2-2-2 Conditions of Related Infrastructures

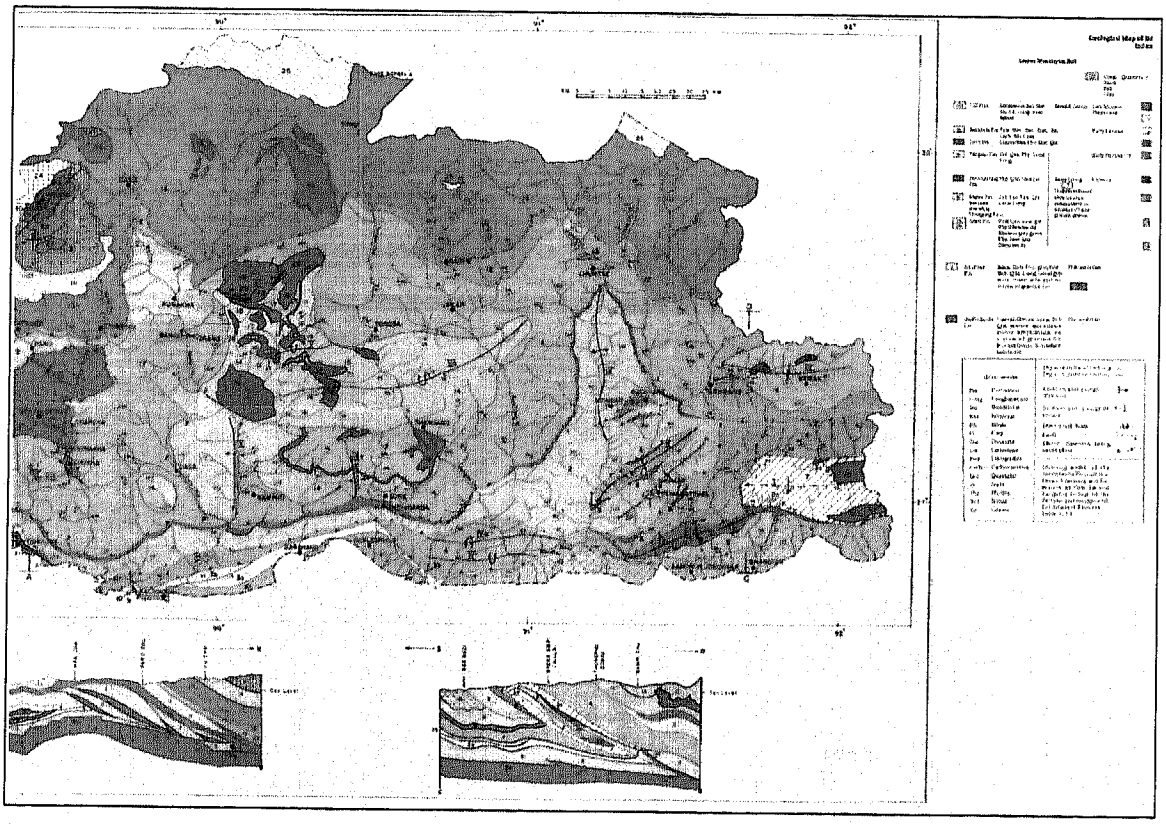
Among the five bridges covered by the Project, Dolkhola Bridge and Jigmiling Bridge are on National Highway No. 5 and located between the city of Gelephu in the southern region and Sarpang. On National Highway No. 5, the road blocks are implemented for the road widening works, as the traffic volume of construction vehicles and such is significantly increasing due to the construction work for Punatshangchu hydropower project. As for Mandechhu (Reotala) Bridge, Kela Bridge and Jangbi Bridge, they are located on the farm road which connects to National Highway No. 4. In the areas adjacent to these three bridges, the construction of farm roads which will be connected to National Highway No. 4 is planned.

2-2-3 Natural Conditions

(1) Topographical and Geological Conditions

The land of Bhutan for the most part has a steep topography. No.9 Mandechhu (Reotala) Bridge, No.19 Kela Bridge and No.20 Jangbi Bridge on the farm road are constructed on very steep land, and the bedrock is exposed at the location of the bridges.

On the other hand, No.17 Dolkhola Bridge and No.18 Jigmiling Bridge on National Highway No. 5 in the southern part of the country are located on a plain, and the riverbanks are covered in a thick layer of deposits consisting of sand, gravel and boulders carried down from upstream. Also, according to the geological classification map of Bhutan, the area around the three bridges on the farm road corresponds to the Chekha Formation, while a sedimentary layer is distributed around the bridges on National Highway No.5.

