ROYAL GOVERNMENT OF BHUTAN
Ministry of Communications
Division of Roads

Environmental Assessment
Lhuntse - Dungkhar Road

Jimba Consultancy
July 1999
ENVIRONMENTAL ASSESSMENT

LHUNTSE – DUNGKHAR ROAD

This report was commissioned by the Division of Roads under the World Bank Technical Assistance for the Rural Access Project

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EXECUTIVE SUMMARY

1. PROJECT DESCRIPTION

- **Project Title:** Lhuntse – Dungkhar Road
- **Project Location:** Stretching from Gangzur – Kurteo Geog, Lhuntse Dzongkhag
- **Proponent:** Lhuntse Dzongkhag
- **Implementing Agency:** Division of Roads (DoR), Ministry of Communications
- **Funding Agency:** RGoB and the World Bank
- **Approx. road length:** 371 Km
- **Major bridges:** 2 with approx. spans of 45m and 10m
- **Approx. cost of construction by traditional method:** Nu. 120 million or US$ 2.86 million (1US$ = Nu. 42)
- **Recommended construction method:** Environmental friendly

2. LEGISLATION AND ENVIRONMENTAL GUIDELINES

- The environmental assessment of the proposed road project closely followed the National Environment Commission (NEC) Guidelines, more specifically Environmental Sectoral Guidelines, Highways and Roads, February 1999.
- Considerations of the World Bank environmental guidelines were looked into as conveyed through the Terms of Reference, EA Lhuntse – Dungkhar Road.
- The land expropriation and compensation were based on The Land Act of Bhutan 1979, amended in 1998 and Land Compensation Rate, 1996.

3. BASELINE CONDITIONS

Physical Environment

Kuri Chhu is the main river running through the project area joined by a number of tributaries. Kuri Chhu is not used for irrigating the field or for drinking purposes. Kuri Chhu including other streams is quite clean in winter while in monsoon it goes muddy. The watershed management plan doesn’t exist for the locality.

The project area falls between 1500 m to 2500 m.a.s.l. The monsoon in the project area is relatively warm with max temperature going up to 31°C. In winter the temperature drops down to -2°C recorded in December. The max rainfall recorded in a day is about 35mm.

The rock types in the study area consist mainly of granitoid gneisses belonging to the Thimphu Group. Within these gneissic terrain, several linear bands of meta-sedimentary rocks occur as enclaves.

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1 This is as per DoR feasibility studies and EA has estimated the road length at approx. 36 Km. This may vary as investigation for the best route alternatives (in two stretches) need execution.
Biological Environment

The project area does not fall into any of Bhutan’s declared protected areas. The vegetation in the project area can be described by three types: (i) the sub-tropical forests type, (ii) Chir pine forests and (iii) the cool broad-leaved forests. Rare or protected plant species are not recorded/observed in the project area. The area acts as a rich habitat for bird species while mammals are little found. Amongst those recorded animal species rare, endangered, or endemic species are not observed.

Social, Economic and Cultural Conditions

The economy of the project area is characterized by the predominance of people engaged in subsistence agriculture. The main crops are rice, potato, maize, millet, wheat and chili. Cash income is earned through sale of chili and diary products.

All farmers seem to have a house, which is relatively of a high standard compared to the rural population in the region. Despite education being provided free many could not attend the school because of long walking distances. The people also enjoy free medical facilities.

Fuelwood is the main energy of the people chiefly used for cooking and lighting. In a few villages mini-hydropower projects are under construction.

The guests are always greeted with a warm welcome.

4. IMPACT FINDINGS

Physical Impact

- Landslides could be a major threat if construction is executed in a traditional method as average side slopes of the project area exceeds 75%.
- There are two difficult stretches of construction that may result into a chain of negative impacts (between takeoff point and chainage 1+350 and 12+900 – 22+450 Km) as cut material roll down damaging soil surface and vegetation.
- The hydrology is not expected to disturb.
- Impact on land use from road activity per se is not expected to be significant but traditional method of tipping down spoil material can cause forest cover to turn barren triggering landslides and leading to chain of negative impacts.
- Air and noise pollution is not considered significant. The noise pollution also during operation phase from traffic intensity is considered insignificant as experienced in other existing feeder roads in Bhutan.

Biological Impact

- Vegetation clearings and damage downhill begins from chainage 4+200Km and more happening from 12+900 Km as the area is densely vegetated.
- Impacts on rare/endangered/endemic vegetation species are not foreseen.
- It is estimated that about 4909 m$^3$ of fuelwood, 414 m$^3$ of chirpine logs and 2790 m$^3$ of hardwood logs will be harvested from the corridor clearing as a result of construction.
- The habitat of other bird species can have some negative impacts, as broad-leaved forests are their main habitat.
- Livestock, an important livelihood of the locals can have some impacts to its natural pasture as a result of construction activity.
Social, Economic and Cultural Impacts

- Estimated that about 5 permanent houses may need resettlement.
- 8 temporary houses (huts) can be directly effected.
- About 18 electric transmission poles needs relocation at Gangzur and Thimyul.
- Irrigation channels at 7 drawing points can get effected as road alignment passes through.
- At the road takeoff point (Priority II) air and noise impact can effect about 20 shopkeepers and the hospital compound.
- The private land that may need expropriation permanently for a corridor are 12.60 acre of Tseri (shifting cultivation), 4.52 acre of Chuzhing (irrigated paddy land), 15.72 acre of Kamzhing (dry cultivated land), and 8.19 acre of Tsamdo (natural pasture).
- Orange orchard of about 2 acre can get partially impacted.
- About 11 acre of Chuzhing may have to temporarily be expropriated as it may be subjected to disturbance as a result of construction.
- If irrigation channels are not properly attended during construction there is likelihood of about 40 acre of Chuzhing being cut of water supply (places identified are at Gangzur, Lingabey, & Tabi, Dungkhar).
- Impact on the local culture is not anticipated by the presence of workforce, as their stay is temporary.
- The alignment may encounter 10 different types of religious monuments such as Chorten, Chukor Mani, and Mani Dangrim. These monuments can be protected if construction is carefully executed.
- The negative impacts concerning health is that foreign diseases may be transferred to the locals and their existing medical facilities may get impacted. However, the positive impacts resulting out of the project would be considerable as further services can pour in easily and ailing people can reach better medical setups in shorter time.
- On education, the project can have much positive impacts as walking distance to schools are shortened. The enrollment rate is also anticipated to increase as told by District Education Officer, as a result illiteracy will decrease. Further, the proposals of establishing schools in remote places will become realistic.
- Concerning fuelwood, the Gangzur people will be heavily effected if workforces are allowed to collect freely as the village is already in fuelwood dilemma. Rest of the villages may not feel the impacts with fuelwood immediately, as it is much available.
- With the economy there are many opportunities that the project can benefit the region as farm products can easily get exported which is presently being constrained due to lack of transportation. As walking distances are shortened people will have more time to spend in the farm and on other cash income activities. The exploration of other natural resources can be researched which can improve the regional economy.

5. PUBLIC CONSULTATION

Consultations were had with several stakeholders’ viz. central government agencies, local governments, NGOs, and project area people. In the project area consultation was done with 143 HH and included villages: Gangzur, Kilung, Nimshong, Lingabey, Rotpa, Tshrima, Shawa, Zhamling, Khoachung, Tabi and Dungkhar. The outcome of the consultation was that people were very supportive and positive of the project. They were willing to help the project implemented successfully by extending labor support & even compromising with loss of their agricultural land and other properties.
6. MITIGATION MEASURES

- Alignment alternatives are proposed at two stretches, one at the takeoff point and between 12+900 – 22+450 Km.
- The horizontal alignment should always follow natural contours unless otherwise necessary.
- Attempts should be made to reduce the cut material as much as possible.
- In a side slope of less than 70% it is proposed to use ‘balance cut and fill’ method.
- Wherever appropriate move the road centerline 1m or 2m away towards the valley side by constructing a masonry wall and reduce cut material.
- Log barriers can be used to retain spoil rolling down.
- Excavators of appropriate sizes (suitable for Bhutan terrain conditions) are recommended for construction.
- Blasting should adopt controlled methods (not overcharging) and never hole by hole detonation. A proper way to blast is through benches by detonating a series of holes at a time and the next series after few seconds later. Blasting should start from the crown of the rock face and gradually downward.
- V-shaped drains of 1mx0.50m are recommended for earth and 0.50mx0.30m for the rock section. It is recommended that minimum size of humepipe should be of 60cm. At least 10 culverts are recommended for 1km of road. All water collected should be discharged in to a natural gully. In marshy or slide prone areas catch water drains should be provided to tap the excess water.
- To upkeep the landscape and environmental aesthetics cut material should be prevented from rolling down as much possible. All landslides and exposed surfaces should apply bioengineering measures.
- The finished side slope of the road should be 0.1:1 (H:V) for hard rock, 0.3:1 for ordinary rock, 0.5:1 for hard soil, 1:1 for ordinary soil.
- The key stakeholders’ viz. FSD, GSoB, MHoE, Lhuntse Dzongkhag, and the local people should be consulted and coordinated for upright project implementation.
- The impacts on existing infrastructures can be eliminated/reduce if public coordination is done and construction carried out as suggested by EA.
- Work camp should be carefully sited: away from local people settlement and from drinking water sources. The wastes including oil and grease generated from the camps should be collected properly and disposed off to the safe places. Sanitary facilities should be provided to all campsites.
- To implement road construction in an environmental friendly way the DoR engineers need to get training, some foreign and some in country under project TA component.
- Land compensation should follow the Land Compensation Rate, 1996 issued by Ministry of Home Affairs. Lhuntse Dzongkhag and Project Unit, DoR should assess the actual land expropriation. Temporary land expropriation should be done depending upon the quantity of damage during the construction phase.
- Should houses be impacted the compensation should be as specified in the Land Compensation Rates 1996 page no. 8 clause no. 3(b).
- Petty construction works of the project, the priority should be given to Lhuntse Dzongkhag contractors and locals.
• The workforces should be prepared with their own fuelwood at least between stretch 0+000 – 4+900 km. Fuelwood extraction of workforce should be limited to road corridor clearings.

• Impart labors on wildlife poaching awareness and monitor poaching.

7. MONITORING PLAN

The monitoring is segregated into two:

• Construction phase monitoring

• Operation and maintenance phase monitoring

Construction phase monitoring takes into three different forms:

• Routine monitoring

• Periodic monitoring

• Evaluations (phase-wise)

Operation phase monitoring can take into two forms:

• Routine monitoring

• Periodic monitoring

8. CONCLUSION AND RECOMMENDATIONS

Conclusion

• Overall the proposed project does not foresee negative impacts of significance on the physical, biological and social environment.

• Ample positive impacts are predicted from the project to the region particularly to the quality of life improvement through education, better medical facilities, direct cash income, and accessibility to foreign construction and cooking resources.

• There are opportunities to mitigate whatever marginal negative impacts assessed which is a good indication of advancing the project implementation.

Recommendations

• The project formulation should incorporate the findings and recommendations of EA and must include the EMP in the contract document as a binding clause.

• Due to accessibility it is suitable to engage two construction parties at a time. DOR can take take-up part construction to experience the cost of road construction engaging excavators.

• Road takeoff alternative decision needs DOR to have close coordination with Division of Health.

• DOP have to be informed and coordinated with regard to relocation of some of the existing electric transmission poles intersecting with road alignment.

• FSD should be coordinated with hauling of logs obtained from road corridor clearing.

• Detailed slope stability study is required by geo-technical engineer between Yuwa and Zhamling (12+900 – 22+450km) and before reaching road terminal point (Dungkhar Nagtsang) to consider EA recommended alignment alternatives

• design the road along the natural contours as the traffic intensity is low;
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1 INTRODUCTION, METHODOLOGY AND PROJECT DESCRIPTION

1.1 GENERAL BACKGROUND

The Kingdom of Bhutan covers an area of 46,500 km², roughly measuring 150 km north to south and 300 km east to west, and is bordered by the Tibetan plateau in the north and the Indian plain in the south. The terrain is amongst the most rugged and mountainous in the world; most of the country includes part of the Himalayan range. The V-shaped valleys formed by rivers and streams, between the high mountain ranges align the north and south, drain the catchments from the high altitudes in the north to the plains in the south. The altitude declines from approximately 7500 m to 200 m above sea level.

The climate varies due to the altitude with winter and summer as two distinct seasons. The climate and soil type determines natural vegetation and can be zoned as: alpine tundra (above 3800 m), the cold temperate forest (3000-3800 m), the warm temperate forest (2000-3000 m), the semi-humid subtropical forest (700-2000m), and the humid subtropical rain forest (200-2000 m). Land use also correlates fairly well with altitude. Forests occupy 72.5% of the total land area and is the dominant land cover. In agriculture, the major land uses are Kamzhing (dry land), Chuzhing (irrigated/wetland), and Tseri (slash and burn cultivation).

Administratively the country is divided into 20 Dzongkhags (districts), and the Dzongkhags are further subdivided into 202 geogs. The population of Bhutan is estimated to be 600,000 and is one of the least populated countries in the South Asia. The current population growth is 3.1%. The average household size is estimated at 5.6. About 85% of the population live in rural areas.

1.2 PROJECT RATIONALE

Since 1959 Bhutan has constructed some 3,375.65 km of motorable roads of which 2,000 km are black topped, 1,100 km with base course only and rest are dirt roads. The lack of an elaborate road network is a major constraint for the socio-economic development through out the Kingdom of Bhutan.

The district highway in Lhuntse measures some 65 km following closely the drainage of Kuri Chhu touching very few settlement areas. The only feeder/rural roads in the district measuring about 10 km connects Tangmachu, one of the important settlement areas contributing significantly towards socio-economic development. Considering the importance of the motor road network in the district the Royal Government of Bhutan (RGoB) considered the construction of Lhuntse-Dungkhar road (approx. 37 km) in the Eighth Five Year Plan as needs had been identified and proposed by the Geog Yargye Tshogchung (Block Development Committee) and the Dzongkhag Yargye Tshogchung (District Development Committee). Equally important to the road network development is the improvement of the existing district highway particularly in Rotpashong, a nightmare landslide spot during monsoon often cutting off traffic for months.

Understanding the importance of roads for the improvement of rural living conditions the World Bank has expressed its interest to finance the roads under the Rural Access Project. However, before a decision is

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2 Division of Roads, Ministry of Communication, Thimphu, Bhutan, 1999.
reached on the modality of the project implementation it is the policy of the RGoB and the World Bank to have a study conducted apprising them of the environmental implications of the proposed project.

1.3 OBJECTIVES

The main purpose of environmental assessment (EA) is to reveal positive and negative environmental consequences to the decision-makers and other interest groups, and to provide environmental information that makes it possible to design, construct and operate the road in an environmentally friendly manner. The objectives can be summarized as below:

i. It assists the proponent in planning the project better for instance, the impacts such as project impairing the existing infrastructures in the area can result in a lot of complications and confrontations with the users of the infrastructure during the implementation period often impinging the work progress and provoking other complications. If the impacts are identified earlier before the project is initiated and key stakeholders are consulted and then the mitigation plan put into place future problems can be avoided.

ii. It enables the decision-makers to make informed, reasoned choices by making the information available about the pros and cons of the project; and

iii. It helps the people to better understand the full ramifications of the project. For instance, EA can make people understand the importance of the implementation of the project; the coordination between locals and the project staff for achieving the project target; the optimal use of resources available locally is made use of; and negative impacts identified so solutions can be suggested.

1.4 SCOPE OF WORK AND LIMITATION

1.4.1. Scope of Work

The environmental assessment includes the following:

- Collect and review environmental baseline information relevant to the project characteristics;
- Assess significant environmental impacts;
- Suggest best route alternatives suitable economically, environmentally, and socially;
- Propose mitigation measures against significant negative impacts;
- Propose monitoring actions to ensure the implementation of suggested mitigation measures.

1.4.2. Study Limitations

To quantify the assessments precisely was not possible as best route alternatives are yet to be identified before the final decision on alignment is reached. Efforts have been paid to put assessments in quantitative terms however, it would be advisable to use them as indicators. For instance: how much acreage of Kamzhing will be expropriated for road has to be assessed at a later stage once the alignment has been

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finalized and compensated accordingly. Further, if EA has to quantify its impacts precisely there is a need to involve EA at an early stage of the project cycle as early as the route feasibility study is carried out by the Division of Roads (DoR). More detail of its involvement and what benefits can be accrued is discussed in Chapter 5.

The study is covered from takeoff points, nearby Lhuntse Dzong up to the endpoint of Dungkhar involving about 10 day intensive field assessments. Emphasis has been placed on suggesting best route alternatives as a means to reduce negative impacts while enhancing benefits.

1.5 STUDY METHODS

The methods employed in the EA has followed the Bhutanese Environmental Assessment Sectoral Guidelines, Highways and Roads, February 1999 and the Terms of Reference from the DoR that incorporated the World Bank guidelines.

The EA process is in short depicted in Figure 1.1 The first step describes the project layout with the project components that are superimposed on the natural conditions in the project area.

Baseline information is the existing information on the relevant topics: environmental, social, and cultural. Besides conducting field surveys, available baseline data and reports of project relevance have been evaluated. The collected data will be compiled and analyzed upon which impact mitigation measures have been built. Finally, a framework for a monitoring plan is suggested both for the construction and operational phase.

![Diagram of EA Process]

**Figure 1.1: EA Process**
1.6 PROJECT DESCRIPTION

The technical description given below is based on the judgment of the consultants in consultation with DoR personnel as environmental friendly construction is still at an early stage of development. It should therefore, be noted that certain information may change at a later stage of the project cycle, depending upon detailed field assessments and design.

1.6.1. Major Project Data

Road length: approx. 37 km
Maximum longitudinal gradient: ±8%
Beneficiaries: 487 households
Major bridges: 2 (approximately 45 m over Kuri Chhu and approximately 10m over Kilung Chhu)
Approximate traditional construction cost: US $ 2.86 million (exchange rate US $ 1 = Nu 42.00) (by bulldozer)

1.6.2. Project Location

The project is located at Lhuntse Dzongkhag, in east Bhutan. Its location by latitude is between 27° 30' - 28° 00' north and by longitude between 91° 00' - 91° 15' east (refer map in the following page). Lhuntse Dzongkhag is bordered by Bumthang Dzongkhag to the west, Trashi Yangtse Dzongkhag to the east and Monger Dzongkhag to the south. It borders Tibet to the north.

The takeoff point has two possibilities and has been prioritized. The alignment if followed by priority I follows a rough tract up to approximately 7 km constructed by the DoP to transport material for a mini hydro project.

If priority II takeoff is chosen the new construction joins the existing rough tract after 1.35 km. The road passes through different land uses and reaches a crossing at Yuwa (over Kuri Chhu) where a major bridge is necessary. It crosses through the foothills of steep rocky cliffs and makes several hairpin bends to reach Wantanga from where it gradually falls until Zhamling.

Two alignment alternatives are proposed for the stretch between Yuwa and Zhamling that needs detailed field assessments. From Zhamling it gradually falls and at certain points rises to reach Dungkhar. Detail explanation on alignment alternatives is provided in the chapter Environmental Management Plan.

1.6.3. Summary of Topography, Geology, Land Use

1.6.3.1 Topography

The topography of the project area in general is relatively very steep with an average percent gradient exceeding 75%. There are deep valleys with perennial streams and some portions are quite marshy. The road hits major rocky cliffs which needs careful location during final alignment fixation. The construction in certain stretches might become difficult, which could be categorized under residual impacts i.e. nothing can be done but to go ahead. At the best EA has to look into the most appropriate alignment which DoR needs to consider closely (refer Mitigation measures in Chapter 5).
1.6.3.2 Geology

The study area exposes mainly granitoid gneisses belonging to the Thimphu group. Within this gneises terrain, several linear bands of metasedimentary rocks occur as enclaves.

1.6.3.3 Land Use along the Proposed Route

Permanent Land use

The permanent land uses that will be stripped off for the road can be segregated into two:

- during construction;
- post road construction.

During Construction Phase:

- From takeoff point I (priority I) until change 1+350 Km the land use that will be stripped off is a dry shrub forests.
- From takeoff II (Priority II) the land use that will be involved for road construction are: 2 permanent residential Bhutanese traditional houses, 2 bamboo hutts, approx. 525 m² Kamzhing (dry land), approximately 305 m² Sokzhing (local protected forest), 11 electric transmission poles, approx. 300 m² Tsamdo (pasture) and dry shrub forests.
- 1+850 km - 4+200 km: land use is basically grassy vegetation, lemon Grass (cympobogan species), and Tsamdo about 3.7 acres, Tseri about 2.59 acres and 2 electric transmission poles.
- 4+200 km - 12+900 km: thick broad leafed forest (good for fuel wood), Tseri about 2.73 acres, Kamzhing about 6.68 acres, Chuzhing about 900 m², Sokzhing about 1.4 acres, 3 electric transmission poles, one double storey permanent house, rocky cliff and thorny shrub vegetation at certain spots.
- 12+900 km - 22+450 km (Priority I): thick broad leafed forest, scree (gathered rolled boulders/stones) in certain spots, touches patchy chirpine forest.
- 12+900 km - 14+900 km (Priority II): land use that will involve chirpine forest and steep rocky cliffs.
- 22+450 km - approximately 34+000 km (Dungkhar): can strip broad leafed vegetation about 74 acres, 3 temporary huts, Sokzhing about 1200 m², Kamzhing about 1.5 acres.

After Construction (for maintenance):

Two campsites can be suggested for the 37 km road, one above Gangzur and another at Zhamling. Keeping one person every 4 km will require 10 people to maintain approximately 37 km of road with minor problems.

The total area that will be required for one campsite with a small kitchen garden would be about 0.45 acres. Two campsites will therefore require about 1 acre. The proposed sites are at the moment used as Tsamdo (pastureland).
Temporary Land Use

Temporary land expropriation is required for two cases:

- Setting up labor camps, workshops, etc. during construction; and
- Cultivated land that may be under temporary disturbance during construction. For instance rolling stones from the road head may prevent cultivation downhill temporarily.

Labor camp, Workshops

Labor camps and workshop setup are required and identified at 5 different places: above Gangzur, nearby Chuneygang Chhu, little after Lingabey, at Yuwa, after Zhamling. The sites that need to be expropriated are 2 acres of Tsamdo at Gangzur; 2 acres of Tsamdo after Zhamling and 2 acres of Kamzhing at Yuwa. Rest campsites are in government land.

Cultivated land that may be disturbed (located below road)

During the construction period cultivation below the road may not be safe to work given the steep geographical terrain. The possible important sites are 4 acres of Chuzhing before reaching Gangzur, 2 acres of Chuzhing before reaching Chuneygang, 5 acres below Lingabey. The former 4 acres may not be disturbed if Priority I takeoff is chosen.

1.6.4. Technical Design

The roads in Bhutan have been categorized basically into 3 categories of which Lhuntse-Dungkhar road falls under category 'C' which is gravel road. Unless otherwise stated the design standards prepared by Snowy Mountains Engineering Corporation, Australia for the DoR, Bhutan under the Asian Development Bank patronage is very good which the Project can follow.

In summary category C has the following specifications:

- Formation width 5.0 m
- Pavement 3.0 m
- Shoulder width 0.5 m on each side
- Drain width 1.0 m
- Maximum gradient 10%
- Minimum curve radius 8 m

As the emphasis is on an environmentally sound road construction there is a need to consider some additions to the road design. As rolling cut material downhill causes the vegetation, soil and other damages to the environment, to reduce the cut material is one of the solutions. The Figure 1.2. illustrates the construction by shifting C-line.
In a woody forest logs could be laid to prevent rolling material.

**Road Drainage**

From the experiences of Bhutan and elsewhere in the region durability of roads depend mostly if not all on good drainage systems. For the proposed feeder road V-shaped drains of 1mx0.5m is appropriate. For the rocky section 0.5mx0.3m is good enough which should be achieved through a series of dynamite blasts.

In 1 km of road there should be at least 10 hume pipe culverts with 60 cm as the minimum size of each hume pipe. Importance should be attached to draining the water from the cross drains to the natural gully.

