REVIEW
LANDSLIDE AND SOIL STABILIZATION PROJECT
FAR WESTERN HILLS ROADS

Godavari to Dadeldhura, Nepal

USAID Project No.367-0138

Completed July 15, 1982

by

Martin C. Everitt, P.E.

Geotechnical & Materials Engineer

December 1983

Kathmandu

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Persons Contacted:

Mr. Jaya Bahadur Bada, Overseer, Godavari

Mr. D.P. Banstola, Deputy Regional Engineer,

Mr. Jitendra Bahadur Basnet, Chief District Officer, Dadeldhura

Mr. Ram Dutta Bhatta, Assistant Engineer, Bhatkanda-Doti Road Project

Mr. Bishnu Bhatta, Overseer, Bhatmanda-Doti Road Project

Mr. Ganesh Prasad Bhatt, Panchayat Chief, Dadeldhura

Mr. Ghambhir Chand, Assistant Engineer, Bhatkanda-Doti Road Project

Mr. Madhav D. Joshi, Zonal Engineer, Seti Zone, Godavari

Mr. S.D. Nepali, Divisional Engineer, Kathmandu, formerly LSS Project Manager.

Mr. B.R. Pant, Divisional Engineer, Dhangarhi

Mr. Maheshwar Shrestha, Acting Divisional Engineer Bhatkanda-Doti Road Project

Mr. M.B. Shrestha, Divisional

Mr. Shankar Govinda Shrestha, Acting Chief, Mechanical Section, Godavari

Mr. D.J. Thapa, Superintending Engineer, Foreign Cooperation Division, Department of Roads

Mr. Naresh Singh Thapa, Kailali District Forest Controller, Dhangarhi

Mr. Shiva Hari Upadhyaya, Senior Accountant, Godavari

ENGINEERING REVIEW

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I LSS CONSTRUCTION

INTRODUCTION

One of the primary missions of the team was to review the construction done under LSS to determine whether it was done substantially as specified, whether or not it was successful, and what might be done differently another time. The team was fortunate in the presence of some DOR engineers and overseers who were generally able to distinguish between LSS installations and those done under the original construction projects.

It was much harder to distinguish damage caused by the recent, very intense storm of 26 and 27 Bhadra, 2040 (11 and 12 September, 1983) from that still remaining from earlier more or less normal monsoon storms, which had not been totally removed, and the team's judgement may not have been completely correct on occasion.

In evaluating the LSS designs reliance was placed primarily on the reports by Kojan (1)* and Mathur (2). Some difficulty in identifying specific sites occurred because chainages have been revised since the earlier reports and distance variations of three to six kilometers were encountered. Some reliance was placed on Kojan's photos of specific sites as well as the recollections of the accompanying DOR personnel.

* Refers to items in the Reference List.

Kojan's recommendations were stated in general terms both for individual sites and broader areas. Mathur modified to some extent, and translated those generalities into site specific work items tabulated in his report, and displayed on plan and profile sheets which he signed. Later some additional modifications were proposed by DOR engineers, and endorsed by AID. Most of those were made necessary by budget limitations.

The team did not attempt to check each and every item, but rather, representative installations of each item were found and checked and an overall impression of the total project was developed by six days spent on the road, both walking and riding. The major landslides, given individual names by Kojan were examined and photographed. Some of the photos are included in this report.

It is evident that both Kojan and Mathur, and also this writer in an earlier visit to Nepal, tended to underestimate the ability of DOR and Nepali Contractors' personnel to execute quality work and to understand that does work in the Nepali environment.

Mathur is to be complemented on his standard designs for gabion walls, ditches, subdrains, interceptor drains and other facilities as presented in his report. These designs were well executed and nearly all have performed as well as, or better than should have been expected. Some walls which

at first appear to have failed did not fail, but were over-topped and buried by slide debris from higher on the slope.

Where failures did occur, most are attributed to the intense storm of September 11 and 12 which clearly exceeded design parameters.

Kojan and Mathur were somewhat unrealistic in specifying items such as rock bolts, plastic membranes, horizontal drilled drains and sophisticated blasting techniques which are not readily available in Nepal. At the same time however, there is a reluctance on the part of the DOR to acquire unfamiliar technology, even that which is not excessively expensive and has a very high probable benefit.

MATHUR'S RECOMMENDATIONS, FINDINGS AND COMMENTS:

The following section discusses each of Mathur's final recommendations, which are derived from Kojan's earlier study. The recommendation is summarized or paraphrased, followed in each case by the team's findings and then by additional comments as appropriate.

1. Recommendation: No construction or reconstruction work should be allowed to proceed unless there are working drawings for each site technically reviewed and approved by the project manager or other competent authority.

   Finding: Plan and profile sheets were prepared for all LSS work. These plans were generally adequate, though

rudimentary by US standards. Details of standard items, such as Mathur's gabion buttresses, were provided separately. Detail drawings of one-of-a-kind special treatments, for example, the "Dig Muther" landslide, apparently were not provided. At least, none were seen in the plans which were spot checked. Not all plans have survived, and not all of those that did were reviewed.

Comment: The amount of plan preparation and review done for LSS is said to be exceptional for a DOR project. Whether review by officials higher than the Project Engineer would be beneficial is difficult to say, since the Project Engineer is generally considered to be more competent technically than administrators. However, complete and detailed plans are essential and should be required in AID projects.

2. Recommendation: Surveying, geotechnical investigations and geologic mapping should be done for all major landslide areas.

Finding: Mathur signed all of the plan sheets seen by the team which indicates his acceptance of the design work done in each case.

Comment: Mathur's meaning is not clear. If he intended that DOR adopt the LSS standards nation-wide, this team

cannot comment on whether or not that has been accomplished. . Certainly, it would be worthwhile objective.

3. Recommendation: Pilot slope stabilization works .. .. should be monitored .. ..

   Finding: There is no surviving record of any systematic monitoring of these sites. However, the overall success of the LSS works suggests that any results would have been generally positive.

4. Recommendation: Alternative locations proposed by Kojan should be considered.

   Finding: The alternatives were considered, and some survey work was carried out. Amendment No.1 to the Project Grant Agreement, dated 12/30/80 states that designs would be prepared for relocations "if deemed necessary ... and retained in DOR and utilized if further landslides occur." However, it was concluded that the cost was not likely to be justified by the savings over the existing route, and none of the relocations was built. To date, the decision appears to have been supported by events.

5. Recommendation: All slope stabilization works should be completed in three working seasons.

Finding: The project was declared completed in July 1982 approximately three years after Mathur's report.

6. Recommendation: At least 3 engineers should visit the US .. .. ..

Finding: This was done. All three are believed to be still with DOR and one (B.B. Deoja) is now Project Engineer on the Rapti Zone road work sponsored by AID.

7. Recommendation: A short course on rock bolting and horizontal drains should be conducted for about 10 DOR engineers. This should be followed by site visits to projects in India.

Finding: Several engineers visited India to investigate blasting technique but there appears to have been no follow-up technology transfer to others in DOR and no purchase of drills, etc. to implement blasting technique.

There was apparently no actions on the horizontal drain or rock bolting proposals. DOR engineers seem to feel that India does very little road work in the hill country and so has little to offer Nepal in terms of hill country experience or training.

8. Recommendation: "Geometrical constraints should not be clamped routinely in the case of mountainous roads .. .. unless supported by proper justification.

Comment: The function of the transportation system planner is to predict the kind and amount of commodities which are likely to be transported over a road during the analysis period. The optimum vehicle(s) can then be determined and the geometric characteristics of the road based on the size, weight, gradability and other characteristics of these vehicles. Every reduction in standards below those optimums has a cost which can be predicted, and the final compromise between construction cost, maintenance cost and user costs can be analyzed if data exists. If the geometric standards are reduced occasionally, for short segments, the cost is low and signs can be placed to warn drivers of hazards. If standards are too low, the cost of using the road will increase and consumers will be forced to pay more for their goods. Standards must consider realities, but should not go too far toward minimums.

9. Recommendation: The width of road in mountainous terrain should be kept as small as possible to satisfy traffic criteria.

Finding: This item is closely related to recommendation 8 preceding. The Western Hills Road was designed to have a 6.5 m travelled way with an additional 1.0 m for the inside ditch. The team agrees with the philosophy

of the recommendation but doubts, as a practical matter, that a reduction of more than 1.0 m would have been possible.

10. Recommendation: The road should be outsloped wherever feasible.

Finding: There are many kilometers of beautifully laid, grouted rubble masonry ditches which are non-functional for two reasons: (1) they are blocked by slide debris, which in some cases has not been cleared for more than a year or (2) the road surface has eroded below the ditch edge so that water cannot get into them.

Comment: Outsloping generally would improve the surface drainage, especially since there are far too few culverts. However, it probably would be detrimental in the area of unstable sandy soils, roughly from the temple near Melkhara to km 130. If the 40 km/hr design speed is ever to be achieved, superelevation of the curves will force inside drainage in many places.

Team Recommendation: The paved or lined ditches should be abandoned, primarily because they must be cleared by hand labor. Outsloping should be used where the soils will not be excessively eroded, and a steady improvement program aimed at eventually achieving a cross culvert at intervals of no more than 100 m, usually

more frequently, should be begun using maintenance personnel. Where inside ditches are used, they should be designed for machine maintenance for speed and economy.

11. Recommendation: An effective maintenance crew should patrol the road during the monsoon period to clean culvert inlets and other maintenance activities.

Finding: This is apparently done to some extent, though not as regularly and systematically as would be desired.

Comment: This is the single most important item toward keeping the Western Hills Road in service. The drainage and machine maintainable ditches mentioned earlier are an important component of the preventive maintenance concept which will be discussed further in another section of this report. The local overseer should cover his section at least daily during the monsoon and several times weekly in other seasons. He should be assigned a jeep for the purpose. Consideration should be given to installing a mobile radio system for maintenance activities.

CONSTRUCTION ITEMS PROPOSED BY KOJAN AND MATHUR:

Peripheral Drains: These were shown on plans signed by Mathur and many were noticed in the field. The team did not attempt to verify each and every item, but accepts

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that these were generally built as planned. Several failed for various reasons and appear to have caused the problems they were supposed to prevent. Peripheral drains, both open and rock filled are a qualified success. Failures should be investigated to determine what, if any, design elements should be modifieid.

Gabion buttress and Breast Walls: These appear to have been built as planned. The quality of the gabion work is exceptionally good and those responsible should be complimented. No serious trouble due to rusting wire, as has been reported in Dang, was noted and very few installations have failed.

Counterfort Drains: An effort was made to observe these in the field but only a few installations were located. Plan sheets did include the counterfort drains and since most of them could have been buried either by design or accident, it is possible that many are in place and functioning. Due to lack of specific memories of these units on the part of local overseers, who are usually knowledgable, the writer suspects that some counterfort drains were omitted. Omission in many cases probably would not be greatly detrimental to the walls.

Side Ditches and Subdrains: In some cases side ditches have failed due to later movement of the slides, or because

of sloughing and filling. Subdrains were built, in general, though in some cases to lesser depth than was specified by Mathur, because of hard rock excavation.

One overseer and an engineer noted that subdrains worked well for a year or two and then apparently failed by clogging. Time did not permit digging any out to verity this situation or to examine the aggregate filling to see whether it was as specified.

- Cross Drains: Included in the above remarks.
- Horizontal Drilled Drains: None have been attempted.
- Rock Bolting: None have been attempted.
- Removal of Slide Material: In several places Mathur specified removal of a substantial part of a slide mass to reduce the driving forces. This was never recognized to have been done and in several cases, a gabion wall was built to support the material in lieu of removing it.

Removal of the material probably would have been cheaper and more effective than the walls, but disposal of the waste material is a problem in many places.

However, many walls are now supporting surcharge loads far in excess of those considered in the designs. These loads have been caused by new material falling on to the body of the slide above the wall, or by deliberate raising of the roadgrade as a means of disposing of excess materials.

Since some buttresses on the cut side of the road (Mathur's Types A,B, and C) are designed for relatively steep sloping surcharges, the probable overstress may not be too serious except in scattered cases during the monsoon. However, many of the walls used on the fill side (Types D,E,F & G) were designed for only slight surcharges. It is possible that some of these are highly overstressed and subject to failure with minor additional loads. Several walls of both types have already yielded noticably.

Maintenance engineers and overseers should review the plans and prepare an "as built" listing of all walls which precisely describes the allowable surcharge. They should then assure than maintenance forces remove all recognized overloads as well as all material which will probably erode and run onto the road during normal rains. If this is not done consistently, there is a strong probability of an increasing number of wall failures as the project ages.

Slide Shed at Km 126 + 100: This was not built and does not appear to have been necessary. There are a number of spots in the vicinity where such a structure would be useful but the team did not recognize the specific site.

CONCLUSION

The overall conclusion is that the engineering works prescribed were generally built as designed and to a high level of quality workmanship. The works have performed

to or beyond the design requirements in all cases but continued maintenance will be necessary to preserve the investment in these facilities.

II OPERATION AND MAINTENANCE

INTRODUCTION

Since the Western Hills Road is the first to be constructed by Nepali Engineers and Contractors, so it must also be the first to be operated and maintained by Nepali forces. The team reviewed maintenance planning and equipment and found that the present situation is not adequate and that much improvement is necessary if the road is to be a useful, substantially all weather, facility. Some government policies should be changed and overall a "maintenance ethic" must be created where none now exists.

Any successful road maintenance effort is largely preventive in nature. That is, the engineer and his overseers must be personally familiar with every meter of the road and must concentrate on recognizing potential problems before they become major, and taking corrective actions immediately. This is more art than science.

Organizations, personnel staffing, equipment selection and location, budgeting, and virtually all other aspects of road maintenance develop in response to the behavior of the road. While a history of performance accumulates over time, it is already apparent that most of the serious landslide problems are North of Budar and so one might anticipate that Budar, near the middle of the road, may

evolve into the most important maintenance station. Bhatkanda, at the Doti road junction, may well become another major maintenance station while Godavari becomes an administrative center and equipment repair station with a lesser role in road maintenance operations.

MAINTENANCE OBJECTIVES

The DOR must develop a series of maintenance objectives for this, and all other roads. These objectives will govern, directly and indirectly all aspects of the maintenance activity and, as will be seen in the following paragraphs, the cost of the maintenance program will depend on the chosen objectives.

Objectives must be chosen on the basis of Government policy, the needs of the people served by the road and the costs and benefits of the road. A higher standard of maintenance will have higher maintenance costs, but also greater benefits to the people and lower user costs for fuel, tires, truck repairs and driver time.

The choice of the appropriate maintenance objective is ultimately based on an economic analysis of maintenance cost, user cost, and the capital cost of improvements such as pavement, with some recognition of political considerations.

An example of several possible maintenance levels or objectives follows; based loosely on those of the US Forest Service. It is recognized that some of these are not appropriate for the Western Hills Road but they are included to complete the illustration. Modifications should be made as appropriate.

Level 1: Custodial maintenance only. Drainage structures are maintained and environmental damage prevented but the road will not be reopened if closed by landslides.

Level 2: The road is kept passable for four wheel drive vehicles with high clearance but speed or passenger comfort are not factors. Drainage is maintained and fallen trees, rocks, etc., are removed if they are a hazard to traffic or block drainage. Closures of several weeks duration are permitted, with public notice posted.

Level 3: The road is kept passable for ordinary autos and trucks. All obstructions are removed from the travelled way, shoulders and ditches. The surface is maintained so that autos can pass, but speed or comfort are not factors. Closures of a few days duration may be permitted.

Level 4: The road surface is maintained to permit moderate speed. Passenger comfort is considered. Dust is abated in congested areas. Any closures or obstructions are removed within one day.

Level 5: The road is maintained for the full design traffic volume at the design speed. Passenger and driver comfort are a major considerations, closures of more than a few hours are not permitted, and dust is controlled if the road is not paved.

Based on the writer's understanding of the situation, and the impacts of the road on the people served as described by T.B. Thapa elsewhere in this report, maintenance objectives similar to Level 3 should be the present goal. Level four or five might be the ultimate goal, to be achieved some years in the future after additional improvements are made, particularly in drainage facilities. The present capability is no more than Level 2.

It is strongly recommended that the DOR determine the appropriate maintenance objectives for the Western Hills Road and state these objectives as a matter of official policy. The above examples are incomplete but could form a basis for the development of appropriate local policy.

MAINTENANCE EQUIPMENT AND PARTS

The team visited the offices and shop at Godavari and met with several individuals. Unfortunately the Zonal Engineer and the Deputy Regional Engineer were away and while they were met briefly on the road, they were not available for lengthy interviews. It is hoped that their views were accurately presented by others.

The maintenance stations at Budar and Bhatkanda were also visited as were the two tree nurseries. The nurseries will be discussed in another section by Paul Winkelaar.

Present Situation

Equipment: The list of equipment currently on inventory at the Godavari Division Headquarters is included in the appendix. It includes 106 pieces of various kinds, built by at least 30 different makers in six nations. Thirty-two pieces are in working order, fifty are awaiting repair parts, twenty-three are beyond repair and one, a pile hammer, is idle for lack of appropriate work. Three machines are on the Doti road and the rest are listed as being at Godavari or Budar, though the team did not see anywhere near the number of pieces of equipment listed.

Except for perhaps a dozen pieces, mostly trucks, all of the equipment is more than ten years of age and under the best of conditions would be at the end of its economical service life. The unservicable items have been cannabalized to keep the others running and authority has been sought to sell this junk equipment at auction.

There is a substantial inventory of parts on hand and it appears to be well organized and efficiently cataloged. However, about 1/3 of the items are for equipment which is no longer located at Godavari. This same problem was noted by D.J. Gephart in a trip report dated 11/20/79. For

some reason, the DOR has not authorized disposal of these parts which would release valuable storage space for other uses and possibly generate some revenue through sales.

Persons contacted indicated that most or all of the parts needed to place the fifty repairable machines in service can be obtained in Kathmandu or India if purchase were authorized. The authorization must come from Kathmandu and action is unnecessarily slow. Apparently the approving officials are not aware of the cost of idle equipment. They should be required to act more quickly.

The Chief Mechanical Engineer has an annual emergency parts budget of 15,000 rupees and can make single purchases for up to 5,000 rupees on the basis of three quotes. Purchases exceeding 5,000 rupees must be tendered. Since a single truck tire costs about 7,300 rupees, it is obvious that the Chief Mechanical Engineer cannot do much to expedite parts supply.

There is no accounting system to amortize the equipment throughout its life-span and to provide repair or replacement money. When a piece of equipment must be replaced, the entire process must begin from point zero, despite the fact that the need can easily be predicted well in advance of the fact.

To illustrate by an example, the US Forest Service has a working capital fund (WCF) for this purpose. When a piece

of equipment is bought, it is assigned an estimated service life and estimated maintenance costs. Whenever the equipment is in use, the using project is charged a monthly rate which is set aside in a fund for eventual replacement of the machine, and a daily or hourly rate which pays for fuel and routine maintenance. If a machine is no longer needed, it is transferred to another location or sold.

Use rates charged are reviewed periodically and adjusted to reflect the actual costs of the individual machine, which may be more or less than was originally estimated. When it is time to replace the machine, funds are available in WCF to pay for the new item.

Mechanics Tools: No special tools or equipment were in evidence. There are no engine analyzers, test gauges or any of the special lifts, dollies, or other apparatus usually found in a heavy equipment shop. No lube truck was seen, though it was not specifically requested.

Hand tools are in poor condition and not plentiful. In 1983 some 5,000 to 6,000 rupees was spent on new tools but that probably purchased only about what a weekend auto hobbyist would have in the U.S.

Selection of Maintenance Equipment

Maintenance equipment must fulfill a different mission than construction equipment. Speed and maneuverability are

usually more important than high production rates, so more small pneumatic tired equipment might be expected. Large earthmovers probably will be absent. A few specialized items may be necessary, such as a small truck crane with a clamshell bucket for clearing culvert inlets.

The following items would be basic to any maintenance operation:

Crawler Bulldozer D-7 or D-8 size, with transport readily available;
Pneumatic Tired Front Loaders, medium size;
Patrol Graders - Cat. #12 size;
Backhoe-Case CK or equivalent;
Dump Trucks - 5 CY single axle;
Fuel and Lube Truck.