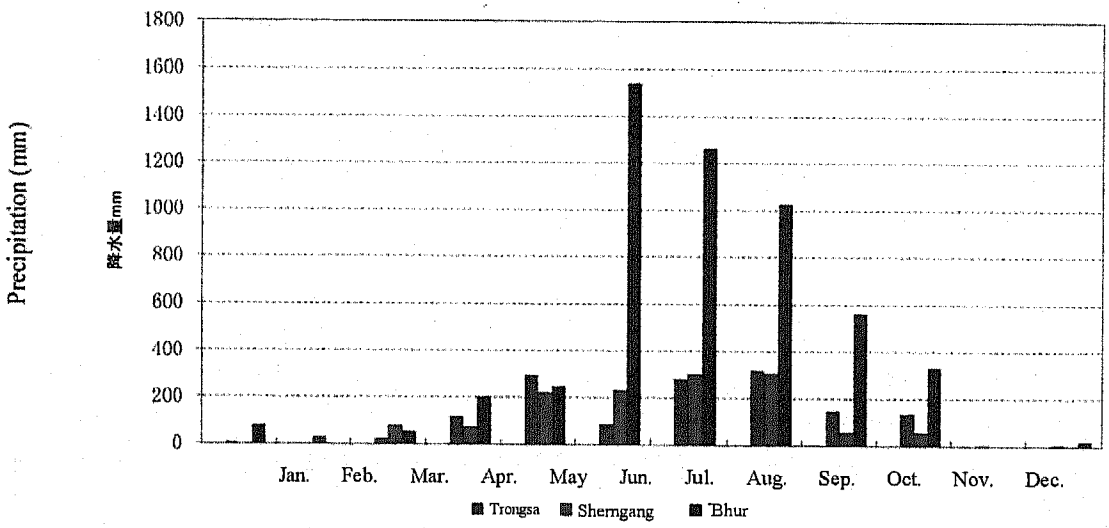


Source : Material provided by DoA

Figure 2-5 Geological Classification Map of Bhutan

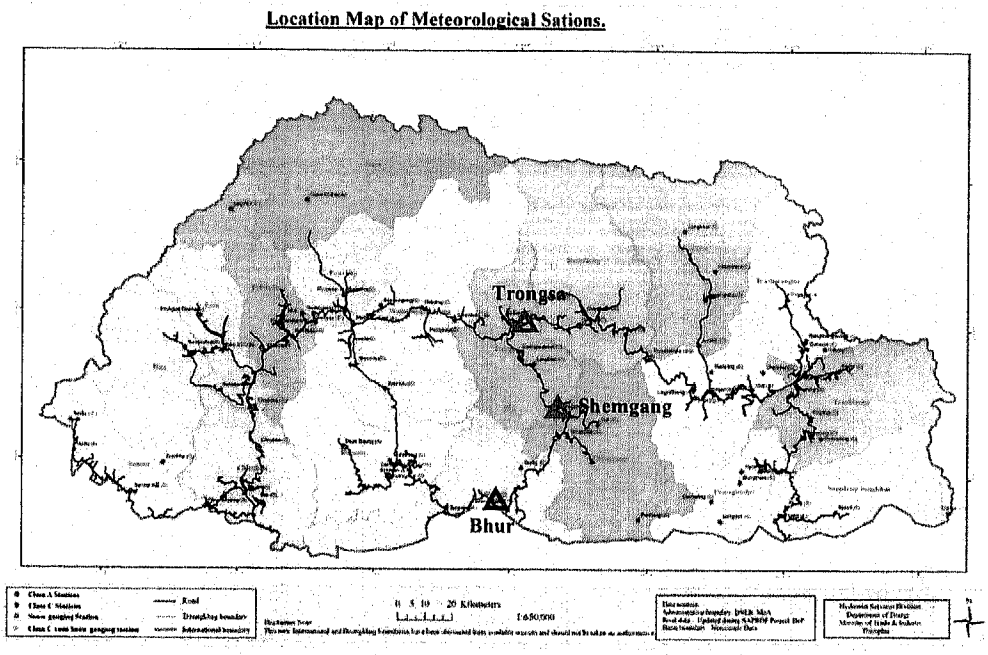
(2) Meteorological Conditions

The climate of Bhutan is divided into three regions; an alpine climate in the northern area where the altitude is 3000m or higher, a subtropical climate in the southern area sharing a border with India, and a temperate climate in the central area between the northern and southern areas. The area in which Dolkhola Bridge and Jigmiling Bridge are located is in the subtropical zone, and the area in which Mandechhu (Reotala) Bridge, Kela Bridge and Jangbi Bridge are located is in the temperate zone. The maximum precipitation in the temperate zone is no more than 400mm/month, while in the subtropical zone, rainfall in excess of 1000mm/month falls for three months or more during the rainy season.



Source : Prepared on the basis of material provided by DoA

Figure 2-6 Monthly Precipitation in East Area (2009)



Source : Material provided by DoA

Figure 2-7 Map showing Locations of Meteorological Stations

(3) River Hydrology

(3)-1 Outline of the River Basins

1) Mandechhu River Basin

The Mandechhu River which is spanned by Mandechhu (Reotala) Bridge, Kela Bridge and Jangbi Bridge has a total length of about 164km. It runs from its source in the Himalaya Mountains southward through the central part of Bhutan, joins the Bumthang River and flows down into India. The catchment basin has an area of 4272km^2 and in the upper reaches there are a number of glacial lakes.

2) Bhur River Basin

The Bhur River which is spanned by Jigmiling Bridge has a total length of 10km. It runs from its source at the foot of mountains at an altitude of about 1000m along the eastern side of an alluvial fan at an altitude of 400m down into India. The catchment basin has an area of about 80km^2. Boulders measuring about 1m in size that have been carried down from upstream are scattered around the location of the bridge. Boulders, gravel and sandy soil are visible in the riverbank deposits.

3) Dolkhola River Basin

The Dolkhola River which is spanned by Dolkhola Bridge has a total length of 6km. It runs from its source in the mountains at an altitude of 800-900m along the western side of an alluvial fan at an altitude of 400m down into India. The catchment basin has an area of about 23 km^2. Boulders measuring about 1-2m in size that have been carried down from upstream are scattered around the location of the bridge. Boulders, gravel and sandy soil are visible in the riverbank deposits. The mountain slope on the right bank upstream of the bridge has partially collapsed, and soil and gravel have flowed into the river.