**Soil erosion and landslides**

Civil engineering retaining structures (for instance gabion wire mesh retaining/breast walls) will be implemented to prevent landslides. In marshy areas catch drains will be constructed to tap water and disposing it to a natural gully. Further, a combination of civil engineering structures with bioengineering will be sought to mitigate erosion and landslides.

**1.6.5. Construction Accessories and Activities**

Construction might involve at least 50 labors (including families 150 heads) and a set of construction equipment brigades. The proponent of the project will provide safety shelters for the labors as the standards set in this report. The waste generated from the camps will be disposed off to a safe place as prescribed.

Safety of the workers and to the surrounding environment will be ensured by the construction responsible. Waste generated from the machine such as oil and grease will be collected and disposed off to the proper place.
1.6.6. Resource Demands

From the takeoff point until 7 km there is an extreme shortage of fuel wood resources. The people of Gangzur during consultation have expressed this problem to EA team. The labors should therefore be prepared with their own energy for cooking. The construction agency should be responsible. Fuel wood beyond 7 km can be obtained from road corridor clearing.

With the health care limited in the project area the construction party should be prepared with their own medical facilities.

1.6.7. Construction Plan

The construction method will be to reduce damages to the environment. This would mean switching over to excavator machines from traditional bulldozer construction.

Further, in steep slopes cutting is recommended in benches/layer. Where there are no natural depressions cut material will be transported to safer places as site condition may dictate. In rocky sections where slopes exceed 100% to mitigate impacts (material rolling down) are almost impossible and it is suggested to cut in benches using explosives in series rather than going single shot hole blasting.

The road can also be constructed in several phases: first a track of 2 m width and after one monsoon extension up to 3.5 m and gradually to the design of the width. Slopes will be re-vegetated using bioengineering preferably local species. The construction is proposed to begin by early fall 1999 and is targeted to complete 10 km each year.

The suggested principal road construction equipment are listed below:

1. Excavator (320B Cat) -2 no. (with varying bucket sizes and by type)
2. Dump trucks - 4 no.
3. Motor grader (small size)- 1 no.
4. Small dozer – 1 no.
5. Pay loader - 2 no.
6. Air Compressor - 2 no.
7. Power Chainsaw - 2 no.

As project area encounters rocky cliffs at various stretches blasting could be very intensive. Controlled blasting would be adopted. More details have been given in the impact management chapter 5.

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2 ENVIRONMENTAL POLICIES, LEGISLATION AND GUIDELINES

2.1 BHUTAN’S ENVIRONMENTAL POLICY

Perched in the eastern Himalayas, Bhutan is a global bio-diversity hot spot. About 72.5% of the land is under forest cover and 26.23% of the total land has been declared as protected area\(^1\).

Ever since embarking on its first socio-economic development planning, the RGoB’s policy has been to ensure the process of development in all its aspects be consistent with maintaining the environmental and cultural integrity of the country. This is the guiding principle upon which Bhutan’s sustainable development strategy was based. This was further elaborated in the 1990 Paro Resolution on Environment and Sustainable Development, which concluded with the statement: “This is the challenge of sustainable development: to raise the material well being of all citizens and to meet their spiritual aspirations, without impoverishing our children and grandchildren.”

The Paro Resolution formed the basis for further institutional change and development in government agencies responsible for environmental management, culminating in the formation of the National Environment Commission (NEC) in 1992.

General government policies towards the environment are:\(^2\)

1. Improving existing, and introducing new legislation, policies to ensure sustainable utilization of natural resources;

2. Preparation of Master Plans for different sectors of the economy, e.g. forestry, power, and roads. These plans will ensure that development is carefully planned, minimize environmental impacts, and ensure utilization of natural resources in a sustainable way;

3. Use of economic incentives to encourage sustainable utilization;

4. Increasing involvement of community and non-governmental organizations (NGOs) in planning and implementation of environmental activities. The decentralization process will enable greater participation of the population in developing appropriate responses to environmental problems;

5. Developing an integrated land use planning capability to provide information for sustainable development planning in all sectors. It is also the RGoB’s policy to keep the country a minimum of 60% under forest cover at all times through a network of protected areas;

6. Building on existing resources management practices, rather than adopting new control mechanisms; and


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\(^1\) Biodiversity Action Plan, for Bhutan, 1998.

\(^2\) NEC February 1999, Reference document.
The Buddhist faith plays an important role in all aspects of life, it stresses the respect for all life forms and makes policy implementation harmonious.

2.2 LEGAL FRAMEWORK

There are strong elements of environmental legislation and administrative instruments in Bhutan. Many basic elements of environmental legislation exist and new elements are being added taking into consideration the most up to date international issues. The Environmental Act at present is the Forest and Nature Conservation Act of 1995 and the Land Act of 1979 amended in 1998 stands strong.

The key acts applicable to environmental protection and development in Bhutan are:

- Forest and Nature Conservation Act 1995
- Water and Sanitation Rules, July 1995
- Draft Environmental Assessment Act (1997)
- Environmental Compliance Notification No. NEC/EA/98-99/655 dated 24th February 1999
- Draft Watershed Management Policy and Act 1990
- Draft Regulations and Policies on Pasture Land 1998

Until the Environmental Assessment Act is formerly approved the road construction activities in Bhutan should comply with the environmental compliance notification No. NEC/EA/98-99/655 dated 24th February 1999 issued by the Chairman of the NEC.

2.3 ADMINISTRATIVE FRAMEWORK

The National Assembly, the Royal Advisory Council, the Judiciary, the Council of Ministers and the sectoral Ministries are organizations that play a crucial role in the governance of the Kingdom of Bhutan. Nevertheless, at the district, block, and village level, there are established mechanisms that ensure people's participation in the decision-making process.

Decentralization of administrative functions began in 1981 through the establishment of District Development Committees (Dzongkhag Yargye Tshochungs) and further in 1991 with the establishment of Block Development Committees (Geog Yargye Tshogchungs).

The key development and environmental agencies in the Bhutan are: Ministry of Agriculture, Ministry of Communication (DoR is responsible for the road network development), Ministry of Trade and Industry, Planning Commission, and National Environment Commission (NEC) and Secretariat (NECS).

2.4 ENVIRONMENTAL ASSESSMENT (EA) GUIDELINES AND STANDARDS

EA guidelines were formerly approved by the government in February 1999 and henceforth all development policies, programs and projects should comply with the guidelines. NEC has issued 6 sectoral environmental guidelines of which road construction in Bhutan should follow the “Highways and Roads.”
The draft EA Act 1997 specifies that projects should be screened through the following categories:

a. Complex projects
b. Impact significant, management known
c. Impacts moderate, project repetitive
d. Impacts moderate, management simple

All the projects falling in A, B, and C needs environmental clearance from the NEC before development consent is permitted.

All the road projects need to conduct detailed environmental assessment and clearance issued by the NEC. At the moment there are no environmental standards for roads in Bhutan however, the Environmental Code of Practice (ECP) under development through the patronage of the World Bank and the Netherlands Development Association should become standard.

2.5 LAND ACQUISITION, COMPENSATION AND REHABILITATION

The Land Act of Bhutan 1979 (amended in 1998) regulates land acquisition by the government of Bhutan. The key principals of the Act applicable for this project are:

- As far as possible the government shall give substitute land instead of cash compensation while acquiring land.
- Allotment of all substitute land shall be from the same Dzongkhag.
- In case a house is acquired by the government, the compensation for any category of house whether built with RCC/brick/stone masonry or in traditional style, shall be paid on the basis of evaluation carried out in each case by a qualified engineer appointed by a competent authority.

A committee consisting of a representative from the Ministry of Finance, Ministry of Agriculture, DoR and the concerned Dzongkhag does land acquisition for road construction. Land Compensation Rate, 1996 governs the compensation.

Note: The review of the World Bank guidelines are not included as IDA Pre-Appraisal Mission of 26 February 1999 from the World Bank has found the Bhutanese environmental guidelines comprehensive.
3 BASELINE CONDITIONS OF THE PROJECT AREA

3.1 PHYSICAL CONDITIONS

3.1.1. Watershed Conditions

Kuri Chhu is the main river in the project area and road alignment up to approximately 12 km closely follow this drainage. Of the many tributaries joining Kuri Chhu the prominent ones are Rong Chhu, Gangzur Chhu and Kilung Chhu. Mini-hydro power projects are under installation over Rong Chhu and Gangzur Chhu. Kuri Chhu has practically no usage for locals either for irrigation or for drinking besides wildlife and aquatic life.

The river in winter is very clean while in monsoon it becomes very muddy. Sediment load recordings in these river systems are non-existent. An overall watershed or sub-watershed management plan presently does not exist.

3.1.2. Climatic Conditions

The project area falls under an altitude between 1500 m and 2500 m. The climate in the area is relatively warm in summer. During winter the temperature falls as low as -20°C recorded during December. The maximum temperature recorded in the project area is during the month of July up to 31°C. The average humidity for a year has been calculated at 85%. While maximum rainfall recorded in a day is 35 mm and the rainfall total in a year is calculated at 1482 in average.

The maximum rainfall recorded in a day per month is illustrated in Figure 3.1, Temperature maximum and minimum recorded during 24 hours by the month is depicted in Figure 3.2.

Source: Meteorology Unit, Division of Power, Thimphu 1999

3.1.3. Geology and Soil

The area falls in the northern extension of the Lesser Himalayas. A prominent N-S trend high hill range which extends northward to join E-W trend ranges of the Greater Himalayas and forms a conspicuous physiography feature. The crest line of these hills range from south to north and are marked by Phoming La (3914m), Dong La (3971m) and Kam La (3458m).
The area is dissected by the numerous streams where Kuri Chhu forms the main drainage system. It originates from Kula Kangri Glacier in the Tibetan region and flows in the south-easterly direction up to Nye and changes its course to south-easterly till it reaches Lhuntse Dzong.

Further downstream the Kuri Chhu flows in a southerly direction. The main tributaries of the Kuri Chhu are Tangkhar Chhu, Chuneygang Chhu, Kilung Chhu, Rong Chhu, Nye and Dungkhar Chhu.

The rock types in the study area consist mainly of granitoid gneisses belonging to the Thimphu Group. Within this gneissic terrain, several linear bands of meta-sedimentary rocks occur as enclaves. The linear bands of metasedimentary rocks of variable dimensions are found around Kilung, Thimyul and south of Dungkhar. The lithopackage includes garnet mica schist, micaceous quartzite (at places hematitic), graphitic mica schist, marble and calc-silicate gneiss. The contact of the Naspe Formation with mica silliminate gneiss of the Surey Formation is concealed in most of the places.

The detailed lithological variations found in the area are described as follows:

1. **Feldspathised garnet mica schist**

   Around Kilung, Khoatangla and Thimyul, several lenticular bands of graphitic schist occurs within feldspathised mica schist. It is highly fractured and fragmented.

2. **Marble**

   Coarsely crystalline marble of variable dimensions are exposed near Thimyul and south of Dungkhar. The marble is intimately associated with calc-silicate gneiss and calc granulite in which amphibole rich bands are very common.

3. **Micaceous Quartzite**

   Around Thimyul and SE of Kilung micaceous quartzite is hematitic with limonite encrustation and interbanded with graphitic schist and marble. The rock in these areas is ferrugineous. But the same rock found in the south of Dungkhar contains elliptical augen like patches of micaceous material in the highly recrystallised quartzitic matrix. It is found highly fractured and sheared where quarry is presently being operated causing landslides.

4. **Surey Formation**

   This formation covers most of the area and lies above the Jaishidanda formation. It is represented by mica granitoid gneiss with xenoliths of high grade mica schist are often traversed by later pegmatite and quartz veins.

5. **Flaggy Quartzite**

   Greyish white, fine grained, thinly bedded, hard and compact. It is noticed from 3+650km to 4+200km. Primary structures such as color bedding and ripple marks are clearly visible on the outcrop. The rock belongs to Shumar formation and it appears to have been thrusted into the Surey formation due to the nearness of Jaishidanda thrust.

6. **Intrusives**

   Small scale intrusion of tourmaline pegmatite, granite and quartz veins as thin sills and dykes occur in all the litho-package.

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7. Soil types

A thin film of top soil—brownish colored—is underlined by grayish brown sand with some silt/clay. Pockets of deep red colored silt/clay is observed in a few places. These soils are mixed with clastics of gneiss, marble, quartzites, schists etc. The size of the clastic ranges from boulders to gravels and are usually angular in shape.

3.2 BIOLOGICAL ENVIRONMENT

3.2.1. Land Use and Agricultural Practices

3.2.1.1 Lhuntse Dzongkhag

General

As like other parts of Bhutan land use in Lhuntse also correlates fairly well with the altitude. The land area of the Dzongkhag is approximately 2887.5 km² of which 78% is dominated by forest cover. The other land use details are provided in the Table 3.1.

| Table 3.1: Lhuntse Dzongkhag land use details as per Land use working map a scale 1:50,000 |
|---|---|---|
| Land use | Area (ha) | Percent of total area |
| 1. Agricultural land |  |  |
| Chuzhing (wetland/irrigated) | 2079 | 0.3 |
| Kamzhing (dryland) | 3477 | 0.5 4% |
| Tseri | 3288 | 26 |
| Mixed arable land | 19008 | 48 |
| Total arable land | 100 | |
| 2. Forest |  |  |
| Conifer | 45882 | 26 |
| Chirpine | 8687 | 5 60% |
| Broad leafed mixed with conifer | 119828 | 69 |
| Total forest | 100 | |
| 3. Scrub forest | 42849 | 15% |
| 4. Pasture (natural) | 9451 | 3% |
| 5. Settlements | 35 | 1% |
| 6. Others that includes snow/glaciers, rock outcrops, land slips, water spreads, marshy areas. | 49105 | 17% |

Source: Land Use Planning Section, MOA, 1999
TABLE 3.2: AGRICULTURAL DATA FOR LHUNTSE DZONGKHAG

<table>
<thead>
<tr>
<th>Crop</th>
<th>Area (acre)</th>
<th>Production (M tons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rice</td>
<td>5285</td>
<td>4662</td>
</tr>
<tr>
<td>Potato</td>
<td>5285</td>
<td>387</td>
</tr>
<tr>
<td>Wheat</td>
<td>784</td>
<td>331</td>
</tr>
<tr>
<td>Buckwheat</td>
<td>279</td>
<td>85</td>
</tr>
<tr>
<td>Mustard</td>
<td>178</td>
<td>41</td>
</tr>
<tr>
<td>Barley</td>
<td>91</td>
<td>34</td>
</tr>
<tr>
<td>Maize</td>
<td>4611</td>
<td>2586</td>
</tr>
<tr>
<td>Vegetables</td>
<td>770</td>
<td>1232</td>
</tr>
<tr>
<td>Millet</td>
<td>479</td>
<td>173</td>
</tr>
<tr>
<td>Legumes</td>
<td>312</td>
<td>126</td>
</tr>
<tr>
<td>Chili</td>
<td>94</td>
<td>54</td>
</tr>
<tr>
<td>Ginger</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Orange</td>
<td>30</td>
<td>99</td>
</tr>
<tr>
<td>Apple</td>
<td>33</td>
<td>40</td>
</tr>
</tbody>
</table>

Source: Land use Planning Section, MOA, 1999

3.2.1.2 Land Use of Kurteo and Gangzur Geog (road beneficiaries)

Kurteo Geog has a land area of 990.9 km$^2$ of which forest is the dominating land use with 66% of the total area covered. Agricultural land is only 2% while the rest is natural pasture, snow/glaciers, water spreads, landslides and etc. Details of the land use are provided in Table 3.3.

Gangzur Geog has a total land area of 535.5 km$^2$ of which 78% of the land area is under forest cover. The arable land is only 4% and the rest is all rock outcrops, snow glaciers, land slips etc.

TABLE 3.3: KURTEO GEOG LAND USE DETAILS AS PER LAND USE MAP

<table>
<thead>
<tr>
<th>Land use</th>
<th>Area (Ha)</th>
<th>Percentage of Total area</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Agricultural land</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chuzhing</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>Kazkzhing</td>
<td>442</td>
<td>2%</td>
</tr>
<tr>
<td>Tseri</td>
<td>1398</td>
<td></td>
</tr>
<tr>
<td>Mixed total arable land</td>
<td>1854</td>
<td></td>
</tr>
<tr>
<td>2. Forest land</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conifer</td>
<td>12978</td>
<td></td>
</tr>
<tr>
<td>Mixed forest</td>
<td>10603</td>
<td>38%</td>
</tr>
<tr>
<td>Broad leafed forest</td>
<td>12550</td>
<td></td>
</tr>
<tr>
<td>Broadleaf, mixed with conifers</td>
<td>1659</td>
<td></td>
</tr>
</tbody>
</table>
Table 3.4: Land use for Gangzur as per land use working map

<table>
<thead>
<tr>
<th>Land use</th>
<th>Area (acre)</th>
<th>Percentage of total area</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Agricultural land</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chuzhing</td>
<td>84</td>
<td>4%</td>
</tr>
<tr>
<td>Kamzhing</td>
<td>497</td>
<td></td>
</tr>
<tr>
<td>Tseri</td>
<td>489</td>
<td></td>
</tr>
<tr>
<td>Mixed cultivation</td>
<td>1173</td>
<td></td>
</tr>
<tr>
<td>2. Forest land</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conifer (Chirpine and Fir)</td>
<td>9954</td>
<td></td>
</tr>
<tr>
<td>Mixed forest</td>
<td>23945</td>
<td>78%</td>
</tr>
<tr>
<td>Broad leafed forest</td>
<td>2355</td>
<td></td>
</tr>
<tr>
<td>3. Scrub forest</td>
<td>4488</td>
<td>8%</td>
</tr>
<tr>
<td>4. Pasture natural</td>
<td>1366</td>
<td>3%</td>
</tr>
<tr>
<td>5. Settlement</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>6. Others: Snow/glaciers, water</td>
<td>3570</td>
<td>7%</td>
</tr>
<tr>
<td>spreads, marshy areas, land</td>
<td></td>
<td></td>
</tr>
<tr>
<td>slips, rock outcrops.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Land Use Planning Section, MOA, 1999

The other details of the land use is as illustrated by the following map (page 3-6).

3.2.2. Vegetation and Forestry

The vegetation in general can be divided into three main categories: (i) the sub tropical forest type, (ii) chir pine forests and (iii) the cool broad-leaved forests.

(i) The sub tropical forest type: This forest type is prevalent along the river Kuri Chhu, from the riverbed up to 15-200 meters above the slope. Due to the micro-climatic effect of the slope and the river, there are a number of species inter mixed in this forest type.

(ii) The Chir Pine Forest: The proposed road passes through 7 km of chir pine forest. This forest predominantly comprises of chir pine (Pinus roxburghii) trees with an average size of 20-30 cm dbh (diameter at breast height) and 15-25 m in height. The under storey also consists of chir pine regeneration of varying sizes and ages. The ground flora consists mainly of lemon grass (cymbopogon flexuosus) and other shrubs of the Lyonia species, Budleja asiatica, Indigofera heterantha etc.
Land Use Along
Lhuntse - Dungkhar Road

Division of Roads
Ministry of Communications

June 1999

Settlements

Proposed Roads:
- Proposed Priority I
- Proposed Priority II

Existing Roads:
- Rivers/Streams
- Contours (200m interval)

Land Use:
- Agriculture: Dryland Terrace
- Agriculture: Dryland Un-terraced
- Agriculture: Mixed Cultivated Land
- Agriculture: Shifting Cultivation
- Agriculture: Irrigated
- Forest: Broad Leaf 1
- Forest: Broad Leaf 2
- Forest: Broad Leaf 3
- Forest: Broad Leaf - Mixed Conifer
- Forest: Conifer - Chir Pine 1
- Forest: Conifer - Chir Pine 2
- Forest: Conifer - Fir
- Forest: Conifer - Mixed
- Forest: Scrub
- Pasture: Natural
- Others: Rock Outcrop
- Others: Water Spreads
- Settlements

Kilometers

July 1999
(iii) The Cool Broad-Leafed Forest: the major part of the road passes through this forest, after the chir pine forests. It is here that the diversity of the forests is observed, with higher number of plants species mix and wild life including the avi fauna. Found here are pure patches of mature Alnus nepalensis, indicating landslides in the past.

Since the road alignment ascends through the forest, the species varies with the altitude. Commonly observed species are Quercus lamellosa, Castanopsis species, Alnus nepalensis, Juglan regia, Betula species, Schima wallichii, michelia spp., Rhododendron arboream, Mesea chisa, Aconitum spp.

For about 1-2 km the road alignment passes through a thick patch of thorny bamboo (Chimonobambusa callosa). A detailed flora list is provided in Annex 3.

3.2.3. Wildlife

From the field observations of actual sightings, droppings and wildlife sounds, supplemented by information provided by many meetings with local communities the following species are available in the forests. Rhesus monkeys, white capped langurs, squirrels, barking deer, wild boars, bear, leopard, jungle fowls and snakes.

About more than 30 species of avi-faua have been recorded, however no endangered species has been observed. According to local information there are pythons and leopards in this forest. This is however not being observed during assessment. Since both these species are protected in Schedule I of Forest and Nature Conservation Act 1995, they are to be monitored. (See annex 3 for more detail).

3.3 SOCIAL, ECONOMIC AND CULTURAL CONDITIONS

As most the local people are not exposed to modern developments their ways of doing things and beliefs are still largely intact. It is always a practice to give a foreigner a warm welcome. In the evening of guest arrival people come to see the visitors with a bottle of locally brewed alcohol (ara) and spend hours entertaining them. The people are just subsistent farmers but look happy with whatever they can afford to live on.

3.3.1. Gender in the Project Area

Unlike in neighboring countries women in the locality enjoy a relatively high status. Although local practice varies, the predominant inheritance rules are favorable to women and women head most households. Even in public gatherings women outnumber men (refer public consultation document in the annex 2).

3.3.2. Socio-Economic Baseline, Beneficiary Geogs (Kurteo and Gangzur)

3.3.2.1 Land holdings and Crop Production

There are 190 households (HH) under Kurteo Geog and with 369 HH under Gangzur Geog benefiting directly from the project (refer map in page 3-8). Keeping an average HH at 6 heads the population of two geogs can be estimated to 3354. The average arable land holdings per household comes to around 1.35 acres which is small by any standard. A complete scenario of HH for Lhuntse Dzongkhag by geog is provided in Table 3.5.
TABLE 3.5: HH SCENARIO FOR LHUNTSE DZONGKHAG BY GEOG

<table>
<thead>
<tr>
<th>GEOG</th>
<th>HH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gangzur</td>
<td>369</td>
</tr>
<tr>
<td>Khoma</td>
<td>265</td>
</tr>
<tr>
<td>Menbi</td>
<td>373</td>
</tr>
<tr>
<td>Kurteo</td>
<td>190</td>
</tr>
<tr>
<td>Menjay</td>
<td>212</td>
</tr>
<tr>
<td>Tshenkhar</td>
<td>318</td>
</tr>
<tr>
<td>Jarey</td>
<td>192</td>
</tr>
<tr>
<td>Metsho</td>
<td>228</td>
</tr>
</tbody>
</table>

Source: Lhuntse Dzongkhag, 1999

The land acreage for two geogs is given under with crop productions.