One problem with the present fleet is the multiplicity of different makes and models which greatly complicates mechanic training and parts supply. In selecting and distributing equipment, the DOR should try to keep the variety of makes and models of similar equipment to a minimum.

Recommendations

The following actions are recommended with respect to the maintenance equipment fleet equipment to be located on the Western Hills Road:

1. After establishment of the maintenance objective, and consideration of labor vs. machine intensive operations, determine the type and numbers of machines needed, and the placement of these at various locations.

2. Purchase the equipment as rapidly as possible, but limit the number of different manufacturers and models.

3. Purchase a generous inventory of spare parts and any special tools recommended by the manufacturers.

4. Establish some form of revolving fund to provide for repair and replacement of equipment. The US Forest Service Working Capital Fund is suggested as a model, though the Nepali version should be less complicated.

5. Dispose of any existing unservicable equipment and any other equipment not required for the Western Hills Road by sale or transfer to other locations. Also dispose of unnecessary spare parts.

ORGANIZATION, PERSONNEL AND TRAINING

Present Situation

Maintenance of the Western Hills Road is under the overall direction of the Deputy Regional Engineer for the Far Western Development Region located at Godavari and the Zonal Engineer for the Seti Zone, also located at Godavari. These two men are also responsible for the other roads in

their Region or Zone, totaling some 342 km in addition to the subject project. The Godavari equipment shop and the inventory of equipment previously described also serve these other roads.

Staff positions on the WHR include District Maintenance Engineers at Dhangarhi and Budar who are responsible for km 0 to 73 and km 73 to the end respectively. They are assisted by overseers at Dhangarhi and Khani Dada. Some organizational changes are under consideration by DOR, but are not yet decided.

The following positions are presently on the regular payroll at Godavari, though presumably the individuals could be working on any of the roads under by the Godavari Regional Office.

Fuel Man	1
Storekeeper	1
Loader Operator	3
Bulldozer Operator	3
Senior Mechanics	7
Junior Mechanic	2
Helpers	10
Mechanical Engineer	1
Radio Operator	1

In addition, the following daily wage or seasonal hires are authorized as needed:

Machinist	1
Helper	8
Chowkidar	9
Electrician	1
Generator Operator	2
Pump Operator	1
Roller Operator	3
Office Assistant	4

Laborers as needed to budget limit.

These lists include both road and shop workers. Obviously, the equipment operators and laborers generally would be on the road and the others would be based in the office or repair yard, though mechanics would make many repairs on-site.

The team is not competent to assess skills and training needs. Because of the Tihar Festival there was little activity in progress. However, the mechanics' ability to keep at least some of the equipment functional should not be overlooked. Apparently most of the mechanics have been trained in either Kathmandu or India.

No equipment operators were seen in action. Since the most difficult maintenance machine to operate skillfully is the motor grader, special training and incentives should be considered for the men assigned to these machines.

It is assumed that there is a need for training in the area of maintenance management which probably will be most directly performed by the District Engineer. Maintenance management, in addition to intimate knowledge of the road and all of its trouble spots, requires thorough knowledge of the cost of each of a large number of specified work items regularly done, and the tools, equipment and supplies needed for each. It is essentially a cost accounting system.

While a "Maintenance Management System" as the term is currently in vogue in the U.S. probably is excessively sophisticated for Nepal, it may be useful for several maintenance engineers to visit the U.S. to study maintenance in rural countries in the western mountain states, in the U.S. Forest Service, or some smaller State Highway Departments. The National Association of County Engineers probably could suggest an itinerary.

Alternatively, a maintenance engineer could be brought here on a PASA or a contract to help set up a maintenance plan for the WHR which could be expanded to the rest of the country. Since some of the best maintenance men are not graduates in engineering, but simply very experienced "old hands" it is not necessary that high academic requirements be established.

Recommendation

The team has no recommendations in the area of organization because the needs of the WHR have not yet fully emerged.

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1. It is recommended that the DOR consider sending some maintenance specialists to the US to study all aspects of maintenance operations and management in rural country organizations in the mountain areas.

2. Some form of maintenance accounting and management system should be established using the principals, if not the details and computer storage, of a Maintenance Management System.

PLANNING AND BUDGET

Present Situation

There are two parallel Zonal budgets for DOR. One is called the Development Budget and the other is the General Maintenance Budget. The Development Budget generally includes improvement and capital items while the maintenance budget includes road maintenance activities, fuel, supplies and labor. Only two years of history are available for the WHR since in previous years the road was under the construction budget, rather than maintenance.

Available figures are as follows:

		Dev. Budget	Maint. Budget
FY 2039/40	Budgeted	Rs. 3,540,000	Rs.1,118,000
	Spent	Rs. 3,435,000	Rs.1,118,000
FY 2040/41	Request	Rs.13,455,000	Rs.1,500,000
	Budgeted	Rs. 3,990,000	Rs.1,400,000*

* Includes Rs. 700,000 for storm damage clearing. Remaining maintenance budget is Rs. 700,000 for routine work vs. Rs. 1,118,000 last F.Y. Persons interviewed indicated that Rs. 5,000,000 would be a realistic figure for the current Fiscal Year.

A major problem lies in the budget process. Only the present fiscal year is budgeted so there is no opportunity for future programming. Due to the festivals early in the F.Y. the final budget advice is not released to the field until about 3 months have passed and even then expenditures must be resubmitted for final review and approval. Late in the F.Y. cuts not previously anticipated may be imposed arbitrarily so that final spending often falls short of the original authorization. Much of the engineer's time is spent in manipulating the budget process instead of the work.

After the Zonal Engineer submits his budget request for the coming F.Y., the Headquarters office normally makes cuts by line item. These cuts are usually not coordinated with field priorities. Thus, the Engineer has little or no authority to shift or reallocate funds within his overall spending limit, or to readjust his priorities in the face of changing field conditions.

Since the budget advice lags behind the start of the F.Y. and also the Monsoon, the field engineers have minimal authority to spend money for emergency damage control work. Since preventive maintenance during the monsoon has been

strongly recommended several times in this and other reports, some provision for emergency funding must be made.

With respect to equipment purchases, there is no orderly system for planning acquisitions or for paying for them other than by line item in the current budget. Since a large item such as a bulldozer is easy to cut from the budget request, it is difficult to make capital purchases on a timely or logically planned basis. Given the lead time required for delivery of a major item from outside Nepal, the lack of budget carryover authority beyond the end of the F.Y. is a major handicap. All orders must be placed immediately after the start of the fiscal year to assure delivery before the end of the F.Y. when all spending authority is automatically frozen.

Recommendations

In addition to the specific budget and planning recommendations presented here, the reader is requested to review related items stated earlier under the equipment heading. It is anticipated that some of these recommendations will require changes of government policy.

1. Persons having responsibility should also have the authority to fulfill their responsibility. Spending authority for emergency items should be delegated to the Zonal or District Engineer, subject to audit by Headquarters, and some realistic overall limits.

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a. The Chief Mechanical Engineer should be given authority to purchase parts up to at least Rs. 50,000 with tenders required on single items above some higher limit than at present, for example, Rs. 15,000. DOR should maintain stocks of common items such as tires.

b. Eliminate headquarters review on small purchases and require that reviews on all except very large purchases (say 1 lakh or more) be completed within five days.

2. Remove equipment from the annual budget and place it in a working capital budget.

3. Begin the budget process two or three years in advance so that long range planning can be systematically accomplished.

a. Get final budget advice to the field before the start of the Fiscal Year with adequate authority for emergency work during the Monsoon.

b. Reduce line item detail so that Zonal and District Engineers have authority to reprogram funds within guidelines and overall spending limits.

c. Permit year end carryover of authorized funds.

4. Begin a system of maintenance cost accounting and develop a maintenance budget based realistically on the performance of the road. Accept the fact that the WHR probably will require a higher annual maintenance budget than most other roads in Nepal due to the unstable terrain which it crosses.

III IMPROVEMENTS

Maintenance forces always find some slack time during a year and during these periods they can be useful in making small improvements to the road. Such items as,

- Replacing undersize culverts with larger culverts or small bridges (slab culverts);
- Building new gabion buttresses;
- Adding crushed rock to the surface;
- Stockpiling emergency supplies in areas of expected use;
- Improving camp facilities;
- Painting signs and equipment;
- Clearing debris from streams above culverts; and
- Underdrain installations in soft areas

are appropriate activities for maintenance forces.

Maintenance engineers should always have several such projects planned and if necessary budgeted, so that their forces can be put to work for a few days whenever a slack period develops.

While there seems to be an underlying awareness that this kind of work is necessary, there appears to be no provision for it in the planning or budgeting process.

The WHR needs a very large number of additional culverts where there are none now. In addition, a few pipe culverts

should be replaced with larger structures such as slab (box) culverts or small bridges. A supply of pipe segments should be stockpiled at every maintenance station and culvert installation should be pursued systematically by maintenance forces until the total job is completed.

IV OTHER ENGINEERING ITEMS

Rubble Masonry Walls

A local engineer has indicated that partially grouted rubble masonry walls are cheaper to build than gabions and has proposed that they be used in lieu of gabions.

There is no difference in the design analysis between the two wall systems. Both are analyzed as gravity structures and no structural credit is taken for the wire in the gabions. Sliding at the base, shear through the structure and overturning are calculated in exactly the same way.

The gabion baskets are a construction convenience. Their use permits smaller rock, rounded rock, and less carefully fitted rock to be used. Steeper frontslopes are also possible, even to the vertical in some applications.

The major benefit of the wire is in its behavior at the point where the structure has yielded slightly. The gabions then mobilize the strength of the wire to hold the rocks in place, even after displacements of ½ meter or more. Some of the interlocking and friction between the rocks is thus retained and the wire ties the entire wall together preserving its integrity. The rubble wall probably will fail under much less movement. Individual stones will drop out of the structure and cracks will widen until part or all of the wall fails.

So long as design stresses are not exceeded and neither wall yields, the rubble masonry wall will be as good as the gabion wall and well justified by cost. At the point of impending failure, where a little movement has occurred, the gabion system is most superior and response by maintenance forces in removing part of the sliding mass above the structure can save it from further damage.

Local field engineers should be able to recognize when rubble masonry can be used and when gabions should be used. Generally rubble masonry would be appropriate where the designed safety factor is conservative, the slope to be protected is not excessively steep or unstable, and the apparent consequences of a failure are not major.

Concrete Culvert Pipe

R.F. McDonald, in an appendix to Kojan's report dated April 26, 1978 was critical of the quality of the concrete culvert pipe being manufactured at the Chunepani pipe casting yard near Godavari. The present writer visited the yard on November 7, 1983 and found conditions to be about the same as described by McDonald though there was no activity due to Tihar.

All culverts on the WHR were installed under the original construction contract. At the most, only one or two may have been installed under LSS so McDonald's remarks about the quality of installations, and the inlet or outlet

conditions are still appropriate. All pipes are thus five to ten years old, and some, where exposed at the ground surface were seen to have partially failed, apparently by disintegration of the concrete. However, no culvert installations are known to have totally failed due to collapse of the pipe or erosion by water leaking out through holes, misplaced or damaged joints.

Only two sizes of pipe, about 60 cm and 90 cm, are available. Larger pipes clearly are needed. It is unfortunate that corrugated metal pipe (CMP) of the sort usually used in the US cannot be obtained. Its ease of manufacture and installation, adaptability to nearly any site condition and comparatively light weight are powerful advantages.

If galvanized steel of the appropriate grade and weight is available in India, the DOR should consider purchase of the corrugating and forming machinery to manufacture CMP. The equipment is made by Armco Steel Co., of Butler, Pa. Nepali Engineers visiting the US can see CMP manufacturing plants in many cities.

Debris Racks on Pipes

The problem of plugging or burial of culvert inlets by debris remains as difficult today as it was several years ago. Transportation Research Board Compendium No. 9(3) includes articles on treatment of culverts which will be of interest to DOR engineers.

Paving

It is understood that DOR wants to apply a bituminous pavement structure to the WHR as soon as possible. Bituminous pavements are attractive but for the present, the writer believes that the disadvantages outweigh the advantages.

Some typical advantages for a bituminous pavement structure include:

- Higher traffic speed resulting in lower user costs,
- Waterproofing the surface resulting in all weather capability,
- Reduction of maintenance, and
- Reduced surface erosion and dust.

Some disadvantages include:

- Cost of construction,
- Cost of maintenance and patching,
- Loss of capability for machine maintenance,
- Damage by falling rocks and cleanup equipment, and
- Inability to work on culverts without pavement cuts.

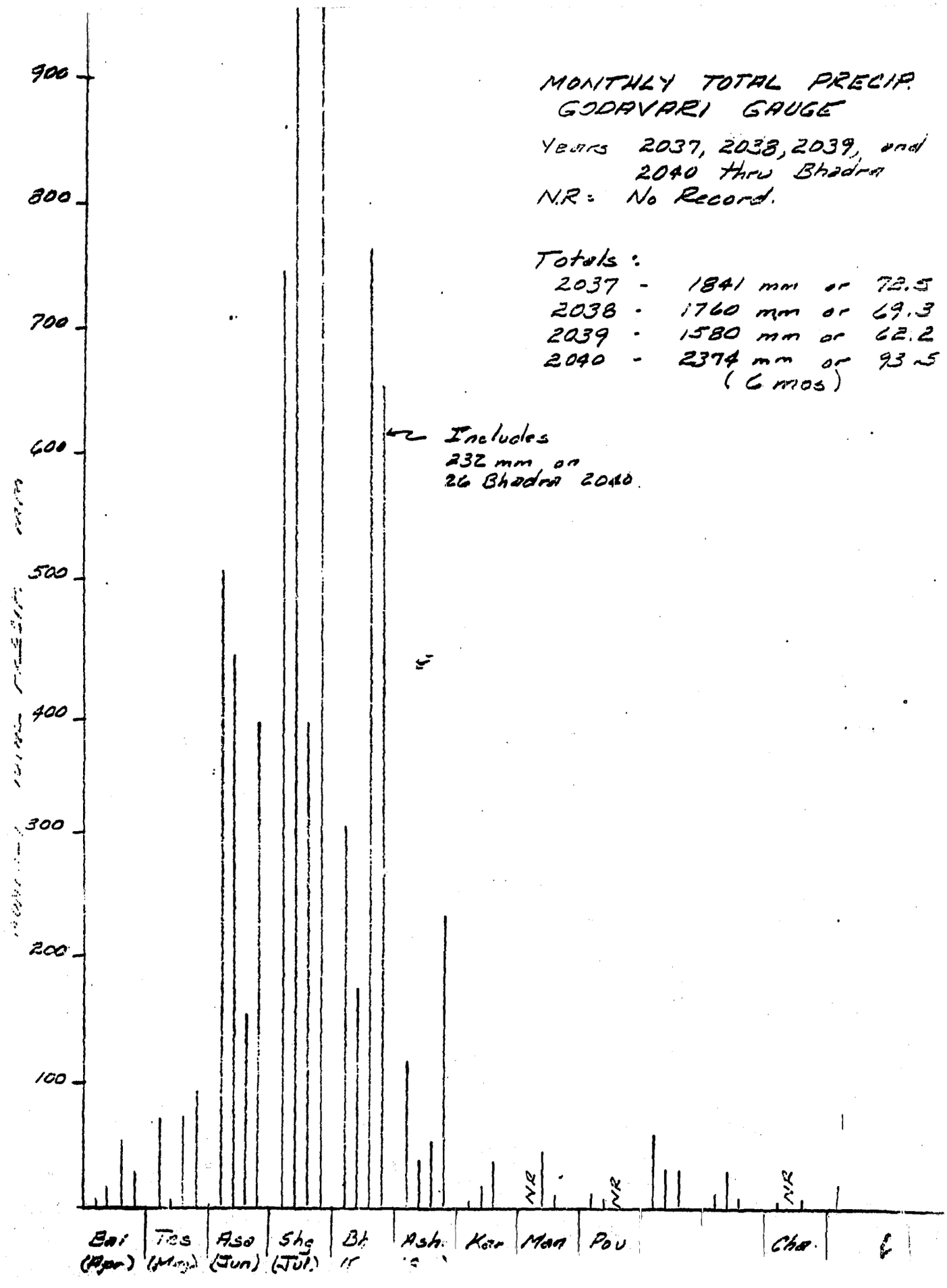
The last two disadvantages seem compelling for the present. First of all, large rocks falling on to the road surface will do considerable damage. This will be a particular problem from around km 90 to 130. Secondly, where slides do fall on the road surface, it is totally destructive to use a crawler bulldozer for slide cleanup on a bituminous

surface. Pneumatic tired equipment must be used. Finally there is the recommendation elsewhere in this report for the addition of many more culverts before a bituminous surface is constructed.

Therefore, until the remaining slide stabilization work is completed and additional culverts are installed, it is recommended that the road be operated with a crushed rock surface which can be maintained by a motor grader. Considerable work in completing the roadbed to finished grade and replacing soil lost to erosion must be done before a crushed rock surface may be placed.

Priority items for the Feeder Road Project could include:

1. Finishing the subgrade and gravel or crushed rock surfacing
2. Equipment procurement
3. Maintenance Management Training.



MONITHLY TOTAL PRECIP.
GODAVARI GAUGE

Years 2037, 2038, 2039, and
2040 Thru Bhadra

N.R: No Record.

Totals:

2037	-	1841 mm	or 72.5
2038	-	1760 mm	or 69.3
2039	-	1580 mm	or 62.2
2040	-	2374 mm (6 mos)	or 93.5

V APPENDIX

Reference List

1) Kojan, Eugene, "Engineering Geologic Evaluation of Landslide Problems, Western Hills Road Project, Godavari to Dadeldhura Nepal, USAID 1978.

2) Mathur, Tej, "Recommendations for Stabilization of Road; Western Hills Road Project, Godavari to Dadeldhura, Nepal." USAID 1979.

3) Transportation Technology Support for Developing Countries: Compendium No. 9, Control of Erosion. Transportation Research Board, Washington, D.C. 1979.