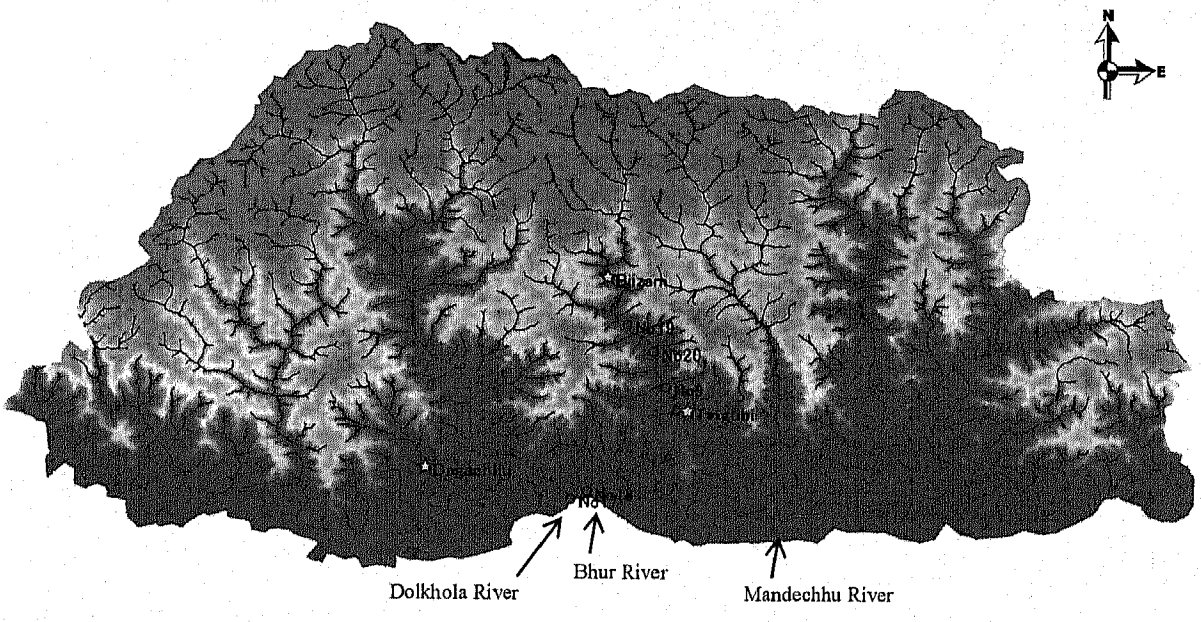


Figure 2-8 Map Showing Location of Rivers

(3)-2 Flow Rate Observation Station

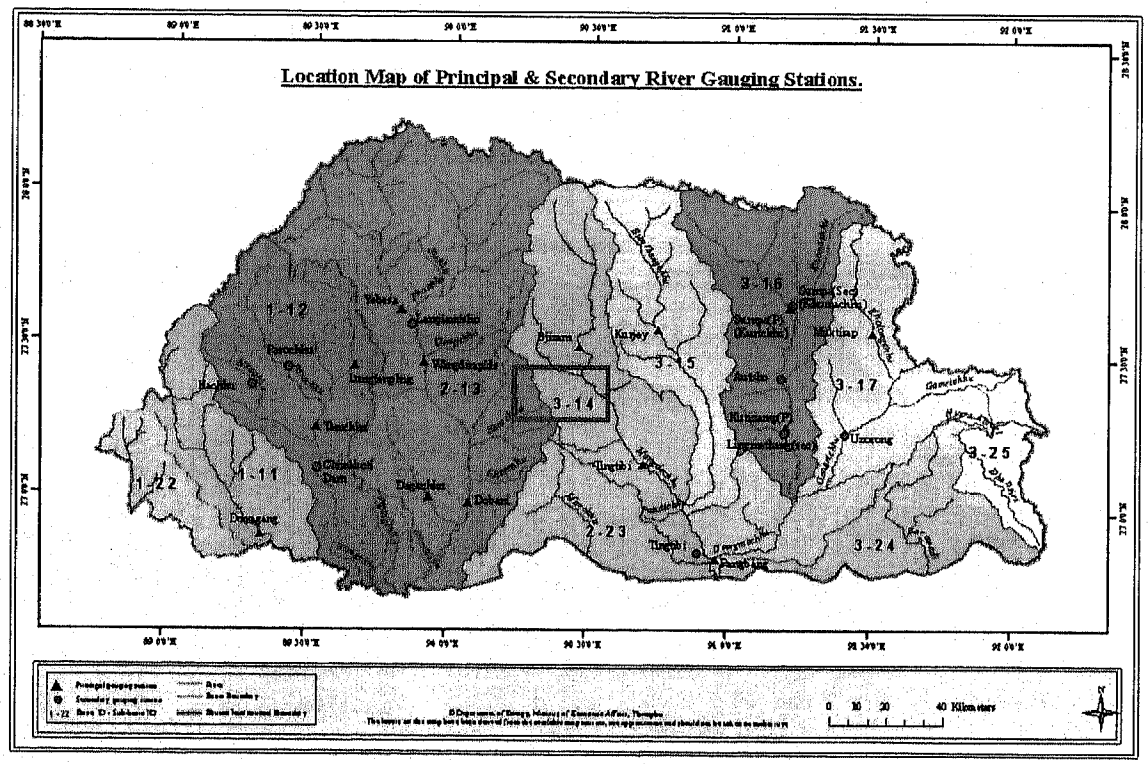
A map showing the location of river flow rate observation stations in Bhutan is shown in "Table 2-3 Flow Rate Observation Stations used in the Study". Mandechhu River, which is spanned by Mandechhu (Reotala) Bridge, Kela Bridge and Jangbi Bridge, has two observation stations. The data from the Bjizam flow rate observation station, which is relatively near to the three bridges, was used in consideration of the design flow rate at each location.