TABLE 3.6: ACTUAL LANDHOLDINGS BY TWO GEOGS

<table>
<thead>
<tr>
<th>Land use</th>
<th>Gangzur Geog (acre)</th>
<th>Kurteo Geog (acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chuzhing</td>
<td>319</td>
<td>178</td>
</tr>
<tr>
<td>Kamzhing</td>
<td>441</td>
<td>355</td>
</tr>
<tr>
<td>Pangzhing (fallow land)</td>
<td>49</td>
<td>38</td>
</tr>
<tr>
<td>Tseri</td>
<td>527</td>
<td>395</td>
</tr>
<tr>
<td>Tshesa (kitchen garden)</td>
<td>21 9 acre)</td>
<td>11</td>
</tr>
<tr>
<td>Sokzhing</td>
<td>113</td>
<td>79</td>
</tr>
<tr>
<td>Tsamdo</td>
<td>1032</td>
<td>589</td>
</tr>
</tbody>
</table>

Source: Lhuntse Dzongkhag, May 1999

TABLE 3.7: CROP PRODUCTION FOR GANGZUR AND KURTEO GEOG

<table>
<thead>
<tr>
<th>Crop production</th>
<th>Gangzur Geog (Mtons)</th>
<th>Kurteo Geog ( Mtons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rice</td>
<td>272</td>
<td>152</td>
</tr>
<tr>
<td>Potato</td>
<td>56</td>
<td>21</td>
</tr>
<tr>
<td>Wheat</td>
<td>38</td>
<td>52</td>
</tr>
<tr>
<td>Buckwheat</td>
<td>18</td>
<td>9</td>
</tr>
<tr>
<td>Mustard</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>Barley</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>Maize</td>
<td>348</td>
<td>227</td>
</tr>
<tr>
<td>Millet</td>
<td>20</td>
<td>13</td>
</tr>
<tr>
<td>Vegetables</td>
<td>202</td>
<td>88</td>
</tr>
<tr>
<td>Legumes</td>
<td>24</td>
<td>20</td>
</tr>
<tr>
<td>Chili</td>
<td>30</td>
<td>20</td>
</tr>
<tr>
<td>Ginger</td>
<td>4</td>
<td>-</td>
</tr>
<tr>
<td>Orange</td>
<td>20</td>
<td>-</td>
</tr>
<tr>
<td>Apple</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

Source: Lhuntse Dzongkhag, May 1999
3.3.2.2 Land Ownership

Investigations have revealed that much of the land in Kurteo geog were owned by absentee landlords/ladies living mostly in Thimphu. The tenant farmers hand over one half of their yield to the owners. In some cases, the owner demand only their share of rice and the rest of the crops left for the farmers. In Gangzur geog the absentee landlords are minimal though most of the land belongs to the Jangehuling Monastery that are sharecropped by the farmers.

As the agricultural land for the road right-of-way in the Kurteo Geog is estimated to take only about 1.5 acre of Kamzhing the livelihood of the tenant farmers is not going to affect. The tenant farmers can benefit from the project by involving in petty construction works.

3.3.2.3 Cottage Industries

Under the whole Lhuntse Dzongkhag there are 82 trade license holders, some are active and few reported dormant. A total 17 licenses are for construction and the rest are for restaurants, general shops and bars. Manufacturing does not exist besides lemon grass distillation.

At the Lhuntse-Dungkhar Road takeoff point there are 20 shop license holders of which 18 are actively operating and 2 are closed for financial reasons. There are 3 restaurant operators where basic food is provided and logging facilities are non-existent except at the Dzongkhag guesthouse with 3 rooms equipped with basic things.

3.3.2.4 Public Services

Lhuntse Dzongkhag has telecom facilities and a couple of Basic Health Units (BHUs) are connected but reported not in order.

Electricity for the Dzongkhag has still a long way to go. Important houses of the Dzongkhag get lighted from 1800 to 2200 hours by a diesel generator. Two mini-hydropower projects are under construction one at Gangzur with 110KW and at Thimyul with 220KW, both located close to the proposed project.

Convenient postal services are limited in and around Lhuntse Dzong. For far distances Gups (Block Administrator) usually take care of the mail to reach to the right addresses.

To transport goods and people there is a truck service running from Monger to Lhuntse and back twice a week. There is still an urgent need to upgrade the transportation system.

3.3.2.5 Education

There are 15 schools in the Dzongkhag of which 1 is a high school, 8 primary schools, and the rest community schools. In the project area there are two primary schools located at Dungkhar and near Lhuntse Dzong and two community schools at Nye and Zhamling. The education facilities are free and availed even for the project work force. Table 3.8 gives a full scenario of education sector in Lhuntse Dzongkhag.
TABLE 3.8: EDUCATION IN LHUNTSE DZONGKHAG

<table>
<thead>
<tr>
<th>S.No.</th>
<th>School</th>
<th>Geog</th>
<th>Total students</th>
<th>Teachers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Boys</td>
<td>Girl</td>
</tr>
<tr>
<td>1.</td>
<td>TangmaChu High School</td>
<td>Menbi</td>
<td>351</td>
<td>125</td>
</tr>
<tr>
<td>2.</td>
<td>Tangmachu Primary School</td>
<td>Menbi</td>
<td>129</td>
<td>142</td>
</tr>
<tr>
<td>3.</td>
<td>Lhuntse Primary School</td>
<td>Gangzur</td>
<td>154</td>
<td>128</td>
</tr>
<tr>
<td>4.</td>
<td>Wambur Primary School</td>
<td>Tshenkhar</td>
<td>151</td>
<td>78</td>
</tr>
<tr>
<td>5.</td>
<td>Zangkhar Primary School</td>
<td>Jarey</td>
<td>171</td>
<td>95</td>
</tr>
<tr>
<td>6.</td>
<td>Ladrong Primary School</td>
<td>Jarey</td>
<td>93</td>
<td>50</td>
</tr>
<tr>
<td>7.</td>
<td>Dungkhar Primary School</td>
<td>Kurteo</td>
<td>95</td>
<td>61</td>
</tr>
<tr>
<td>8.</td>
<td>Khoma Primary School</td>
<td>Khoma</td>
<td>89</td>
<td>66</td>
</tr>
<tr>
<td>9.</td>
<td>Minjay Primary School</td>
<td>Minjay</td>
<td>77</td>
<td>80</td>
</tr>
<tr>
<td>10.</td>
<td>Nye Community School</td>
<td>Gangzur</td>
<td>32</td>
<td>22</td>
</tr>
<tr>
<td>11.</td>
<td>Zhamling Community School</td>
<td>Gangzur</td>
<td>23</td>
<td>15</td>
</tr>
<tr>
<td>12.</td>
<td>Tshochen Comm. School</td>
<td>Tshenkhar</td>
<td>40</td>
<td>22</td>
</tr>
<tr>
<td>13.</td>
<td>Autsho Com. School</td>
<td>Tshenkhar</td>
<td>65</td>
<td>76</td>
</tr>
<tr>
<td>14.</td>
<td>Gortshum</td>
<td>Metsho</td>
<td>46</td>
<td>34</td>
</tr>
<tr>
<td>15.</td>
<td>Kupingsa</td>
<td>Tshenkhar</td>
<td>16</td>
<td>13</td>
</tr>
</tbody>
</table>


3.3.2.6 Extension Services

Like the other geogs the extension services are also available for Gangzur and Kurteo. The services include forestry, animal husbandry, and agriculture. There are two extension centers both located under Gangzur geog. The extension services are provided at free of cost.

3.3.2.7 Livestock

Livestock plays an important role in the daily life of the farmers. It’s employed for cash income, manure for the fields, and draughts for transporting and tilling the field. The Table 3.9. gives the overall picture of livestock in the district reflecting also Kurteo and Gangzur geog, project influence.

Table 3.9: Livestock for the Dzongkhag

<table>
<thead>
<tr>
<th>GEOG</th>
<th>HORSES</th>
<th>CATTLE</th>
<th>PIGS</th>
<th>SHEEP</th>
<th>GOST</th>
<th>HEN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gangzur</td>
<td>214</td>
<td>3858</td>
<td>487</td>
<td>-</td>
<td>-</td>
<td>1458</td>
</tr>
<tr>
<td>Kurteo</td>
<td>213</td>
<td>1334</td>
<td>163</td>
<td>-</td>
<td>3</td>
<td>910</td>
</tr>
<tr>
<td>Khoma</td>
<td>247</td>
<td>2813</td>
<td>39</td>
<td>165</td>
<td>-</td>
<td>525</td>
</tr>
<tr>
<td>Metsho</td>
<td>95</td>
<td>2026</td>
<td>112</td>
<td>-</td>
<td>4</td>
<td>1112</td>
</tr>
<tr>
<td>Menbi</td>
<td>130</td>
<td>942</td>
<td>189</td>
<td>-</td>
<td>-</td>
<td>972</td>
</tr>
<tr>
<td>Jarey</td>
<td>105</td>
<td>1643</td>
<td>5</td>
<td>-</td>
<td>-</td>
<td>669</td>
</tr>
<tr>
<td>Minjay</td>
<td>227</td>
<td>1676</td>
<td>315</td>
<td>-</td>
<td>-</td>
<td>704</td>
</tr>
<tr>
<td>Tshenkhar</td>
<td>301</td>
<td>1509</td>
<td>416</td>
<td>-</td>
<td>4</td>
<td>1657</td>
</tr>
</tbody>
</table>


3.3.2.8 Irrigation

Rice is the principal crop for both the geogs. Cultivation often becomes difficult as irrigation water has to draw from far places extending up to several kilometers. Gangzur geog has an irrigation channel for
a length of 20.44 km to irrigate paddy fields of a 199 hectares serving 239 HH. Kurteo geog has about 12 m irrigating approximately 137.5 hectares benefiting 129 HH. Most of the channels are earthen while some critical ones are concreted.

3.3.2.9 Health Facilities

The main hospital in the Dzongkhag is located at Phaling under Gangzur geog and Dungkhar geog has one Basic Health Unit (BHU) at Dungkhar. A big hospital at Tongkangla under Gangzur geog is under construction that will ease many health difficulties encountered at the moment. For far distant places there is outreach clinic visiting once in every week from the main hospital.

3.3.2.10 Water Supply and Sanitation

Drinking water is quite a problem in both the geogs as it has to draw from far away points. It is basically surface water, relatively clean and safe. As most of the villages are scattered in pockets it has been difficult for the government to provide common tap water facilities.

Smokeless chimneys are provided under UNICEF’s patronage covering all most all villages but have become defunct, as it has proved inefficient. Cooking is all by firewood in their traditional mud stove and the smog and pollution in indoors is worth mentioning.

With the geogs connected with road the people can switch over/access to other cooking energies such as kerosene and LPG. This can avoid the indoor pollution to certain extent.

Pit latrines are practiced by almost all HH but in some cases an open toilet has become quite common.
4 ASSESSMENT OF IMPACTS

The impacts are both positively and negatively assessed. Positive impacts are those that improve existing situations while negative impacts are associated with unwanted aspects. The social, economic and cultural impacts are discussed in two distinct headings i.e. one under specific chainage and the other general discussion that applies to all chainages. Physical and biological impacts are arranged by chainage-wise.

4.1 CHAINAGE 0+000¹ -1+350 KM (TAKEOFF PRIORITY II) (0 TO GANGZUR)

4.1.1 Physical Impact

4.1.1.1 Air Quality and Noise

As the takeoff point is heavily settled with about 20 shops and many others it is likely that dust pollution can have some impact on the built in ecosystem. Similarly, noise from the machine and construction blasting could have some impact in the initial stage. In the post construction period the impact from vehicle frequency is not expected as experienced in other feeder roads in Bhutan.

4.1.1.2 Landslide, Geology and Soil

The rock type in the portion is irregularly exposed and is made up of predominantly of feldspathised garnet biotite gneiss with ± sillimanate. Wide opened discontinuities sets, which is further weakened by the fracture, fragmented and folded. Greyish brown colored topsoil underlined by light yellowish sand with a few pockets of silt/clay constitutes the main portion. Stabilized landslides are reactivated at places and further triggered by seepage of water and rainfall. The minimum side slope gradient recorded is 45% while at certain points the sides slope gradient exceeds 100%. The average side slope gradient in this stretch can therefore be concluded as 75%.

4.1.1.3 Water Resources and Hydrology

There are no adverse effect on water resources and the hydrology of the area. The only concern would be surface water during and after construction as road longitudinal gradient makes water flow toward settlement areas.

4.1.1.4 Landscape and Environmental Aesthetics

This stretch will be much impacted with landscape as area is sparsely vegetated and further cut material rolling down may become unavoidable due to rugged steep terrain causing massive land area scar.

4.1.1.5 Land Use

On pastures it might have some marginal impact, as most of the areas are used for grazing.

¹ 0+000=0 (Kilometer) + (meter)
4.1.2. Biological Impact

4.1.2.1 Vegetation

Anthropological and cattle activities have heavily degraded the area between this stretch. Few vegetation's found are *Rhododendron species, Quercus Griffithi, Artemesia species, ferns, Lyonis species, Rubia manjjita* etc. In the south facing slopes the ground cover has been dominated by *Cympobogon species* (lemon grass). Negative impacts on vegetation out of road construction are not foreseen.

4.1.2.2 Wildlife

Important wildlife species are not observed in this stretch nor reported by the locals when interviewed. Few birds species found are *Bulbul, Doves, fly Catchers, and Babler*. These species are not included under the protected list of the Forest and Nature Conservation Acts 1995 or under the list of International Union for Conservation of Nature (IUCN).

4.1.2.3 Livestock

Livestock (referred to cattle only) is an important part of their daily living. As can be seen from the baseline data chapter Gangzur geog has the maximum heads of cattle. Due to construction activity livestock may have certain impacts which should be mitigated properly.

4.1.3. Specific Social, Economic and Cultural Impacts

4.1.3.1 Land Expropriation

As the road takes off through steep slopes it is likely that rolling material will make immediate downhill cultivation difficult. About 0.13 acres of Kamzhing will get impacted. It will also involve 2.26 acres of Tseri, Chuzhing about 0.2 acres, Sokzhing about 0.74 acres and approximately 0.74 acres of Tsamdo.

In this stretch there involves a couple of hairpin bends on steep slopes at certain points hitting natural rock piles. It is therefore likely that materials can easily roll down affecting 4 acres of paddy cultivation as construction mass disposal site doesn’t exists nearby.

4.1.3.2 Impacts on Infrastructure

Just a few meters after the takeoff point about 3 permanent Bhutanese traditional houses may be effected as it is located a little above the road head. A couple of huts, housing shops at the moment may also be effected. 2 electric transmission poles needs re-location at the Phaling area and further about 11 poles crossing the hair pin bends.

As electric transmission lines are yet to be tensioned the road would have a positive impact during installation.

4.1.3.3 Fuelwood Impact

Fuelwood is not much available in this stretch. People spent about 4 hours to fetch a back-load of fuelwood. The construction workforce can compound this impact if freely allowed to collect in the vicinity.
4.2 1+350 - 4+200 KM (GANGZUR TO CHUNYEYGANG CHHU)

4.2.1. Physical Impact

4.2.1.1 Air Quality and Noise

Gangzur people and the workforce of the Mini-hydropower project located close to Gangzur are the populous who will be effected most by this pollution. As the impacts are temporary people are willing to compromise as expressed in the public consultation session held at Gangzur on May 3, 1999.

4.2.1.2 Landslide, Geology and Soil

Deep red colored silt/clay goes about 150m from Tangkhar Chhu. Grayish yellow to red colored, fine to medium grained sand with clastics of sharp and tabular shape gneiss and quartzite, thinly bedded flaggy quartzite having a color bedding and ripple marks starts at chainage 3 + 600 km. The rock dips towards the road, which may cause plane failure. The contact between gneiss and quartzite appears to be thrusted. Though the slope is quite favorable proper construction methods need to be adopted as chances of plane failures are likely.

The maximum slope gradient has been recorded at 75% while the minimum is about 35% and the average slope gradient comes to around 55% which is the most favorable stretch of the total.

4.2.1.3 Water Resources and Hydrology

Drinking water sources for the settlement areas are not predicted to be effected. As construction hits a rocky stretch to obtain abutment space at the Gangzur Chhu crossing heavy blasting may cause water clogging as a result of material piled up over the crossing. If this happens it can flood the downstream paddies during monsoon as the occurrence of flash floods been reported by the locals and evidences observed during assessment.

A little before reaching the end of the chainage a heavy cut is expected which may roll all into Kuri Chhu. Besides foreseeing little impact on fish life much hydrological problems are not predicted as the river width is wide enough to accommodate the monsoon rise.

4.2.1.4 Landscape and Environmental Aesthetics

This stretch runs through relatively easier terrain and landscape impact is not much foreseen as construction can adopt balanced cut and fill method. However at certain points it may be impacted.

4.2.1.5 Land Use

The camps for the project are proposed in the Tsamdo area of Gangzur, which might change the existing land use slightly. Otherwise much adverse effect is not foreseen.

4.2.2. Biological Impact

4.2.2.1 Vegetation

There is not much vegetation in this stretch of the road, as it passes through agricultural land and scrub forest, except at around Chuneygang Chhu where the vegetation is well stocked. The vegetation's found
Around Chuneygang Chhu the tree species found are Syzygium cumminii, Mallotus philippensis, Alhezzia lebbeck, Terminalia myrocarpa, Castanopsis spp., Sappindus sebiferum, Brasiiopsis hainla, Clerodendron spp. There might be some negative impacts on the vegetation as there will be some clearance of forests along the road. The clearance of the forests will make approximately 100 m3 of fuel wood readily available.

4.2.2.2 Wildlife

Important wildlife species are not observed in this stretch nor reported by the locals when interviewed. Only Rhesus monkeys and lizards were observed and as per the local reports there are wild boars and snakes as well. The bird species observed were, Whistling thrush, Scarlet-breasted sunbird, Red-vented bulbul, Stripe-throated Yuhina, Ashy drongo, Rufous-backed Shrike. These species are not included under the protected list of the Forest and Nature Conservation Act 1995 or under the IUCN.

4.2.2.3 Livestock

The road transacts through the middle of natural pastures where people frequently herd their cattle. Construction can have some impact particularly with the blasting activity.

4.2.3. Specific Social, Economic and Cultural Impacts

4.2.3.1 Land Expropriation

In this chainage the road construction can have a minimum influence on the pristine agricultural land if mitigation measures are properly attended. The only land that may be appropriated for the road would be about 5 acres of Tsmado, and about 3.5 acres of Tseri. 2 acres of Chuzhing may be effected due to rolling materials as it is located immediately below the road.

2 acres of Tsmado for temporary project camp setup. For permanent maintenance setup it might require about 0.45 acres for 5 families with a small kitchen garden.

4.2.3.2 Impacts on Infrastructure

Little above Gangzur two electric transmission poles can be effected which may need re-location. The major impact on infrastructure could be on the irrigation channels drawing at about three sources. If irrigation channels are not well attended to the construction might effect Chuzhing cultivation of more than 20 acres, the lifeline for Gangzur people.

4.2.3.3 Fuelwood Impact

People in this stretch also faces severe fuelwood shortages. Yeshey Dorji of Gangzur expressed during public consultation that to fetch a back-load of quality fuelwood takes them at least 5 hours. If fuelwood from scrub forest is collected then within 3 hours a back-load can reach their door.
4.3 4+200 - 12+900 KM (CHUNEYGANG CHHU TO YUWA)

4.3.1. Physical Impact

4.3.1.1 Air Quality and Noise

As this stretch is relatively populated dust pollution may have some adverse impacts on the settlement as a result of construction activities. Further the area being quite dry might accelerate dust pollution.

4.3.1.2 Landslides, Geology and Soil

Quartz mica schist (+ Garnet ± sillimanite), micaceous quartzite with minor graphitic schist, hematite and calc gneiss is thrust over granite gneiss and garnet mica schist (+ sillimanite) of Survey formation. In the contact the rocks are highly fractured, fragmented and sheared. Greyish brown to yellow colored sand with elastic of gneiss of quartzite is loosely set. Few pockets of deep red silt/clay and scree materials are observed. Small landslides and marshy lands are also seen at places. In most of the locations the distance between proposed road alignment and Kuri Chhu are quite close which may have some toe erosion problem. The average slope gradient is about 65% with minimum side slope of 40% and at certain places exceeding 85%.

4.3.1.3 Water Resources and Hydrology

Before reaching Kilung Chhu and little after Kilung Chhu most of the Chuzhings are located above the road head. The spill over irrigation water may make the road construction and maintenance difficult. In some areas there are marshy spots which may be a great problem.

4.3.1.4 Landscape and Environmental Aesthetics

Landscape impact is not much foreseen as road runs through thick broad leaved forest. At certain points the road hits scrub forest with steep terrain where construction should be executed carefully.

4.3.1.5 Land Use

The land uses that might change are the road corridor opening up to maximum 30m, camps need to be settled which might take some pasture land, and 2 acres of Kamzhing into temporary settlement. Impacts are rather minimum which can be ignored.

4.3.2. Biological Impact

4.3.2.1 Vegetation

This stretch is predominantly covered by the sub-tropical forest species. At two places patches of Quercus griffithii exists. The vegetation around Yuwa village is denser with tall and matured trees of Macaranga species and Schima wallichii. The other species found are, Syzygium cumintii, Mallotus philipenensis, Albezzia lebbeck, Terminalia myrocarpa, Castanopsis spp., Macaranga species, “Kaphal”, Bombax ceiba. Shrubs and undergrowth species are, Brassiopsis hainla, Clerodendron, Ficus cunia, “Darimpatte” Xanthoxylum species, Rhus species, Murrya koenigii, Callicarpa species, Artemesia species, Aesophodaeda sp., Emblica officinalis, “nushing” Adhatoda vessica, Maesa chisa, Rubus spp, Rubia manjita, Pandanus sp., “pipla”, Arisaema sp., Viburnum erubescence.

July 1999
Assuming that average road corridor will take about 15m width, approx. 13 hectare will be subjected for corridor opening. Taking Pre Investment Survey Report (forest) of Bhutan the growing stock for the project area forest type (hardwood) is projected to have a volume of about 228 m³/ha². The tree volume that may be harvested from the corridor can be estimated to about (13 ha x 228 m³/ha) 2964 m³. Of 2964 m³, 1185 m³ (40% of the total for broadleafed) will be log volume and rest fuelwood volume.

4.3.2.2 Wildlife

Important wildlife species are not found in this stretch. The few species observed are the common bird species described earlier and the following additional species such as, Forest Eagle owl and the Himalayan tree pie.

However, a little concerning aquatic life, there might be some impacts on the migratory fishes in the Kilung Chhu. This river is being used by migratory fishes for spawning purposes and construction spoil disposal and dumping of trees and branches might clog and obstruct the free movement of these fish during and after spawning.

4.3.2.3 Livestock

As the locality have a lot of livestock traditionally herded in the natural pasture land the construction might have certain impacts particularly as a result of blasting. Warning needs to be given in advance.

4.3.3. Specific Social, Economic and Cultural Impact

4.3.3.1 Land Expropriation

This is the critical chainage, which encounters agricultural land at various points. The land needs to be expropriated for road right-of-way about 2.84 acres of Tseri, approximately 2.16 acres of Chuzhing, and Kamzhing about 10.39 acres.

About 5 acres of Chuzhing is located immediately below which may need temporary appropriation, as it would be unsafe to cultivate during construction. Further 2 acres of orange orchards about 2 years old may also partly be disturbed.

4.3.3.2 Impacts on Infrastructure

Between these chainages the infrastructures that may be negatively effected are: 3 temporary huts at Nongma Chorten, double storeyed traditional house after Lingabey measuring about 80 m² at the plinth, and 3 electric transmission poles that may be disturbed. At Nongma Chorten there is also a double storeyed traditional Dzongkhag extension building that may be effected if construction is carried out quite traditionally.

The irrigation channel for 5 acres of Chuzhing below the road intersects with the road alignment that may be effected.

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2 Pre Investment Survey (PIS) Report, Eastern Zone, Bhutan.

July 1999
4.3.3.3 Fuelwood Impact

Fuelwood is much available and people express no impact due to the presence of workforce. However, control should be put in place to avoid random clearing, which might have impact in the long run.

4.4 12+900 - 22+450 KM (YUWA TO ZHAMLING)

4.4.1 Physical Impact

4.4.1.1 Air Quality and Noise

Local people are not affected, as settlements are located at far distances.

4.4.1.2 Landslides, Geology and Soil

This stretch also belongs to the survey formation consisting of gneiss and garnetifereous mica schist with thin bands of quartzite. In the proposed (Priority II) hairpin (Yongmaling) region is made up of scree boulders piled one over the other. The upstream of the proposed hairpin bend consists of topsoil and residual soil (sand) with clastic of gneiss. There are few sag ponds (at present dry) break in topography, spring water etc. that may be the indications of creep deformation/instability. However, through visual observation particularly with vegetation growth the area seems quite stable with occurrence of landslides estimated at more than 300 years old.