Persons Contacted:

Mr. Jaya Bahadur Bada, Overseer, Godavari

Mr. D.P. Banstola, Deputy Regional Engineer,

Mr. Jitendra Bahadur Basnet, Chief District Officer, Dadeldhura

Mr. Ram Dutta Bhatta, Assistant Engineer, Bhatkanda-Doti Road Project

Mr. Bishnu Bhatta, Overseer, Bhatmanda-Doti Road Project

Mr. Ganesh Prasad Bhatt, Panchayat Chief, Dadeldhura

Mr. Ghambhir Chand, Assistant Engineer, Bhatkanda-Doti Road Project

Mr. Madhav D. Joshi, Zonal Engineer, Seti Zone, Godavari

Mr. S.D. Nepali, Divisional Engineer, Kathmandu, formerly LSS Project Manager

Mr. B.R. Pant, Divisional Engineer, Dhangarhi

Mr. Maheshwar Shrestha, Acting Divisional Engineer Bhatkanda-Doti Road Project

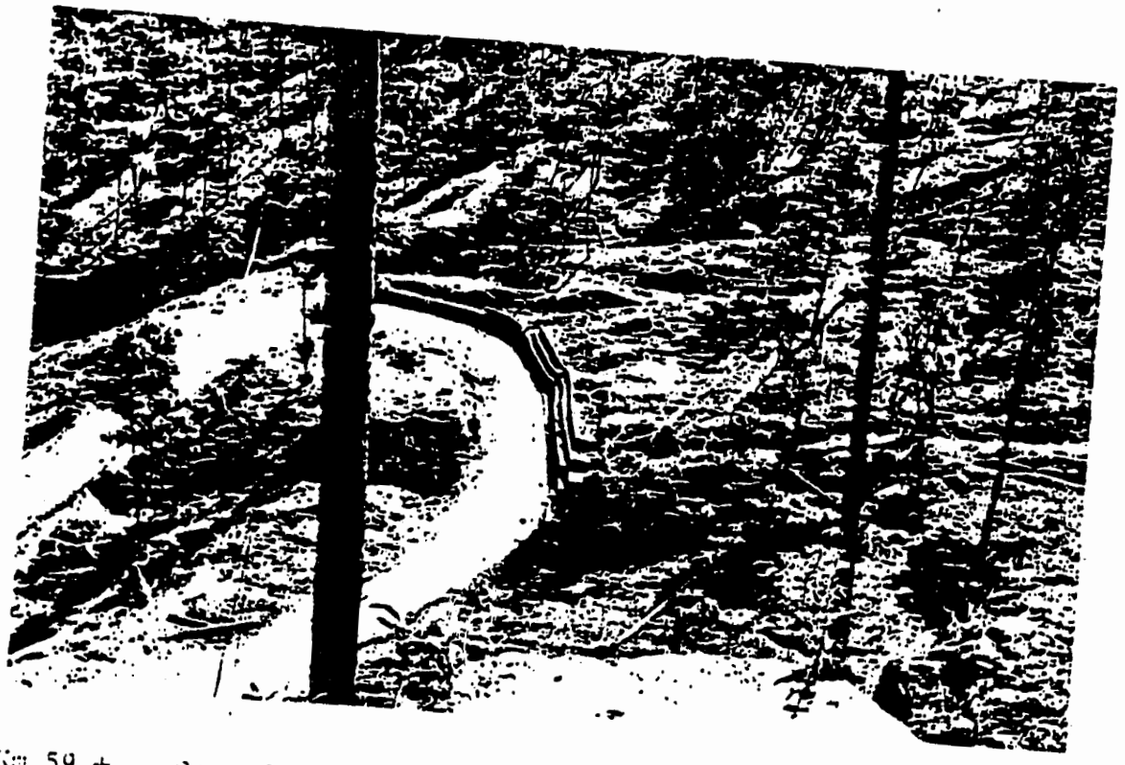
Mr. M.B. Shrestha, Divisional

Mr. Shankar Govinda Shrestha, Acting Chief, Mechanical Section, Godavari

Mr. D.J. Thapa, Superintending Engineer, Foreign Cooperation Division, Department of Roads

Mr. Naresh Singh Thapa, Kailali District Forest Controller, Dhangarhi

Mr. Shiva Hari Upadhyaya, Senior Accountant, Godavari

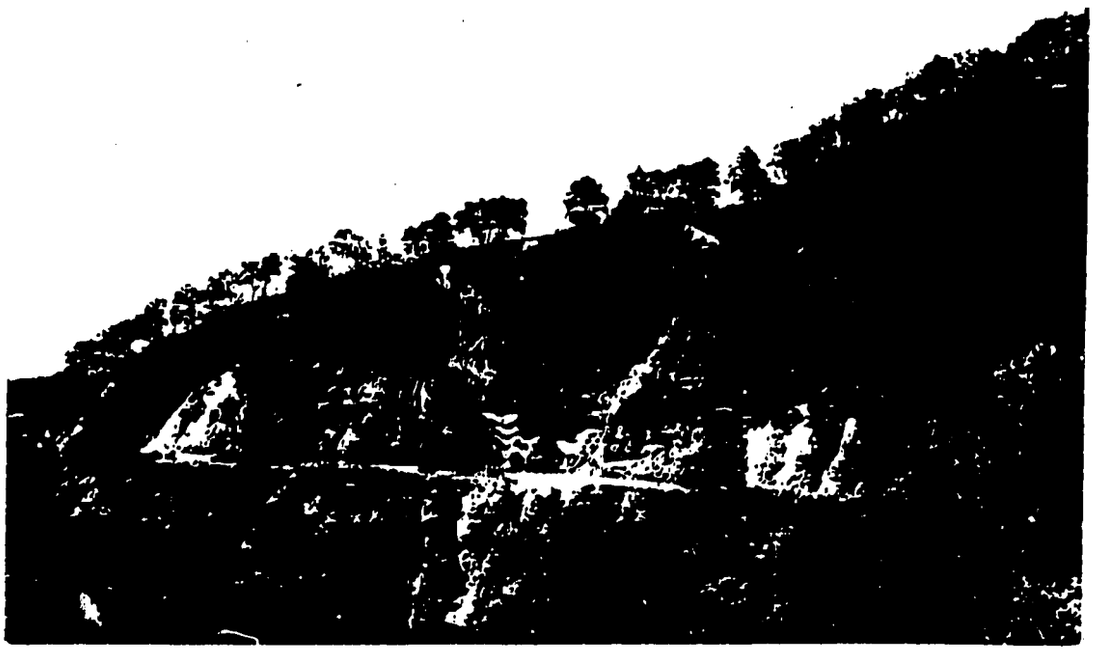


Km 59 ± One of several shallow mudflows discussed by Kojan. Gabion buttress and rock filled trench drains are generally successful, though buttress has moved slightly at the center, and rutting in wheeltracks suggests that some water is passing under drains which either were built too shallow or are clogged.

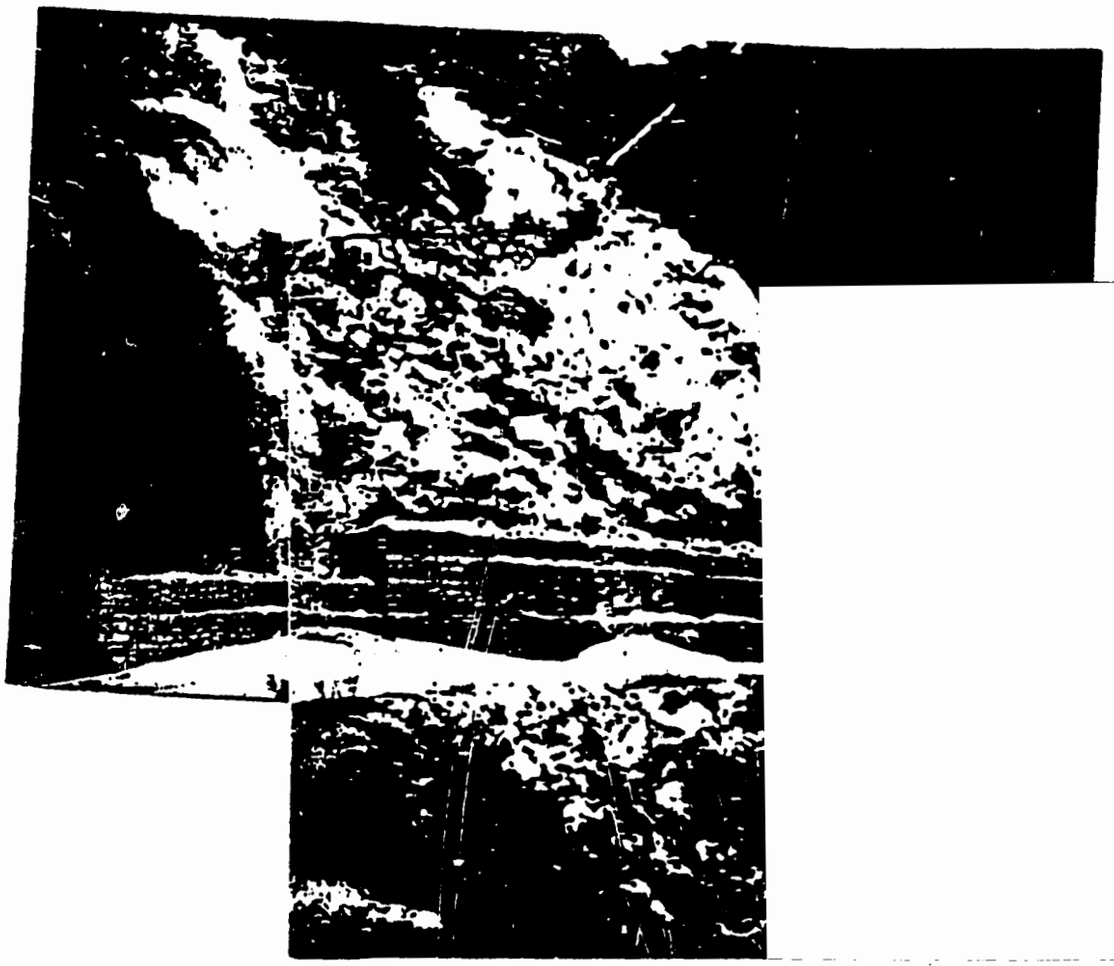
Km 91 ± Kojan's "Big Mother" slide. Gabion wall has yielded from excess loading, but except at ends, has not failed. New slide activity is mostly along right and left flanks where drains and check dams have been destroyed. Central mass of slide body is semi-stable and partially revegetated but should be about 50% removed to reduce overstress on wall.

Km 98 + Rock filled interceptor drain above Kojan's "Elsie" has failed and caused headward migration of the slide. Probable cause of the failure is that trench intersected the contact between soil overburden and rock surface and so conducted water into the zone of weakness rather than away from it.

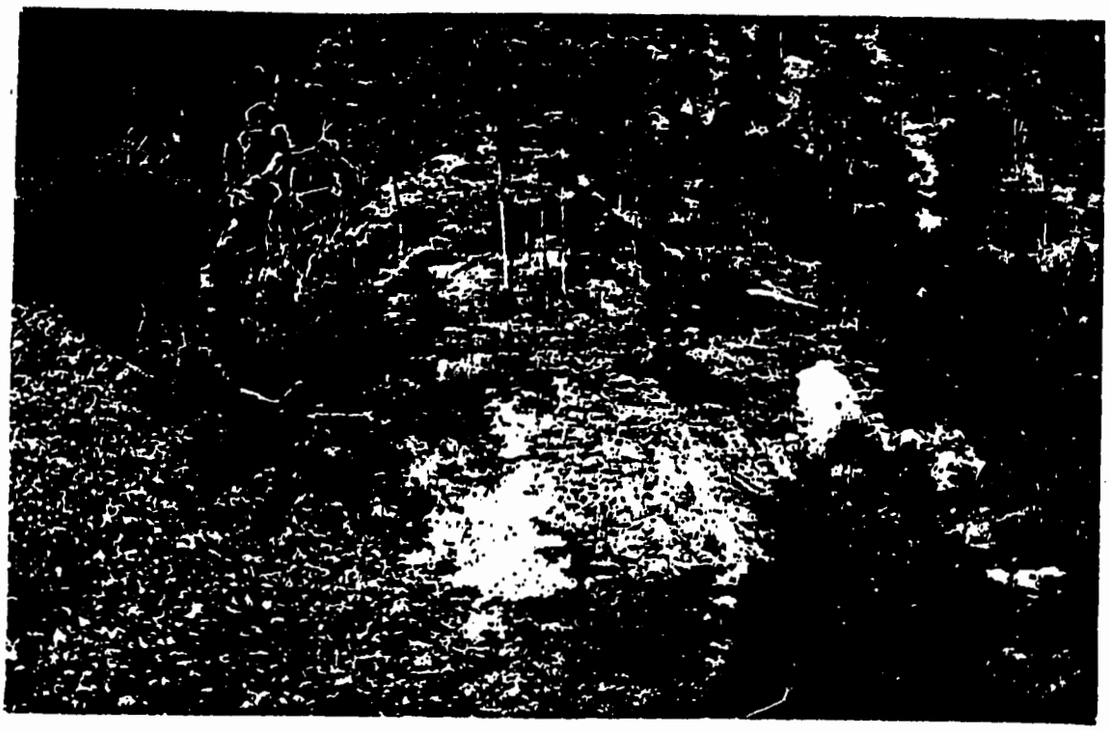
Km 99 ± Kojan's "Topsie" slide. Comparison with Kojan's pictures suggests that removal of 1/3 of slide body was not done and larger gabion buttresses above and below the road were built instead. New activity has rumined scarp drains and head has moved upslope. Erosion continues to wash material onto road and promotes damage below road.



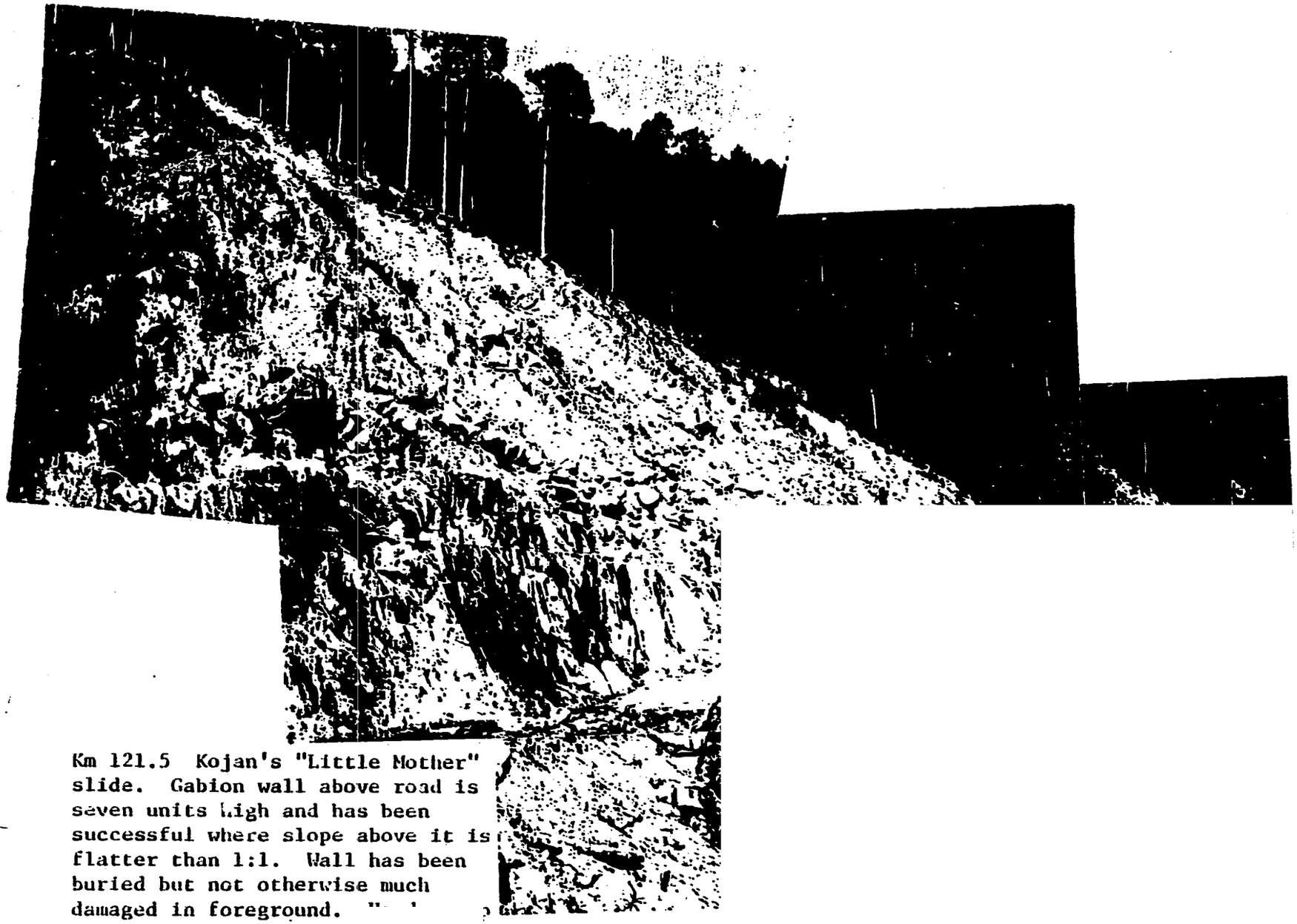
Km 102 + 500 Kojan's "Old Man" rockslide. Essentially all of the loose rock material has been removed from the slide body. New activity is shallow and limited to light areas. Natural and planted vegetation had made a good start on old scarp and multiple check dam system has reduced damage at, and below the road.



Km 106+500 5 unit gabion wall built under LSS above masonry wall built under original project. Masonry wall has failed in background. Slide debris has reached a slope of about 1½:1 above gabions and except for erosion visible in foreground is working well.

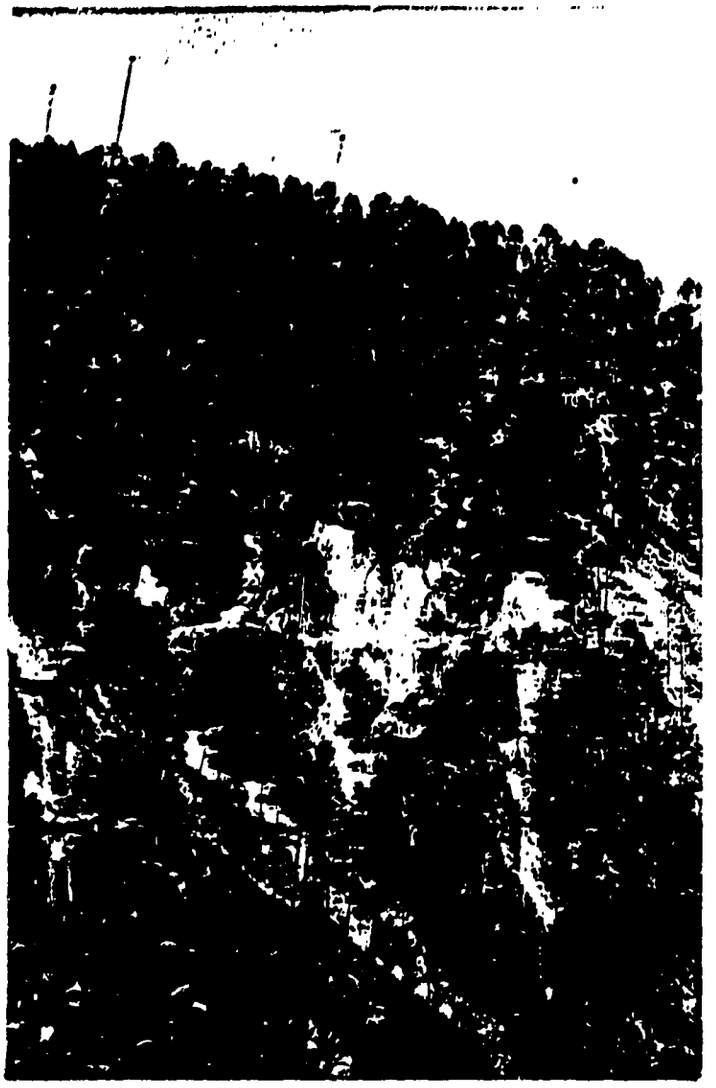


Km 118 ± Rubble filled trench interceptor drain appears generally successful though a small slide on the right is working upslope. Ground surface is not as steep and natural vegetation is more vigorous than in failed ditch at km 98 pictured earlier.



Km 121.5 Kojan's "Little Mother" slide. Gabion wall above road is seven units high and has been successful where slope above it is flatter than 1:1. Wall has been buried but not otherwise much damaged in foreground. " ' has migrated up slope. road are surcharged by re yiel : is no coul .n

67



Km 122.5 ± White scars through timber to the skyline are tracks of debris avalanches which plugged ditches and culverts at the road causing erosion around ends of walls etc. This is a common situation especially North of Budar. The problem should be considered in drainage design.

Km 122.5 Larger than usual rockslide with two unit gabion buttress. Buttress was buried on left but except for some wires broken by impacts is undamaged. In this kind of situation, the buttress will catch some small spalls, but rolling boulders will pass over. The buttress probably is or marginal value here since the volume of rock retained compared to the size of the slide is not very significant.

Km 123 + 100 Typical situation where gabion wall is yielding under surcharge load of slide debris. About half of the sliding material, up to the trees just above the men should be removed to reduce load on the wall. Planting above near end of the wall has been fairly successful.

EVALUATION OF REVEGETATION, SLOPE PLANTINGS, AND SOIL STABILIZATION EFFORTS ON THE FAR WESTERN HILLS ROAD

Godavari to Dadeldhura
Nepal
USAID Project No. 367-0138
Completed July 15, 1982

by

Paul Winkelaar
Soil Scientist, Wasatch
National Forest, Salt Lake City, Utah.

November 1983
Kathmandu, Nepal

CONTENTS

GEOLOGY AND SOILS

Introduction

From November 1, 1983 through November 7, 1983, as part of the evaluation team Paul Winkelaar, Soil Scientist, Wasatch National Forest and Martin Everitt, Geotechnical Engineer, Denver, examined in the field the soils, geology and landscape features on the Far Western Hills Road between Godavari (23 km) and Dadeldhura (138 km).

The numerous landslides, especially in zone #4 were fieldchecked, and the soils were described and evaluated in each of the four recognized zones.

Values for the physical attributes of the four different zones were described and evaluated. For engineering purposes soil strength, plasticity and any other properties on which the design of the road is based were evaluated, and the soils were tentatively classified in the Unified Soil Classification System.