On the other hand, the Bhur River which is spanned by Jigmiling Bridge and Dolkhola River which is spanned by Dolkhola Bridge do not have flow rate observation stations; and the design high water level was set as equivalent to the flood mark level.

Table 2-3 Flow Rate Observation Stations used in the Study

No.	Bridge name	River name	Adopted flow rate observation station
No.19	Kela	Mandechhu	Bjizam
No.20	Jangbi	Mandechhu	Bjizam
No.9	Mandechhu	Mandechhu	Bjizam
No.18	Jigmiling	Bhur	-
No.17	Dolkhola	Dolkhola	-

Source : Material provided by DoA



Source : Material provided by DoA

Figure 2-9 Map Showing Location of Flow Rate Observation Stations

(3)-3 Design Flow Rate

The design flow rate at the location of each bridge over Mandechhu River was set by determining the maximum flow rate at each location by converting the yearly maximum flow rate at Bjizam observation station into a specific flow rate, and applying stochastic processing using the Gumbel method. The design flow rate at the location of each bridge is shown in "Table 2-4 Design Flow Rate at Location of Each Bridge".

Table 2-4 Design Flow Rate at Location of Each Bridge

No.	Bridge name	River name	Specific flow rate (m^3/s)	50-year probability flow rate (m^3/s)
No.19	Kela	Mandechhu	0.34	709
No.20	Jangbi	Mandechhu	1.93	860
No.9	Mandechhu	Mandechhu	2.08	1029

(3)-4 Calculated Water Level

Based on the above-mentioned design flow rate at each location, the design high water level of each river was calculated using the steady flow calculation.

1) Calculation Conditions

"Table 2-5 Steady Flow Calculation Conditions" shows the calculation conditions. The roughness coefficient at each location is determined based on page 89 of the Hydrological Formula Handbook (2009 version).

Table 2-5 Steady Flow Calculation Conditions

No.	Bridge name	River name	Riverbed slope (survey result)	Roughness coefficient	Design flow rate (m^3/s)
No.19	Kela	Mandechhu	1/90	0.05	709
No.20	Jangbi	Mandechhu	1/80	0.05	860
No.9	Mandechhu	Mandechhu	1/50	0.05	1029
No.18	Jigmiling	Bhur	1/40	—	—
No.17	Dolkhola	Dolkhola	1/50	—	—

(3)-5 Results of the Flood Mark Level Survey

A field survey was carried out in collaboration with the DoR and DoA to measure and record the flood mark level. (See the following "Flood Mark Level Measured at Each Bridge)

Table 2-6 Flood Mark Level Measured at Each Bridge

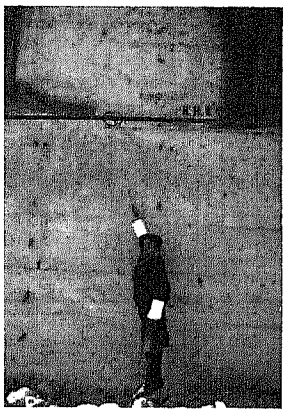


Photo - No.17 Dolkhola Bridge

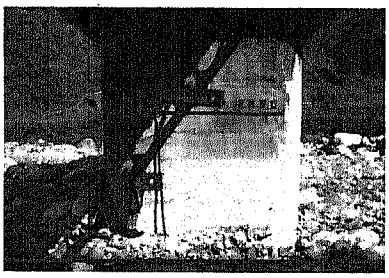


Photo - No.18 Jigmiling Bridge

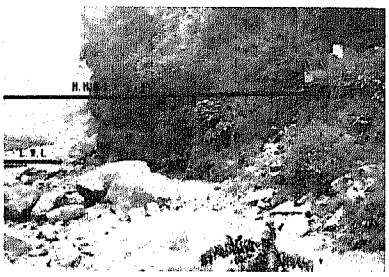


Photo - No.9 Mandechhu (Reotala) Bridge

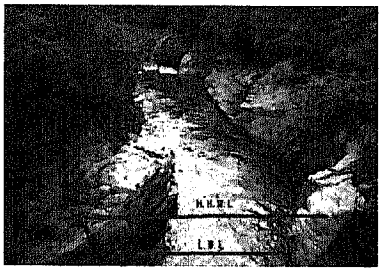


Photo - No.20 Jangbi Bridge

Photo - No.19 Kela Bridge

(3)-6 Setting the Design High Water Level

The results of the steady flow calculation and the flood mark level were compared and the water level at the risk side was set to be equivalent to the design high water level at each bridge location. It should be noted that there is a glacier lake in the upper reaches of the Mandechhu River and this being the case the possibility of a GLOF (Glacier Lake Outburst Flood) occurring in the future cannot be denied. However, since it is practically impossible for rainfall and the outburst of the glacier lake to occur and cause flooding at the same time, the possibility was not taken into account in this survey.