As the EA mission has suggested alignment Priority II in this area detailed investigation of the site needs to be executed before final decision on this alignment is solicited.

The Priority I alignment in this chainage may hit about 500m of rocky section in which construction may be quite formidable. The average side slope in most of the sections exceeds 100%.

4.4.1.3 Water Resources and Hydrology

As there is abrupt break in the topography there are chances of water pooling into the gorges where the road makes several hairpin bends. Water clogging/flooding may be a major problem in those bends. As all the cut material are likely roll downhill Kuri Chhu might be impacted.

4.4.1.4 Landscape and Environmental Aesthetics

This stretch is quite critical concerning landscape impact as it runs through steep rocky terrain. Particular attention should be paid to choose the best route alternative and proper construction technology.

4.4.1.5 Land Use

If the construction is not properly executed the existing land use might have major changes as the terrain is very steep. There are possibilities of forest area becoming bare giving the landscape an aesthetically unpleasing look. The impact may extend down to Kuri Chhu bed.
4.4.2. Biological Impact

4.4.2.1 Vegetation

The road encounters forest at different lengths, broad leaved forest and a pure patch of Albezzia species for 1.5 km. The chir pine forest goes for about 7 km, up to Tshombi village. Then for about 2 km the road enters the cool broad-leaved forests up to Zhamling. The species found are, Syzizium cumini, Albezzia, Chir pine, Lyonia, Buddleja asiatica, Indigofera dosua, Rhus paniculata, Woodfordia fruticosa, lemon grass, Emblica officinalis, Alnus nepalensis, Acer species, Betula alnoides, Quercus lamellosa, Brassaiopsis alpina, Lindera species, Persea species, Juglans regia and other broad-leaved species.

Approximately 414 m$^3$ of chir pine logs, 622 m$^3$ of fuel wood can be obtained from right-of-way felling. Negative impacts on vegetation are foreseen, especially in the chir pine region as the slope is very steep and rocky.

4.4.2.2 Wildlife

The wild life is richer in this section. According to the locals python is available which falls under the protected list of Schedule I of the Forest and Nature Conservation Act, 1995. Other species observed are wild boars, barking deer, rhesus monkeys. The bird species observed are, Common Hawk Cuckoo, Indian Cuckoo, Himalayan Barbet, Red vented bulbul, Shrike, Golden oriole, doves, jungle crows, fly catchers, whistling thrush, Ashy drongo, kali pheasant. The locals reported about the existence of leopard and Crimson Horned pheasants (Monal) and the Impeyan Pheasant. These species fall under the Schedule I of the Forest and Nature Conservation Act, 1995.

Negative impacts on the habitats of the above wildlife are not foreseen. However, poaching could be possible threat by the road construction work force.

4.4.2.3 Livestock

As the general topography is very steep most of the areas may not be accessible for grazing. However, at the fringes of rocky cliff cattle are seen grazing which might have certain impacts. The road can however facilitate for easy cattle migration which at the moment takes days to reach the next pasture.

4.4.3. Specific Social, Economic and Cultural Impacts

4.4.3.1 Land Expropriation

No private land involved.

4.4.3.2 Impacts on Infrastructure

There are about 3 houses in this stretch, which the road may have some influence during construction. This is only the case if alignment is followed as per the EA mission recommendation. However, should alignment be adopted as per the DoR plan (refer Annex 5) the damages may be slightly higher. The main infrastructure impact in this chainage would be on drinking supply channel for the Ropna people (about 11 HH).
4.4.3.3 Fuelwood Impact

Rotpa people have fuelwood scarcity problem. The workforce should be prepared with their own cooking energies. Others are as discussed in the section 4.3.3.3.

4.5 22+450 - 37+000 KM (ZHAMLING - DUNGKHAR)

4.5.1. Physical Impact

4.5.1.1 Air Quality and Noise

In this chainage air quality and noise pollution could be of little concern as the road touches two heavy settlements. Air pollution could basically be dust as a result of construction and emissions from machines. Noise as a result of blasting can have some impacts on wildlife and livestock.

The impact due to traffic intensity in the operation period is not foreseen.

4.5.1.2 Landslides, Geology and Soil

The area is quite marshy with few exposures to gneiss associated with marble, silicate and mica schist. Before reaching the proposed road terminal (Dungkhar Nagtsang, active landslides are observed with white micaceous quartzite that are highly sheared, fractured and fragmented. It is strongly recommended that detailed slope stability investigation should be carried out by geo-technical engineer before decision is made.

The geological assessment map provided in page 4-10 details possible stone quarrying sites and other geological findings. Suitable spoil disposal sites are not illustrated in the map but EA recommends that small natural gullies/depressions can be used.

4.5.1.3 Water Resources and Hydrology

Drinking water sources are located far distances and there are chances that the road construction may degrade the water quality and continuity through the development of diseases vector ponds. Proper location of wastes disposal sites, toilets should be emphasized.

A stream passing between Tabi and Tongdenla flows through a narrow ravine, which may be clogged through a build up of spoil material. This may trigger flash floods, which may effect the ecosystems of the locality and beyond those borders.

4.5.1.4 Landscape and Environmental Aesthetics

As the proposed alignment runs through thick broad-leaved vegetation the landscape is not expected to impact much favored by mild terrain side slope. Log barriers can be used to protect vegetation damage by cut material rolling down.

4.5.1.5 Land Use

The land use that will be impacted in this stretch will basically be agricultural land before reaching Dungkhhar and the natural broad-leaved forest. Except the opening of road corridor major land use change are not foreseen.
Geology Along Proposed Lhuntse - Dungkhar Road

Division of Roads
Ministry of Communications
June 1999

GEOLOGICAL DETAILS

1. SHUMAR FORMATION
Flaggy Quartzite
Quarry

2. NASPE FORMATION
Quartz mica schist
(gneiss amphibolite)
micaeous Quartzite
minor graphic schist
and calc gneiss

3. NASPE FORMATION
Calc-silicate marble
calc gneiss and minor
mica schist

4. SUREY FORMATION
Gravillid gneiss, gneiss
mica schist (almandite)
augens
4.5.2. Biological Impacts

4.5.2.1 Vegetation

The road passes through the cool broad-leaved forest and its vegetation composition is nearly the same as described in section 4.4.2.1. There is a patch of thorny bamboo, (Chimonobambusa callosa) underneath the forest, which continues for about 2-3 km.

Approximately 1605 m$^3$ of hardwood logs and 2408 m$^3$ of fuelwood will be available from the clearance of forests for road construction. As the area is thickly vegetated despite steep terrain in some places there is danger of getting the downhill-vegetated area barren.

4.5.2.2 Wildlife

The wildlife is the same as described in the previous chainage as the same forest type continues until the road end. Therefore the negative impacts as described in the previous section are also applicable here.

4.5.2.3 Livestock

The area is rich in livestock (particularly cattle) as can be seen from the baseline data and from the field observation. The road passes along the potential natural grazing spots. The construction activities mainly blasting can have serious impacts on the livestock.

4.5.3. Specific Social, Economic and Cultural Impact

4.5.3.1 Land Expropriation

At Zhamling the road might take about 3.7 acres of Kamzhing and Tseri about 4 acres. Tsamdo at some points may be effected but precise figures could not be drawn as persons representing the geog in the EA mission do not know much about the boundaries.

At Dungkhar the land that may be appropriated for the road right-of-way is estimated at approximately 0.3 acres of Sokzhing and 1.5 acres of Kamzhing.

4.5.3.2 Impact on Infrastructure

At Dungkhar it is estimated that about 3 temporary huts may need resettlement as alignment may hit slightly above or below these huts. Approximately 35 acres of Chuzhing is located below the road head, irrigating water drawn at several locations. Road construction can have serious impacts on these irrigation channels, which is a lifeline for about 19 HH.

4.5.3.3 Fuelwood Impact

Zhamling people will have lesser fuelwood impact compared to Dungkhar. The workforce should limit their fuelwood collection to corridor opening.
4.6 GENERAL SOCIAL, ECONOMY AND CULTURAL IMPACT

4.6.1. Health Facilities

The project will increase the demand for health services in the area which will have impacts on the local populace. There is also a general need to improve the awareness about health and sanitation issues in the area. There are chances of spreading foreign diseases vigorously due to an illiteracy problem.

The communities like Thimyul, Samling, Lingabey, Tsholing and Nye are thickly populated which sustains little medical facilities through an outreach clinic. People have to hike for a day to reach Lhuntse hospital for proper treatment. The basic medical facilities are provided by outreach clinics visiting once a week in a designated place. There is therefore a need to improve medical care. Similarly, the people of Shawa, Rotpa, Shesa, Zhamling have this problem. Dungkhar people are little better off due to a BHU setup at Dungkhar.

The project can have a truly positive impact as services can pour in easily or patients can be transported in an hour or so compared to nearly 2 days journey at present.

4.6.2. Education Facilities

It is likely that as a result of many external influences accompanying the project, more farmers will want to have their children educated. Migrant workers who bring their families will need education facilities for their children, as will the children of maintenance staff after completion of the project. These will have impact on the existing education facilities.

The positive impact of the road is that the illiteracy rate may increase as the number of school enrollment will increase as facilitated by the road.

Another positive impact would be that the road can help establish a proposed Junior High School at Phyum and a community school at Thimyul smoothly. The road can encourage the enrollment rate in schools at Lhuntse and elsewhere as communication becomes easier.

4.6.3. Economic

Economically the region will have a positive impact and some of the direct impacts are employment opportunities and market facilities for local products. Associated with indirect economic impacts:

- development of businesses:
- increase in real income:
- increase in regional GDP as a result of increase in real income:
- monetization of rural economy as agro-based economy will be increasingly monetized as a result of cash flow in the project area:
- flow of goods and services: and
- increase in the value of land.

As of now whatever they produce in the farm is just for their internal consumption as market opportunities hardly exist. For instance, the people of Dungkhar to raise their financial income carries a back load (max. 40 kg) of potatoes all the way up to Lhuntse Dzong (about 1 1/2 days) and ultimately lands up just getting a carrying charge by selling at Nu 5 per kg.
The locals are also under frequent pressures sometimes in their peak cultivation season carrying baggage of visiting civil servants and other public facilities required at Dungkhar.

As the region is climatically suitable for various cash crop cultivation the road can have positive impact to raise the harsh condition of the localities. Furthermore, as some HH have marginal land holdings' people expressed enough time to work in other income activities such as petty road works. The road can also help bring in other public services harmoniously.

4.6.4. Culture

The foreign work force might have some cultural conflict with the locals. It has however been clearly clarified during public consultation by the people of two geogs that they can adjust to it as the foreigners will stay temporarily and the project is purely for their benefit.

4.6.5. Religious Monuments

There is one religious monument at about 300m from the take off point. After Gangzur Chhu the alignment encounters a long stupa (Mani Dandrim) after few meters crossing of the Gangzur Chhu.

Further two water prayer wheels (Chukor Manis) are located below the road that needs careful disposal of construction material. Constant water supply is needed to keep the wheel going around.

Few meters after Chuneygang Chhu a beautifully looking chorten transacts the road, 3 similar chortens and a Mani above Thimyul suspension bridge, 1 mani before reaching Kilung Chhu and 1 recently built chorten after Lingabey.

The identified problem areas and possible work campsites is illustrated in the following map (page 4-14).

4.7 INSTITUTIONAL CAPABILITY

As the road construction following environmentally friendly methods is still at its early stage of development there are needs to build the capability of DoR at every stage of hierarchy of the organizational setup. More elaborated in Chapter 5.

4.8 COMPARISON OF ALTERNATIVES

4.8.1. Alignment Alternatives

EA followed the alignment fixed by the DOR feasibility team (refer Annex 5) and based upon the findings, realignment alternatives are suggested:

- takeoff alternatives; and
- alignment alternatives between Yuwa and Zhamling

TAKEOFF ALTERNATIVES

Lhuntse – Dungkhar Road takeoff is possible from two points along the Lhuntse highway. Priority I takeoff will be from little above the new Lhuntse hospital, at Tongkangla while Priority II takeoff will be just below the old Lhuntse hospital, before approaching Phaling shopping complex. Both the takeoffs ultimately join the existing dirt track (7 km) constructed by the Division of Power (DOP) before reaching Gangzur. The alignment then closely follows the dirt track until the end. Priority I takeoff follows the dirt track. The Priority II takeoff joins the dirt track after approximately 1.50 km.

The DOR feasibility team had also looked into these alternatives.
The prioritization has been based on environmental, social and economic reasons. The map depicting suggested alignment alternatives is provided in page 5-2. The comparisons are provided in the following Table 4.1.

**TABLE 4.1: COMPARISON OF TAKEOFF ALTERNATIVES, LHUNTSE – DUNGKHAR ROAD**

<table>
<thead>
<tr>
<th></th>
<th><strong>PRIORITY I</strong></th>
<th><strong>PRIORITY II</strong></th>
</tr>
</thead>
</table>
| **Takeoff from little above new Lhuntse hospital** | Negative impacts  
• noise pollution to hospital patient | Takeoff from below old Lhuntse hospital (Phaling)  
Negative impacts  
• alignment passes through active landslides areas and steep side slopes > 75% |
| Positive impacts               | • can short cut road by 1km                                                   | • permanent land expropriation estimated are: 0.13 acre of Kamzhing, 0.2 acre of Chuzhing, 0.74 acre of Sokzhing |
|                               | • no damage to agricultural land                                              | • 3 permanent houses can be affected                                              |
|                               | • no forest clearings                                                         | • couple of huts at Phaling need relocation                                         |
|                               | • passes through geologically stable terrain                                  | • 13 electric transmission poles need relocation                                     |
|                               | • does not affect settlements                                                 | • steeper vertical gradients at hairpin bends might need consideration as site is critically confined between ridge and deep gorge |
|                               | • does not affect cultural monuments                                          | • heavy spoil material need proper disposal and might probably roll downhill as sites to lay spoil are non existent nearby |
|                               | • does not need spoil disposal sites                                          | • temporary expropriation of Chuzhing is estimated at 4 acre as a result of spoil rolling downhill |
|                               | Positive impacts                                                             | • many retaining structures are required                                           |
|                               | • proposed Junior High School construction at Phuyum (approx. 600m from takeoff) can benefit and can save cost of approach road construction | • the road will be more than 1 km longer                                           |

**ALIGNMENT ALTERNATIVES BETWEEN YUWA AND ZHAMLING**

Fixing best suitable alignment is very crucial between this stretch as considerable length of road passes through steep rocky terrain. As per DOR feasibility study (refer Annex 5) one hairpin bend was proposed a little after Yuwa and then alignment passes through the middle of steep rocky section. As this will have considerable negative impact environmentally and economically following two alternatives are suggested:

**Alignment Priority I**

A little after Yuwa bridge maintain couple of hairpin bends and then align with relatively higher gradient to hit the crown of the steep rocky section, passing somewhere above Khoatangla ridge.
Alignment Priority II

Few hundreds meter from Yuwa bridge maintain several hairpin bends until reasonable gradient is achieved to hit the Wamtangla ridge.

Since, EA Team had the limited time to study the alignment alternatives thoroughly both the possible alternatives need detailed study before deciding the recommended alternative.

The possible alternatives are from our preliminary investigations and comparison of these alternatives are provided below in Table 4.2.

TABLE 4.2: COMPARISON OF ALIGNMENT ALTERNATIVES BETWEEN YUWA AND ZHAMLING

<table>
<thead>
<tr>
<th></th>
<th>PRIORITY I (Red color in the map)</th>
<th>PRIORITY II (Violet in the map)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive Impacts</td>
<td></td>
<td>Positive Impacts</td>
</tr>
<tr>
<td>• few hairpin bends will be required</td>
<td>• initial construction cost might be lower</td>
<td></td>
</tr>
<tr>
<td>• once constructed the road will be stable requiring less maintenance as area is geologically stable except at the hairpin bends which has some doubt of soil stability</td>
<td>• there are possibilities to extend road up to Kulongpho to benefit people of Shawa and thrima villages</td>
<td></td>
</tr>
<tr>
<td>• there are possibilities to extend road up to Kulongpho to benefit people of Shawa and thrima villages</td>
<td>Negative Impacts</td>
<td></td>
</tr>
<tr>
<td>Negative Impacts</td>
<td></td>
<td>• several hairpin bends will be involved which might require regular maintenance</td>
</tr>
<tr>
<td>• initial construction cost might be slightly higher</td>
<td>• it passes through good stock of broad leafed forest</td>
<td></td>
</tr>
<tr>
<td>• as it passes through steep terrain spoil rolling down may become unavoidable damaging vegetation downhill of road</td>
<td>• screes/talus are observed in which case the slope stability is doubtful</td>
<td></td>
</tr>
</tbody>
</table>

The proposed project has also been compared with executing the project with different methods of construction and with do-nothing alternative i.e. without a road project. Environmental Friendly Construction Method (EFCM) incase of enough resources availability and Traditional Construction Method (TCM) will adopt when resources are limited.

The comparison scenario is as provided under in Table 4.3.

TABLE 4.3: COMPARISON SCENARIO BETWEEN EFCM AND TCM AND WITH DO-NOTHING ALTERNATIVE

<table>
<thead>
<tr>
<th></th>
<th>EFCM</th>
<th>Traditional Construction method (TCM)</th>
<th>Do-nothing alternative</th>
</tr>
</thead>
<tbody>
<tr>
<td>RANK I</td>
<td></td>
<td>RANK II</td>
<td>RANK III</td>
</tr>
<tr>
<td>Negative impacts</td>
<td>high initial construction cost</td>
<td>more vegetation damage due to cut and throw material downhill</td>
<td>* Every indication that the locality will remain poor as region gets landlocked (not accessible by any mode of transportation except hard walk).</td>
</tr>
<tr>
<td>Positive impacts</td>
<td>low maintenance cost, environmentally less</td>
<td>wildlife disturbance as vegetation cover is reduced</td>
<td>* Inaccessible to other</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
damaging and aesthetically pleasing
- modality of implementation is acceptable to all parties as mitigation measures are arranged

- more landslides and erosion as mitigation
- conflict with the locals
- high maintenance cost

\textbf{Positive impact}
- low initial construction cost

\textbf{Foreign resources such as}
- cooking energies, and
- house construction material.
- Other development proposals are hindered as communication becomes difficult.

\hline

\textbf{4.9 PUBLIC CONSULTATION AND DISCLOSURE}

Public consultation has been held at different levels: central government, local government (Dzongkhag), project affected area, and Non Governmental Organizations.

The purpose of the consultations were:
- Collect information relevant to the project
- Invite suggestions for the benefit of the project
- Inform the people about the nature of the project and implementation modalities and coordination that should be rendered when the project is implemented
- Solicit views of the people wherever possible

\textbf{4.9.1. Central Government}

The government agencies held consultations with:
- National Environment Commission (NEC);
- Ministry of Agriculture;
- Forestry Services Division;
- Geological Survey of Bhutan;
- Survey of Bhutan (Land Records); and
- Division of Roads.

\textbf{4.9.2. Local Government (Dzongkhag)}

Extensive discussion were held with Lhuntse District Administrator (Dzongdag) and other Dzongkhag officials met were:
- Dzongkhag Administration Officer;
- Service sector: District Engineer, Public Health Officer, Education Officer;
- Range officer;
- Forestry extension officer;
- Agriculture extension officer;

\text{July 1999}
Veterinary extension officer;

4.9.3. Project Affected People

As illustrated in the map elsewhere in this report that Gangzur and Kurteo geog are the two main direct beneficiaries of the project.

The consultations were held at different places through individual interviews and group discussions. The consultations were at:

1. Gangzur, representing 14 households (HH) of which 8 were women and 4 men (100% HH representation from this village)
2. Kilung and Nimshong people, 5 HH of which 2 were women and rest men (45% HH present)
3. Lingabey, 16 HH of which 10 were women and 6 men (85% HH present)
4. Rotpa, Tshrima and Shawa; 54 HH of which 21 were women and 33 men (95% HH represented)
5. Zhamling and Khaochung, 25 HH of which 10 were women and 15 men (100% HH represented)
6. Dungkhar and Tabi, 29 HH of which 14 were women and rest men (95% HH represented)

The methods adopted were:

a) Introducing/explaining the whole project related activity (both positive as well as negative impacts) by Karma Jimba.

b) The Gup facilitated the meeting supported by Mangiap (village headman) and Tshogpa (village representative to Geog Yargye Tshogchung);

c) The meeting/consultation was to ensure that it was not dominated by an individual (vibrant speakers)

d) Consensus drawn on points if all agree on what the others say

The basic conclusions of the consultation were:

- People agree with whatever conditions they may have from the government relating to the project as the road request proposal have come out of them;
- They agree to cooperate for the success of the project as project is for their own benefit;
- Little damage that road may cause for their agricultural field or to few houses, they voiced with a will to compromise at a compensation arranged by the government. Many people expressed that without little effect there won't be good cause for which they have no negative feelings.
- Shawa and Tshrima people gathered at Khoatangla to meet EA team expressed that though there are problems to reach road up to their village given difficult terrain but it should be considered that proposed road plan which bends at little above Khoatangla towards Zhamling be extended up to Kulongpho so that their walking distance be reduced from 4 to 1 hour to reach their villages.
- People extends happiness and satisfaction for the government for having sent the EA team to consult with them and given to understand the full proposal of the project.

Full consultation is documented in (Annex 2).
4.9.4. Non-governmental organization

Consultations were held with Dr. Kinley Dorji, the executive Director of Royal Society for the Protection of Nature (RSPN) and also responsible for World Life Fund Bhutan Program. The only concern that he expressed about the project was effect on the proposed wildlife corridor connecting Bomdeling Wildlife Sanctuary and Thrumshingla National Park (refer Annex 7). As important wildlife was not observed during EA fieldwork it may be assumed that animal movements might be happening seasonally. If project considers environmental management plan (EMP) the impacts on wildlife concern can be eliminated or reduced.

4.9.5. Disclosure of EA findings and recommendations

The findings of EA and recommendations were disclosed to the key stakeholders:

1. On 17th June 1999 presented to Lhuntse Dzongkhag stakeholders at conference of Lhuntse Dzongkhag, involving Dzongkhag sector heads, Gups, Mangiapps, Tshogpas of Kurteo and Gangzur Geog. The gups were charged with responsibilities to relay the findings and recommendations to their respective block people as reported in EA report. Overhead aid was used to present findings. No significant comments were received from the house.

2. On 16th June 1999 presentation was held for officials at Thimphu at the conference hall of the Ministry of Communications. The participating institutions were DoR engineers, NEC, Forestry Services Division, Ministry of Agriculture, Planning Commission Secretariat, Non-governmental Organizations, Division of Health, Survey of Bhutan, and the Netherlands Development Association, based in Thimphu.

Extensive discussions went on particularly on the road takeoff points. The discussions indicated that Health Division is not in favor of the road takeoff from near new Lhuntse hospital.
5 ENVIRONMENTAL MANAGEMENT PLAN (EMP)

There are two important features that is responsible for the efficient management of negative impacts resulting during and after construction while enhancing benefits:

- Impact mitigation measures; and
- Impact monitoring plan.

5.1 IMPACT MITIGATION MEASURES

The mitigation measures can help:

- to look for better ways of execution so that negative impacts are minimized or eliminated while promoting benefits; and
- to ensure that the public or individuals do not bear costs, that are greater than the benefits that accrue them.

To take up environmentally friendly construction it must consider two main types of intervention: preventive and corrective measures.

Preventive measures must be applied in selection of best alignment alternative, while corrective measures must be applied in the construction phase.

5.1.1. Alignment Alternatives

5.1.1.1 Takeoff alignment Alternatives

Based on the environmental findings the road takeoff alternative from just above new Lhuntse hospital, at Tongkangla is recommended.