For the evaluation of the properties for agronomic purposes such as plantings for erosion and stability, the soil is classified in the latest Soil Taxonomy 1975 (U.S.D.A. SCS Agri. Handbook No. 436). The classifications have not been correlated and are tentative approximations.

The four zones encountered are landscape units that have a reasonable degree of homogenity for most practical purposes. These zones are associations of soil and geology composed of components that are interrelated and could be recognized in the field.

The soils described for each zone showed distinct differences in texture, depth, color and other properties so that they too fall in four different Taxonomic classifications.

The climate is in the temperate monsoon with precipitation in the 1,000 to 1,500 millimeter range. It is a combination of warm temperate rainy upland climate and subtropical climate (klöppers classification). There is winter precipitation here as in other far western regions.

The nurseries were visited on November 3 and November 5, 1983, and in section II a report with a summary of finding and a summary of recommendations follows the individual descriptions of the four zones that we recognized.

Included in this report in the evaluation of the plantings that were attempted on the landslides for erosion control.

Unfortunately many plantings had failed. The few indigenous species that were planted showed good growth and appears to be well adopted to the climate and soil.

In the appendix is a short description of the 4 major soils included along with pictures of the soils and the plantings.

DESCRIPTION OF ZONE 1. Km 60 to Km 23

Geology: A transition zone is present between 44 km to 60 km. In this area sandstone is the major rock formation. From Km 32 to Km 44 the sandstone is interbedded with variable colored shale, and siltstone, ranging from dull olive gray to reddish gray, depending upon the reduction versus oxidation processes in this material.

Slopes: The slopes are in the 40 to 60 percent range, with a few steeper areas.

Landslides: There are no serious landslide problems in this zone. At km 33 a landslide in the interbedded shale may require regular maintenance. From km 44 to 60 the major problem is overgrazing on the shallow to moderetely deep soil that shows extensive gullying and surface erosion. The road crossing these gullies at km 67 in particular could be severely damaged if the grazing is not controlled. Mudflows were noted below km 44.

Soils: The soils in this zone are slightly acid, moderately deep soils, that have formed in sandstone, silstones, shale

and related rocks. The topsoil, 8 to 12 inches is a dark colored gravelly silty clay loam that grades into a brown and reddish brown subsurface and subsoil with clay loam textures. Gravel content throughout the profile range from 10 to 30 percent. In the lower part of the profile distinct mottles can be noted. This indicates the presence of a seasonal high water table.

Engineering Properties: The tentative classification of this soil in the unified soil classification group is SC - clayey sands, sand-clay mixtures. The SC soils are slightly plastic with fair cohesive properties. If the soil is placed on the road bed as subgrade material it is subject to rutting, it becomes very slippery when wet, very dusty when dry, and erodes easily. It is easily deformed. This soil needs a gravel surface to overcome these problems.

Vegetation: From Godavari to km 44 the major vegetation is Sal and Rhododendron. In the sandstone transition area above km 44 the cover is mainly open stands of Chir pine with a grass understory.

Soil Profile: A soil profile was described at Km 33 in a landslide in the sandstone - interbedded shale area.

DESCRIPTION OF ZONE 2. Km 60 to Km 82

Geology: Deep colluvial deposits along the ridgeline - schist, sandstone and quartzite, with some local igneoks intrusion into sandstone bedrock.

Slopes: The unit is located along a ridge line with low benches and terraces with slopes ranging from 25 to 45 percent. It is the least sloping unit along the road.

Landslides: Landslide incidence in this zone was low. The landslides observed were caused mainly by a positive pore pressure zone in the deep colluvial material, due to excess ground water or springs.

Soils: The soils in this zone are formed in colluvium that is influenced and derived mainly from quartz and schist. The soils are deep, strongly acid, with a brown clay loam subsoil, and a gravelly clay loam subsurface to 3 feet or more. It then grades into a reddish brown gravelly heavy clay loam with a red subsoil of extremely gravelly clay loam below four feet. Rock fragments range from 30 percent to 70 to 80 percent or more in the subsoil. The soil is stable. Cementation of the soil material is enough to support near vertical cutbanks of 12 feet and higher.

Engineering Properties: The unified soil classification group is CL - Inorganic clays of low to medium plasticity gravelly sandy or silty lean clays over SM - silty sands, sand silt mixtures. The area is stable with regard to cutslopes. A few slopes exhibited positive pore pressure zones where seeps are present.

Vegetation: The major vegetation is stands of Chir pine and Sal trees, with an understory of grass. The cutbanks, even those nearly vertical were well vegetated with a fairly tall grass species. The Utis plantings did very well, and were more vigorous on west and northwest slopes. The area is partly cultivated and grazed.

Soil Profile: A representative soil profile of the major component - colluvial deposits - was described at Km 82.

DESCRIPTION OF ZONE 3. Km 82 to Km 107

Geology: In this zone the geology is an intermixed area of fine-grained schist and granitic gneiss. The gneiss shows extensive foliation. It behaves similarly to the decomposed granite. In parts that are unstable the schist overlies the granitic gneiss.

Slopes: The upper slopes exceed 90 percent in most of this zone. In the lower sloped ridges ranging up to 60 percent, the soil is used for cultivation and grazing.

Landslides: Many slides, including the "Big Muther" and associated slides occur in this zone. Most occur in areas where the schist overlies the highly foliated, partly decomposed, unstable granitic gneiss. This zone has the second highest incidence of landslides. The slides in the Schist controlled rocks are smaller in scope and size.

Soils: The soils in the Schist rocks are moderately deep, strongly acid, brownish, gravelly clay loam top and sub-surface soil that grades at depths of 20 to 40 inches into highly fractured schist bedrock. The rock fragment content in the profile ranges from 20 to 30 percent. The rock has a strong platy structure and is partly decomposed. On the lower slopes, the coarse granite soil derived from granitic gneiss is the major cause of the landslides.

Engineering Properties: The Unified Soil Classification group is SM - Silty sands, sand silt mixtures for the soil formed in the Schist, and GP - poorly graded gravels, gravel sand mixture, little or no fines for the soil formed in decomposed granitic gneiss. The SM soil is slightly plastic, with fair cohesive properties. If the soil is placed on the road bed as sub-grade material it is dusty when dry, becoming slippery when wet. Gravel surfaces should eliminate that problem.

Vegetation: The vegetation is Baanjh and Chir pine. The soil is used for cultivation, and grazing especially in the saddles of the terrain on lower sloped ridges.

Soil Profile: A representative soil profile of the major component - Fine grained schist - was described at Km 98.

DESCRIPTION TO ZONE 4. Km 107 to Km 135

Geology: In this zone the most important and major component is decomposed granite. It is in an association with transition zones of fine-graned schist which overlies intrusions of decomposed granite.

Slopes: The slopes exceed 90 percent for most of this zone. One transition zone from Dadeldhura to roughly Km 131 was less steep, even with some small areas of 30 to 40 percent. Such areas were heavily grazed and partly cultivated and terraced.

Landslides: The most severe landslides occur in this unit, and range from rotational slides to debris flows and rockfalls. Land slips were numerous, after starting at the top of the ridge, overtopping road structures on the cutslope and fillside with considerable amounts of decomposed granite rock fragments ranging in size from gravel, cobble, stones and even boulders. The larger sized landslides occur in this zone, some occupying up to 10 acres. The landslides generally are not deep seated. Most are debris avalanches or structurally controlled rock slides and rock falls.

Soils: The major soil is a deep slightly acid, brownish, granitic soil with a thin, 6-8", dark-colored clay loam topsoil; a thin, 8-10", very gravelly loamy fine sand that grades into an extremely gravelly, cobbly, and stony loamy sand subsoil. Included in this soil are many boulders. The amount of loamy sand soil materials range only from 5 to 10 percent. The rest is taken up by rock fragments, 90 to 100 percent. It is this incompetent portion of the soil that collapses and slides down when moist.

The soil is non-plastic and exhibits very little cohesion. Erosion rates are high. It has no expansion properties when dry, will readily absorb free water until the voids are filled and then it will drain very rapidly and dry readily.

The textural classification is extremely, gravelly, cobbly, stony coarse sand by the U.S.D.A. classification.

Engineering Properties: The Unified Soil Classifications group symbol is GP - Poorly graded gravels, gravel sand mixtures, little or no fines.

The soils in the inclusions are moderately deep strongly acid, soils that are 20-40 inches deep over highly fractured schist bedrock. The top and subsoils are gravelly clay loams. The top and subsoils are gravelly clay loams. The soil contains

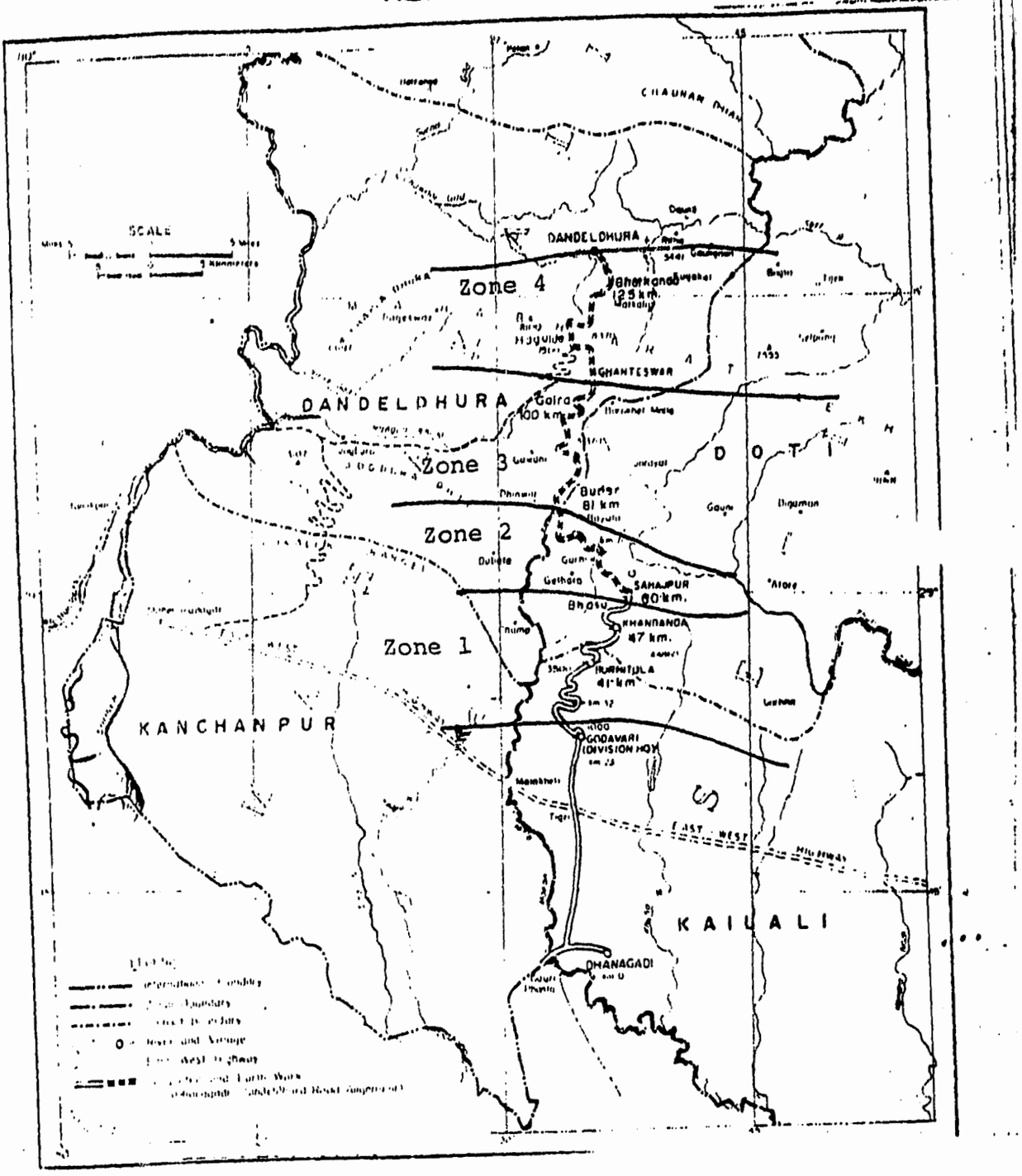
20 to 30 percent rock fragments, which are mainly gravel size. The slides generally occur in the decomposed granite inclusions within the schist. The unified soil clarifications group symbol is SM over GP. The soil is slightly plastic.

Vegetation: Vegetation of the major component is Chir pine on the South and East slopes with patches of Baanjh on the more North or North-west slopes.

The inclusions support a vegetation of Baanjh and Rhododendron or Baanjh and Chir pine. Transplants of Chir pine have been very successful, but bamboesa plantings failed in this zone. Most species that were not indigenous to the area did not succeed after transplantings in the field.

Soil Profile: A representative soil profile of the major component - decomposed granite - was described at Km 123.

WESTERN HILLS ROAD ALIGNMENT



ZONE MAP

EVALUATION OF THE NURSERIES, PLANTINGS WITH RESULTANT FINDINGS AND RECOMMENDATIONS

Bhatkanda Nursery: (125 km) 8,100 feet elevation. On November 3, 1983 we visited the Bhatkanda nursery.

The site selected for the nursery was well chosen. It was located on a sunny, rather level ridge. The site was fenced off to protect it from goats and other livestock.

It consists of 84 beds, 4 x 12 feet in size. The system that was used was that of "raised beds." The individual beds had rockstone walls, replacing an older system of wood baffles that had mostly rotted away.

The plants were raised in one and two quart-size perforated polythene bags. The soil mix used was topsoil, sand, and goat manure in the ratio of 3:2:1, which is an excellent mix.

The plants had been shaded and the watering was done by manual labor. The water used was trucked in and stored in a concrete water trough. Remains of the three feet high structures that were used to provide the shade could be noted.

According to the nursery man a total of 67,000 plants had been planted at various sites along the road. No count of individual species planted was available. Neither were the various planting sites mapped.

$5

Unfortunately, no accurate records had been kept. The nursery was started 1-1-1981 and upon reaching yearling size the plantings were planted during the months of February, March, July and August.

This fiscal year the nursery work has been stopped.

The major seed was purchased from the Pratap Nursery and seed stores in Dehra Dun, India. No records were available as to the amount purchased and prices of various seeds.

For two local plant species, Utis (Alder) and Ritha (Soap nut), local seed was utilized.

The major plant species that were growing in this nursery, although past yearling size by now, were:

1. Koiralo - (Bauhinia variegata) - Mountain ebony. It is a species that needs an inocculum which might not have been used. It is a low altitude species with an altitude range of 900-2400 feet. It is used for fodder or fruit.

2. Ritha - (Sapindus Mukorossi) - Soap nut. The fruits are used for making a local soap. It is used also for fodder, and is considered a low altitude species.

3. Accacia deabata - A low altitude species that is mostly grown in river deltas.

4. Utis - (Alnus nepalensis) - Alder. It is a fast spreading tree used for fuel or timber. It is very useful in plantings in landslips. Although in the literature it is considered a low altitude species, it is thriving very well at higher altitudes. In the plantings the Utis showed good vigor.

5. Kalki phul - Weeping bottle brush, a fuelwood species with red flowers. It is more suited to swampy ground or seasonally flooded areas. It is a dense shrub.

6. Robinia pseudo acacia - locust tree. It is a high altitude species with a habitat range of 3000 to 8400 feet. It is considered a very useful plant for erosion control, and is used also as a protective hedgeplant.

7. Ghangaru - (Pyracantha crenulata). It is a thorny shrub used for hedges.

This nursery served the 96 km to 135 km stretch of the road. The nursery man walked with us along this portion of the road to show us the plantings.

Of the 7 species of plants grown in the nursery only Utis and Ritha showed successful growth. It is to be noted that these are local plant species.

The nursery man admitted that the species that had not survived were outside their altitude range. A tremendous amount of plantings may also have been wiped out due to the landslides which were very numerous in this area.

Another species of plants that had failed in most spots were Bamboesa clumps that had been transplanted from the forest. Bamboesa grows in damp places in the ravines on deep soils with thick topsoil and is very shade tolerant. Most plants had died after two years on the dry south facing slopes of the Chir pine area.

An attempt had been made to fence off stretches of the berm side of the road which had been planted with species from the nursery. The one-wire fence was nearly completely obliterated and no plantings could be detected. This effort had failed due to goats grazing along the road on the way to the market.

We made note that much natural revegetation had taken place on the older landslides, especially on the South and East slopes in the Chir pine sites. One small stand of vigorous growing Chir pine, 7 to 8 years old, at km 96 was especially noted. The nursery man was not sure whether these trees had been transplanted from the forest. David Reed, the AID Technician, who was in charge of the nursery and plantations, never mentioned Chir pine plantings in his report.

We found many Utis and Ritha plants had been planted on top of the gabions. This is a practice that should not be repeated. Utis trees with their roots will severely damage the gabion structures as the trees reach maturity. Obviously, this practice did not have the endorsement of the Road Department engineers.

Budar Nursery: (81 Km) 6,000 feet elevation. On November 5, 1983 we visited the Budar Nursery.

This nursery used the same type of layout and size of beds as the Bhatkanda nursery. It also was fenced and provided with a concrete water trough and provisions for the shading of the plants.

The nursery had planted everything it had grown in the past. The soil used was the same as the Bhatkanda nursery soil.

When we visited the nursery two workers were preparing a few beds and were filling the perforated polythene bags with the soil mix of topsoil, sand, and goat manure.

The nursery man provided us with a list of 1983 plantings

1.	Alnus Nepalensis - Utis - Alder	5,097 plants
2.	Agave - Ketuki - A thorny shrub or hedge plant	2,904 "
3.	Sapindus Makorossi - Ritha - Soap nut	2,470 "
4.	Acacia Japanesena	5,949 "

5.	Walsua Trijuga - Ankha Taruwa	600	plants
6.	Melia - Bacaino - Persian Lilac	426	"
7.	Acacia deabata	1,000	"
8.	Bauhinia variegata -Koiralo - Mountain Ebony	1,933	"
9.	Collestemom viminalis - Kalki Phul - Weeping bottle brush	104	"
10.	Leucaena leucocephala - Oosiris - Coffee bush	4,723	"
11.	Poincinia regia - Gulman - Flamboyan tree	576	"
12.	Phyllantus emblica - Amala	150	"
13.	Pinus patula - Patula pine - Patti Salla	50	"
14.	Reubinia Pseudo acacia - locust tree	750	"

1981-1982 Plantings

1. Morus Alba - Kimbu Kaphal - White or Silkworm mulberry. It is a timber and fodder species which produces edible fruit. These were experimental plantings surrounding the nursery only, and were not planted on the landslides.

According to the nursery man the best results were obtained by Utis and Amala plantings, followed by Kalki, Agave, Ritha, and acacia deabata. All other species never got established. In the stretch of road that was served by the Budar Nursery many Utis plants had been planted on top of the gabions.

White clover was tried, but never germinated. The Bamboesa plantings had completely failed. A few plantings of dead Bamboesa were visible along the road.

The species of plants that were growing with a fair success rate were Utis, Ritha, Agave, and Acacea deabata. The nursery man could not show us any successful plantings of Kalki or Amala.

Here again, of the 14 species that had been planted Utis and Ritha, two local indigenous species, showed successful growth.

Because of no records, other than the planting list, one could not know whether the time of plantings was wrong, or whether a number of other factors could have played a role in the high failure rate of the species that had been tried.

The major landslides in this zone of fine-grained schist with intrusions of decomposed granite occurred in the decomposed granite soils similar to those on the stretch of road served by the Bhatkanda Nursery.

Summary of Findings

1. Natural vigorous revegatation of Chir pine on steep, bare slopes was evident on many cut and fill slopes.

2. Most Utis plantings on steep slopes had been destroyed by the landslides. The most successful Utis plantings were on top of the gabion structures, along with the Ritha plantings.

3. Bamboesa plantings on south and east facing slopes had completely failed.

4. Of the 15 species of plants that had been planted only 4 showed success, of which Utis and Ritha showed the greatest vigor followed by Acacia deabata and Kalki phul.