Table 2-7 Design High Water Level at Each Bridge Location

No.	Bridge name	River name	Water level determined from steady flow calculation (m)	Flood mark level (m)	Design high water level (m)
No.19	Kela	Mandechhu	1137.0	1137.2	1137.2
No.20	Jangbi	Mandechhu	896.9	897.3	897.3
No.9	Mandechhu	Mandechhu	635.4	643.9	643.9
No.18	Jigmiling	Bhur	—	372.7	372.7
No.17	Dolkhola	Dolkhola	—	353.9	353.9

(4) Study of Natural Features

A topographical/river survey and geological survey were conducted as described below, and the results were incorporated into the design.

(4)-1 Survey

A topographical survey of the design section was carried out by outsourcing the work to a local contractor. The survey consisted of setting the benchmark and the vertical central line, a cross-sectional survey and a river survey. The CAD data of the planimetric map and the vertical and cross-sectional profiles of the area surrounding the existing bridges were created as outputs of these surveys.

(4)-2 Geological Survey (Borehole Survey and Laboratory Test)

For the purpose of verifying the load-bearing layer, a borehole survey was carried out at the following 12 points by outsourcing the work to a local contractor. Also, sampling and laboratory tests were conducted to confirm the strength of the base material at the site. A brief description of the geological conditions at the planned location of each bridge is shown by "Table 2-8 Number of Boreholes".

Table 2-8 Number of Boreholes

Bridge name	Number of boreholes	Borehole location
Kela Bridge	2	Bridge abutment of the right and left banks
Jangbi Bridge	2	Bridge abutment of the right and left banks
Mandechhu (Reotala) Bridge	2	Bridge abutment of the right and left banks
Jigmiling Bridge	3	Bridge abutment and bridge pier of the right and left banks
Dolkhola Bridge	3	Bridge abutment and bridge pier of the right and left banks

i. Kela Bridge

The embankment layer on the left bank side of the bridge is of low relative density sand-gravel mixture deposits about 1-2 m in thickness, below which there is bedrock of quartz schist. The embankment layer on the right bank is also of low relative density sandy soil deposits about 3m in thickness, below which there is bedrock of quartz schist and gneiss. Both the right and left banks are sufficiently capable of carrying a vertical load.

ii. Jangbi Bridge

The embankment layer on the left bank is of low relative density sand-gravel mixture deposits about 1 m in thickness, below which there is a deposit of a tightly-bound layer of sand-gravel mixture with an N value of 50 or greater, of 5m in thickness. It has been confirmed that there is bedrock below these layers. A layer of sand-gravel mixture of about 1m in thickness is observed on the right bank. It has been confirmed that there is bedrock of gneiss below this layer. Both the right and left banks are sufficiently capable of carrying a vertical load.

iii. Mandechhu (Reotala) Bridge

The embankment layer on the left bank side of the bridge is of low relative density sand-gravel and silt mixture deposits about 2m in thickness, below which there is bedrock of quartz schist with an N value of 50 or greater. The bedrock outcrop of quartz schist is observed on the right bank. The N value is 50 or greater for both of them. Both the right and left banks are sufficiently capable of carrying a vertical load.

iv. Jigmiling Bridge

A low-density layer of sand-gravel mixture deposits extends from the ground surface to the end of the borehole on the left bank. The N value is 50 or greater at all depths. The right bank and the planned location of the bridge pier has a sand-gravel mixture layer with an N value of 50 or greater extending 6-7m from the ground surface. It has been confirmed that there is bedrock below this layer. A sufficient vertical load carrying capacity can be expected of both the right and left banks.

v. Dolkhola Bridge

The left bank has a low-density layer of sand-gravel mixture about 1m in thickness extending from the ground surface. Alternate layers of cobble and a sand-gravel mixture are observed below this layer. The surface of engineering bedrock with an N value of 50 or greater exists about 4m below the ground surface. The right bank also has a low-density layer of sand-gravel mixture about 1m in thickness extending from the ground surface. Alternate layers of cobble and a sand-gravel mixture are observed below this layer. The N value is 50 or greater at a depth of 1m or deeper. A low-density layer of sand-gravel mixture about 1m in thickness extends from the ground surface at the planned location of the bridge pier. Alternate layers of cobble and a sand-gravel mixture are observed below this layer. Boreholes cannot be made any deeper due to the rebound from the cobble layer. A sufficient vertical load carrying capacity can be expected of the area around this bridge.

2-2-4 Environmental and Social Considerations

2-2-4-1 Organization and Legislation System for the Environment

(1) Organization

Bhutan is undergoing reform of its central administration system and extending local autonomy significantly so as to transfer administrative authority to local governments and to the relevant ministries and agencies, aiming thereby to establish a simpler, more effective and more efficient administrative organization.

1) The National Environmental Commission (NEC)

The National Environmental Commission was established in 1998 as an independent organization to deal with domestic issues relating to the environment. Given the authority to request assistance from all government agencies and related organizations, it is the supreme national body concerning the environment and has the legal authority to exercise management and enforcement over, and provide assistance to, all public and private activities relevant to the utilization of natural resources, and also carries out environmental impact assessment in development projects to ensure the sustainable development of the country. The functions and roles of the Commission consist of coordination with other agencies with respect to the environment, and the drafting and implementation of environmental legislation and policies.