Should this takeoff be chosen then small dust and noise pollution predicted to affect the patients and to the hospital compound should be mitigated by constructing a stone masonry wall of approx. 80 m (Length) x 6 m (height). Appreciable noise pollution that needs worth consideration in this area from vehicular traffic is not foreseen as the maximum vehicle per day will only be five as been experienced in other feeder roads in Bhutan¹. As reported by Lhuntse Dzongkhag Administration there are also no future major planned development activities in these two geogs that will invite heavy traffic. Given the current trend of road network development in Bhutan, it may also be concluded that up-gradation of proposed road will go a long way.

To decide on this road takeoff point it is suggested that DoR initiate coordination with the Division of Health (DOH), Ministry of Health and Education (MOHE). However, for other reasons if priority II is decided then mitigation measures should follow wherever necessary.

¹ Division of Roads, MOC, 1998
d problem areas, camping sites, and present alternatives

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5.1.1.2 Alignment Alternatives Yuwa and Zhamling (12+900 - 22+450)

After crossing at Yuwa two alignment alternatives were identified as the area particularly between Yuwa and Khoatangla encounters steep rocky section, the worst in the whole road length. The alignment alternatives are discussed by priority:

**Priority I (red color in the map) alignment description**

This should make a couple of hairpin bends after few hundreds meters from Yuwa Bridge and pass through the crown of the rocky cliff to reach above Khoatangla top. From here the alignment should enter further behind Khoatangla in the direction of Shawa to reach Kulungpho. From hairpin bend at Kulungpho the alignment heads Zhamling.

This alternative needs further study before decision and final survey is initiated.

**Priority II (violet color in the map) alignment description**

Yuwa crossing until first hairpin bend the alignment follows same as Priority I. From this hairpin bend further several hairpin bends continue until reaching Wantangla ridge. From here alignment extends until Kulungpho and heads towards Zhamling with a hairpin bend at Kulungpho.

This area, where hairpin bends are suggested is predicted to be an old unstable area now fairly stable with thick vegetation growth mostly huge trees. The detailed stability of the area needs to be studied involving an experienced engineering geologist.

**Note:** both the alternatives need thorough investigation (no substitute for legwork) to correspond EA findings.

5.1.2. Construction Code and Technology

To arrive at an environmental sound road construction an attempt should be made to reduce the cut material wherever possible. For the feeder roads the construction should closely follow its natural contours, which is an option to minimize cut. Box cut designs should be avoided in unfavorable slopes, as cut percentage is more.

Considering the doubtful slope stability a shifting of road centerline towards a valley side (by a retaining wall) should be implemented. By carrying out shifts in C-line the undercutting of the fragile slopes could be reduced and part of the cut material be filled in the valley side at the back of retaining wall. In slopes less than 70% a balanced cut and fill in the same cross section can be achieved.

An excavator CAT 320B with a small motor grader have proved a good combination for environmental sound road construction (refer indicated list of road equipment brigade in Chapter I, project description) assisted by some other construction accessories. The recommended sequence of construction should be:

---

1 refer map to identify places
2 43 HH of Shawa and Tshrima people will benefit
3 Forestry development Corporation, 1998
- Removal of vegetation along construction corridor to secure visibility and no hindrance for machine;
- Removal of topsoil and deposition in a safe place for bioengineering reuse;
- Foundation excavation for retaining structures and excavated material should be properly stacked for reuse;
- Construction of walls with tight stone backfill;
- Laying log barriers on the valley sides to withhold cut material from sliding downhill;
- Opening of small track with a small excavator or manually to provide access for later machines;
- Retaining wall construction (adequate drainage below fill, e.g. culvert) along gullies to facilitate deposition of cut material;
- Formation cutting with cut material deposited as per mass distribution plan (stones to be stacked for later use);
- Excavation of breast wall foundation and erection;
- Construction of temporary side drains and causeways;
- Distribution of topsoil, and application of bio engineering methods on both slopes, above and below road; and
- Other super structures such as laying gravel, side and cross drain construction etc.

In case of high cut slopes (usually earth sections) it is suggested that construction be carried out in bench layering so that slope failures are minimized. If the road passes through settlement areas it is recommended to black top the stretch to control dust pollution. Water spraying may be adopted for that stretch of road passing through settlement areas. Regular maintenance required during construction should be carried out by the construction responsible to keep other environmental damages (slope failure due to water clogging) controlled.

During operation proper maintenance must be attended to particularly drainage systems. Bio-engineering in combination with civil structures should be applied to keep the slope failures minimum.

5.1.3. Blasting Requirements

Given the site indications it is very likely that construction would involve massive explosives. For the blasting to be effective, it is important that personnel engaged in blasting cover all recommendations.

- The construction should adopt controlled blasting methods. The controlled blasting involves not overcharging which usually does not follow in any construction in Bhutan, and other norms that should adhere to (refer DoR blasting manual). Overcharging is not only an expensive affair but much more damaging by far flying rocks. Depending upon the site condition and circumstances other alternatives should be explored such as: silent blasting, heating and cooling rapidly, forcing rock splitting iron bars on drilled holes etc.
- The shotfirer should have attended a recognized course of training and be at least 21 year old.
- Where the blasting operation is extensive several shotfirers are required with one appointed as an overall control.
- Explosives recommended are Power Gel 801 and Special Gelatine SG80, with lesser preference to the later.
Detonating cord should be used to have a series of holes blasted at a time and other series with a few seconds later to arrive at cost effective blasting.

Experience has illustrated that people react negatively if an operation is begun with out their knowledge, and reactions could take in the form of complaints. For this reason it is advisable that people in the surrounding area be informed before the operation.

The blasting record should be maintained on a daily basis showing details of calculations made for charging holes, quantity used, shots fired, name of shotfirer etc.

Site storage, transport of explosives, and handling should follow guidelines produced by Ministry of Home Affairs, and DoR manual.

5.1.4. Water Management

The important salient features to keep the mountain road durable and in condition is by providing a good drainage system and maintaining it properly at all times. Water is often damaging if not properly drained. Experience suggests that most of the slope failures are triggered by excess water flowing into the road area. The sources of water should be thoroughly investigated and water-training structures put in properly.

V-shaped drain is the appropriate recommended longitudinal drain for this road. For the earth section the longitudinal side drains should be the size of 1m (length) x 0.5m (width) and in rocky sections 0.5m (length) x 0.3m (width). To discharge the run off smoothly there should be a cross drain (hume pipe) at 100m intervals with a minimum diameter of 60 cm. It must be ensured that the surface run off from the road is discharged into the natural gully to prevent slope failure.

Between chainage 12+900 - 22+450 km several hairpin bends are suggested and the area looks fairly wet with numbers of creeks passing by. The retaining structures should be provided with adequate weep holes and at the base of the retaining structure the side drain should be a little larger than proposed. In such cases it is also advisable to tap the water by constructing catch water drains such as the French Drain (stones filled in trench) allowing the catch water to drained into a natural gully.

5.1.5. Right-of-Way Felled Timber Management

FSD staff must mark all the trees that need felling along the proposed road. The Project Unit Lhuntse-Dungkar (PU) or contractor should intimate FSD for hauling out logs once felled. Trees required for log barriers should be coordinated with FSD. The used No trees should be buried under the earth. For efficient hauling of logs from the corridor FSD and PU must closely coordinate. Should private contractor be awarded with construction contract the felling, bucking and hauling of logs from stump to depot can be mandated to the same contractor by FSD and paid regular government rate.

5.1.6. Landscape and Environmental Aesthetics

Landslides could be a common cause in the region if not properly attended to given the steep terrain conditions. Besides landslides there are also chances of creeping soil, sheet erosion, rill and gully. A combination of engineering structures with bioengineering should be applied to mitigate identified impacts. In order to select techniques of bioengineering, it is necessary to consider the engineering functions (i.e. catch, armor, reinforce, anchor, support or drain) which is required in each site. Some of the indicated bioengineering measures are dealt under:

Landslides
Stabilize slope with bio engineering measures such as, Brush Layer, Live Stacking, Brush Matting, Seeding and Planting

Construct surface and subsurface drains to prevent water from entering into the sliding area and drain the catch water into nearby natural gully

Construct retaining walls

Creeping Soil

It occurs in steep slopes:

Construct surface drain at the crown of the creeping area to prevent water from entering into the area

Apply live stacking

Broadcast seeds of fast Growing plants (such as seeds of lemon grass)

Sheet Erosion

The rain carries down the soil in steep slopes and over a period it will be all transported downhill leaving an infiltration surface. This increases runoff and erosion. The possible measures are:

Seeding/planting grass and trees

Wattle fencing and terracing

Brush matting

Rill and Gully Erosion

Rills are formed due to irregularities of soil surface when the surface water runs down creating shallow canals. When many rills join a gully is created. Gullies can trigger slope failures/landslides. The possible bio engineering measures are:

Construct rip-rap or grass sods

Brush wattle

Brush fences

Planting/seeding of trees and grass

Vegetated palisades

Branch layering

The locally available species recommended for bio engineering are: seeds of cympobogan spp. (lemon grass), branches of popular trees, branches of salix spp. (willow trees), seeds of Artimesia, Erythrina spp. seeds as well as branches, branches of Viburnum spp. and etc.

To have a picturesque view it is suggested that all tree stumps from the road bank be removed and vegetated. This will make the completed road look neat. The recommended finished side slope should be as the following:

0.1:1 (horizontal : vertical) for hard rock

0.3:1 for ordinary rock
0.5:1 for hard soil
1:1 for ordinary soil

Quarries, spoil disposal and work force camps should be reclaimed using bio-engineering methods. To enhance bio engineering the sites should be trimmed properly either manually or by machine. The restoration should begin before construction party leaves the site and supervisor ensures that all is acceptable.

5.1.7. Impacts on vegetation and wildlife

Impacts on vegetation and wildlife can be mitigated through:

- controlled blasting operation and proper spoil disposal in case of heavy cut material
- open road corridor to required width (can minimize opening by not cutting down slopes of road head) ONLY
- in the interest of fish breeding in Kilung Chhu, don’t throw spoil material into Kilung Chhu directly
- advise labors for not poaching and monitor camps frequently
- as area opens there will be resource (forest resources) use competition particular from other region and FSD should monitor this activity

5.1.8. Impacts on Infrastructure and Support Services

The infrastructures that may be effected include: few permanent traditional houses and temporary huts, electric transmission poles, and irrigation channels.

Most of the permanent traditional houses can be saved if enough breast walls are erected, water managed as directed and slopes properly bio engineered. The electric transmission poles that need relocation is involved within the first noted chainage. Should takeoff point priority be chosen the impacts on these transmission poles can drastically be reduced if not to zero impact.

The most significant impact resulting out of road construction would be on irrigation channels. If this impact is not properly attended to the implementation might result in conflict with the locals. To mitigate the impact it is crucial to involve the locals closely and come to a common understanding of the problem.

During construction temporary water pipes should be arranged and put in place (within the area of influence) so that water continuity to their paddies is ensured. Permanent structures should replace temporary water pipes as a permanent measure to the problem.

5.1.9. Work Camp, Health and Sanitation

The location of the work should not be near the settlement area. Some suitable locations are already mapped by the EA, however a few further locations might be necessary. Experience elsewhere in the region has revealed that labor camps are below standard. It is suggested that reasonable shelters should be provided for the labors. The temporary shelters/dwellings for workers should be provided as per EA
Dakpai – Buli Road. Some camp locations have water shortages in which the camps are to be provided with mobile water tanks.

Pit latrines and common garbage bins should be constructed compulsory in the camps and restored when abandoned to keep the contagious diseases at the minimum. Oil and grease waste generating from construction machines should be collected in proper containers and disposed off to a safer place.

As medical facilities in the region is limited it is suggested that the project be prepared with their own medical setup. In the event of foreign labor import it is important that compulsory disease check-ups are carried out right at the Bhutan entry point. This would prevent the mass spread of diseases to the illiterate communities whom they come in contact with.

5.1.10. Occupational Health and Safety

It should be mandatory to equip construction workers with adequate safety gadgets such as helmets, mouth respirator for drillers, handgloves, gumboots, goggles for drillers, ear protector, and red sugar (molasses) for the driller. The site engineer responsible should monitor that workers put on safety gadgets at all times until it becomes habit. First aid kits should be provided in all work sites. All likely danger operations should be warned adequately to the co-workers and people nearby.

In case of accident compensation should be paid as per prevailing government rules depending upon seriousness of the damage.

5.1.11. Strengthening of Institutional Capability

To implement the construction in a way that is less damaging to the environment it is crucial that the engineers and operators of the DoR as well as construction company know about the environmentally friendly construction. The stages where there are needs for capability building are:

- Planning and surveying (with emphasis on best alignment fixation);
- Design and layout in the field;
- Construction and supervision (trained operators can make lot of positive impacts); and
- Monitoring, reporting and providing feedback.

Key responsible engineers should be sent overseas for a short exposure to have a real feel of the construction method. Others can be covered by technical assistance TA that is indispensable for this project.

5.1.12. Social, Economic and cultural

5.1.12.1 Land Expropriation and Compensation

Land expropriation can be segregated into two:

- Permanent for road right of way; and
- Temporary (those under construction disturbance).

For the permanent expropriation there are of course other agencies to be involved but the most important is the Lhuntse Dzongkhag administration and the DoR. The compensation should be made based on actual measurements once the road Peg-line has been decided.
The temporary expropriations are required for Chuzhings at three different locations and work campsites. Temporary compensations for Chuzhing should be based on the annual crop yield with manpower involvement deducted. Similarly, this applies to work campsites.

The expropriation of land should be governed by the Land Act of Bhutan 1979 amended in 1998 and compensation as per the approved Land Compensation Rate, 1996. It is noteworthy that the compensation rates were derived with a consideration that rural people can afford to buy from the government as almost all the registered land holdings are much beyond excess when measured physically. The Land Compensation Rate, 1996 still holds up to date (adjustment formula to pay current compensation does not take into account).

The summary of the Land Compensation Rates, 1996 applicable for this project is provided:

**Land Compensation Rates, 1996**

<table>
<thead>
<tr>
<th>TYPE</th>
<th>Rates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chuzhing</td>
<td>Nu. 35,000/acre</td>
</tr>
<tr>
<td>Kamzhing</td>
<td>Nu. 20,000/acre</td>
</tr>
<tr>
<td>Tseri</td>
<td>Nu. 5,000/acre</td>
</tr>
<tr>
<td>Tsamdo</td>
<td>Nu. 200/acre</td>
</tr>
</tbody>
</table>

There might involve expropriation for some traditional houses. In case a house is appropriated the compensation should be based on valuation (based on the Bhutan Schedule of rates) carried out by the District Engineer in the Dzongkhag representing the Urban Housing and Development Division, Ministry of Communication.

Further, certain fruit trees may be involved in the process of construction. The compensation should follow Annexure “C” and “D” of the Land Compensation rates, 1996.

5.1.12.2 Economic

There are significant positive opportunities that the project can stimulate to the local economy. As can be seen from the baseline data that Dzongkhag has a number of petty contractors some basically remaining idle. Within their capability it is recommended that the work preference be given to these contractors.

There is also scope of improving the local economy through the sale of farm products. The RNR extension workers can play a crucial role to make this happen.

As the area gets opened up there are chances of creating resource use competition. Fuel wood could be an important area, which needs careful attention.

5.1.12.3 Fuel Wood

The stretch particularly between 0+000 to 4+200 km, fuel wood is a major concern being a mainstay of the communities. As the camping sites are recommended in this stretch it is likely that the work force can effect the resources. The construction party should be equipped with their own cooking facilities. Beyond this critical stretch fuel wood is abundant which can be obtained from the road corridor felling. This should be properly hauled, stacked and supplied to the construction parties.

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Since most of the land above Gangzur is scrub forest fuel wood plantation can be an appropriate solution to improve the micro climate and fuel wood shortage problem.

5.1.12.4 Cultural Sites

As can be seen from the assessment of impacts the alignment encounters a number of cultural sites/monuments. Shifting the road C-line towards slope side can save all of these monuments. The only danger for these monument is related to dust pollution which is recommended to restore/paint after the construction is completed.

5.1.13. Cost Estimates

An attempt for cost calculation is carried out for a comparison between traditional and environmental friendly methods. It should be noted that calculation of cost may not be correct as standard output of excavators are not available. In lieu of unavailable data the following assumptions are considered:

- Excavator cut is 35% more expensive than dozer cut (EIA Dakpai - Buli Road)
- By eliminating all box cuts, the reduction is 40% which arrives at 27.5m3/m
- 1 m shift of center line result in a cut reduction of 65% compared to full cut
- in 1m shift C-line 795 m (Length) x 2m (height) dry masonry toe wall is required in 1 km of road
- for 2 m height wall top width as 0.6m and base 1.5m
- Nu. 485.87 per m3 of dry wall plus 42% as cost index
- External environmental cost has not been considered

<table>
<thead>
<tr>
<th>TABLE 5.1: COST ESTIMATION COMPARING BETWEEN TRADITIONAL CONSTRUCTION AND ENVIRONMENTAL FRIENDLY CONSTRUCTION METHOD (EFCM) PER KM</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TRADITIONAL METHOD</strong></td>
</tr>
<tr>
<td>------------</td>
</tr>
<tr>
<td>Item</td>
</tr>
<tr>
<td>1.</td>
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<tr>
<td>2.</td>
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<td>3.</td>
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<tr>
<td>4.</td>
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<td>5.</td>
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<tr>
<td>6.</td>
</tr>
<tr>
<td>Including environmental cost the total cost (excluding landslides and frequent cost involvement) in 20 year</td>
</tr>
</tbody>
</table>
1. Formation cutting by excavators (30% more than Dozer cutting) with small motor grader assisting 1.769
2. Power chains, labor and blasting cost @200 per meter 0.200
3. Toe wall construction with 1m shift C-line (2 m as wall height) about 1669 m³ @ Nu. 690/m³ 1.150
4. Breast wall required per km for Lhuntse situation will be about 15 @ Nu. 60,000/no. 0.900
5. 10 culverts per km @ 35000.00 0.350
6. Cement concrete drain per km will cost 0.200
7. Base course remain same as traditional method 0.460
8. Bioengineering including monitoring cost per Km 0.100
9. The maintenance cost (20 year) will remain very low say 1/3 of Nu. 0.215 0.072
\[ \text{Total cost in 20 year} \quad 5.201 \]

Note: as Dakpai - Buli Road is the first to follow EFCM, realistic cost estimates can be derived after it has completed some kilometers.

5.1.14. Operation and Maintenance Code

As is the normal practice the maintenance during operation should be the responsibility of the Lingmethang Maintenance Division with its sub-division located at Autsho. The maintenance should follow the Environmental Code of Practice (ECP) that is under the draft form prepared under the patronage of the World Bank and the Government of Netherlands.

5.2 IMPACT MONITORING PLAN

Monitoring is necessary for the following reasons:
- To see what impacts have occurred;
- To ensure that the impacts are maintained at the levels predicted;
- To ensure that the conditions of approval are adhered to; and
- Benefits expected from the EA are achieved as the project proceeds.

The monitoring for road is not only foreseen during the construction period but also in the operation period as poor maintenance in the later stage can also result in environmental havoc.

For e.g. clogged roadside drain can make runoff to spillover the road and often massive landslides are triggered. The baseline data provided above should be used as a bench mark to base environmental monitoring.

5.2.1. Construction Period Monitoring

The monitoring during this period can be taken in three different forms:
- Routine monitoring and reporting;
- Periodic monitoring by an external team; and
- Monitoring by donor: project phase-wise evaluation as been formulated in the project.
5.2.1.1 Routine Monitoring

This will be carried out by the agency responsible for road construction i.e. if the construction is carried out departmentally then DoR engineers are responsible for this activity. Should construction be carried out by the private party in which case contractor are responsible. This monitoring can also be called internal monitoring. The basic monitoring activities include keeping vigil for landslide areas and initiating measures against it, see road drainage are not choked, prepare bio engineering plan, blasting operation and etc. All the actions attended to should be documented, reported to the responsible authority and produced on demand by an external monitoring team.

5.2.1.2 Periodic Monitoring

To carry out this monitoring an external team must be necessary. The indicated team members are: construction site responsible DoR Engineer, NEC EA officer, Gups of Kurteo and Gangzur geogs, District Engineer (DE) Lhuntse Dzongkhag, environmental consultant (to be identified by DoR or donor), engineering geologist GSoB, and Forester FSD. It may be necessary to involve the affected people in the monitoring activities through geog gups.

The Project Unit (PU), Rural Access Project should be responsible for initiation and mobilization of the monitoring team. The consensus findings should be compiled and instructions be made to the construction agency for corrective measures.

The budget for monitoring should be in built in the project cost. If bi-annual monitoring is not possible, at least once a year must be mandatory during the monsoon period. Ad hoc monitoring may be called as the situation dictates.

5.2.1.3 Phase-Wise Evaluation

This can be initiated by the donor depending upon the need and in accordance with the project document. The evaluation team should be acceptable to all the parties concerned i.e. donors as well as RGoB. The findings and specific recommendations of the mission should direct the project in a better way.

The indicated monitoring parameters provided in Table 5.2 is a guide for the monitoring team. It can be used at various stages of monitoring.
### TABLE 5.2: SUMMARY ENVIRONMENT MANAGEMENT PLAN (EMP)

<table>
<thead>
<tr>
<th>Activity/Environmental Parameter of Concern</th>
<th>Mitigation Measures &amp; Responsibilities</th>
<th>Monitoring Actions, Indicators and Responsibilities</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A) Pre-construction Phase</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| 1. Decision on takeoff alternative          | • DOR should coordinate with Division of Health to come to a common understanding and agreement | • Takeoff point decided and agreed upon by relevant stakeholders  
• No conflict |
| 2. Study of route alternative between Yuwa and Zhamling (12.900 – 22.450 Km)
  | • Two alignment alternatives should be thoroughly studied for best possibility and slope stability involving DOR engineers and experienced geo-technical engineer | • PU (Lhuntse – Dungkhar Road) to initiate the study  
  Indicators:  
  • Consultants mobilized and budget utilized  
  • Findings document and best alignment arrived |
| 3. Land acquisition and compensation*       | • Compensate landowners for land (and trees or other crops) used for the road right of way. Process to be fully in accordance with agreed policy and framework for land acquisition and compensation rate 1996.  
• Make arrangements to compensate farmers for crop loss or damages to trees | • Project Unit (PU) to coordinate with Lhuntse Dzongkhag Administration and be responsible and to manage the process and Lhuntse Dzongkhag should monitor:  
  • number of properties affected  
  • accuracy of surveys of crops, etc.  
  • timeliness of payments (prior to construction on land affected)  
  • number of complaints or appeals |
| 4. Slope stability investigation before reaching the road terminal point | • Detailed slope stability study to be carried out by geo-technical engineer before alignment decision is made | • PU to initiate the study |
| **B) Construction Phase (incorporate mitigation actions into contract clauses and specifications)** |                                        |                                                  |

1 Alignment alternative and slope stability is in the construction phase since this can be carried out when construction proceeds for the 1st Km keep going.

2 It is assumed that when former 10 km is under construction the geological investigations, alignment fixation and land compensation for the rest can be carried out.