5. Grass seedings had not been attempted.

6. The greatest numbers and largest landslides were in the decomposed granite or decomposed granite intrusions.

7. No nursery book or accurate records had been kept.

8. The numbers of plants reportedly planned seems to be on the high side.

Summary of Recommendations

1. All Utis plants growing on top of the gabion structures should be girdled or cut off. No attempt should be made to rip them out. This could damage the structures.

2. Either rely on natural revegetation of Chir pine or transplant them from the forest on the south and east slopes of zone four along with topsoil to assure the presence of mycorrhiza in the soil.

3. No bamboesa plantings should be made on the south and east facing slopes.

4. Plantings of species that are introduced outside their altitude zone should not be attempted in the future, unless it can be proven that the plants do grow vigorously in this zone.

5. Transplant areas of Chir pine or natural revegetation area should be protected from grazing or fire where possible.

6. Plantings of grass species should be attempted on the advice of local expertise. There are grass species available for steep slopes - Bankas (Khar) was one that was mentioned by Forest officials that we met. It is a matter of greatest importance that each species be put only on the types of soil and site suited to it as indicated by good growth in natural forest or older plantations. Grasses are easily reproduced from both seed and vegetative tissues, through tillers or entire plants, and rhizomes.

7. No attempt should be made to plant plants along the berms where movement of goats can be expected to take place.

8. The DOR should select an individual with a "green thumb." The individual should receive training in revegetation work;he should be able to collect and should give considerable attention to information from local farmers,residents and

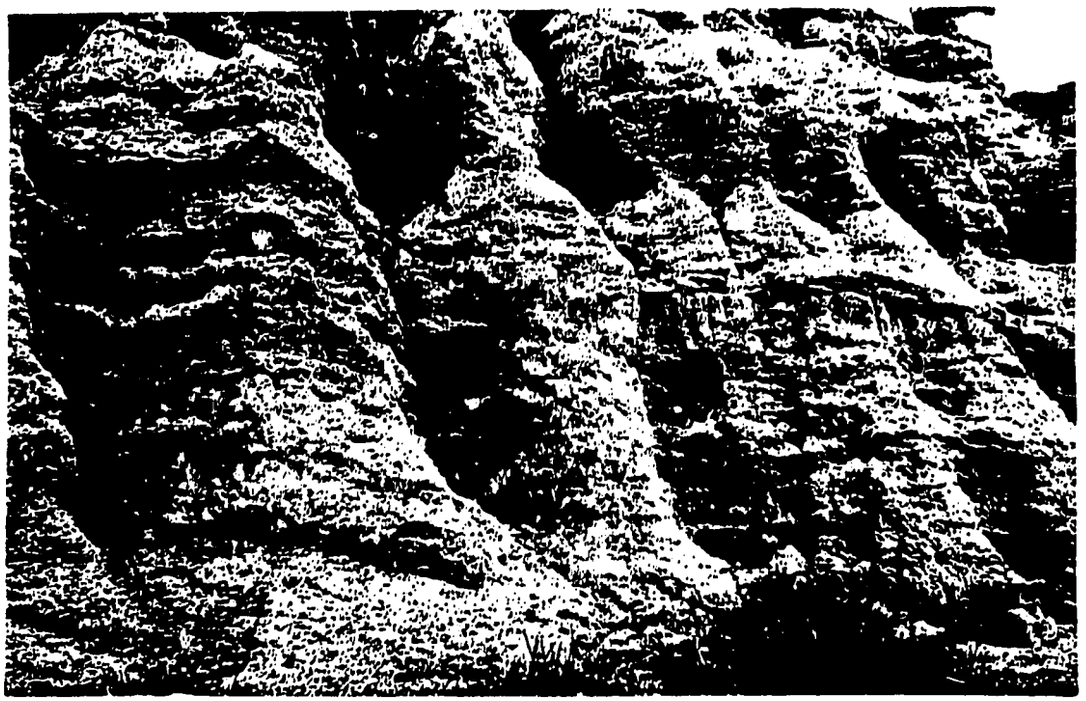
officials, and should be able to coordinate with the Panchayat officials to protect plantings. The individual should be employed and under direction of the DOR.

9. Utis and Ritha plantings, if continued, should be planted on the steep slopes behind the gabions and other structures.

10. Retaining structures should be built first prior to the plantings to assure that the soil is stabilized and will not be disturbed due to construction activities.

11. Do not plant clover in any grass mix. Nitrogen fixing plants are very highly competitive and consume disproportionately large quantities of water and nutrient sources once they become established. White clover plantings in the Budar Nursery completely failed.

12. Accurate records should be kept. Keep careful note on planting dates, growth and development, plant, height, dates of observations, etc. Map planting sites and dates of plantings, with follow-up checks as to their growth and adaptability.



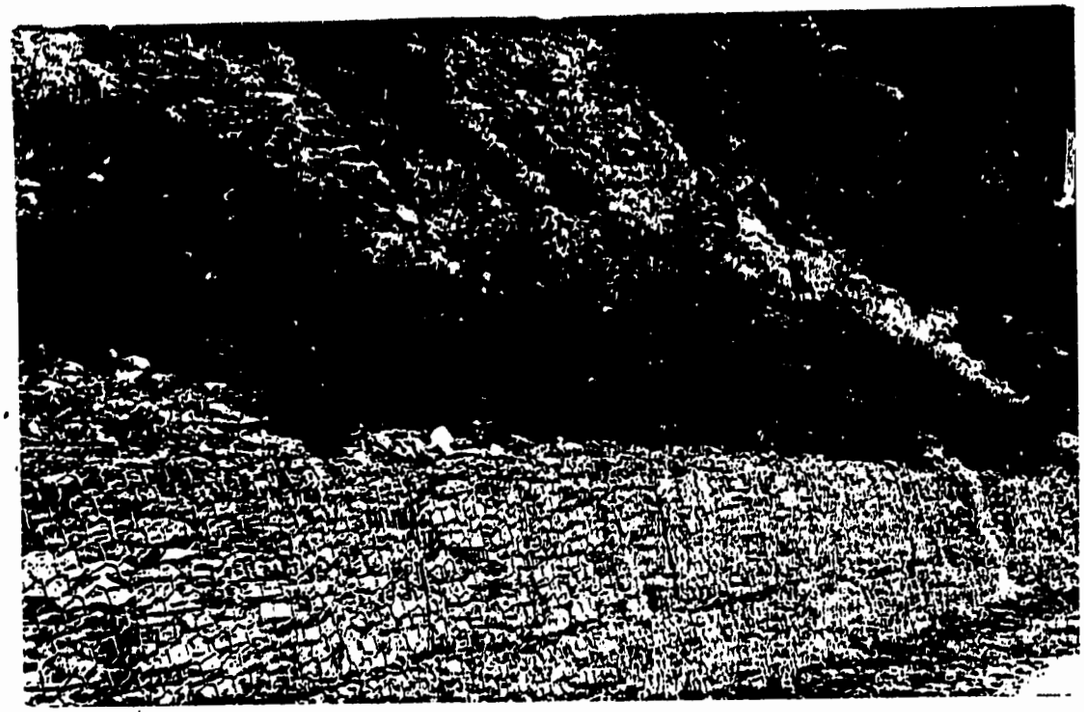
Erosion of weathered decomposed granite in which the less resistant rock components has eroded away. The soil aggregate stability is very low. A significant increase of landslide incidence can be expected if the rock weathering and fracture of parent material will increase with time.

Landslide in the decomposed granite zone.
Boulders are generally incompetent bedrock.

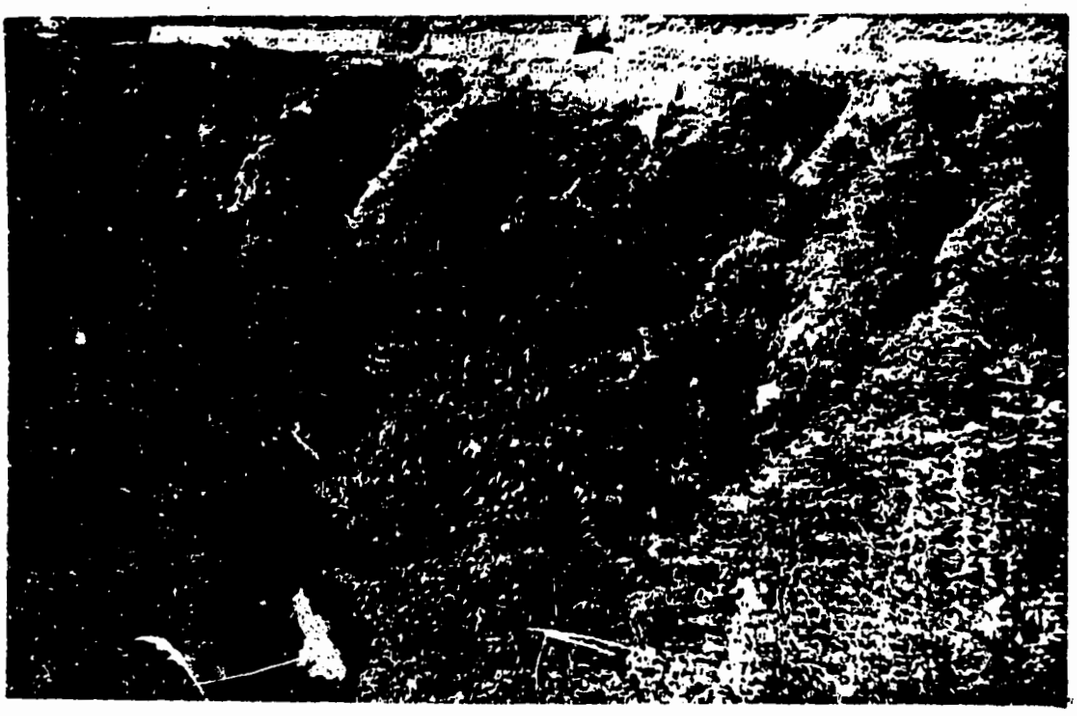
Typical landslide in the decomposed granite zone in which the amount of soil is small, and the amount of granitic rock is very high.

Landslide in the decomposed granite zone. Cultivation and grazing above the slide caused this mass soil movement to occur at the slope break.

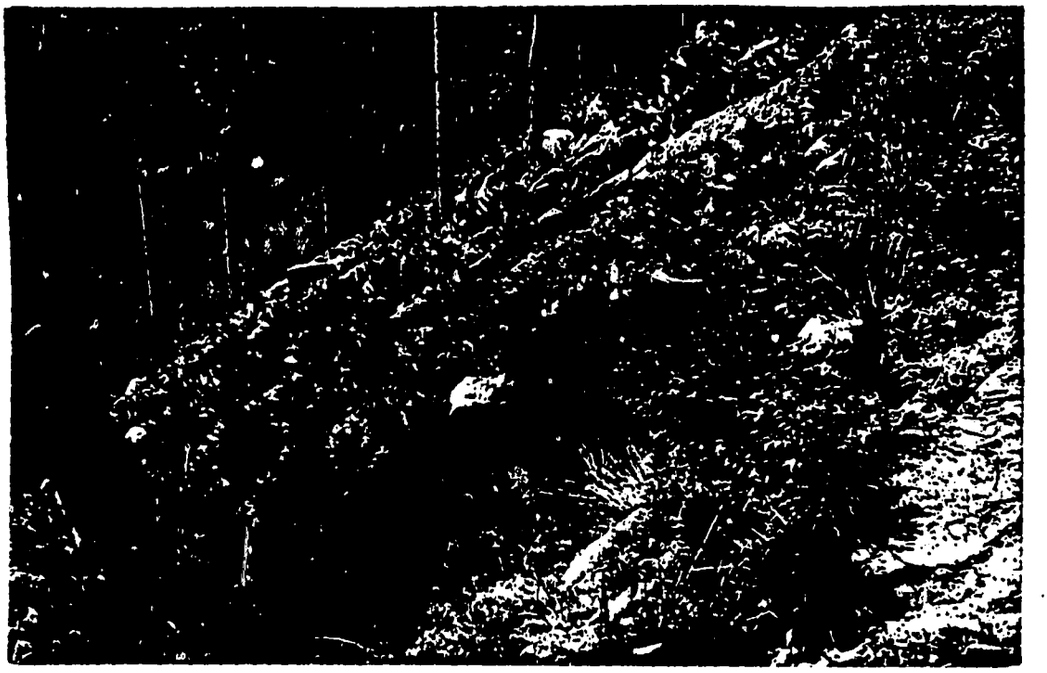
Soil Profile Km 123 _ 100 (Stop 1). Shallow top and surface soil over decomposed granite (gruss) soil material that is partly consolidated, partly paralithic. East aspect; Chir pine - Rhododendron - Kar grass vegetation.



Successful planting of utis and Ritha between Bhatkanda and Dadeldhura.



Successful Utis plantings - Alnus Nepalensis - (Alder) on fillslopes.

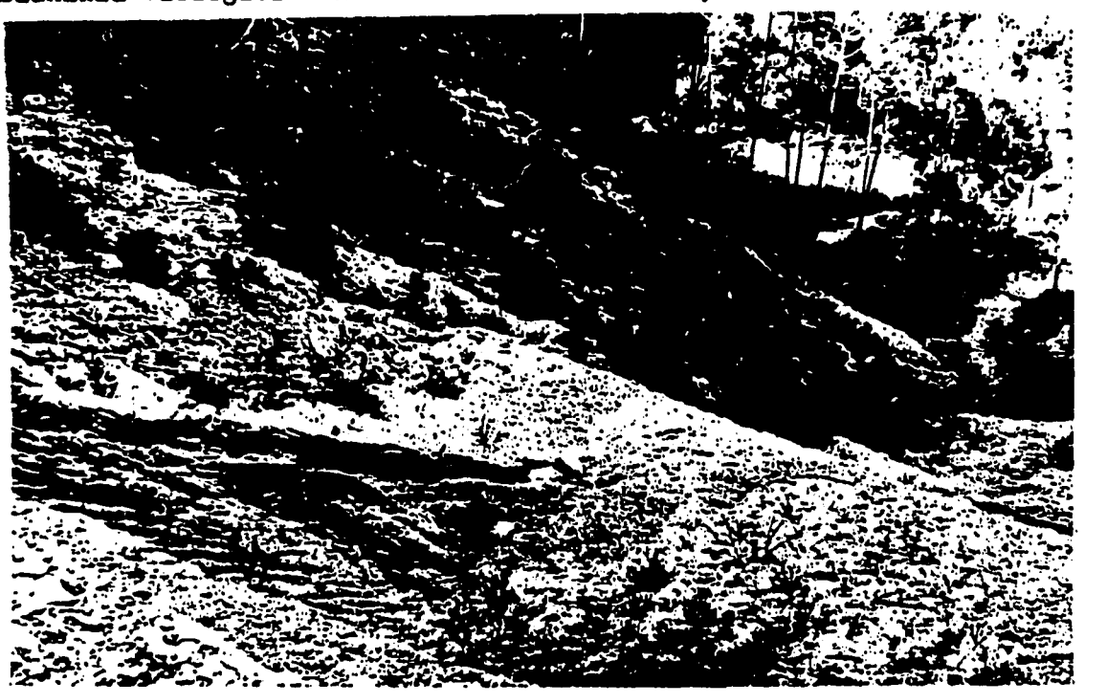


Natural revegetation of Chir pine on fill and cut slopes on South and East exposures in the decomposed granite zone. The presence of seedlings and intermediate-aged plants together with fully matured ones, is a strong indication that the species is capable of meeting all the requirements for revegetation

Excellent revegetation of Chir pine above the gabion wall. These were transplants from other slopes. This is in a granite intrusion on a South East slope. The trees were approx. 7 to 8 years old. The trees had some forest soil under and around the trunks. This adds mycorrhiza to the soil mixture. Km 96.

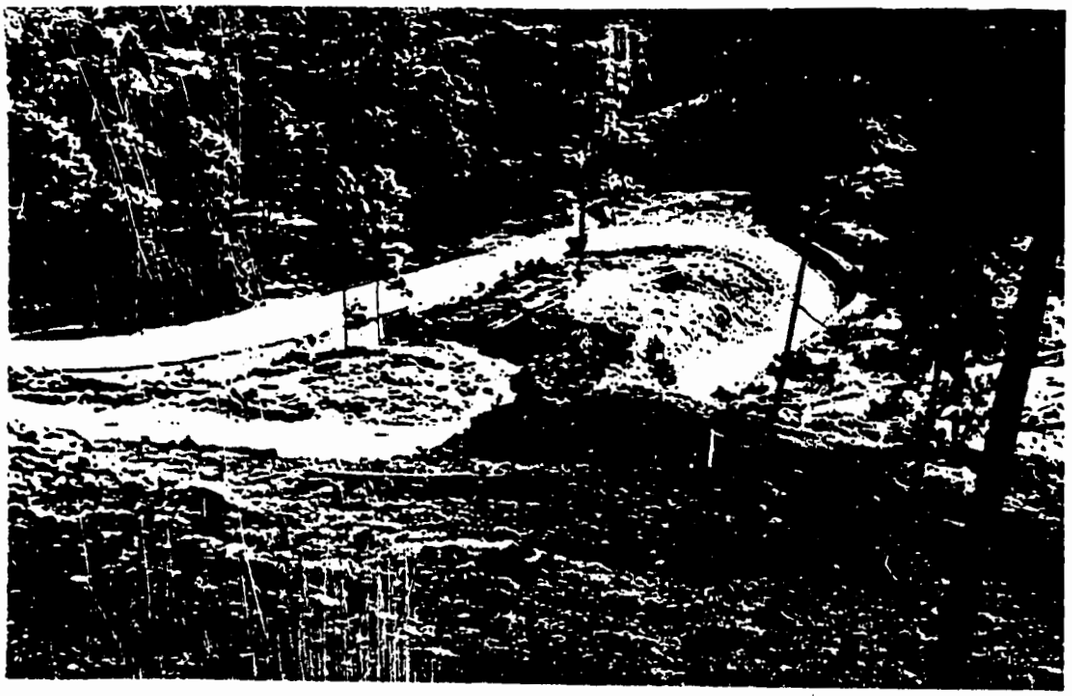
Very poor plantings of Bauhinia variegata on South slopes of granite intrusion. This was 1,000 feet from the successful Chir pine transplants. Km 96.

Bauhinia Variegata - Koiralo - Mountain ebony.



Fair growth of bottle brush at km 84. Note: natural revegation of Chir-pine on landslide material from a landslide 6 years ago in the background.

At Km 67. The shallow and moderately deep soil over sandstone showing the gullies and severe surface erosion caused by overgrazing. It may threaten small bridge in hair-pin turn in the road below.



Small bridge threatened by gully erosion above this site caused by heavy overgrazing. Km 67.

Short Soil Profile Description of Major Soil in Zone 1

This deep, slightly acid soil is formed in sandstone that is interbedded with shale, siltstone and mudstone. A fairly thick dark-colored top and subsurface soil of gravelly silty clay loam and light clay loam grades at 2 to 3 feet into a variable colored, often mottled, heavy clay loam subsoil that is variable in gravel content or color. The mottles indicate the presence of a seasonal water table. Few incidences of major slides are present. The landscape is one of steep to very steep mountainsides that support a stand of Sal, Sagh, with an understory of grasses. Elevations range from 4,000 to 5,300 feet.

A1-0-12 inches. Grayish brown (10 YR 5/2) dry, Very dark brown (10 YR 2/2) when moist, gravelly silty clay loam; weak fine platy structure; slightly sticky and slightly plastic; 20% gravel, 10% cobble; p^H 6.2.

B1-12-24 inches. Brown (7.5 YR 5/2) dry, Dark brown (7.5 YR 4/2) when moist, gravelly clay loam; weak fine subangular blocky structure; slightly sticky and slightly plastic; 30% gravel, p^H 6.2.

B2-24-36 inches. Light brown (7.5 YR 6/4) dry, Brown (7.5 YR 4/4) when moist with common, fine and medium prominent mottles of yellowish brown and yellowish red, heavy clay loam; weak medium blocky structure; slightly sticky and slightly plastic; 20% gravel; p^H 6.4.

B/C 36-48 inches+ Light reddish brown (5 YR 6/3) dry, Reddish brown (5 YR 4/3) when moist, gravelly clay loam; massive structure; slightly sticky and slightly plastic; variable amount of gravel; pH 6.4.

The soil is used for grazing, and cultivation.

The tentative classification is Typic Haplumbrepts; fine-loamy, mixed, frigid.