With respect to the decentralization of environmental administration, reform is under way for the future transfer to local governments and central government bodies of the authority to issue all permits and approvals, which will allow the NEC to concentrate on the drafting of national environmental policies and plans and the implementation of environmental impact assessment of national projects that are considered to be important. Therefore, the authority for environmental approval in the project fields described in the environmental impact assessment manual has been transferred to the ministries and agencies managing each project, and the department and bureau in charge are to be responsible for implementing environmental impact assessment.

2) Environmental Unit within Each Ministry and Agency

An environmental unit has been set up within each ministry or agency responsible for projects affecting the environment. These units carry out the environmental impact assessment necessary for the planning of each project.

The Ministry of Works and Human Settlement (MoWHS) contains an environmental unit to handle operations relating to environmental impact assessment. In the case of the Ministry of Agriculture, the Dzongkhag Agricultural Office (DAO) within the Dzongkhag (district) government is responsible for such operations.

(2) Legislative System

1) Legislative System Concerning the Natural Environment

The environmental policies and outlook of Bhutan are based on the national environmental strategy entitled "The Middle Path – National Environment Strategy for Bhutan" developed by the National Planning Commission in 1998. This strategy states that the country aims to balance economic development with

environmental protection for the purpose of achieving sustainable development, and prescribes the need to consider the environment in industrial development, to prevent cultural loss resulting from economic development, and to develop legislation for environmental protection. On the basis of this strategy, a series of acts on environmental and social considerations have been enacted, including legislation for the introduction of the environmental impact assessment (EIA) system.

The Bhutan's basic environmental legislation is the Forest and Nature Conservation Act of Bhutan, 1995. This law was enacted in order to ensure for the future the conservation of forests, flora, fauna and related resources as well as sustainable forest development, and it prescribes the establishment of a system for the protection of biodiversity and the conservation of soil, water and other natural resources.

Another law enacted in Bhutan in support of the EIA system is the Environmental Assessment Act, 2000. This law prescribes the implementation of the EIA and its processes. Based on this law, the Regulations for the Environmental Clearance of Projects 2001-02 were established as an EIA guideline. In addition, the Environmental Code of Practice has been set up as a reference for the relevant ministries and agencies in the implementation of projects.

2) EIA Guideline

The legal basis for environmental impact assessment is provided by the Environmental Assessment Act enacted in 2000, and the Regulations for Environmental Clearance of Projects and the Regulations on Strategic Environmental Assessment that were established in 2002.

As described above, with respect to the implementation of the projects mentioned in the EIA manual, authority has been delegated from the NEC to the relevant ministries and agencies responsible for the projects, so that environmental approval can be issued at the discretion of the EIA units set up within these ministries and agencies. For example, in the case of small-scale road repair and bridge construction, the environmental unit within the Ministry of Works and Human Settlement, which is responsible for such projects, has the authority to carry out the EIA and issue environmental approval.

3) Environmental Discharge Standards

The Environmental Discharge Standards were studied along with a review of the Regulations for the Environmental Clearance of Projects in 2003 and they were made public in August 2004. These Standards consists of environmental discharge standards concerning water quality, air quality and noise.

In the implementation of the bridge reconstruction project, noise is likely to make an impact on the environment during the construction period. "Table 2-9 Noise Standards" shows the environmental discharge standards for noise.

Table 2-9 Noise Standards

Land Use Category	Max (Leg)		
	Day (6AM – 9PM)	Night (9PM – 6AM)	Unit
Industrial	75	70	dB (decibel)
Commercial	65	55	dB
Rural / Residential	55	45	dB

Source: Environmental Discharge Standards, August 2004, NEC

2-2-4-2 Organization and Legislative System for the Social Environment

(1) Organization

The procedures for the relocation of residents are the responsibility of the National Land Commission.

In the bridge reconstruction project, even where the bridges are to be relocated, in most cases the new locations are still within the land allotted for the road. Therefore, land expropriation procedures will not be necessary unless there is extensive rerouting.

With regard to the expropriation of private land, a committee assesses the land and immovable properties and compensation is awarded in line with the recommendations of the committee. Since the budget for land expropriation is appropriated after submission of the project plan, in most cases, the land will be secured in the fiscal year following. With regard to national land, as it was considered the property of the king in the past, its expropriation meant the granting of the land by the king. However, after the shift of power to civilian rule, at present the government is supposed to manage national land as national property, by means of examination by the expropriation committee.

(2) Legislative System and Procedures

1) Legislative System

The Land Act, the Land Role and the Land Registration Act form the relevant legislation to have been enacted.

2) Procedures

The procedures for land expropriation and resident relocation are as follows:

i) Acquisition of Private Land

When private land is to be expropriated in public projects, for each project a land expropriation committee is organized in the dzongkhag in which the project is implemented. This committee makes the decisions on the conditions of expropriation, the amount of compensation and the securing of substitute land. The committee decision is final and not subject to appeal. The committee examines the land registered at the National Land Commission. Unregistered land is basically regarded as national land and is not subject to compensation. In the case of unregistered land, forced displacement and expropriation are carried out following three months' prior notice.

ii) Acquisition of National Land

In principle, national land is managed centrally by the Department of Forests in the Ministry of Agriculture. When the acquisition of national land is needed, an application should be submitted to the Department to enable the land to be utilized for public projects and to change the management.

iii) Relocation of Residents

In principle, as is the case with the acquisition of private land, a committee is organized in the dzongkhag to deliberate the details of the relocation, and decisions including compensation for relocation are made according to the results of deliberation.