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<table>
<thead>
<tr>
<th>Activity/Environmental Parameter of Concern</th>
<th>Mitigation Measures &amp; Responsibilities</th>
<th>Monitoring Actions, Indicators and Responsibilities</th>
</tr>
</thead>
</table>
| 1. Construction code and technology        | • Use balance cut and fill method in side slopes less than 70% by shifting C-line towards the valley (1m or 2m) or laying log barriers in woody areas  
• Avoid box cuts to reduce cut material  
• Transport the spoil material in case of fragile downhill slope and to save agricultural land/houses/other infrastructures below  
• Use recommended equipment viz. excavators, small dozer to help level the road and formation cutting in gentle slope to achieve progress, pay loaders, air compressors, portable drilling machine, and power chainsaws. | • Contractor engaged by PU should be responsible to comply with the requirements and the compliance requirement must be included in the contract clause and PU should monitor  
Indicators:  
• Equipment on site  
• Less spoil rolling downhill  
• Walls erected to shift C-line  
• Log barriers visible  
• Less vegetation damage  
• No complaint from locals |
| 2. Blasting requirements                    | • Follow controlled blasting i.e. not over charging, execute charge calculation and safety operation  
• Employ qualified and experienced personnel in-charge of explosive  
• Use Power Gel 801, detonating cord, and relay detonators for effective blasting  
• In case of sensitive sites (e.g. cultural sites) explore other forms of detonation such as: silent blasting, heating and cooling rapidly, and forcing rock splitting iron bars on drilled holes  
• Lay gabion wiremesh or bamboo mats over charged rocks to control fly rocks  
• Commence the blasting operation from the crown of the slope by benching and then gradually downward  
• Warn the people in the vicinity about operation | • Contractor engaged by PU should enforce the contractor to comply by including in the contract clause and daily routine to be carried out contractor’s engineer and PU monitor that action are implemented  
Indicators:  
• No damage to surrounding vegetation and locals  
• No complaints  
• blasting operation maintenance register (includes charge calculations)  
• specific site |
<table>
<thead>
<tr>
<th>Activity/Environmental Parameter of Concern</th>
<th>Mitigation Measures &amp; Responsibilities</th>
<th>Monitoring Actions, Indicators and Responsibilities</th>
</tr>
</thead>
</table>
| 3. Water management                         | • Identify the sources of water (particularly spillover of paddy water) and tap it using catch water drain (surface or subsurface) and discharge into nearby natural gully  
• Coordinate with Lhuntse Dzongkhag and locals when road intersects irrigation channels and provide cross drains to suit all parties  
• Document the understandings made and future responsibilities  
• Construct V-shaped drains both in earth and rocky section  
• For efficient surface discharge construct cross drain after every 100m interval and draw discharge into natural gully | • The contractor engaged by PU should be responsible and PU can facilitate contractor, Lhuntse Dzongkhag and locals coordination  
• PU should monitor Indicators  
• No water entering into road influence area  
• No landslide  
• No conflict with the locals  
• Work progress |
| 4. Right of way felled timber management     | • Coordinate with FSD to mark trees and hauling of logs  
• For efficient timber management same contractor can be awarded with felling, debucking and hauling of logs along the corridor (stump to depot contract system as practiced by FDC) | • PU to coordinate with trees marking and intimation to FSD for hauling  
Indicators:  
• No logs buried  
• No work progress hindrance |
| 5. Landscape and environmental aesthetics    | • Maintain finished side slopes/batter as 0.01:1 (H:V) for hard rock, 0.3:1 for ordinary rock, 0.5:1 for hard soil and 1:1 for ordinary soil  
• Bioengineer bare slopes (refer interim bioengineering measures prepared by John Howell for Division of Roads, June 1999)  
• Identify quarries involving geo-technical expert and local people  
• Locate quarries away from the road head through approach roads  
• Operate quarries from the crown of the slope and spray water in case of significant dust pollution  
• Reclaim quarries through site dressing and plantation of vegetation | • PU should make the contractor to comply with the environmental conditions as included in the contract document  
• PU should monitor the actions implemented and PU engineers should be satisfied with quarries reclamation before issuing work completion certificate to the contractor  
Indicators:  
• Slopes stable and erosion not observed  
• Quarries identified involving suggested team members  
• Quarries located with approach road  
• No dust pollution  
• No accident  
• No complaint from locals |

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### Activity/Environmental Parameter of Concern | Mitigation Measures & Responsibilities | Monitoring Actions, Indicators and Responsibilities
---|---|---
6. Impacts on vegetation and wildlife | • Controlled blasting operation and proper spoil disposal in case of heavy cut material  
• Opening road corridor to the required width to only  
• Don’t throw spoil material into Kilung Chhu to save fish breeding  
• Advise labors and monitor camps for poaching | • PU should make contractor comply with the requirements for road corridor opening and spoil disposal in designated sites (identify site for spoil disposal by PU)  
• PU should coordinate with FSD staff in the Lhuntse Dzongkhag to make awareness of wildlife disturbance and monitoring of poaching  
Indicators:  
• Spoil disposed in designated sites  
• Availability of fishes in Kilung Chhu  
• Workers imparted with awareness on wildlife poaching and consequences  

7. Impacts on infrastructure and support services | • Coordinate with Division of Power (DOP) on relocation of existing power transmission poles  
• Use controlled blasting and work operation in stretches encountering houses and erect retaining/breast walls to save permanent houses located above road  
• Bioengineer slopes between retaining wall and exiting house  
• Coordinate with locals and compensate if houses need relocation (compensation should be based on recent estimates carried jointly by PU and Lhuntse Dzongkhag district engineer)  
• Coordinate with locals to arrive at amicable irrigation water problems and provide cross drains (temporary during construction and substituted later by permanent structures) not to interrupt e irrigation water continuity with the best location discussed with the locals | • PU should coordinate closely with DOP, Lhuntse Dzongkhag and locals to arrive at common understanding on existing infrastructure  
• PU should enforce contractor for compliance by including in the contract agreement  
Indicators:  
• All institutions coordinated  
• No complaint  
• No landslide
<table>
<thead>
<tr>
<th>Activity/Environmental Parameter of Concern</th>
<th>Mitigation Measures &amp; Responsibilities</th>
<th>Monitoring Actions, Indicators and Responsibilities</th>
</tr>
</thead>
</table>
| **8. Work camp, health and sanitation**    | • Locate work camps away from local settlement areas in close coordination with the locals  
• Provided shelters for labor as recommended for Dakpai – Buli road  
• Water shortage camps should be provided with mobile water tanks  
• Pit latrines and common garbage bins should be constructed in all work camps (dust collected in the bins should be burned safely or transported to safe places)  
• Equip camps with medical facilities  
• Oil and grease should be collected and transported to safe places  
• Import of foreign labors should undergo compulsory medical check-ups  
• Provided land compensation to the locals  
• Reclaim all work camp sites once abandoned through dressing and plantation | • PU to ensure that labors are provided with reasonable shelters and other facilities as agreed in the contract document  
Indicators:  
• Prescribed shelters and pit latrines for labors erected  
• Work camps free from garbage and pollution  
• No spillover of oil and grease  
• No complaint from the locals |
| **9. Occupation health and safety**         | • Equip the construction workers with safety gadgets viz.: helmets, mouth respirator for drillers, handgloves, gumboots, goggles, and ear protectors  
• The site engineers should ensure that labors make habit of wearing at all times during work  
• Provide first aid kits  
• Compensate as per rule in case of accident | • PU should ensure that contractor provide labors with safety gadgets and comply with other requirements  
Indicators:  
• No accident  
• Better performance of work  
• Labors put on safety gadgets  
• Accident victim compensated |
<table>
<thead>
<tr>
<th>Activity/Environmental Parameter of Concern</th>
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<th>Monitoring Actions, Indicators and Responsibilities</th>
</tr>
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</table>
| 10. Strengthening of institutional capability | • Request TA to strengthen the weak institutional capability of DOR viz: planning and surveying, design and layout alignment in the field, training of supervisors and operators (most important) and monitoring, reporting and implementing actions.  
• Involve contractor of the project in the training  
• Key engineers of DOR and contractor should be sent for training of supervisors and operators (most important) and monitoring, reporting and implementing actions. | • PU should initiate the capability building and involve key engineers including DOR as well as contractors.  
Indicators:  
• Engineers received training  
• Engineers follow the environmental codes of construction  
• Environmental structures implemented and visible  
• Spoil disposed off safe places |
| 11. Social, economic and cultural considerations |  
| i) Permanent and temporary Land acquisition (permanent land acquisition dealt in section A.3. of this table) | • Schedule construction timing to avoid damages to local crops that might involve temporary land acquisition and compensation  
• Compensate for crop damages based on annual harvest/yield  
• Temporary sites acquired for work camps should be compensated as per land compensation rate, 1996 | • PU to initiate in close coordination with Lhuntse Dzongkhag Administration  
• Dzongkhag (respective gup) to monitor on acquisition and compensation  
Indicators:  
• People are compensated  
• No complaints from the locals  
• Project made progress |
| ii) Economic | • Petty work such as small wall construction and bioengineering stuffs can be awarded to locals  
• Open outlets for farm product sale  
• Local petty contractors should be encouraged to participate in the project  
• FSD should control forest resource use competition as area gets opened up | • PU should avail opportunities of works to locals and even incase of work awarded to one contractor (petty contractors can get sub-contract)  
Indicators:  
• Local petty contractors build confidence in work  
• Purchasing power of locals increased |

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### Activity/Environmental Parameter of Concern

<table>
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<tr>
<th>Activity/Environmental Parameter of Concern</th>
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</thead>
</table>
| iii) Fuelwood                              | - Between stretch 0+000 - 4+200 Km the construction party should be prepared with cooking energy  
- Beyond this chainage fuelwood can be obtained from the road corridor clearing (fuelwood should limit to road corridor clearing and centralize the supply to labors)  
- Labors should not be allowed to collect fuelwood in the natural forest | - The contract should include this condition and PU in close coordination with FST staff Lhuntse Dzongkhag should enforce and monitor  
Indicators:  
- No complaint from the locals  
- Fuelwood stacks not visible in the labor camps |
| iv) Cultural sites                          | - Shift the road center-line either towards valley side or towards slope side to save the religious monuments and disposing off spoil material (it is feasible by shifting C-line)  
- Blasting should be carried out controlled method  
- Paint/restore once road is constructed | - The contractor should comply the requirements to retain the monuments and restore  
PU and Lhuntse Dzongkhag/locals should monitor  
Indicators:  
- The monuments exist  
- Paintings/restorations carried out |
<p>| C) Operation and maintenance phase         | - <strong>Follow Environmental Codes of Practice (draft form), DOR which has section for road operation and maintenance</strong> |                                                  |</p>
<table>
<thead>
<tr>
<th>Environment Criteria</th>
<th>Indicator</th>
<th>Data collection source and method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bank Stability</td>
<td>Erosion, landslide</td>
<td>Monitor areas requiring slope stability</td>
</tr>
<tr>
<td>Water supply and sanitation</td>
<td>Coliform bacteria and human diseases (this needs to establish baseline data)</td>
<td>Sampling of water sources</td>
</tr>
<tr>
<td>Water management, drainage and erosion support structures</td>
<td>Proper and adequate structures put in place and functioning of drainage systems.</td>
<td>observations</td>
</tr>
<tr>
<td>Waste management and disposal</td>
<td>Management practices, storage and disposal locations</td>
<td>Observation</td>
</tr>
<tr>
<td>Oil and grease management</td>
<td>Management practices, storage and disposal locations</td>
<td>observation</td>
</tr>
<tr>
<td>Quarry site management</td>
<td>Operation code followed, rehabilitation plan carried.</td>
<td>observation</td>
</tr>
<tr>
<td>Blasting operations</td>
<td>Damages in the surroundings, mishap reports, and code followed.</td>
<td>Observation and record maintained</td>
</tr>
<tr>
<td>Pressure on forest</td>
<td>Fuelwood collection</td>
<td>Observation in construction camps</td>
</tr>
<tr>
<td>Pressure on wildlife</td>
<td>Reduce forest cover</td>
<td>Interviewing locals</td>
</tr>
<tr>
<td>Bioengineering</td>
<td>Survival rates</td>
<td>Sampling species observation</td>
</tr>
<tr>
<td>Proper compensation</td>
<td>Land/cash</td>
<td>Project record; Interviewing locals</td>
</tr>
<tr>
<td>Employment</td>
<td>No. of jobs created</td>
<td>Survey of local area</td>
</tr>
<tr>
<td>Living standards</td>
<td>Housing</td>
<td>Information from Dzongkhag administration</td>
</tr>
<tr>
<td>Assets</td>
<td></td>
<td>Interviewing locals</td>
</tr>
<tr>
<td>Labor activity</td>
<td></td>
<td>observations</td>
</tr>
<tr>
<td>Water supply</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Indirect social benefit</td>
<td>Education</td>
<td>Survey and information from Dzongkhag</td>
</tr>
<tr>
<td></td>
<td>Health</td>
<td></td>
</tr>
<tr>
<td>Economic benefits</td>
<td>Trade and business</td>
<td>Information from Dzongkhag</td>
</tr>
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<td></td>
<td></td>
<td>Interviewing locals</td>
</tr>
<tr>
<td></td>
<td></td>
<td>observations</td>
</tr>
<tr>
<td>Culture</td>
<td>Cultural interaction</td>
<td>Observation</td>
</tr>
</tbody>
</table>
The parameters provided above should be monitored with new listed included if deemed necessary.

5.2.2. Operation Phase Monitoring

To upkeep the road open for traffic at all times and in a manner that is environmentally pleasing monitoring during the operation phase is also equally important. The monitoring can take in two different forms:

- Routine maintenance monitoring
- Periodic maintenance monitoring

5.2.2.1 Routine Maintenance Monitoring

This will be carried out by the Section Officer in-charge of Lhuntse-Dungkhar road on a routine basis. The actions needed for problem areas can be reported to Lingmethang Maintenance Division.

The areas of monitoring are:

- Drainage system and its adequacy
- Landslides and other similar problem areas
- Road surface and quality including operation and maintenance performance in terms of inputs (labor, materials, equipment) and frequency
- The impairing of other support services due to the road
- The suitability of bio engineering and measures survival rates
- Resource use conflicts
- Etc.

5.2.2.2 Specific Maintenance Monitoring

Specific maintenance monitoring is required ONLY when site condition demands. The request for monitoring may probably come from Lhuntse Dzongkhag supported with areas that need monitoring attention. This can be called ad hoc monitoring. In any case it should be a practice to monitor the road once annually as a new move to efficient environmental management. The budget for monitoring should be included in the road maintenance cost.

The indicated team members would be:

- Engineer, Construction and Maintenance Cell, DoR
- EA Officer, NEC
- District Engineer, Lhuntse Dzongkhag
- Gups Gangzur and Kurteo geog

Lhuntse Dzongkhag should be initiating the program and mobilizing the team. Consensus findings should be compiled by the Dzongkhag and submitted to the DoR for corrective action.
5.3 CONCLUSION AND RECOMMENDATIONS

Conclusion

- overall the proposed project does not cause any significant negative impacts on the physical, biological and social environment that needs serious attention
- it does not conflict with any of the Bhutan's declared protected areas or areas worth of protection
- protected wildlife species that is of international and national significance are not recorded in the area during survey nor reported by the locals when interviewed
- the project can bring ample positive impacts to the region particularly to the quality of life improvement through education, better medical facilities, direct cash income, and accessibility to foreign construction and cooking resources.
- there are opportunities to mitigate whatever marginal negative impacts assessed which is a good indication of advancing the project implementation

Recommendations

The recommendations provided below applies for this proposal and for future projects:

- the project formulation should incorporate the findings and recommendations of EA and must include the EMP in the contract document as a binding clause;
- as the area is suitable for engaging two parties for construction at a time due to accessibility it is recommended that DOR should carry out part construction besides employing private contractor. This provides good opportunity for DOR to experience the cost of construction engaging excavators;
- the road takeoff alternative needs DOR to have close coordination with DOH;
- the DOP have to be informed and coordinated with regard to relocation of some of the existing electric transmission poles intersecting with road alignment;
- FSD should be coordinated with hauling of logs obtained from road corridor clearing;
- land/property expropriation compensation should be coordinated closely with Lhuntse Dzongkhag Administration;
- detailed slope stability study is required by geo-technical engineer between Yuwa and Zhamling (12+900 – 22+450km) to consider EA recommended alignment alternatives;
- also detailed slope stability study is must before reaching road terminal point (Dungkhar Nagtsang);
- design the road along the natural contours as the traffic intensity is low; and

Adopt the following during road planning, feasibility and design stages:

- the desk study planning should be based on the following:
  - procure topographical map of 1:25,000 scale with 10m contour interval;
  - geo-technical assessment by aerial photographs should help the tracing of road alignment in the map.

  Feasibility stage (fixing alignment) is what can be considered the most crucial where preventive measures can prove effective. Incorporate the following in considering this work:

- involve better qualified engineers (DoR), EA consultant, and engineering geologist to arrive at the best route alternative;
EA Final Report

- spend at least 20 days (field work only) for approximately 35 km;
- use simple instruments viz. pedometer, GPS, clinometer and ready made paints (different colors) to fix different route alternatives; and
- mark the alignment on trees or other structures to enable the EA and survey team to execute better assessments after this stage of work.
Bibliography:

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5. Road Design Manual, PWD, MOSS, RGOB, prepared by SMEC/ADB


17. Atlas of Bhutan, 1:250,000, land cover & area statistics of 20 dzongkhags, Land Use Planning Project, Ministry of Agriculture, RGOB

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Annex 2

Terms of Reference (ToR)

Environmental Impact Assessment (EIA) for the construction of Lhuntse-Dungkhar road under Lhuntse Dzongkhag.

1. Background

Construction of approximately 37 km of feeder road connecting Lhuntse with Dungkhar is proposed during the 8th Five Year Plan of Lhuntse Dzongkhag. Division of Roads (DoR), under the Ministry of Communications (MoC), has the responsibility for road construction and maintenance in Bhutan and will also be the executing agency for the Lhuntse-Dungkhar road. The cost of constructing this road is proposed under the Rural Access Project to be funded by the World Bank. The prerequisite for funding under the World Bank Assistance is Environmental Impact Assessment (EIA) of such road construction.

The Royal Government of Bhutan (RGoB) has given the mandate to the National Environment Commission (NEC) to review and assess the need for environmental impact assessment in relation to development projects and to scope the EIA. Bhutan's fragile mountainous environment with its rich biological diversity and its unique culture and religious background makes it imperative to carry out EIAs for any major development projects.

The main purposes of the EIA are to reveal positive and negative environmental consequences of the project to decision-makers and other interested parties, and to provide environmental background information that makes it possible to design, construct and operate the road in an environmentally sound way. The EIA takes place concurrently with technical and economic feasibility studies of the project, and in an iterative interaction with these studies in order to make it possible to incorporate environmental considerations equally with technical and economic aspects. Thus, EIA is considered a flexible and transparent tool for ensuring environmentally sound development.

DoR will be responsible for the execution of the EIA, whereas the EIA will be retroactively financed by the World Bank subject to following the IDA guidelines.

The EIA should address the proposed road project as well as potential alternatives. The alternatives could include alternative transport modes, alternative alignments and alternative designs.

2. Project Objectives

The objectives of the proposed road project is to improve rural access to some of the remotest villages in the country thereby improving the socio-economic status of the rural population of Gangzur and Dungkhar Geogs consisting of a population of over 4000 people by providing direct and indirect benefit to the rural communities. The distance of villages like Nye and Shawa under Gangzur Geog from Lhuntse which is a day’s walk could be reduced to merely 3 hours from the proposed road.
3. Project Description

The construction of the Lhuntse-Dungkhar road will be executed by the DoR departmentally and/or through contracts. Of the three alternative alignments studied the alignment which is 37 Km has been selected based on socio-economic and technical considerations. The selected alignment requires construction of a 45 metres span bridge over Kurichu and another over Kilungchu having a span of 10 metres. The road alignment passes through an area of loose soil for about 12.5 Km, in hard soil for about 18 Km and in hard rock for about 6.5 Km. The proposed road alignment takes off from a bend on the Mongar-Lhuntse road near the new hospital (under construction) about 1.5 Km below Lhuntse Dzong. A box cut of about 8 metres depth may have to be done just after 250 metres from the take off point to avoid possible damage to an old chorten (Tabub Choedten). Two hairpin bends are required in order to safeguard a mini hydropower station at Gangzur which is under renovation at the moment. The alignment then follows the road constructed by the Power Division which terminates at Nongma chorten. New formation cutting for about 1.85 km has to be carried out from the take off point and remaining 4.65 km of power road has to be improved and upgraded to feeder road standard.

In view of the proposed Hydropower project at Thimyul and unavailability of a suitable bridge site, the alignment has to necessarily continue till Yuwa, a village lying southwest of Tsholing village. A bridge is required to be constructed over Kurichu below Yuwa. After crossing Kurichu, the alignment continues at an ascending gradient and eventually connects Rotoa with three zigs. The alignment then passes through Shamling village and terminates at Dungkhar. Minor landslides has been observed at two stretches along the road alignment before reaching Dungkhar.

(Refer Project Map at the annex)

4. Project Benefits

The expected benefits from the project are as follows:

The construction of this road is expected to benefit 533 households under 61 villages of Dungkhar and Gangzor geogs. It will provide the necessary access for marketing of agricultural products and reduce the transportation costs of imported goods for rural people. The extension services within the Dzongkhag will be enhanced as a result of improved communication. Further, it will facilitate other development activities in the Dzongkhag by improved transportation system. It will encourage the people to produce more cash crops, vegetables, and even surplus food, which could be marketed outside their gewogs. It will reduce the post harvest losses, middle men business activities, and improve the quality of cash crops.

In brief, the overall benefit after construction of the Lhuntse-Dungkhar road will be the upliftment of the rural population for educational status, medical facilities, improvement of the living standard, and outlet facilities etc.
5. Scope of Work

The ToR for the Lhuntse-Dungkhar road have been prepared to meet the needs for an EIA and mitigation plan which are in agreement with the Environmental Impact Assessment Guidelines for Bhutan. 1993. / 

The impact assessment should identify, describe and assess potentially significant adverse and beneficial environmental impacts of the road project and necessary activities imposed by the project, such as extraction of construction materials, disposal of excess materials and establishment of labors' camps. The impact assessment should cover the construction period as well as the operation period. The impacts of various alternatives should be compared and assessed against the situation of not implementing the project, that is the do-nothing alternative.

The mitigation plan should identify a set of responses to potentially adverse environmental impacts; determine requirements for ensuring that those responses are made in an effective and timely manner; and describe the means of meeting those requirements. Emphasis should be given to roles and responsibilities of agencies charged with implementing, mitigation and monitoring, that is who is going to do the work and pay for it?

5.1 Public Consultation and Disclosure.

Groups potentially affected by the project shall play a role in identifying issues and ensuring that local knowledge and values are understood and taken into account. Public opinions should be taken into consideration when choosing between alternatives, when deciding on the relative importance of issues, and when developing mitigation plans. However, the affected communities may need assistance to fully understand the project proposal, alternatives, potential impacts, the environmental assessment process, and articulating their concerns.

Therefore, at the start of the EIA process the EIA team should determine the most appropriate way of (i) informing the communities of the project proposal, (ii) obtaining the communities views and opinions, and (iii) disclosing the results of the EIA process, including the proposed mitigation and monitoring actions, to the communities concerned. One possible way of involving the affected groups could be through the Gewog Yargye Tshogshung (GYT) while dzongkhag officials, gups, chimis and tshogpas could act as facilitators. Summary information on the project and the EIA should be displayed in public at the gewog and dzongkhag levels. The conduct and the results of the public consultation process and the manner of disclosure shall be summarized in the EIA report, including the executive summary.

5.2 Identification and Assessment of Impacts.

Identification, description and assessment of environmental impacts should be based on observations from field investigations covering land use, topography, geology, flora and fauna in the study area that may contain environmental issues relating to the project. The field observations should be supplemented with various baseline data (maps, aerial photos, reports, scientific literature etc.), for example from the Land Use Planning Project (LUPP) under the Ministry of Agriculture. The
assessment should cover both the proposed project and alternatives that have been considered, including the do-nothing alternative. It should include, but not necessarily be limited to the following aspects:

- Land use with particular emphasis on critical watershed areas, loss of agricultural land, replacement of settlements, and loss of ecologically valuable areas.

- Topography

- Landscape and environmental aesthetics.

- Geology, hydrogeology and hydrology with special regard to soil erosion and landslides. Possible sites of landslides due to loose soil and landslide prone areas should be mapped. Planned earth movements should be described. Will downstream water bodies be impaired by siltation or by polluted run-off water from the road?

- Existing land and water rights should be included, as well as existing irrigation canals and their command areas.

- Ecology, flora and fauna, including a description of biotopes with relevant lists of flora and fauna. Number of trees required to be logged along with species, and, if possible, the approximate quantity in cubic meter/feet.