Location of soil described: Km 33 along the road between Dadeldhura and Dhangarhi on November 6, 1983.

Short Soil Profile Description of Major Soil in Zone 2

This deep, slightly acid soil is formed in colluvium of quartz and schist. A fairly thick dark-colored clay loam grades into a yellowish red subsurface and subsoil to a depth of 6 feet or more. The soils gets more gravelly with depth with up to 70% gravel in the subsoil zone. Texture remains a gravelly to a very gravelly red clay loam. The landscape is one of a series of steep colluvial ridges on E and NE slopes. Elevations range from 5,300 to 6,200,, and supports a tand of Sal, Chir pine grasses and forbs. The landscape is stable, and has a low incidence of landslides.

A-10-14 inches. Brown (10 YR 5/3) dry, Dark brown (7.5 YR 3/2) when moist, clay loam; moderately fine and medium subangular blocky structure; slightly sticky and slightly plastic; 10% gravel, pH 5.2.

B1-14-34 inches. Yellowish brown (10 YR 5/2) dry, Dark reddish brown (5 YR 4/6) when moist, very gravely clay loam; weak fine subangular structure; slightly sticky and slightly plastic; 30% gravel; p^H 6.4.

B2-34-48 inches. Yellowish red (5 YR 5/6) dry, Yellowish red (5 YR 4/6) when moist; very gravelly heavy clay loam; massive structure; slightly sticky and slightly plastic; 50% gravel; p^H 6.0.

B/C-48-72 inches.+ Red (2.5 YR 5/6) dry; Red (2.5 YR 4/6) when moist, extremely gravelly clay loam; massive structure; slightly sticky and slightly plastic; 75% gravel p^H 6.0.

The soil is mainly used for grazing and cultivation.

Tentative Classification is Typic Haplumbrepts; loamy - skeletal, mixed, frigid.

Location of Soil Description: Km 82 along the road between Dadeldhura and Dhangarhi, on November 6, 1983.

Short Soil Profile Description of Major Soil in Zone 3

This moderately deep, strongly acid soil is formed in fine-grained foliated schist.

A thin dark-colored, gravelly light clay loam topsoil overlies a reddish yellow gravelly clay loam subsoil, which at a depth of 20 to 40 inches, over lies the highly fractured schist bedrock. The landscape is one of extremely steep mountains, facing mostly East and South-east, with an elevation range of 7,500 to 6,00 feet, and supports a stand of Chir pine, Baanjh trees (grey oak), and an understory of mostly grasses. Intrusions of decomposed granite at the lower slopes have caused many of the landslides in this zone.

A1-0-6 inches. Brown (10 YR 5/3) dry, Dark grayish brown (10 YR 4/2) when moist, gravelly light clay loam; weak fine, subangular blocky structure; slightly sticky and slightly plastic; 20% gravel pH 5.6.

B-6-22 inches. Reddish yellow (7.5 YR 6/6) dry, Brown (7.5 YR 4/4) when moist, gravelly light clay loam; weak, fine, subangular blocky structure; slightly sticky and slightly plastic; 30% gravel; pH 5.2.

R-22-36 inches. Highly fractured fine-grained schist bedrock which is partly decomposed, and has a strong platy structure.

This soil is relatively stable, and is used mainly for grazing and in part for cultivation on the lower slopes.

Tentative Classification Udic Dystrochrepts: fine-loamy mixed, frigid.

Location: Km 92 along road between Dadeldhura and Dhangarhi, West Nepal, November 5, 1983.

Short Soil Profile Description of Major Soil in Zone 4

This deep, slightly acid soil is formed in decomposed granite. A thin dark colored clay loam topsoil overlies a very coarse texture subsurface and subsoil that consists of gritty decomposed granite particles with a very high content of rock fragments. The landscape is one of extremely steep mountains, mostly facing East and Southeast, with an elevation range of 7,500 to 8,200' and supports stands of Chir pine, Baanjh trees (grey oak), Rhododendron with a grass understory.

A1-0-7 inches. Grayish brown (10 YR 5/2) dry, very dark grayish brown (10 YR 3/2) when moist, clay loam; weak fine subangular structure; slightly sticky and slightly plastic; 10% gravel; p^H 6.2

C1-7-18 inches. Light yellowish brown (10 YR 6/4) dry, brown (10 YR 4/3) when moist, very gravelly loamy sand; massive structure; nonsticky, non-plastic; 40% gravel, p^H 6.4.

*C/R-18-60$^+$ inches. Light brownish gray (10 YR 6/2) dry, brown (10 YR 5/3) when moist, extremely gravelly, cobbly, and stony loamy sand; massive structure; nonsticky, non-plastic; 50% gravel, 30% cobble, 10% stones; p^H 6.4.

* The C/R material often contains boulders. It consists of decomposed granite, that upon collapse completely disintegrates and forms a loose mass of the various rock fragments and loamy sand soil material. It is then very loose, often single grained and highly erosive and unstable. This material causes the highest incidence of landslides in zone 4. The soil is droughty.

Tentative Classification: Typic Haplumbrepts; sandy skeletal mixed, frigid.

Location: Km 123 along road between Dadeldhura and Dhangarhi, November 4, 1983, West Nepal.

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EVALUATION
OF
SOCIO-ECONOMIC IMPACT OF THE WESTERN HILLS ROAD

Dhangarhi to Dadeldhura
Nepal
Completed July 15, 1982

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by

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SUMMARY AND CONCLUSIONS

This evaluation study was conducted to determine the extent to which the Western Hills Road (WHR, from Dhangarhi in Terai to Dadeldhura in Hills) has made a social impact upon the lives of the people in its area of influence. USAID/N financed the construction of the 135 km road which was completed in 1979. Later in 1979, AID/Nepal provided financial assistance to HMG/N through the Landslide and Soil Stabilization Project (LSS) to stabilize the road and minimize the risk of future landslides on the road.

In the main, the impacts of the WHR are impressive. The price differentials of essential commodities not locally produced in the Hills like salt, kerosene and sugar have significantly narrowed with the advent of the road. On the other hand, the price received by the producer of exported goods, particularly ghee, has increased resulting from improved transportation. This contributes to the increased rural income.

Though there is much left to accomplish with regard to adoption of modern agricultural technology, the contribution of improved varieties of major foodgrain crops, paddy and wheat to increased total production is recognized. In the meantime, more forest and marginal lands, especially in the Terai, were brought under plow. The transportation of foodgrains and modern agricultural

inputs like seeds, fertilizers and pesticides has been facilitated by the road. During the past few years, traditional consumption habits have changed, especially by including a wider variety of vegetables in the diet.

There are now some 210 production industries (mostly agro-based) in Dhangarhi. Industries generating significant employment opportunities are non-existent in Dadeldhura. The turpentine factory under construction at Dhangarhi will probably generate some employment and will utilize pine pitch that comes from the Hills. The pine pitch exported to India in 1982/83 contributed about Rs.206,092 to government revenue.

There is increasing awareness, especially among younger and educated parents, to limit the size of a family. People using both contraceptives and surgical services were found, but the access of women to these methods was limited because of the lack of female motivators in the villages; female surgeons tend to be unwilling to visit these places. The responses by men for not practising family planning methods were lack of awareness, self control, few children, shaman, unwillingness and frustration.

People have learned to visit the hospital, but the treatment depends on the ability of a patient to buy medicines. Respondents sent their sons to school, some educated their daughters too. Available statistics shows greater enrollment

of both boys and girls in school. The forest degradation due to increasing population and heavy grazing has doubled the time needed for collecting fuelwood and fodder. On the other hand, time required for fetching drinking water has shortened with availability of polythene pipes. Some of these effects are more directly related to the road than others.

During and after the construction of the road, there have been opportunities for jobs locally. The construction of extension and feeder roads has employed unskilled laborers who otherwise went to the Terai or to India for seasonal employment.

The fiscal procedure developed and adopted in the LSS project proved effective in the smooth running of the project. Since 1982/83, a similar procedure has been adopted by AID and HMG/N for all bilaterally or multilaterally financed projects in the Kingdom.

Bus and truck traffic average 3.4 and 7.5 units per day to Dadeldhura. Monthly bus traffic is an estimated 550,000 passenger km. A monthly average of 1575 tons of freight is carried over the road. The traditional porterage system along the road corridor has collapsed and would probably be difficult to revive.

RECOMMENDATIONS

The following recommendations suggest ways to enhance the impact of this and other road projects:

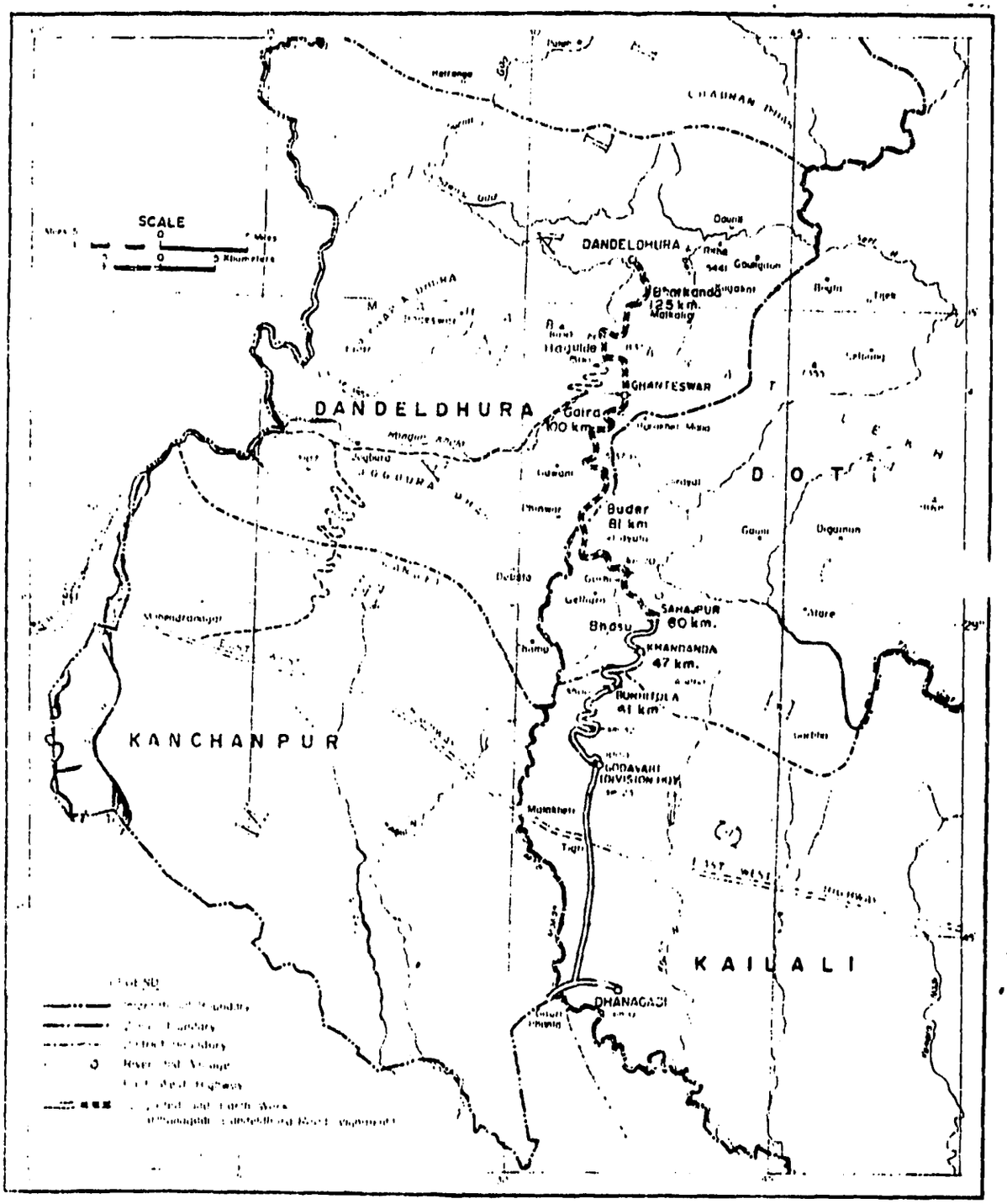
First, there has been an excessive time lag between completion of the road and development of other job opportunities in the Western Hills. Other government agencies (e.g., the Ministry of Agriculture and the Ministry of Industry) should give priority in program planning to areas opened up by roads to strengthen service delivery and support systems in these areas, and thus take maximum advantage of better transportation and the surplus labor available. As an additional benefit, the availability of south bound cargos will reduce haulage costs by assuring pay loads in both directions and promote the growth of the two ecozones (the Hills and the Terai).

Second, provision of basic transportation network gives access to incremental investments in the areas influenced by the road. The World Bank since 1980 has extended financial assistance in the development of Dadeldhura, Baitadi and Darchula through the Mahakali Integrated Rural Development Project which envisages agriculture, livestock, construction work and support services. Recently, the Asian Development Bank has extended loan to HMG/N to upgrade the WHR with an extension of a feeder road to Baitadi (Patan), and several other projects.

Third, the lack of an efficient marketing system has hindered expansion of agriculture into high value crops especially in the Far Western Terai. This development will accelerate with the connection of the East-West Highway to the remainder of the system which should be given a high priority.

Finally, the WHR must be kept operational substantially year round to protect consumers from shortages, sustain rural income at the present level and permit the orderly operation of industrial enterprises.

WESTERN HILLS ROAD ALIGNMENT



I. INTRODUCTION

Basic infrastructures are pre-requisites to any developmental activities. In countries like Nepal which are characterised by rugged terrain an improved transportation network plays a vital role in economic development. In developing the roads system in Nepal, prime consideration has been given to high-ways that directly contribute to social and economic development of the country. An economic survey (HMG, 1983) states that ... "with a view to provide facilities for the rural sector and especially to those people residing in remote areas of the Hills ..., due priority has been accorded to the construction of ... motorable roads." The Western Hills Road (Dhangarhi to Dadeldhura) was completed in 1979 with USAID/N assistance to connect the two ecozones with the purpose of alleviating rural poverty. Latter in 1979, AID increased the assistance by financing the LSS Project to stabilize the soil and landslides so that the road might be open all year round. This evaluation addresses the socio-economic impacts of the road provision in general and the following questions is particular:

a. "How and to what extent have the lives of the people living in the area been influenced by this road?" and

b. "Did the fiscal procedures developed during the course of this project (LSS) contribute to the smooth running

of the project? What specific recommendations can be made regarding procedures to be used in future project?"

II. FINDINGS AND ANALYSIS

A. Economic Impacts

a. Agriculture

In 1981, out of the total of 637,135 economically active population in the Far Western Development Region, 96% (612,078) were engaged in agricultural occupation.[1/] Thus in any effort to uplift the quality of life of the people in this part of the Kingdom, agriculture receives the top priority. After the Hills districts of this region were connected to the food surplus area in the south by WHR, this remote area is now subject to new economic and social forces. However, the pressure of ever increasing population on the already closed land frontier has raised the question of survival for the people in the area. The role of the WHR in relieving this aggravating problem is vital.

The improvement in agriculture largely depends on the farmer's potential for responding to the new economic relationships related to the advent of the road. There is an impressive increase in the area grown to major foodgrain crops in the region, except on maize (Table 1). The cropping pattern

1/ Population Census - 1981, National Planning Commission Secretariat, Central Bureau of Statistics, Kathmandu.

Table 1.

Area Under Major Crops in Selected Districts of
Far Western Development Region, Nepal
1967/68-1982/83

District	Paddy		Maize		Wheat		Millet & Potato	
	1967/68	1982/83	1967/68	1982/83	1967/68	1982/83	1967/68	1982/83
Kailali	39,000	42,800	12,000	11,500	1,800	13,910	175	1,880
Kanchanpur	12,000	27,480	5,000	8,610	800	9,240	75	730
Doti	3,900	6,920	4,400	4,200	4,200	10,510	250	2,250
Dadeldhura	2,900	5,380	3,100	2,540	4,500	8,900	150	3,120
Bajhang	2,500	2,940	3,600	900	3,900	2,350	175	1,170
Achham	2,700	1,930	3,050	2,850	3,700	3,200	150	1,120
Baitadi	2,825	3,300	2,700	2,900	3,275	3,300	175	1,280
Bajura	2,800	1,470	2,800	780	3,100	2,000	75	900
Total	68,625	92,220	36,650	34,280	25,275	53,410	1,225	12,450
% Change	34.4		-6.5		111.3		916.3	

Source: (1) For 1967/68; Rana, Ratna S.J.B., "An Economic Study of the Area around the Alignment of the Dhangarhi-Dadeldhura Road, Nepal," Kathmandu CEDA, Tribhuvan University, 1971.

(2) For 1982/83; Department of Food and Agricultural Marketing Services, Kathmandu, Nepal.

is dominated by foodgrain due to the high pressure of population and hence the main focus is on food self-sufficiency. This in turn discourages the production of high value cash crops. Lack of irrigation and marketing facilities have slowed the process of adoption of modern agricultural technology. Chemical fertilizers and pesticides use is limited to big farmers and irrigated field. In recent years lucrative farming is constrained by deteriorating soil fertility and increasing labour costs due to urban attraction by industry. Farm yard manure is the major source of nutrients added to the soil.

Our field survey observed changes in the cultivation of major foodgrains. The increase in production can be attributed to the use of new crop varieties, and marginal and forest lands brought under plow. In general, the long run agricultural productivity has either declined or stagnated. The eradication of malaria and resettlement programs in the Terai districts attracted more people from the Hills. As a result, large population increases occurred (Table 2). However, no more increase of population is desirable because of the decreasing land-man ratio. The agricultural lands are characterised by small scale operations, especially in the Hills, and are inefficient.

Table 2.

Population Statistics for the Selected Districts of Far Western Development Region, Nepal

1961, 1971 and 1981

District	Total Population			% Change	
	1961	1971	1981	1961-71	1971-81
Kailali	89,910	128,877	257,905	4.3	10.0
Kanchanpur	18,889	68,863	168,971	26.4	14.5
Doti	295,367	166,070	153,135	- 4.4	- 0.8
Dadeldhura	87,108	94,743	86,853	0.9	- 0.8
Achham	165,699	132,212	185,212	- 2.0	4.0
Baitadi	163,308	128,696	179,136	- 2.1	3.9
Bajura	NA	61,342	74,649	NA	2.0
Bajhang	NA	108,623	124,010	NA	1.4
Darchula	NA	68,868	90,218	NA	3.1

NA = Not available

Source: For 1961; see (1) Table 1.

For 1971 and 1981; Population Census 1971 and 1981, HMG, National Planning Commission Secretariat, Central Bureau of Statistics, Ram Shah Path, Kathmandu, Nepal, 1975.

The provision of roads is not the only answer to agricultural development. Farmers are faced with location specific problems like physical, biological and institutional constraints. The cropping pattern now followed is largely governed by these factors. Irrigation facilities, introduction of improved crop varieties and the adoption of new methods are complementary to increased productivity. Paddy is grown in the monsoon season because of the high water requirement. This is followed by mustard or wheat in the winter season. The lack of market has inhibited the potential production of wheat. Mustard is grown as a cash crop in the Terai. Surplus rice and mustard oil is exported to Bhairahawa, Pokhara and Kathmandu via India. Rainfed crops dominate the arable land in the Hills. Maize, millet and upland paddy (ghaiya) are cultivated in the terraces which depend on rainfall.

Some specific changes brought about by the improved transportation, among others, are the introduction of high yielding varieties of paddy, wheat, maize and potato. In 1982/83, 250 and 21 quintals of improved paddy and wheat respectively were distributed in Dadeldhura under the agricultural program of the Mahakali Integrated Rural Development Project. The figures for 1981/82 were 792 and 320 kg respectively of improved seeds of paddy and maize transported by Agricultural Inputs Corporation to Dadeldhura. New varieties of

potato and vegetables are increasingly popular in the Hills. Potatoes are locally marketed and is the source of cash to buy daily necessities from the same market. Seasonally, vegetables in excess of home consumption are sold out. Vegetables from India also have found markets in the Hills, though in small quantities.

Due to heavy rain in the region on September 11 and 12, 1983 the WHR was rendered impassable. Heavy landslides occurred. The potential of the road is realized primarily through its effect on output prices. At Dadeldhura, the unit prices of imported consumer goods rose sharply after the road closure, for example in cases of potatoes (40%), Onions (33%) and cooking oil (20%).