2-2-4-3 Policies Relating to Consideration of the Environment and Society

(1) Survey of Site Conditions

A survey was conducted in collaboration with the staff of the DoR and DoA to ascertain the environmental and social impacts that may affect the area surrounding the locations of the new bridges to be constructed. The results are as follows:

(Social Environment)

- There are no residents within the area that will be affected by the construction work for any of the bridges. Therefore, there will be no relocation of residents.
- The land surrounding the construction sites is national land. Therefore, there will be no need for land acquisition.

(Natural Environment)

- Although the construction work for each of the bridges may have an impact on the river, it may be possible to alleviate the impact through the adoption of appropriate construction methods.
- There are no rare fauna or flora in the area that will be affected by the construction work.
- The field survey revealed that Mandechhu (Reotala) Bridge, Kela Bridge and Jangbi Bridge are located alongside the river borders in the Jigme Singye Wangchuch National Park. National Environment Commission (NEC) is at the highest level of environmental administration in Bhutan and focuses on the development of the national environmental policy and plan as well as the implementation of environmental impact assessment for national project that are considered important. The authority to issue environmental approval for the project fields in the environmental impact assessment manual, including the construction of roads and bridges, has been transferred to the ministries and agencies supervising each project. However, after confirming the impact of the construction with DoA, the bridges are not considered to be located in the park, as well as not imposing major influence on the environment of the national park. Thus, no restriction will be imposed on bridge construction to make an application for an environmental clearance.

(2) Initial Environmental Examination (IEE)

1) Scoping

The results of the scoping which are based on the field survey are shown on the next page. From these results, it was determined that none of the bridges will have a significant impact on the natural or social environment, although some impact may be observed.

The agreement of the DoR and DoA was obtained with regard to the results of the field survey, assessment method and scoping, after these had been explained.

The DoR and DoA prepared the environmental checklist needed to make an application for an environmental clearance, on the basis of the consultant's report of the field survey and the scoping results. Then, an application was made to the bureau in charge of environmental examination. The clearance was issued when the field survey was conducted in April 2011.

Table 2-10 Scoping Results for Mandechhu (Reotala) Bridge

Environmental parameter			Assessment	Rationale
Social environment	1	Compulsory relocation of residents		There will be no relocation of residents because there is no residence or private land at the site of the bridge reconstruction.
	2	Regional economy, including employment, means of livelihood,		The bridge reconstruction will not have an adverse impact on the regional economy
	3	Use of land and regional resources		The bridge reconstruction will not have an adverse impact on the use of land and regional resources.
	4	Social capital and social organization, such as the community decision-making body		The bridge reconstruction will not have an adverse impact on social capital or social organization.
	5	Existing social infrastructure and services		The bridge reconstruction will not have an adverse impact on social infrastructure or services.
	6	The poor, indigenous people and minorities		There will be no adverse impact because there are no residents at the site of the bridge reconstruction.
	7	Damages and uneven distribution of benefits		This project will not give rise to damages or uneven distribution of benefits because it is a reconstruction project of an existing bridge.
	8	Cultural heritage		There is no cultural heritage around the site of the bridge reconstruction.
	9	Conflict of interest within the community		This project will not cause any conflict of interest because it is a reconstruction project of an existing bridge.
	10	Water use, water rights/common rights		There will be no impairment of water use or water rights around the site of the bridge reconstruction.
	11	Public health		The bridge reconstruction will not have an adverse impact on public health.
	12	Disasters, HIV/AIDS and other infectious diseases		The bridge reconstruction is unlikely to cause any disaster or outbreak of infectious diseases.
Natural environment	13	Geological and geographical features	B	Substructure work at the construction stage may cause topographic deformation.
	14	Soil erosion	B	Rainfall during the rainy season may cause an outflow of surface soil during substructure work at the construction stage.
	15	Groundwater		The bridge reconstruction will not have an adverse impact on the groundwater.
	16	Hydrological conditions		The bridge reconstruction will not have an adverse impact on the river flow.
	17	Coastal area (mangrove forest, coral reef and tidal flats)		Not applicable.
	18	Flora, fauna and ecosystem		The bridge reconstruction will not have an adverse impact on the flora, fauna or ecosystem.
	19	Climate		The bridge reconstruction will not have an adverse impact on the local climate.
	20	Landscape		The bridge reconstruction will not have an adverse impact on the landscape.
	21	Global warming		The bridge reconstruction will not have an adverse impact on global warming.
Environmental pollution	22	Air pollution (dust emission)	B	The bridge reconstruction may cause some dust emission.
	23	Water pollution	B	Pollution of the river water may occur due to the inflow of earth and sand during the substructure work at the construction stage.
	24	Soil contamination		The bridge reconstruction has no relevance to causes of soil contamination.
	25	Solid wastes	B	Surplus soil and waste construction materials may be generated when the existing bridge is demolished.
	26	Noise/ vibration	B	Noise and vibration may be generated by the construction work at the construction stage.
	27	Ground subsidence		The bridge reconstruction has no relevance to causes of ground subsidence.
	28	Offensive odor		The bridge reconstruction has no relevance to causes of offensive odor.
	29	Sediment		The bridge reconstruction will not change the river sediments.
	30	Accidents	B	Flooding and other disasters may occur as a result of rainfall during the rainy season at the construction stage.