- Protected areas. Will the road project affect protected areas, nature reserves or sanctuaries?

- Historical, cultural and religious areas and monuments.

- Occupational health and safety during construction and maintenance.

- Construction camps and work sites.

- Socio-economy. What are the expected intentional and unintentional induced development resulting from the road? Does the road provide for reasonably equitable service to rural residents? With respect to possible displacement of people, are provisions for property compensation and rehabilitation reasonably fair?

- Consequences for existing development projects, such as possible siltation that may affect the existing micro-hydel plant.

- Resource demands.

- Impacts of traffic, based on an estimate of vehicle frequency.

- Vibrations from blasting.
• Easier extraction and removal of logs for commercial purposes once road is built,

• Overgrazing by cattle without regulation on steep slopes in the vicinity of road with negative impacts on slopes and drains,

• Increased soil runoff, and potential for increased incidence of fires which further augment the runoff and erosion and reduce soil moisture retention thereby increasing the seasonality of stream and river flows.

NOTE: All identified significant direct and indirect impacts should be covered by mitigation plans and actions, including monitoring measures.

5.3 Comparison of Alternatives

Based on an assessment of impacts, the environmental advantages and disadvantages of project alternatives should be compared, and alternatives should be ranked environmentally. Comparisons should relate to the do-nothing alternative, and to the greatest possible extent, the impacts should be presented in quantitative terms. Permanent effects should generally be considered more critical than temporary, and impacts that cannot easily be mitigated should similarly be considered more critical than impacts that can easily and for economical costs be mitigated.

Assessment and ranking of alternatives considering environmental advantages and disadvantages should also be applied to the alternative routes and alignments which are usually examined in the early design stages. These considerations should be documented in the EIA report.

5.4 Mitigation Plan

Based on the findings of the above evaluation, a mitigation plan should be prepared. The mitigation plan should describe in detail mitigation actions needed, estimate their costs, staffing needs, and timing for corrective measures and actions. Roles and responsibilities in relation to the actions needed should be specified in detail.

The mitigation plan should specifically include:

a) Technical Mitigation Measures.

Technical measures that are, or could be, incorporated into project design and construction phases to eliminate or reduce adverse environmental impacts should be identified and described in general terms. Description and technical details should be presented for each suggested mitigation measure, including cost estimates, staffing needs, and timing for corrective measures and actions. The level of detail of the technical description should be approximately that of a preliminary design. The following aspects should be specifically addressed:
- Construction technology,
- Need for blasting,
- Drainage system alongside the road,
- Types of retaining walls in major landslide prone areas, or any other alternatives for stabilising slopes,
- Provision for culverts or larger drainage systems for the monsoon season,
- Temporary disposal of fertile top-soil to be reserved for reclamation,
- Establishment of native shrubs/trees for further prevention of landslides above and below the road,
- Land tenure, land use rights and land values,
- Raw material extraction, handling, storage and transportation,
- Disposal of excess material from construction works,
- Reclamation plan for the roadside, left quarries and disposal sites.

b) Environment Management Plan for the Construction Phase.

A draft environmental management plan for construction activities should be prepared with the purpose of incorporation of environmental terms and conditions into the road construction Tender Documents. The management plan should cover all aspects of road construction, and responsibilities should be assigned, including responsibilities for mitigation operations, emergency response procedures, supervision, financing, monitoring and reporting. Institutional capacity for implementing the plan should be reviewed and training needs assessed. Special attention should be paid to the following issues:

- Implementation of technical mitigation measures
- Occupational health and safety issues, including labors' camps and work sites.
- Waste management, water supply, traffic, housing and services for labors.
- Possible spills or accidents resulting from use of hazardous materials such as in blasting.
- Response actions in case of accidents or unforeseen events.

c) Operation and Maintenance Plan.

A draft operation and maintenance plan or a code of maintenance practice should be prepared. The plan/code or practice should describe maintenance procedures and assign responsibilities in relation to regular maintenance, emergency response actions, supervision, financing, monitoring and reporting. Institutional capacity for implementing the plan should be reviewed and training needs assessed.

d) Environmental Monitoring.

A monitoring programme covering the construction phase as well as the operation phase of the road should be prepared, including assignment of responsibilities and an implementation schedule. The monitoring programme should make sure that the proposed mitigation plan are implemented by the agencies or companies that are in charge of road construction and
road maintenance.

e) Environmental Training.

An implementation plan for environmental training of planners, designers and road workers should be prepared in accordance with the findings of the training needs assessment.

f) Estimated Costs.

The costs and/or savings from the proposed mitigation plan should be estimated. (In a number of instances, the maintenance costs of not constructing proper retention walls and road drainage systems will exceed the investment costs of these constructions. Hence, in a long term prospect, such mitigation measures result in net savings).

(g) In addition to mitigation plan, a monitoring plan shall be drawn up setting out the functions, roles and responsibilities for monitoring the implementation of the mitigation action. Clear and simple monitoring reporting formats and indicators shall be prepared, reasonable monitoring frequencies set, and a budget shall be estimated for any additional costs of monitoring.

6. Report Format

The EIA report should include a non-technical executive summary and a technical part supplemented with relevant annexes.

6.1 Executive Summary

The EIA report should include a precise, non-technical description of significant findings and recommendations, including (reference to) relevant maps, photos and figures.

6.2 Technical EIA Report

The technical component of the EIA report should include the following sections:

a) Project Description.

The project description should cover both the proposed project and alternatives considered. The description should be at a level of detail that provides adequate background information for comparison and ranking of project alternatives. At a minimum, the project description should include the following information:

- Location of the road.
- Length and width of the road.
- Brief summary of topography (slope gradient), geology and land use along the proposed
route.
- Technical design of the road. Special attention should be paid to road drainage and to supporting structures to safeguard against soil erosion and landslides.
- Accessory constructions and activities (quarries, disposal of excess material, temporary roads, workers' camps etc.)
- Resource demands.
- Construction Plan, including construction technology.

b) Review of Policy and Legislative Framework.

This section should review the policy and legislative framework relating to the project.

c) Baseline Information.

This section should contain a description of the existing environment situation based on field investigations complemented with available literature, maps, etc. Quantification should be made whenever possible. Documentation from the field investigations should be presented here or be put into an annex of the report.

d) Assessment of Impacts.

This section should describe and assess significant potential environmental impacts of the proposed project and project alternatives.

e) Comparison of Alternatives.

This section should compare and rank project alternatives.

f) Mitigation Plan.

This section should present a mitigation plan with fundings and recommendations based on the impact assessment.

7. Reporting and Timing

A draft report should be prepared by the proponent and to be reviewed by the DoR, the NEC, the GYT, the DYT and possibly other relevant institutions to be selected by the NEC.

Six copies of the draft final report should be submitted to the NEC for comments and approval by the NEC not later than two weeks after the completion of the review of the draft report. Similarly four copies should be submitted to DoR for comments.

The NEC will submit its comments to the DoR within two week after receipt of the draft final report.
Ten copies of the final report should be submitted to the NEC not later than three weeks after receipt of comments from the NEC on the draft final report. Similarly, ten copies should be submitted to DoR.

8. Background Information

Background Information from Lhuntse Dzongkhag:

- 8th Five Year Plan Document.

Background Information from the NEC:

1. Introduction

Though Public consultation has been much versed in the NEC guidelines it was further emphasized by the World Bank Mission (IDA Pre-appraisal Mission Aide Memoire February 26, 1999) of its importance.

The comments of the World Bank have been relayed through the Terms of Reference of EA. The consultation with the affected people was held at the time when the physical environment assessment was carried out. Prior to the consultation the EA Team leader convened a meeting with Dasho Dzongdag, Lhuntse. The logistics required during consultation were arranged and information on the EA program to be relayed to the concerned villages was requested. Dasho provided sensible insights that helped the EA team to conduct assessments and consultation fruitfully.

2. Program for consultation

Day 1: Gangzur
Day 2: Kilung and Nimshong
Day 3: Lingabey
Day 4: Rotpa, Tshrima, Shawa, Khaochung, and Zhamling
Day 5: Dungkhar and Tabi

3. Methodology

Participatory Rural Appraisal (PRA) involving all the attendance in the discussion. Individual key stakeholders were identified and interviewed for soliciting their views and opinions expressed by others.

The consultation was made informal so that the rural people felt easy to express their views. Gups, Mangiapps and Tshogpas were well briefed prior to consultation so that they facilitated the consultation smoothly.

4. Proceedings and record of consultation

Day 1: Gangzur

Attendance: 14 HH (8 women: 6 men)

Others present were:
- Gup, Gangzur Geog
- Tshogpa, Gangzur
- Karma Jimba (EA Team Leader)
- Kamal Dan Chamling (EA biologist)
- Lhakpa Sherpa (DoR, Survey Team Leader)

The Gup (Sonam Phuntsho) opened the consultation by introducing the guests and relating the purpose of discussion.

KARMA Jimba, EA Team Leader addressed the gathering
We are here with you to consult the Lhuntse – Dungkhar Road. This is a relatively new approach as in the past, people were not consulted for development projects undertaken in their geogs. The situation is different now as the government and the people work hand in hand for the greater benefit of both people and the government. This consultation is important as it can influence the project implementation modality if adverse impacts are considerable. However, such a consultation can only be successful if the people speak their minds freely. As the project covers your geogs, only you can tell us the exact problems or benefits accruing from it. Decisions involving your paddy field, pastureland, and even your houses should not be left to us as you know what is in your best interest.

Karma said positive as well as negative aspects associated with the project such as expropriation of their agricultural field, sound pollution, pristine vegetation, even houses at some point, cultural conflict with the foreign labors, impacts on their services as number of people pour in the project site. And views were invited from the gathering.

In response Yeshy Dorji said, project execution does not happen in isolation, certain riddles are bound to outcrop but when considering the benefits the little negative impacts should not really matter to them. The others supported the statement.

Kunzang Pemo of Gangzur said, road cut material rolling down could make her paddy cultivation (about 4 acre) impossible during construction period and requested the EA team to look into the matter.

Karma Jimba then introduced fuelwood issues and the impacts that the workforce might create on them. To this Sonam Phuntsho replied that fuelwood is an issue for the Gangzur people and a back load of fuelwood to reach their home takes at least 6 hour. The workforce should not be allowed to collect the fuelwood in their site. Said Sonam Phuntsho.

Then Karma Jimba touched upon labor camp setups and locations. To this a lady said that their camps should be located fairly away from the local communities as cultural conflicts might occur particularly with beliefs and daily doings.

Another villager said that if the road hits their house there should compensation as it is expensive to build a house. He further added that sound pollution is not foreseen as a problem and with blasting operation they should give a prior warning. Said the villager.

Having no other expressions to hear from the people Karma Jimba concluded the session with thanks for a successful discussion. He also thanked the people for their valuable time spent with the EA team.
CONSULTATION WITH GANGZUR PEOPLE

5. Day 2: Kilung and Nimshong

Attendance: 5 HH (2 women : 3 men)

Others present were same as previous.

The Gup opened the session with introductions and related to the purpose of the discussion.

KARMA Jimba welcomed the HH representatives and addressed the gathering.

In reply to the explanation a villager expressed that from his side they foresee no problem associated with the road project. Even if there are problems we should adjust to it as benefits accruing from the road is much greater than any negative impacts it may cause.

The villagers expressed their difficulties that they were facing at the moment relating the sale of agriculture products and possibilities of production enhancement, medical facilities, educating their children and so forth. Also expressed, the opportunities of increasing their cash income through petty contracts with project.

They also came up with possible campsite locations. Phuntsho (Tshogpa of Lingabey) thanked the EA team for initiating the consultation exercise, which was for their benefit.

Karma Jimba concluded with thanks for their participation and with regret for wasting their busy time in consultation.

6. Day 3: Lingabey

Attendance: 16 HH (12 women : 4 men)

Others present as the previous session.
Gangzur Gup opened the session with introductions of officials present and related the purpose of the meeting.

**KARMA Jimba** welcomed the representative and explained about the objectives and scope of the meeting as the previous session.

Many had the same views/expressions as the people of Gangzur, Kilung and Nimshong.

Sithar expressed a little concerned about the damages to her paddy field and to her double storied house.

Many had optimistic opinions to improve their living conditions through different economic activities outcropping from the road project.

The session was concluded by KARMA Jimba with thanks to all.

7. **Day 4: Rotpa, Tshrima and Shawa (Morning session)**

Attendance: 54 HH (21 female : 33 male)

Others present as the previous session.

Gup (Sonam Phuntsho) opened the session by introducing the guests present and highlighting the importance of the discussion.

KARMA Jimba followed the same sequence as before, welcoming participants particularly the Shawa people which is a 4 hour walk from the conference place.

Sonam (Shawa, Tshogpa) was instrumental in relaying the message to his colleagues.
A villager expressed that they have gathered here knowing that the EA team is arriving to investigate the road alternative possibilities in which they could voice their requests.

He further added that they understand the difficulties of road construction, particularly connecting Shawa and Tshrima with the present road proposal. Despite problems, they requested the road proposal extended up to Kulingpho before making way towards Zhamling. This can cut the journey by 3 hour from the proposed DoR plan, said the villager. Both Shawa and Tshrima people endorsed the request. Even if the project needed their labor support to extend road up to the requested point they were willing to provide. Said the Shawa and Tshrima people.

These two villages also expressed their problem of chili trading they face with transportation as the area is potential for chili growing.

The Rotpa people conveyed thanks to the Royal Government of Bhutan for favoring the road passing near their village. They said they had no statements whatsoever to irk the government.

KARMA Jimba concluded with thanks and with a message of regret particularly for Shawa and Tshrima people for wasting one day in having this consultation possible. The session ended with dancing and singing which is a usual custom to offer to the guests.

8. Day 4: Zhamling and Khaochung (evening session)

Attendance: 25 HH (10 female : 15 male)

Gup (Sonam Phuntsho) opened the session as normal giving remarks to the importance of the discussion.

KARMA Jimba followed the suit welcoming the representatives in a humorous way for having an open discussion.

Tshogpa Rinzin facilitated the discussion supporting his gup. He said, “since we have requested the road any problem arising during implementation should be our duty to solve in any way acceptable to all. Road is so important if living conditions of the communities to be improved. If the village is connected by road then other services flow just naturally”.

A lady pointed out that even if the road hits through her house, “I’m willing to compromise as individual interest should not bear costs on others”. She also explained the difference between those connected by road and not connected. For instance having a village with a number of tin-roofs is an economic indicator brought about by the road while our village is without a road and could not afford for it, said the lady.

Similar discussion went on for an hour.

Karma Jimba concluded the session with thanks for their valuable time and suggestions poured into EA team. The session conclusion was followed by dancing, singing, and drinking home brewed liquor (ara) for about 3 hour, a tradition and culture to welcome and entertain guests.

9. Day 5: Dungkhar, Tabi

Attendance: 29 HH (14 female : 15 male)

Others present as usual.

Mangiapp (Chewang Dhendup) opened session with introducing guests and highlighting the importance and purpose of the discussion.

KARMA Jimba welcomed the representatives and explained the objectives and intentions of the discussion.
Dorji Tshomo said that despite Dungkhar being a historical place it has been isolated lagging much behind than any other places in Bhutan. Road, she said, "is now very crucial for these communities as the walking distance to the dzongkhag is very far away taking 2 days to walk". She also pointed out that as development advances visiting Headquarters became very frequent. She also related the difficulties encountered by a Junior High School construction nearing completion when everything had to be transported through horses, donkeys’ and by people. Everything gets exhausted, she said.

Karma Jimba related negative aspects associated with the road.

A lady said that we would compromise with whatever negative elements associated with the road as sustainable benefits are worth considering than these temporary negative impacts. This was applauded and endorsed by all representatives.

Others threw lots of views on economic activities and opportunities that they will consider when the road comes through.

Karma Jimba concluded with thanks and best of luck to all.
BIOLOGICAL ASSESSMENT OF LHUNTSE -DUNGKHAR ROAD.
BY K. D. CHAMLING

Background: This report covers the environmental assessment pertaining to the flora and fauna for the proposed Lhuntse-Dungkhar road.

The assessment was carried out along the tentative alignment of approximately 37-km road carried out by the Division of Roads.

Extensive field works were carried out along the tentative road alignment. Discussions were also carried out on the socio-economic impacts with the local communities who would benefit from the road.

Possible route alternatives were also discussed during the field works, keeping in view of the best solution possible to minimize the cost of construction and environmental damages.

Vegetation:- The vegetation in general can be divided into three main categories: (i) The sub-tropical forest type, (ii) Chir pine forests and (iii) the cool broad-leaved forests.

(i) The sub-tropical forest type: This forest type is prevalent along the river Kuri Chhu, from the riverbed up to 150 – 200 meters above the slope. Due to the microclimatic effect of the slope and the river, there are a number of species intermixed in this forest type.

(ii) The Chir pine forest: The proposed road passes through for about 7 km in the chirpine forest. This forest predominantly comprises of chirpine (Pinus roxburghii) trees with an average size of 20-30 cm dbh (diameter at breast height) and 15-25 m in height. The under storey also consists of chir pine regeneration of varying size and ages. The ground flora consists mainly of lemon grass (Cympobogon flexuosus) and other shrubs of Lyonia species, Budleja asiatica, Indigofera heterantha and etc.

(iii) The Cool broad-leaved forest: The major part of the road passes through this forest, after the chirpine forests. It is here that the diversity of the forests is observed, with a higher number of plant species mix and wild life including the avi fauna. Here and there are found pure patches of mature Alnus nepalensis, indicating of landslides in the past. Since the road alignment ascends through this forest, the species varies with aspect and altitude. Commonly observed species are Quercus lamellosa, Castanopsis species, Alnus nepalensis, Juglans regia, Betula species, Schima wallichii, Michelia spp., Rhododendron arboream, Mesea chisa, Aconitum spp. For about 1-2 km the road alignment passes through a thick patch of thorny bamboo (Chimonobambusa calllosa).

Wildlife

From the field observations of actual sightings, droppings and through sounds and supplemented by the information provided or obtained through many meetings with the local communities the following species are available in the forests. The species are Rhesus monkeys, White capped langurs, squirrels, barking deer, wild pigs, bear, leopard, jungle fowls and snakes. About more than 30 species of avi-fauna have been recorded. However, nothing endangered or protected species have been observed. According to the local information there are pythons and leopards in this forest. Since both these species are protected in the Schedule I, they are to be monitored. (See appendix for species list.)
Impact Assessment: The road passes a number of agricultural fields and a few patches of forests and “sokzhing” patches. In this stretch of road the damage to the forests is not much except when the road crosses the Kilung Chhu. As per the information obtained from the local people, migratory fish uses this river during the spawning period every year. The spillage and dumping of debris from felled trees and shrubs could easily choke the river and thereby causing physical obstruction and preventing upstream movement of this particular migratory fish species for spawning.

Once the road crosses Kuri Chhu at Yuwa, it enters a pure patch of Albizia forest. The chir pine forests starts beyond this patch and the terrain is much more rugged, steep and rocky. The over cast excavated materials will roll down the slope into the river. Unless the excavated materials are properly removed and dumped/stored at a safer place there is a danger of everything going down the river. A lot of dynamos will be required to break away the rocks, which might create some disturbances to the wild life for some time. A good number of chir pine trees need to be felled along the road alignment.

But the major forest clearance begins once the road reaches the cool broad-leaved forests. It is in this section of the road where the bio-diversity is richer, with larger number of plant species and faunal species. Unless proper restrain is not taken up, it is likely that a good number of wildlife species will fall prey to poaching activities from the road construction workers.

Accurate quantification of volume of timber/fuelwood is not possible at this juncture, as the final road alignment has not been done. Moreover during the road construction many trees will be felled down below the road or get buried under the debris thereby harvesting or extraction of the timber or fuel wood impossible or uneconomical. However, based on the PIS reports and the existing field situation, approximate volume has been projected.

Mitigation measures: One environmental hazard associated with road construction is the wanton spillage of debris down the slope. Associated with this is the temporary loss of ground flora and habitat for some birds, since some of the trees felled are nesting places for some birds and squirrels. Normally in developing countries the environmental safeguards are lacking mainly due to financial and technical constraints. Therefore we must find a suitable, appropriate and cost effective measure to suit the country’s budget and technical know-how. A balance must be sought and often compromises have to be made in trying to safeguard the adverse environmental impacts and the developmental works. There is a no win-win situation and finding a trade-off is the question the government has to go for.

However, the following mitigation measures have been identified that will help to reduce the environmental impacts to a certain degree.

(i) During road construction: This phase is most crucial in the life and quality of the road. A well designed and built road will have a higher initial cost which pays off in the long run as the costs incurred for its maintenance is subsequently reduced.

- The standard of a 30-meter road corridor (right of way) need not be adhered to strictly through out the length of the road. Common sense and technical expertise are required while clearing the corridor as more than often such a wide corridor is not required, except in bends or zigs for clearer visibility.
- In the possible landslides prone areas, extra caution must be provided as to minimize large/further erosion and land slips.
Proper bioengineering techniques must be applied, with suitable local species to restrict soil erosion.

Avoid dumping of large amount of debris in the streams/rivers to prevent clogging and destroying the quality of streams/rivers.

Debris of trees/shrubs and branches should not be thrown in the streams/rivers as these will obstruct the movements of fish and other aquatic marine lives, especially the local migratory movements of fishes during spawning period. This is particularly important and relevant in the Kilung Chhu river, as some local migratory fishes seem to be moving up and down during and after spawning. (Local communiqué).

The trees in the road corridors should as far as possible be felled uphill, for easy extraction of timber in future.

Avoid possible landslide prone areas to check/prevent future major landslides.

Extract and harvest maximum quantity of timber/fuelwood from the corridors, during road construction.

Proper quarry sites need to be selected prior to road construction, to prevent future landslides and subsequent road blocks.

Restrain the workers from illegal poaching, killing, snaring of wild animals, poisoning of streams for fishing.

The workers should be educated and restrained from unwanted forest fires.

(ii) Maintenance:

Regular road inspection for signs of slips and erosions to be carried out and remedial measure taken up to further check the damage.

Bio-engineering works to be carried out further to prevent land slips/erosion and faster slope stabilization.

Wherever possible plant evergreen trees, preferably with flowering and fruiting species for enhancing avi-faunal life.

Conclusion:

The proposed road does not pass through any Protected Area, (but there is a proposal to include this area under Buffer Zone of Bomdiling National Park in future) and the road in general will not cause much environmental degradation to the existing flora and fauna.

However there are some areas which need to be properly studied in detail in the actual process of final road alignment and construction. Therefore, to prevent major adverse environmental impacts, proper alignment and subsequent road construction with adequate environmental safety measures need to be taken. Since the road does not pass through major catchment areas, there isn’t any adverse impact of drinking down below.
The one area of concern is the Kilung Chhu where proper mitigatory measures have to be taken for the migratory fishes. Also adequate measures have to be taken to protect both the python and leopards (which exist as per local information), which are protected under the “Schedule I” by the Forest and Nature Conservation Act, 1995.

A) List of flora.