		Price (Rs/p) per unit, when		
Commodity	Unit	Traffic open	Traffic Closed	% Change
Potato	kg	2.50	3.50	40
Onion	kg	3.00	4.00	33
Cooking oil	ltr	20.00	24.00	20
Milk	kg	6.00	4.00	-33
Ghee	kg	35.00	28.00	-20
Flour	kg	5.00	5.00	0
Rice (Coarse)	kg	5.50	5.50	0
Rice (Fine)	kg	7.00	7.00	0

Source: Field Survey.

On the other hand, the price paid to producers of the major exportable item (ghee) from the Hills has fallen due to the lack of transport. This has a strong negative impact on the income accruing to the farmers in the Hills.

The prices of staple foodgrains have been stabilized to protect the consumers. This was made possible by timely stocking of these commodities by the government owned Nepal Food Corporation for which the products move by WHR.

b. Food Consumption

It is customary to observe some changes in the traditional consumption habits of the people living around a newly constructed road. However, provision of a road is not the only important determinant of improved diet. Other factors like people's income and the prices of essential commodities are important considerations. Improved transportation brings about changes in consumption habits by way of price decrease in consumer goods.

During the past few years, the use of vegetables has increased greatly. Consciously or unconsciously many people have learned by experience the need for other nutrients as evidenced by the use of different kind of vegetables. Similarly, fruits are becoming increasingly popular.

Vegetables and fruits prove highly valuable in situations of marginal food supply and of actual famine. The pattern of use of staple food (cereal grains), of course, has not changed much. The consumption of cereal grains depends on the cropping pattern of the household. New agricultural technology which alters costs and returns of cereal production has effects on consumption pattern. Since the Hills are deficit areas, much of the additional food has to come from the Terai.

Often vegetables and fruits imported into the Hills come from India, mainly in the off-season. Seasonal vegetables are home grown and are also sold in the nearby markets, but the art of growing vegetables year round is lacking in the area. Potatoes are becoming more popular.

c. Animal Husbandry

Agriculture and livestock enterprises are integrated in a whole-farm system. Animals are the principal sources of draft force and manure in the area. Ghee is the most important animal product exported from the Hills. Milk is sold in the local markets, primarily to tea-shops. Some families were still found to have raised 10-12 buffalo depending on the availability of pastures. They seasonally

migrate to the Terai for winter grazing, where they sell livestock products and seek occasional employment. However, this enterprise is affected in the recent years primarily because of the forest degradation by increasing pressure for fuelwood and fodder, and the poor quality of animals. Other animals raised are cows, bullocks for power, goats and sheep.

d. Industrial Growth

The growth of industries that would bring about significant employment opportunities in the Hills are non-existent. The only mill that exists along the road is in Budar (81 km), primarily for rice-flour-oil milling. One furniture industry in Dadeldhura failed due to lack of trained manpower. However, in Kailali, several smallscale industries exist, most of which depend on agriculture for raw materials. Most industries are of the rice-flour-oil milling type. Though the exact number of different industries that were operational was not known, 210 of them were agro-based production industries in 1982/83. Of these 47 were production mills, 47 saw mills and 10 brick factories. Cotton weaving and hosiery are some of the recent establishments. A turpentine factory which will utilize pine pitch from the Hills has a potential for generating signficant employment opportunities in future. Recently, a match factory is one

which is utilizing the forest product. There were attempts to establish soap, charcoal and loaf industries at Dhangarhi but they failed due to lack of raw materials.

e. Rural Income

No attempt was made to measure the income levels of the people served by WHR, nor did any such information exist before and during its construction phase. Therefore, the "before and after" the road construction income comparison was not carried out. Needless to say, agriculture occupation is predominant in the project area. Livestock, government employment and unskilled labor are secondary sources of rural income. Largescale business is limited to administrative centres in the districts, mostly in the Terai. Most shops like teashops, general stores (Kirana shops) and hotels are subsistent in nature.

Presently, the income accruing to the households can be seen through the kind of occupation they are in, and the effect of the road on such income is conceived in components like passenger service, reduced transportation charges, availability of essential goods at cheaper rates, generation of employment opportunities, increased productivity of resources (for example, land), easy access to social services provided by the government and so on.

f. Traffic Flows

Table 3 shows the available information about traffic as counted at Godavari. The record has some months missing and there is no indication whether the data were not collected, lost or the road was closed.

The available 25 months of data shows that 2531 buses and 4571 trucks passed through Godavari North bound. Of course, this same number must have also returned South bound, but since nearly all trucks are empty on the return trip the count is not included.

Buses account for 36% of the total traffic averaging 3.4 vehicles per day in each direction. The greatest single month was Paush 2039 (December 1982) when 190 buses went through Godavari North bound. If each bus carries an average of 20 passengers in each direction, the total traffic has been about 102,000 person trips or about 550,800 passenger km/ month. This is an impressive total in a remote area where road closures are common.

During the review, the team saw several buses per day. Some were crowded, others not, but the average of 20 passengers at any time seems a reasonable guess. Some people also ride on trucks and these are not included in the estimates.

TABLE 3.

TRAFFIC AT GODAVARI

NORTH BOUND

		Baisakh APR	Jestha MAY	Ashadh JUN	Shrawan JUL	Bhadra AUG	Ashwin SEP	Kartik OCT	Marga NOV	Poush DEC	Magh JAN	Phalgun FEB	Chaitra MAR	Total
2038 (1981-2)	Bus	–	–	–	–	11	53	90	99	119	112	124	141	749
	Trk	–	–	–	–	17	54	326	203	305	242	237	386	1773
2039 (1982-3)	Bus	126	116	97	67	57	106	122	181	190	189	–	–	1251
	Trk	283	179	152	60	33	157	224	234	250	327	–	–	189
2040 (1983-4)	Bus	60	58	137	77	52	88	59	–	–	–	–	–	53
	Trk	150	191	269	167	91	44	36	–	–	–	–	–	89
Avg. Daily Traffic		10.3	9.1	10.9	6.2	3.9	6.6	12.7	12.0	14.4	14.5	12.0	17.6	10.9

NOTE: Blank indicates no record.

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Truck traffic averaged 7.5 units per day North bound. If each carried a payload of 7 US tons (6,363 kg) the total North bound freight would be about 39,375 tons in 25 months or some 1,575 tons per month. The greatest single month was Chaitra (March 82) when 386 trucks were counted.

It is here assumed that all traffic went to Dadeldhura. Some cargo is unloaded at various villages and trail crossings but there are no available data on kinds or amounts of such movements. The important South bound commodities seem to be pine pitch collected south of Budar and ghee. The annual tonnage of the pine pitch was 412 metric tons in 1982/83 but of ghee is as yet not known. The pine pitch is presently exported to India but will be utilized in the turpentine factory under construction near Dhangarhi. Other forest products may be developed in the future.

The team heard several statements to the effect that the old porterage system from Dhangarhi to Dadeldhura had collapsed with the coming of the road, and it is now very hard to find porters to move freight when the road is closed. Some shortages of important items such as salt, sugar, and kerosene are felt in the villages and sharp price rises occur as shown below:

Price (Rs/p) per Unit at Dadeldhura

Commodities	Unit	Traffic Open	Traffic Closed
Salt	kg	1.25	5.50
Kerosene	ltr	5.90	14.00
Sugar	kg	9.00	15.00

Source: Field Survey.

The greatest price rise occurred in the case of salt (340%) followed by kerosene (137%) and sugar (67%). The effect of improved transportation on narrowing the price differentials of essential commodities between the Terai and the Hills was felt when the traffic was open.

Price differentials between Dhangarhi and Dadeldhura before the storm of September 11 and 12, 1983:

		Price (Rs/p) per Unit		
		Dhangarhi	Dadeldhura	%
Commodity	Unit	Jul-Aug.	Jul-Aug.	Difference
Salt	kg	1.00	1.25	25.0
Kerosene	ltr	4.90	5.90	20.4
Sugar	kg	8.25	9.00	9.1
Cooking oil	ltr	19.00	20.00	5.2
Ghee	kg	36.00	35.00	- 2.8
Flour	kg	4.00	5.00	25.0
Rice (coarse)	kg	5.00	5.50	10.0
Rice (fine)	kg	5.75	7.00	21.7

Source: Field Survey.

Depending on commodity (some bear a high transport charge per unit bulk, others not), the price difference between the two ecozones was less than or equal to 25%. In case of ghee, the most important single item South bound, the result of trade between regions is to benefit of ghee producers in the Hills. This has substantial effect on income redistribution. This situation when compared with no transportation facility as discussed earlier explains the urgency of road in the area.

What porterage is now available is based at Jhulaghat rather than Dhangarhi. Trucking to km 115, the present closure, and porterage from there to Dadeldhura is not done or is very expensive because there are no unloading or storage facilities at km 115 and sufficient porters are not available. Before the road closure, truck haulage from Dhangarhi to Dadeldhura was Rs.35-45/100 kg. During the survey, the team observed mule transport charge of Rs.150/ 100 kg from km 115 to Dadeldhura (km 135). This is how sharp price rises were caused at Dadeldhura.

	Transport cost (Rs/p) per kg from Dhangarhi to Dadeldhura	
Mode of Transport	1973	1983
Mule	1.50	
Sheep	1.12	
Men	2.00	
Truck		0.35-0.45

Prior to the road construction a trip to Dhangarhi and back took 7 days walking with a load. Most passenger service South bound now consists of shopkeepers performing a round trip in 2 days. No pedestrian walking would be observed when the road was open and the bus passenger charge is Rs. 55/head. Others used the transportation facilities to meet their relatives, to look after farming, for medical treatment, seasonal employment and administrative purposes.

The traffic data also shows that some vehicles of both types passed through in every month, including the maximum monsoon seasons. In 2040 (1983), for example, 406 vehicles passed North bound in Asadh (June), 244 in Shrawan (July), 143 in Bhadra (August) and 132 in Ashwin (September). These figures were posted despite the partial closure after the storm of 26 and 27 Bhadra (11 and 12 September).

It is obvious, then, that the WHR has become an important factor in the area. It is a viable facility under most circumstances and is important to the people served. The previous porterage system has been largely replaced by the road and trucks, and it would be difficult to reconstruct it. The people have learned to depend on the road.

Future Prospects of WHR

The WHR has created basic transportation network in the region. It has already initiated the construction of two feeder roads. Eighty-four km of the Dadeldhura-Baitadi-Darchula road and 60 km of Dadeldhura-Doti road were constructed in 1982/83. After the completion of these roads the significance of WHR will become greater.

B. Social Impacts

a. Education

There was a general awareness among parents to send their children to school. The increase in children's enrollment in schools is drastic (Table 4 and 5).

Apparently the absolute increment in case of boys is far more than in case of girls. Large number of school drop-outs were found, with the numbers increasing as we go from primary to secondary levels, and more in case of girls. Generally, proximity to school and economic reasons were the causes of such drop-outs but early marriages, among others, in girls also caused discontinuity. Traditionally, girls were not sent to school but were kept home for marriage and household works.

The effect of the road on the utilization of education facilities was limited. The road passes from relatively sparsely populated areas in the Hills and the fare is expensive as the transportation network is yet rudimentary

So the teachers and students resort to walking, but on the same road. With the advent of the road, new schools have been proposed by the residents along the corridor.

Table 4.
Number of Students Enrolled, Kailali District
1979/80 - 1982/83

Levels	1979/80	1980/81	1981/82	1982/83	% Change 1979/80-1982/83
Primary					
Male	8,907	10,341	14,143	17,546	32.3
Female	1,868	2,353	3,105	3,088	21.8
Lower Secondary					
Male	4,341*	4,852*	2,083**	2,505**	a
Female	769*	944*	437**	478**	a
Secondary					
Male	964	1,189	1,496	1,819	29.6
Female	122	231	333	427	83.3
Total	16,971	19,910	21,597	25,863	17.4

Source: District Education Office, Dhangarhi

* includes standards 4-7

** includes standards 6-7 only.

a Not calculated because of inconsistency

Table 5.

Number of Students Enrolled, Dadeldhura District
1975/76 - 1982/83

Level	1975/76	1976/77	1977/78	1981/82	1982/83	% Change 1975/76-1982/83
Primary						
Male	3,552	3,102	4,113	7,574	9,304	23.1
Female	390	279	475	1,092	1,182	29.0
Lower Secondary						
Male	1,083*	1,109*	1,183*	1,154**	1,106**	a
Female	37*	24*	29*	48**	46**	a
Secondary						
Male	288	291	285	746	775	24.2
Female	4	5	5	9	17	46.4
Total	5,354	4,810	6,090	10,623	12,430	18.9

Source: District Education Office, Dadeldhura

* includes standards 4-7

** includes standards 6-7 only.

a Not calculated because of inconsistency.

b. Health

People have learned to visit hospital. The practice of relying on shamans has almost stopped. There are government hospitals at Dhangarhi and Dadeldhura. One hospital is run by missionaries in Dadeldhura at Pokhara. The government facilities for medical care are minimal at best. They

are poorly equipped in terms of manpower and medicines. The effectiveness of care largely depends on the ability of the patients to buy medicines. The importance of improved transportation to providing cheaper medicines and access to India by road for cases not attended locally were appreciated. In cases of road closure the medicines which are rather difficult to handle are transported by men and the transport costs added to these medicines are excessively high.

c. Family Planning

The joint family system is still prevalent in the project area. For both cultural and economic reasons parents have a strong preference for sons. However, the attitude towards girls seems to have changed in the case of young and educated parents. This should eventually help in limiting the number of children in a family. During the survey it was found that the number of children increased greatly in the family for want of sons.

The importance of smaller families is realized owing to the fact of limited arable land available for cultivation and increasing costs of supporting a family. The adoption of family planning methods has not been very great in the area, but there are several cases of people using contraceptives and surgical services. Nevertheless, the

cases of female sterilization are minimum at best, primarily because female surgeons are not readily available in those remote areas.

The lack of access to contraceptives held down the percentage of women practicing family planning since there were no female motivators (e.g. in Dadeldhura). In Kailali, female sterilization was practiced. Those who could afford it went to India for surgical services.

The male responses for not practicing family planning methods were various -- unawareness, self-control, the respondents had few children, shaman, unwillingness, and frustration.

d. Migration and Employment

The Hill people unemployed or idle during the slack agricultural season leave their homes in search of seasonal employment and winter grazing for animals in the Terai. They work as unskilled laborers in construction works and farming, and some sell their livestock products for cash to buy necessities like salt, cloth, gur (molasses), etc., which they bring with them on the return trip after 4 or 5 months (generally November to April) in the Terai. Some wealthy hill families have two holdings (both in the Hills and in the Terai) and spend most of the cold winter in the Terai. Resettlement program

in the Terai districts of Kanchanpur and Kailali has attracted people not only from the Hills of this region but also from elsewhere in Nepal. This coupled with purchase of land and clearing of forest has caused major increase in the Terai population of this region (Table 2).

The pattern of off-season employment has changed since the road construction. Considerable numbers of Hill people work temporarily on the Dadeldhura-Baitadi and Bhatkanda-Doti road construction. Some are employed in the maintenance work of WHR. The practice of moving to Terai and to India for seasonal employment has decreased in recent years since a daily wage of Rs.15-20 per day available locally provides a substantial subsistence. People from other regions of Nepal also came into the area to work on roads as contractors and laborers. Thus the provision of WHR has generated additional employment to the people in the area and beyond.

C. Fiscal Procedure

Under HMG/N financial procedures in effect prior to the LSS project, transfer of funds from AID to the project were complex and time consuming. Delays of three to four months occurred with adverse effects on the progress of work. Funds could not be obligated until they were formally released to the project, even though all parties were aware that the money was going to come eventually.

The original sequence was: USAID/N deposited funds in the Nepal Rastra Bank to the credit of the project and the Financial Controller General, Ministry of Works and Transport, the Department of Roads and the project were concurrently notified by AID/N. The Controller General then transferred the funds to the Ministry of Works and Transport which in turn transferred them to the Department of Roads. Then the DOR released the money to the project for obligation.

USAID/N arranged a meeting on May 8, 1980 with the Financial Controller General and other concerned officials of the Ministry of Finance for the purpose of devising a workable financial procedure for release of funds to the LSS project, in order to minimize the time lag between USAID/N deposit date and the date when the project receives the fund. It was decided to adopt and use the following procedure on a test basis for the LSS project.

USAID/N deposited a check to the Nepal Rastra Bank in the name of the Financial Controller General and the project. Concurrently the Ministry of Finance, Ministry of Works and Transport, the Department of Roads, and the project were also notified by AID. The Financial Controller General immediately requested the Nepal Rastra Bank, Central Office at Kathmandu, to credit the amount of the check in the LSS Project account at Dhangarhi branch of the Bank. To execute this, USAID/N followed the HMG/N quarterly

budget request system. The DOR project site office at Dhangarhi also followed HMG/N financial rules and regulations for disbursement of funds and financial reporting from this project account.

The team reviewed above procedure by interviewing officials both at Kathmandu and at the project site. It was observed that the new financial procedure did positively contribute to the smooth running of the LSS Project. The project office reported that the funds reached the site usually within a week, and in cases of delay, it was in within two weeks.

HMG/N financial rules and regulations have substantially changed during the time the above procedure was adopted and now. Since 1982/83 the Financial Controller General has Treasury and Accounts Controller Offices (TACO) in all 75 district headquarters nationwide. Hence the usual process of budget channelling through the concerned ministries and departments has been eliminated. The TAC Office at district headquarters also perform audit functions for the project offices.

Under new financial rules and regulations the fund release is on the trimester basis and the TAC Office lends money to the project offices for a maximum of 2 months after the new fiscal year begins. As soon as the message arrives telegraphically or by issuance of an official letter (which is slower but more

reliable), the district TACO releases the funds to the project on request against the trimesterly allocated budget. However, the failure on the part of the project to follow regular bookkeeping and to identify the amount against each subhead will jeopardise timely funds release.

In the main, the financial procedure adopted in the LSS Project contributed significantly to the smooth running of the project and a similar procedure has been adopted by the Financial Controller General for the AID/HMG bilaterally and multilaterally aided projects in the country since 1982/83 fiscal year.

On-Going Developmental Activities

In recent years, there have been attempts to exploit the natural resources base in the Far Western Development Region. The decline in agricultural productivity seems to have attracted the attention of planners at the centre and huge investments are underway to provide water for arable lands. The Mahakali Irrigation Project in Kanchanpur District, and three irrigation projects in Kailali District are the major investment activities in the Terai.

In the Hills the Mahakali Integrated Rural Development Project has prioritized agriculture development. The project also has extended irrigation facilities, provided animal health care services, and constructed check dams to conserve soil in the project area of Darchula, Baitadi and Dadeldhura.

In its attempt to provide basic infrastructure facilities, the project has started a number of construction works including warehouses, official and residential buildings, suspension bridges, mule tracks, etc. The project has other components such as cottage industries, education, health, and local developmental activities. The major impact of WHR is seen as far as it extends (i.e., Dadeldhura) and future impacts on the other districts will be more noticable after the completion of the feeder roads. Presently, access to higher Hills of Darchula and Baitadi is via India.

Besides bilateral assistance, the local panchayats have carried out several developmental activities such as the construction of irrigation facilities, drinking water projects, school buildings, bridges and trails. These projects incur both HMG financial grants (34%) and people's participation (66%).

ABBREVIATIONS

ADO	Agricultural Development Officer
JTA	Junior Technical Assistant
AIC	Agricultural Inputs Corporation
DOR	Department of Roads
HMG/N	His Majesty's Government, Nepal
WHR	Western Hills Road
TACO	Treasury and Accounts Controller Office
DEO	District Education Office

APPENDIX A

EVALUATION METHODOLOGY

This was an evaluative research effort aimed at determining changes brought about by the WHR in the quality of life of the people living along the road and beyond. Given the time limitation and the study area, no specific methodology suggested by social science research was adopted. In essence, the sampling was purposive in the sense that the knowledgeable people were interviewed along and around the road alignment. Hence the data were collected mainly from three sources: (a) government offices both in Kathmandu and in the field, and (b) questionnaire interviews administered to ordinary people at both ends and along the road and (c) shopkeepers, leaders and others met on the way.