1. Rhododendron arboreum
2. Quercus griffithii
3. Artemesia species
4. Lyonia species.
5. Murraya koenigii
6. Emblica officinalis
7. Xanthoxylum species
8. Litsea species.
9. Ficus species
10. Torricellia tilliifolia
11. Indegofera heternta
12. Desmodium species
13. Agave americana
14. Aseendra butyracea
15. Syzygium cuminii
16. Mallotus philipenesis
17. Mallotus nepalensis
18. Albezzia lebbeck
19. Terminalia myrocarpa
20. Castonopsis species
21. Sappindus sebiferum
22. Brassiopsis hainla
23. Clerodendron species
24. Adhatoda vesica
25. Schima wallishii
26. Maccaranga species
27. Myria rubra
28. Bombax ceiba
29. Rhus paniculata
30. Callicarpa species
31. Maesa chisa
32. Rubus species
33. Rubia manjita
34. Pandanus species
35. Piper species
36. Arisaema species
37. Viburnum erubescence
38. Pinus roxburghii
39. Buddleja asiatica
40. Indigofera dosua
41. Woodfordia fruticosa
42. Alnus nepalensis
43. Acer species
44. Betula alnoides
45. Quercus lamellosa
46. Brachiopsis alpina
47. Lindera species
48. Daphne species
49. Persea species
50. Juglans regia
51. Chimonobambusa callosa
52. Orchids
53. Sauraria napaulensis
54. Other broad-leaved species
B) List of Fauna
1. Ashy Drongo
2. House crow
3. Jungle crow
4. House sparrow
5. Red-vented bulbul
6. Doves
7. Pigeons
8. Eagles
9. Fly-catcher
10. Whistling thrush
11. Scarlet-breasted sunbird
12. Stripe-throated Yuhinia
13. Rufous-backed Shrike
14. Forest Eagle Owl
15. Himalayan tree pie
16. Common Hawk Cuckoo
17. Indian Cuckoo
18. Himalayan Barbet
19. Golden Oriole
20. Kalij pheasant
21. Rhesus monkeys
22. White-capped Langurs
23. Wild boars
24. Barking deer
25. Sambhar deer
26. Snakes
27. Lizards
28. Rats
29. Frogs
30. Squirrels
31. Python*
32. Leopard*

C) Bioengineering species
1. Erythrina species
2. Ficus species
3. Viburnum species
4. Cymbopogon species (lemon grass)
5. Bamboo species
6. Alnus nepalensis
7. Buddleja asiatica
8. Salix species
9. Artemesia species

* Local information and not actually sighted.
1. INTRODUCTION

A preliminary engineering geological mapping along proposed route(A) was carried out in parts of Gangzur and Dungkhar Geogs on 1:50,000 scale, which falls on toposheet no 78M/1 and 2. The aim of the fieldwork was to select the best route alternative considering geologically weak zones and to locate raw materials for construction purposes. Special emphasis was given to the rock and soil types, structure, landslide prone areas, weathering condition etc.

1.1 Accessibility

The area can be approached by a 365km long metalled road from Samdrupjongkha via Trashigang and Mongar. Well maintained foot tracts connect all the villages in between the places.

Physiography, drainage and climate

The area falls in the northern extension of the Lesser Himalayas. A prominent N-S trending high hill range which extends northward to join E-W trending ranges of the Greater Himalayas and forms conspicuous physiography features. The crest line of these hills range from south to north and are marked by Phoming La (3914m), Dong La (3971m) and Kam La (3458m).

The area is dissected by the numerous streams where Kuri Chu forms the main drainage system. It originates from Kula Kangri Glacier in the Tibetan region and flows south-easterly up to Nye and changes its course to south-easterly till it reaches Lhuntse Dzong. Further downstream the Kuri Chu flows in a southerly direction. The main tributaries of the Kuri Chu are Tangkhar Chu, Chuneygang Chu, Kilung Chu, Rong Chu, Nye and Dungkhar Chu.

The climate of the area is like all the Lesser Himalayas which experiences sub-tropical to alpine weather with a severe winter.

2. GEOLOGY OF THE AREA

The rock types in the study area consists mainly of granitoid gneisses belonging to the Thimphu Group. Within the gneissic terrains, several linear bands of metasedimentary rocks occur as enclaves. Based on the field observations the following tectonostratigraphy succession is proposed:

2.1 Naspe Formation

The linear bands of metasedimentary rocks of variable dimensions are found around Kilung, Thimyul and south of Dungkhar. The lithopackage include garnet mica schist, micaceous quartzite (at places hematitic), graphitic mica schist, marble and calc-silicate gneiss. The contact of the Naspe Formation with mica silliminate gneiss of Surey Formation is concealed in most of the places.
The detailed lithological variations are described as follows:

**Feldspathised garnet mica schist**

Around Kilung, Khaotangle and Thimyul, several lenticular bands of graphitic schist occurs within feldspathised mica schist. It is highly fractured and fragmented.

**Marble**

Coarsely crystalline marble of variable dimensions are exposed near Thimyul and south of Dungkhar. The marble is intimately associated with calc-silicate gneiss and calc granulite in which amphibole rich bands are very common.

**Micaceous Quartzite**

Around Thimvul and SE of Kilung micaceous quartzite is hematitic with limonite encrustation and interbanded with graphitic schist and marble. The rock in these areas is ferrugineous. But the same rock found in the south of Dungkhar contains elliptical augen like patches of micaceous material in the highly recrystallised quartzitic matrix. It is found highly fractured and sheared where quarry is presently being operated causing landslides.

2.2. **SUREY FORMATION**

This formation covers most of the area and lies above Jaishidanda Formation. It is represented by mica granitoid gneiss with xenoliths of high grade mica schist and are often traversed by later pegmatite and quartz veins.

**Flaggy Quartzite**

Greyish white, fine grained, thinly bedded, hard and compact. It is noticed from 3+650km to 4+200km. Primary structures such as color bedding and ripple marks are clearly visible on the outcrop. The rock belongs to the Shumar Formation and it appears to have been thrusted into the Sure Formation due to the nearness of the Jaishidanda thrust.

**Intrusives**

Small scale intrusion of tourmaline pegmatite, granite and quartz veins as thin sills and dykes occur in all the litho-package.

**Soil types**

A thin film of top soil brownish colored is underlain by greyish brown SAND with some silt/ clay. Pockets of deep red colored silt/ clay is observed in few places. These soils are mixed with clastics of gneiss, marble, quartzites, schists etc. The size of the clastic ranges from boulders to gravels and are usually angular in shape.

The following table provides the summary of geological findings by chainage-wise.
<table>
<thead>
<tr>
<th>Chainage</th>
<th>Rock/Soil Type</th>
<th>Dynamic/Static movements</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>0+000 - 0+050</td>
<td>Feldspathised garnet, biolite gneiss and schist. Three discontinuities set which are open: chances of toppling and sliding failure</td>
<td>Nearby landslide with dimension 20m width and 40m length. Triggered by seepage of water and active. It is made up of sand.</td>
<td>Take off point</td>
</tr>
<tr>
<td>0+050 - 0+250</td>
<td>Irregular exposure of rocks and predominantly consisting of sand with few small pockets of clay.</td>
<td>Dormant landslides</td>
<td></td>
</tr>
<tr>
<td>0+250 - 0+500</td>
<td>Irregular exposure of rocks and predominantly consisting of sand with few small pockets of clay.</td>
<td>Dormant landslides but at few places small landslide exist</td>
<td></td>
</tr>
<tr>
<td>0+500 - 1+000</td>
<td>20m greyish brown colored top soil followed by light yellowish SAND consisting of plenty of mica. 120m marshy which</td>
<td>Dry land having terraces</td>
<td>Up to 1st hair pin bend.</td>
</tr>
<tr>
<td>1+000 - 1+350</td>
<td>Loose SAND and biolite gneiss which is folded and opened joints</td>
<td>About 100m dry land rest rock and soil (forest land)</td>
<td>1st to 2nd hair pin bend.</td>
</tr>
<tr>
<td>1+350 - 1+800</td>
<td>Feldspathised garnet, biolite gneiss and then cultivated land consisting of SAND. At the stream biolite gneiss with 11 shear plane</td>
<td>Static</td>
<td>Up to Tangkhar Chu</td>
</tr>
<tr>
<td>1+800 - 3+600</td>
<td>150m app. Reddish color clay with clastics of gneiss and schist. Rest medium grained SAND.</td>
<td>Cultivated both dry and wet land. Few small slides</td>
<td></td>
</tr>
<tr>
<td>3+600 - 4+200</td>
<td>Flaggy quartzite, plane failure with SAND pocket.</td>
<td>Forest</td>
<td>Up to Chuneygang Chu - Quarry</td>
</tr>
<tr>
<td>4+200 - 5+050</td>
<td>Mostly medium grained SAND with haphazard by placed massive quartzite and gneiss</td>
<td>Dormant</td>
<td></td>
</tr>
<tr>
<td>5+050 -</td>
<td>Small landslide with dimension of 80m width and</td>
<td>Active</td>
<td></td>
</tr>
<tr>
<td>Position</td>
<td>Description</td>
<td></td>
<td></td>
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<tr>
<td>----------</td>
<td>-------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5+850</td>
<td>100m length – then SAND mixed with quartzite and gneissic clastics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5+850-6+350</td>
<td>Massive quartzite interlayered with gneiss and schist.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6+350-8+180</td>
<td>Massive quartzite interlayered with gneiss and schist. Few active small landslides observed and also sinking area.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8+180-9+830</td>
<td>Micaceous quartzite with thin bands of marble.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9+830-12+900</td>
<td>The area mostly consists of greyish brown colored SAND mixed with gneiss and schist clastics. Marshy land especially between Lekpa and Lingabey. Gneiss interbanded with schist and quartzite just before reaching Yuwa.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12+900-13+500</td>
<td>River terraces which consists of SAND and clastics, with inset—gneiss exposure. Sinking/sliding.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13+500-22+450</td>
<td>Scree boulders stag one over the other without cementing materials at the base and soil intermixed with clastics and dry cultivated land on top. Appears to be unstable. This portion needs more detail study. Priority I.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13+500-15+550</td>
<td>Scree boulders. Priority II Require more detail study</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15+550-16+000</td>
<td>Hard and compact gneiss. Toppling and stable after construction Whole stretch solid rock, priority II cont.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16+000-19+700</td>
<td>Khaotangla area highly fractured quartzite and garnet mica schist with graphitic schist and hematite enter mixed with brown colored silt/clay. Then passes few gneiss outcrops before joining to P I. Steep slope after khaotangla may cause landslide</td>
<td></td>
<td></td>
</tr>
<tr>
<td>19+700-24+200</td>
<td>Marshy with sand and few exposure of gneiss. Rock below Zhamling. Sinking area Require more study. There is break in topography – may be controlled by lineaments.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Section</td>
<td>Description</td>
<td>Notes</td>
<td></td>
</tr>
<tr>
<td>---------</td>
<td>-------------</td>
<td>-------</td>
<td></td>
</tr>
<tr>
<td>24+200-32+500</td>
<td>The road is aligned just above gneiss associated with marble, silicate and mica schist. Above the road usually consists of topsoil and fine to medium grained SAND which are found wet. Marshy at places.</td>
<td>More detail study.</td>
<td></td>
</tr>
<tr>
<td>32+500-35+000</td>
<td>Mostly passes through marble and at few places gneiss. It also goes along cultivated land.</td>
<td>Seems stable. The river area requires study.</td>
<td></td>
</tr>
<tr>
<td>35+000 - 36+000</td>
<td>White micaceous quartzite, which is highly sheared fractured and fragmented.</td>
<td>Active landslide area</td>
<td></td>
</tr>
</tbody>
</table>
Report on feasibility study on proposed Lhuntse - Dungkhar Feeder Road.

Introduction:

Lhuntse Dzongkhag is reflected on 78 M/1 and 78 M/2 of topographical map on 1:50000 scale. Dungkhar (Kurtae) being the historical palace is situated towards the north of Lhuntse Dzong at an altitude of 1800 m above mean sea level and it is yet to be connected by a motorable road. The gentle slope of Dungkhar has been inhabited by more than 118 houses. While the construction of primary school is going on, the students are being taught inside the Nagtsang. The people of Dungkhar are also benefitted by medical facilities with the help of good BHU located just near the Nagtsang. The people of Dungkhar have to walk 2 to 3 days carrying construction materials for development activities from Lhuntse.

By virtue of its landscape location, Dungkhar has the potential for meaningful economic development mainly in agriculture and forestry and when it is connected by motorable road. The road would benefit almost all the villages under Gangzur and Dungkhar gewog. The villages of Nye and Shawa which is a day's walk from Lhuntse could reduce the walking distance to merely three hours from the proposed road. Above all this road would benefit more than 487 houses including the border security force camp situated at Tapkang.

As enumerated by an village elder in Dungkhar the border of China (Tibet) is two days walk from Dungkhar and Nye Khempajong (Bayul) is merely one day walk form dungkhar.
**Map Study.**

The desktop study was carried by Survey & Design Cell of PWD on the available topographical map of 1:50000 scale. Initially two alignments were marked on the map as alignment 1&2 (See annexure -I). The alignment -1 marked in pink comprises of 2 numbers hairpin bends near Thimyul village and reaches Dungkhar via Rotpa and Shamling. The alignment-2 marked in pink & red connects Dungkhar without any zig. Both the alignment were make to take off from the same pont (TP-I) near Lhuntse (refer annexur - I).

With the above desktop study the following team members have proceeded for site to carry out the verification and feasibility study of the above alignments mark in annexure - I with effect from 29.10.98 as per the instruction vide letter No. PWD/S&D/98-99/21/402 dated 13.8.98.

Mr. Pema Wangchen, Offtg. D.E. Lhuntse Dzongkhag.
Mr. Pelden Wangchuck, J.E, Autsho, PWD Lingmethang.
Mr. Tougay Choedup, Offtg. AE, S&D, PWD Thimphu.
Mr. Lhakpa Sherpa, S.O, S&D, PWD Thimphu.
Mr. Tshering Samdrup, SFA, S&D), PWD Thimphu.

**Aim.**

The main aim was to carry out the ground reconnaissance survey of the proposed Lhuntse - Dungkhar Feeder Road as marked on annexure-I and to submit the detail findings. The instruments used during the survey are pedometer, altimeter, compass, camera, topographical maps etc.
It is to apprise that the Division of Power has completed road cutting of about 6.50 Km form Tongkongla TP-I to EP (see annexure 1) near Thimyul Zam. The average width of this road is only 2.5 m. As per the In Charge of road project of Power Division, this road is constructed only to facilitate the installation of mini hydro power plant over Rongchu at Kilung valley.

The take off point.

The take off point and the road constructed by the Division of Power is exactly as per our alignment shown in annexure - I. However this take off point has following disadvantages.

Take off point TP I

- The space available for take off point shall be occupied by new general hospital campuses which is under construction. The Dzongdag of Lhuntse has also instructed the team to not to adopt this take off as the hospital may be disturbed by traffic as and when the road is open (See photo below).

- The road take off point presently being constructed by the Division of Power shall be abandoned as and when their project is completed.
Take off point - II
The team have studied another take off from a zig shown in annexure - I as TP - II. This take off point has also been discarded due to the following reasons.

- This take off point from zig on existing road is situated vertically below new hospital which is under construction and hence the road construction might effect the foundation of the hospital.
- The terrain at this take off point is steep and height of road cutting would reach just below the hospital.

Take off point - III.
The Dasho Dzongdag has kindly made a site visit along with the team members to look for a better and suitable take off point. Finally it was decided for the road to take off from the TP - III as shown in annexure - I (See photo below).

Methodology.
A walk-on survey with help on instruments referred on page 2 has been carried out along the proposed alignments marked on annexure II. The main aim was to determine the following.
approximate road length
Type of terrain
Type of soil
No. of major & minor bridges required
No. of villages benefitted and to above all the survey is aimed to study the most feasible route considering the economic and stability of road beside connecting as many villages as possible.

Ground reconnaissance.
The alignments marked on annexure -I during desktop study has been modified due to the following reasons.

- The power project over Rongchu will be effected by this alignment as it passes right through the power house and intake point as shown in annexure -I as X and Y.
  X = proposed power house
  Y = Water intake point
  X-Y = head distance.
- This alignment does not benefit the villages located at the right bank of Kuri chu.
- This alignment encounters vertical and hard rock before reaching Rotpa village.

The Division of Power had also requested the team to look for other alternative bypassing their project site. It was understood that their project site located at the left bank of Kuri chu shall be connected by rope way from the right bank marked as (RW) on annexure -I.

Due to the above point the team marked a new alignment on the map as shown in annexure -II and named as “Alignment A&B”. This alignment were studied thoroughly on the map and ground as detailed below.
intimated by Gangzur Gup, the alignment “A” would also meet the requirement of the people’s decision submitted to the GYT.

Alignment (A).

This alignment takes off from TP -III as described under topic “Take off point TP III” on page 4. The alignment with maximum of 8% grade is made to connect the power project road near gangzur by introducing two time hairpin bend. These zigs are required in order to safe guard another mini hydro power station at Gangzur which is under renovation at the moment. The alignment then follows the power road which has been terminated at Nongma chorten. As such fresh cutting of 1.85 Km has to be done from the take off point and remaining 4.65 Km of power road has to be improved and upgraded to feeder road standard as their road is having only 2:5 m width.

Due to the obstruction by hydro power project over Rongchu at Thimyul and due to non availability of suitable bridge crossing point, the alignment is made to continue till a place called Yuwa which lies in south- west of Tsholing village. The team earmarked a bridge crossing point at Yuwa and reaches Rotpa village by introducing another two numbers of hairpin bend below Yongmaling village in order to avoid continuous hard rock. The alignment turns from Rotpa and reaches just below Shamling village via Yongmaling village. The alignment is made to descend at the rate of 5% grade from Shamling in order to reach Dungkhar and terminates just below the Nagtsang at Dungkhar as shown in the photo below.
A box cut of around 8 m depth has been proposed just after 250 m from the take off point to safe guard an old chorten (Tabub Choedten). The alignment might effect around 500 m of paddy field in total. The alignment encounters around 20 m of old slide point and 30 m of new slide point before reaching Dungkhar (See photo below).

Summary of alignment “A”

- Take off point: From a bend on approach road to existing hospital near Faaling.
- Terminal point: Dungkhar, below Nagtsang.
- Approx. road length: 37 Km.
- Maximum grade: 8%
- No. of HP bend: 5 Nos.
- No. of bridges: 2 Nos. (45m span over Kurichu an 10m span over Kilung chu)
- No. of houses benefitted: 487 Nos.
- Approx. hard rock: 6.5 Km.
- Approx. hard soil: 18 Km
- Approx. o/soil: 12.50 Km
- Approximate cost of construction = Nu. 119.151 million.
Alignment B (refer topo map attached)

This alignment is same as alignment "A" till the bridge crossing point at Yuwa. After crossing Kurichu at Yuwa this alignment is made to reach Dungkhar directly without benefitting Rotpa, Shawa, Thema, Yongmaling and Shamling. As this alignment follows the river bed, it encounters maximum stretch of very hard rock.

Summary of alignment "B"

<table>
<thead>
<tr>
<th>Description</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Take off point</td>
<td>From a bend on approach road to existing hospital near Faaling.</td>
</tr>
<tr>
<td>Terminal point</td>
<td>Dungkhar, below Nagtsang.</td>
</tr>
<tr>
<td>Approx. road length</td>
<td>33 Km.</td>
</tr>
<tr>
<td>Maximum grade</td>
<td>8%</td>
</tr>
<tr>
<td>No. of HP bend</td>
<td>2 Nos.</td>
</tr>
<tr>
<td>No. of bridges</td>
<td>6 Nos. (45m span over Kurichu, 10m span over Kilung chu and 10m each over other 4 stream)</td>
</tr>
<tr>
<td>No. of houses benefitted</td>
<td>345 Nos.</td>
</tr>
<tr>
<td>Approx. hard rock</td>
<td>10 Km.</td>
</tr>
<tr>
<td>Approx. hard soil</td>
<td>15 Km.</td>
</tr>
<tr>
<td>Approx. o/soil</td>
<td>8 Km</td>
</tr>
<tr>
<td>Approximate cost of construction</td>
<td>Nu. 123.385 million.</td>
</tr>
</tbody>
</table>
Alignment "C"

Although the recce team discarded this alignment due to the reasons highlighted on page 5 of this report, the following are the findings after verification on ground.

Summary of alignment "C"

<table>
<thead>
<tr>
<th>Description</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Take off point</td>
<td>From a bend on approach road to existing hospital near Faaling.</td>
</tr>
<tr>
<td>Terminal point</td>
<td>Dungkhar, below Nagtsang.</td>
</tr>
<tr>
<td>Approx. road length</td>
<td>39 Km.</td>
</tr>
<tr>
<td>Maximum grade</td>
<td>8%</td>
</tr>
<tr>
<td>No. of HP bend</td>
<td>4 Nos.</td>
</tr>
<tr>
<td>No. of bridges</td>
<td>2 Nos. (65m span over Kurichu and 10m span over Rongchu chu)</td>
</tr>
<tr>
<td>No. of houses benefitted</td>
<td>291 Nos.</td>
</tr>
<tr>
<td>Approx. hard rock</td>
<td>13 Km.</td>
</tr>
<tr>
<td>Approx. hard soil</td>
<td>17 Km</td>
</tr>
<tr>
<td>Approx. o/soil</td>
<td>9 Km</td>
</tr>
<tr>
<td>Approximate cost of construction</td>
<td>Nu. 128.166 million.</td>
</tr>
</tbody>
</table>
Comparative Statement.

<table>
<thead>
<tr>
<th>Name of alignment</th>
<th>Approx. Length</th>
<th>No. of zigs</th>
<th>No. of bridges</th>
<th>No. of houses Benefitted</th>
<th>Approx cost. (Nu.-m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>37</td>
<td>5</td>
<td>2</td>
<td>487</td>
<td>119.151</td>
</tr>
<tr>
<td>B</td>
<td>33</td>
<td>2</td>
<td>6</td>
<td>345</td>
<td>123.385</td>
</tr>
<tr>
<td>C</td>
<td>39</td>
<td>4</td>
<td>2</td>
<td>291</td>
<td>128.166</td>
</tr>
</tbody>
</table>

Conclusion / Recommendation

The recce team would like to recommend alignment "A" though it the length is bit longer by 4 Km as it is benefitting more number of villages as compared to alignment "B" where one of the criteria feeder road is being more justified. On the other hand the cost of construction of alignment "A" also lower than that of "B" & "C". All the three alignments stated above seems to be stable.

The Dasho Dzongdag had also strongly supported to adopt alignment “A” as this alignment also fulfills the request of the public submitted to the Gewog Yargye Thsogchung. The Gangzur Gup had also given a written statement that the villages under his jurisdiction will have more benefit by alignment “A” other than Dungkhar gewog.

The team would like to extend our gratitude to Lhuntse Dzongdag and District PWD for their kind hospitality and corporation for the work.

Report prepared & submitted by Tougay Choedup
# Preliminary Cost estimate

**ALIGNMENT "C"**

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Particulars of Items</th>
<th>Quantity</th>
<th>Length</th>
<th>Rate</th>
<th>Amount in Nu.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Earth work in excavation using Bull Dozer, Excluding the cost of major break down and transport at site.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>a) E0388 (loose soil)</td>
<td>53437.5</td>
<td>9</td>
<td>45.2</td>
<td>21738375.00</td>
</tr>
<tr>
<td></td>
<td>b) E0410 (Hard soil)</td>
<td>29625</td>
<td>17</td>
<td>52.33</td>
<td>26354696.25</td>
</tr>
<tr>
<td></td>
<td>c) E0970 (Hard rock)</td>
<td>20625</td>
<td>13</td>
<td>62.86</td>
<td>16854337.50</td>
</tr>
<tr>
<td>2</td>
<td>Base course</td>
<td>39</td>
<td>460000</td>
<td></td>
<td>17940000.00</td>
</tr>
<tr>
<td>3</td>
<td>Permanent Works</td>
<td>39</td>
<td>266000</td>
<td></td>
<td>11154000.00</td>
</tr>
<tr>
<td>4</td>
<td>Cost of bridge</td>
<td>1</td>
<td>65</td>
<td>455000</td>
<td>29575000.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>10</td>
<td>455000</td>
<td>4550000.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>128166408.75</strong></td>
</tr>
</tbody>
</table>

Nu. 128.166 million
PROPOSED LHUNTSE - DUNGHAR FEEDER ROAD.

Tentative Road length

Alignment "A"  37 Km
Alignment "B"  33 Km
Alignment "C"  39 Km
STUDY TEAM

The study team comprised of the following:
1. Karma Jimba, Road Engineer cum Environmental Specialist (Team Leader)
2. Kamal Dan Chamling, Botanist cum wildlife biologist
3. Phuntsho Norbu, Engineering Geologist
4. Sonam Phuntsho, Gup Gangzur Geog
5. Mangiapp Kurteo Geog
6. Lhakpa Sherpa, Survey Team Leader, Lhuntse – Dungkhar Road