The study was conducted mainly in four phases. The first phase consisted of the review of related documents on the subject and the preparation of questionnaires to be utilized in the interview. To avoid the delay, the questionnaires were prepared in advance before the U.S.-based team members (Messrs. Martin Everitt and Paul Winkelaar) arrived in Kathmandu on October 26. The team met in Kathmandu on October 26 to plan the field survey and left Kathmandu on October 29. The second phase of the social survey collected data by interviews in the project area using personal questionnaires and arranging meetings from November 1-9. Feelings and impressions about the road were

gathered from people of various walks of life as we moved along. Thus porters, shopkeepers, laborers, teachers, political leaders, and farmers were met to gather their responses. In the third phase, the personal questionnaires were tabulated and analysed in Kathmandu from November 10-18 (see Appendix B). Finally, the informations was systematically put together in the form of a draft report. The review of related literature went on every morning and evening and during the course of study.

Although the personal interviews were conducted by Tek Bahadur Thapa (Economist), the other team members also actively participated in the meetings especially at Dhangarhi and Dadeldhura. Mr. George Lewis, Acting Deputy Director of USAID Mission to Nepal, showed a great interest in the social research work and stayed a night with the researcher in Dadeldhura.

Besides the personal questionnaires (Appendix B), open-ended questions were listed in advance before meeting local and central government officials. The officials interviewed are given in Appendix C.

Distribution of Personal Questionnaires

By Main Occupation

Agriculture	26
Teaching	6
Government Service	3
Medical Practitioner	1
TOTAL	36

By District

Dadeldhura	23
Kailali	8
Doti	5
TOTAL	36

By Age

23-35 years	11
36-50	19
51-70	6
TOTAL	36

By Education

No school	1
1-5 years	13
6-10 years	19
10 + years	3
TOTAL	36

By Distance of Residence from Western Hills Road

0-1 km	16
2-5 km	15
6-18 km	5
TOTAL	36

Number of political leaders in the sample	10
Number of Village Panchayats in the sample	8
Number of villages in the sample	20

APPENDIX B

ANALYSIS OF QUESTIONNAIRES

A total of 36 personal questionnaires were administered in three districts (two, Kailali and Doti in Seti Zone, and one, Dadeldhura in Mahakali Zone) of Far Western Nepal. Of the three, Doti and Dadeldhura are in Hills whereas Kailali is in the Terai, the northern part of Indo-Gangetic plain.

As dictated by time limitations and terrain, the number of interviews conducted along the Western Hills Road was limited to 36. However, it is believed that the information gathered provides, without losing generality, consistent and valuable insights into the social impact imparted by the provision of the road. The questionnaires were not field pre-tested but the useability was materialized by slight modification and alteration of the content in the original questions. During the survey, no significant problems were encountered since Mr. Tek Bahadur Thapa (Economist) was engaged starting from preparation to administration of these questionnaires. This appendix is the result of 36 personal interviews.

RESULTS OF QUESTIONNAIRES

A. General

Name

Age

Occupation

District

Panchayat

Ward No.

Village

Distance of Residence from Western Hills Road

Membership in Organization

Remarks about the Respondent

B. Migration

B.1. How long have you lived in this village? If migrated, where did you come from?

Migrated to	From	No. of Answers	Years Lived
Kailali, Geta	Dadeldhura	3	9,20 and 20
Kailali, Geta	Baitadi	1	21
Kailali, Geta	Kailali, Sripur	1	6
Doti	Rolpa	1	40

B.2. Who was the previous resident on land?

In Kailali district, 4 of the previous residents were Tharus (local), 1 was from Pokhara (Gandaki Zone) and in Doti, the previous occupant was local.

B.3. Where did he (previous resident) go?

Three Tharus migrated to Kanchanpur (adjoining district), the one from Pokhara went back home. The rest (32) were local.

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C. Farming

C.1. Have you changed your farming practices in the past few years? Yes/No

Distance from WHR	% Yes	Number of Answers
0-1 km	88	16
2-5 km	73	15
6-18 km	60	5
TOTAL	78	36

The reasons given for not changing their farming practices were the lack of irrigation and proper marketing facilities (especially for wheat).

C.1.1 If yes, were you able to increase production? Yes/No

Distance from WHR	% Yes	Number of Answers
0-1 km	86	14
2-5 km	91	11
6-18 km	100	3
TOTAL	90	28

In one case, the respondent unable to increase production said that the soil fertility was deteriorating because of forest degradation.

C.1.1.1 If yes, How?

Distance from WHR	Chemical Fertilizers	Improved Varieties	Improved Methods	Pesti-cides	Fruits	No. of Answers
	Percent Users					
0- 1 km	57	86	22	57	29	14
2- 5 km	45	91	9	36	18	11
6-18 km	33	100	33	67	100	3
TOTAL	50	90	18	50	32	28

The major factor contributing to increased agricultural production was the use of high yielding varieties. Half of the respondents (14) practised indigenous organic source of fertilizer (farm yard manure). Chemical methods of agricultural pest control were in increasing use. Fruit plantations (apple, pear, citrus) were of recent introduction.

C.2. How do you get the idea of improved farming?

Source	% Yes
Government Agency (ADO/JTA)	56
Agricultural Assistant	11
Neighbor	14
Radio Listening	0
Publications	0
Training	14

More than half (20) of the respondents received the idea of modern agricultural technology from the government extension agents. Equal number of

farmers (5 each) received training and consulted neighbors for improved farming. Four contacted agricultural assistants in the village. None listened to the radio and read publications for the purpose.

C.3. Where do you get modern agricultural inputs (seed, fertilizer, pesticide etc.) from?

Source	% Yes
Agricultural Inputs Corporation	42
Cooperatives	25
Neighbors	14

Most respondents (15, from the Hills, i.e., Dadeldhura) purchased agricultural inputs from the government owned corporation (AIC). The Terai (Kailali) farmers got their inputs from village cooperatives, whereas the farmers from Doti had no access to either of the two and so purchased from neighbors.

C.3.1. Are they (agricultural inputs) available when you need them?

Distance from WHR	% Yes	Number of Answers
0- 1 km	92	13
2- 5 km	55	11
6-18 km	75	4
	75	28

Generally, the agricultural inputs were available. Six farmers reported that the inputs usually arrived late in their place.

C.4 How do you market your produce? Which is the main market centre?

After the road provision, some places along the road have emerged as market centres which serve the areas in the vicinity. Geta (in Kailali), Phaltunde, Gaira, Budar, and Dadeldhura (in Hills) are the examples.

Products commonly marketed include paddy, wheat and Tori (Oilseed crop) in the Terai and milk, ghee, vegetables, fruits and potatoes in the Hills.

D. Food Consumption

D.1. Do you find any significant change in your (your family's) food habits after the road provision? Yes/No.

Distance from WHR	% Yes	Number of Answers
0- 1 km	75	16
2- 5 km	80	15
6-18 km	27	5
TOTAL	70	36

D.1.1. If yes, how?

Distance from WHR	Increased use of			No. of Answers
	Vegetables	Cereals	Fruits	
	Percent Users			
0- 1 km	100	25	17	12
2- 5 km	92	42	17	12
6-18 km	100	25	50	4
TOTAL	97	32	22	28

The most significant change that has occurred in food habits is the increased consumption of vegetables followed by cereals and fruits.

D.1.1.1 Where does the additional amount come from?

Distance from WHR	Home Grown (% growers)	Purchased (% buyers)	No. of Answers
0- 1 km	92	42	12
2- 5 km	92	33	12
6-18 km	75	100	4
TOTAL	90	46	28

Majority of the increased food consumers (25) grow the additional food by themselves. Others purchase them from nearby markets e.g. Dadeldhura, Gaira and Budar. Occasionally, vegetables, fruits and food grains are imported into the Hills from the Terai. Vegetables and fruits are also found to have been grown and marketed in the Hills.

E. Health

E.1. Whom do you consult when you are sick?

Almost all informants (34 of 36) visited the hospital for treatment. One used Vaidya (homoeopathist) and the other remained at home and did never visit a hospital.

F. Family

F.1. How many members are you in the family?

The informants generally lived in a joint family (28 of 36). The average number of family members was 13, maximum being 31 in one case. Others (8 of 36) lived in a nuclear family with an average members of 6 (sons 1.6 and daughters 2.4), maximum being 9.

F.2 Do you practise family planning methods? Yes/No.

Distance from WHR	% Yes	Number of Answers
0- 1 km	38	16
2- 5 km	40	15
6-18 km	0	5
TOTAL	34	36

The respondents who practised family planning methods (12 of 36 or 33%) resorted to both permanent sterilization (7) and temporary contraceptive methods (5).

F.2.1 If not, why not?

The reasons given for not practising family planning methods were -- unawareness (5), self control (3), few children (12), shaman (1), unwillingness (1), and frustration (1). One was planning to practise soon.

G. Education

G.1. For how many years did you go to school?

Schooling	Number of Respondents
No school	1
1-5 years	13
6-10 years	19
10+ years	3
TOTAL	36

G.2. Do you send your sons and daughters to school? Yes/No.

Distance from WHR	% Yes		No. of Answers	
	Sons	Daughters	Sons	Daughters
0- 1 km	100	71	15	14
2- 5 km	100	80	12	10
6-18 km	100	25	3	4
TOTAL	100	68	30	28

All informants educated their sons. The girls were not educated because there was no tradition to send them to school (6), the parents were poor (1), and the girls hesitated to go (2).

H. Miscellaneous

H.1. Do you use the road facility? Yes/No.

Distance from WHR	% Yes	Number of Answers
0- 1 km	81	16
2- 5 km	87	15
6-18 km	100	5
TOTAL	86	36

Three respondents who did not use the WHR were from the Terai. The rest (2) were from Dadeldhura who bought their essential commodities from the local market centre.

H.1.1 If so, on the average, how many times a year do you use the transportation facilities? For what purpose?

Occupation	No. of visits/year	No. of Answers
Shopkeepers	24	7
Others	3	24
TOTAL	8	31

Businessmen were using the road facilities most, primarily for transporting goods. Other users occasionally moved out to visit their relatives and to look after farming in the Terai (generally Kanchanpur). At times they also brought essential commodities like salt, sugar, clothes, etc., from the Terai.

H.2. If you need, loan, where do you borrow it from? For what purpose?

Distance from WHR	Cooperatives or Bank	Neighbors	No. of Answers
	Percent		
0- 1 km	75	25	12
2- 5 km	67	33	6
6-18 km	67	33	3
TOTAL	72	28	21

Thirteen informants borrowed for agricultural purposes, four each for household expenses, and for business.

I. Rural Income

I.1. What is your main source of family income?

All informants had agriculture as their main source of family income. Besides from agriculture, 23

informants derived their income from other sources also, viz., government service (12), business (7) and unskilled labor (4).

I.2. Has your family income increased relatively after the road provision? Yes/No. If yes, how?

Thirty one respondents reported increase in their family income. Most increases (17 of 31) were attributed to savings in time and transportation of goods. Fourteen informants reported the increase due to increased business transactions.

J. Resource Endowment

J.1. Farm Size

	Irrigated	Unirrigated	Total
	Ropani*		
Terai	2	119	121
Hills	9	37	46
TOTAL	7	54	61

* 1 Hectare = 20 Ropanis.

J.2. Livestock

	Average Numbers/Household
Buffaloes	1.1
Cows	4.7
Bullocks	3.0
Goats	1.2

K. Revegetation

K.1. Do you occasionally encounter floods, landslides, etc.? Yes/No

If yes, what measures have you taken to overcome these calamities?

Twenty-four respondents answered affirmatively to the first question. All occurred in the Hills, except one in the Terai where the flood damaged the crops. None has taken any step to overcome the floods and landslides.

K.2. Have you heard of afforestation program? Yes/No.

Two-third (24 of 36) were aware of the government effort to revegetate.

K.3. Do you practise tree plantation? Yes/No.

Sixteen (of 36) informants planted trees.

Most of these (9 of 16) are fruit trees. Others planted trees for Panchayat Forests (5 of 16) and forage trees for livestock (2 of 16).

K.4. Please give the source and time taken to collect firewood, fodder and drinking water.

Items	Time taken for each trip (Hrs.) Now	Ten years ago
Firewood	5.2	2.4
Fodder	4.8	2.5
Water	18 min.	25 min.

The time taken to collect fuel-wood and fodder for livestock has doubled in a decade. Most (35 of 36) collected firewood from the forest. One managed to get it from his own plantation. The fodder for livestock generally came from the forest in Hills (29 of 36). The time taken for drinking water has decreased by 7 minutes. This is attributable to the provision of polythene pipes for the purpose. The Terai residents had either the hand pumps (4) or the deep well (3) as a source of drinking water. Eight Hills residents had the privilege of drinking water projects. The rest depended on natural sources like springs (17) and steams (4).

APPENDIX C

PERSONS CONTACTED

1. Mr. Ajambar Rai, AIC, Branch Office, Dhangarhi
2. Dr. Sher B. Chand, Kailali Hospital, Dhangarhi
3. Mr. Maheshwar Ram Joshi, Treasury and Accounts Controller Office Dhangarhi
4. Mr. Ram Bahadur Khadka, Handicrafts Sales, Depot, Dhangarhi
5. Mr. Bir Bahadur K.C., Cottage and Rural Industry Development Section, Dhangarhi
6. Mr. P.D. Subhash, DEO, Dhangarhi
7. Mr. Ram L.P. Dhami, ADO, Dhangarhi
8. Mr. Laxmi D. Panta, Agriculture Section, Dadeldhura
9. Mr. Jitendra B. Basnet, Chief District Officer, Dadeldhura
10. Mr. Ganesh P. Bhatta, Chairman, District Panchayat, Dadeldhura
11. Mr. Basanta K. Shah, Family Planning Officer, Dadeldhura
12. Mr. Maheshwar L. Shrestha, Dadeldhura-Doti Road Project, Bhatkanda
13. Mr. A.K. Dhungana, DOR, Kathmandu
14. Mr. Bhubaneshwar Khatri, Financial Controller General, Kathmandu

OFFICES CONTACTED

1. District Education Office, Dadeldhura
2. Excise Tax Office, Dhangarhi

3. District Office, Dhangarhi
4. . ., Seti Zone Police Office, Dhangarhi
5. Kailali Forest Division, Dhangarhi
6. Central Bureau of Statistics, Kathmandu
7. Nepal Food Corporation, Kathmandu
8. Office of the Co-ordinator, Mahakali Integrated Rural Development Project, Kathmandu
9. Department of Food and Agriculture Marketing Services, Kathmandu.

APPENDIX D

PLACES VISITED FOR PERSONAL INTERVIEWS

District	Village Panchayat	Village
Kailali	Geta	Mohanpur
	Geta	Geta
	Sahajpur	Bayla
Dadeldhura	Ghatal	Kande
	Ghatal	Shera
	Ghatal	Birakham
	Ghatal	Pathroda
	Ghatal	Haat Gaon
	Ghatal	Shand
	Ghatal	Joshina
	Ghatal	Sholpari
	Ghatal	Chirkette
	Ghatal	Kari Gaon
	Ghatal	Maurada
	Bhadrapur	Bhuteun Balnek
	Chipur	Chaundi
	Gankhet	Hartola
Doti	Chhatiun	Budar
	Ghanteshwar	Gaira Badakhet
	Ghanteshwar	Nikane

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Appendix Table A.

Land-use Data for Selected Districts, Far Western, Nepal

(Area in ha.)

District / Category	Bajhang	Bajura	Doti	Baitadi	Dadeldhura	Kailali	Kanchan-pur
F_1	83409.6	88205.9	103427.4	44211.9	63520.9	176938.4	70895.2
F_2	31111.6	11225.7	43521.5	18850.1	53585.3	55291.0	29347.7
C_1	9163.5	8212.1	16751.3	12612.9	6018.0	2119.2	-
C_2	12745.9	4033.9	10717.7	7668.6	7959.8	1658.6	99.6
C_3	6715.2	2940.1	7542.7	3417.6	6545.1	2439.2	-
C_4	-	-	-	-	-	73247.9	47739.1
G	39191.5	38222.7	9223.8	14793.9	4920.1	4888.5	9785.1
O	13976.5	10900.8	16205.5	13720.4	7045.6	3310.2	14.2
R	144774.8	39891.4	313.8	-	-	-	-
B	172.5	-	1067.6	142.5	1550.1	7971.4	6518.8
L	-	-	-	-	-	-	-
UMA	-	-	-	16691.3	-	-	-
Total	341261.1	203632.6	208771.3	132109.2	151144.9	327864.4	164399.7

Source: Land Resource Mapping Project, Land Use Report - 1983.

Note: F = Forest; F_1 = Forest (Hardwood, Coniferous, Mixed Conif., Mixed hardwood)

F_2 = Forest (Shrub, Protection forest, Burned forest, Plantation forest)

C = Cultivation; C_1 = Hillslope cultivation-level terraces;

C_2 = Hillslope cultivation - sloping terraces;

C_3 = Valley Cultivation (with Tars and encroched areas)

C_4 = Terai cultivation; G = Grazing land; O = Others (mised use, settlement, ...)

R = Rock outcrop; B = Boulders (along the riverside or barren too)

L = Lake; UMA = Unmapped Area

Appendix

Table 3. Production of major crops in selected districts of Far Western Development Region, Nepal, 1968/69, 1982/83.

(In MT)

District	Paddy		Maize		Wheat & Barley		Millet	
	1968/69	1982/83	1968/69	1982/83	1968/69	1982/83	1968/69	1982/83
Kailali	64,350	58,680	22,620	13,760	2,250	19,090	1,032	1,300
Kanchanpur	25,800	44,240	10,440	12,720	1,125	9,930	555	600
Doti	10,023	8,650	7,800	6,720	7,815	12,970	1,375	1,560
Dadeldhura	6,398	8,630	6,160	3,630	6,808	7,570	1,960	2,300
Bajhang	6,425	4,910	2,004	1,260	3,320	2,990	1,094	920
Achham	6,548	2,700	3,460	3,420	5,602	3,760	832	940
Baitadi	6,921	6,270	4,463	2,830	5,596	3,310	906	1,100
Bajura	6,944	3,130	1,503	870	4,554	2,720	1,129	630
Total	133,409	137,210	58,450	45,210	42,070	62,340	8,883	9,350
% change	2.8		-22.7		48.2		5.3	

Source: See Table 1 for 1968/69 and 1982/83 data.

Appendix

Table 2. Yields of Major Foodgrain Crops, Selected Districts, Far Western Development Region, Nepal, 1964/65 and 1982/83.

(In MT/ha)

District	Paddy			Maize			Wheat			Millet		
	1962	1964/5	1982/3	1962	1964/5	1982/3	1962	1964/5	1982/3	1962	1965	1983
Kailali	1.10	1.65	1.37	0.60	1.32	1.19	0.59	0.66	1.37	NA	0.82	1.0
Kanchanpur	1.07	1.53	1.61	0.78	1.70	1.47	0.53	NA	1.07	NA	NA	1.0
Doti	2.12	0.99	1.25	2.45	0.55	1.60	1.26	1.09	1.19	1.39	1.09	0.84
Dadeldhura	2.60	1.43	1.60	2.76	1.59	1.43	1.62	0.88	0.8	1.85	0.88	0.8
Baitadi	2.26	0.99	1.90	1.67	NA	0.97	1.18	0.88	0.9	1.16	NA	1.1

NA = Not Available

Source: For 1962 and 1964/65, See (1) Table 1.

For 1982/83, See (2) Table 1.

Appendix Table D Number of Users of Family Planning Methods, Kailali District, Nepal

Methods		1978/79	1979/80	1980/81	1981/82	1982/83
		Number				
Contraceptives	Male	270	219	494	581	1,091
	Female	230	145	372	1,206	840
Surgery	Both	53	a/	281	246	252 b/

Source: Kailali Hospital, Dhangarhi

a/ No program

b/ 207 female + 45 male)

Appendix Table E Number of Users of Family Planning Methods, Dadeldhura District, Nepal

Methods	1981/82	1982/83
	Number	
Contraceptives	2,029	4,438
Surgery	88	219

Source: Family Planning Office, Dadeldhura.

The office was opened at the end of 1980/81 fiscal year.

A P P E N D I X

This appendix includes selected project reports and documents including the PASA agreement covering the LSS review team. These documents are not included in all copies of the report.