Assessment types: A: Likely to have a critical impact
B: Likely to have a moderate impact
C: Unknown
No mark: No impact

Table 2-11 Scoping Results for Dolkhola Bridge

Environmental parameter			Assessmen	Rationale
Social environment	1	Compulsory relocation of residents		There will be no relocation of residents because there is no residence or private land at the site of the bridge reconstruction.
	2	Regional economy, including employment, means of livelihood,	B	Temporary traffic regulation due to the construction work may slightly affect economic activities at the construction stage.
	3	Use of land and regional resources		The bridge reconstruction will not have an adverse impact on the use of land and regional
	4	Social capital and social organization, such as the community decision-making body		The bridge reconstruction will not have an adverse impact on social capital or social organization.
	5	Existing social infrastructure and services	B	Temporary traffic regulation due to the construction work may slightly affect local traffic at the construction stage.
	6	The poor, indigenous people and minorities		There will be no adverse impact because there are no residents at the site of the bridge reconstruction.
	7	Damages and uneven distribution of benefits		This project will not give rise to damages or uneven distribution of benefits because it is a reconstruction project of an existing bridge.
	8	Cultural heritage		There is no cultural heritage around the site of the bridge reconstruction.
	9	Conflict of interest within the community		This project will not cause any conflict of interest because it is a reconstruction project of an existing bridge.
	10	Water use, water rights/common		There will be no impairment of water use or water rights around the site of the bridge
	11	Public health		The bridge reconstruction will not have an adverse impact on public health.
	12	Disasters, HIV/AIDS and other infectious diseases		The bridge reconstruction is unlikely to cause any disaster or outbreak of infectious diseases.
Natural environment	13	Geological and geographical features	B	Substructure work at the construction stage may cause topographic deformation.
	14	Soil erosion	B	Rainfall during the rainy season may cause an outflow of surface soil during substructure work at the construction stage.
	15	Groundwater		The bridge reconstruction will not have an adverse impact on the groundwater.
	16	Hydrological conditions		The bridge reconstruction will not have an adverse impact on the river flow.
	17	Coastal area (mangrove forest, coral reef and tidal flats)		Not applicable.
	18	Flora, fauna and ecosystem		The bridge reconstruction will not have an adverse impact on the flora, fauna or ecosystem.
	19	Climate		The bridge reconstruction will not have an adverse impact on the local climate.
	20	Landscape		The bridge reconstruction will not have an adverse impact on the landscape.
	21	Global warming		The bridge reconstruction will not have an adverse impact on global warming.
Environmental pollution	22	Air pollution (dust emission)	B	The bridge reconstruction may cause some dust emission.
	23	Water pollution	B	Pollution of the river water may occur due to the inflow of earth and sand during the substructure work at the construction stage.
	24	Soil contamination		The bridge reconstruction has no relevance to causes of soil contamination.
	25	Solid wastes	B	Surplus soil and waste construction materials may be generated when the existing bridge is demolished
	26	Noise/ vibration	B	Noise and vibration may be generated by the construction work at the construction stage.
	27	Ground subsidence		The bridge reconstruction has no relevance to causes of ground subsidence.
	28	Offensive odor		The bridge reconstruction has no relevance to causes of offensive odor.
	29	Sediment		The bridge reconstruction will not change the river sediments
	30	Accidents	B	Flooding and other disasters may occur as a result of rainfall during the rainy season at the construction stage

Assessment types: A: Likely to have a critical impact
B: Likely to have a moderate impact
C: Unknown
No mark: No impact

Table 2-12 Scoping Results for Jigmiling Bridge

Environmental parameter			Assessmen	Rationale
Social environment	1	Compulsory relocation of residents		There will be no relocation of residents because there is no residence or private land at the site of the bridge reconstruction.
	2	Regional economy, including employment, means of livelihood,	B	Temporary traffic regulation due to the construction work may slightly affect economic activities at the construction stage.
	3	Use of land and regional resources		The bridge reconstruction will not have an adverse impact on the use of land and regional
	4	Social capital and social organization, such as the community decision-making body		The bridge reconstruction will not have an adverse impact on social capital or social organization.
	5	Existing social infrastructure and services	B	Temporary traffic regulation due to the construction work may slightly affect local traffic at the construction stage.
	6	The poor, indigenous people and minorities		There will be no adverse impact because there are no residents at the site of the bridge reconstruction.
	7	Damages and uneven distribution of benefits		This project will not give rise to damages or uneven distribution of benefits because it is a reconstruction project of an existing bridge.
	8	Cultural heritage		There is no cultural heritage around the site of the bridge reconstruction.
	9	Conflict of interest within the community		This project will not cause any conflict of interest because it is a reconstruction project of an existing bridge.
	10	Water use, water rights/common		There will be no impairment of water use or water rights around the site of the bridge
	11	Public health		The bridge reconstruction will not have an adverse impact on public health.
	12	Disasters, HIV/AIDS and other infectious diseases		The bridge reconstruction is unlikely to cause any disaster or outbreak of infectious diseases.
Natural environment	13	Geological and geographical features	B	Substructure work at the construction stage may cause topographic deformation.
	14	Soil erosion	B	Rainfall during the rainy season may cause an outflow of surface soil during substructure work at the construction stage.
	15	Groundwater		The bridge reconstruction will not have an adverse impact on the groundwater.
	16	Hydrological conditions		The bridge reconstruction will not have an adverse impact on the river flow.
	17	Coastal area (mangrove forest, coral reef and tidal flats)		Not applicable.
	18	Flora, fauna and ecosystem		The bridge reconstruction will not have an adverse impact on the flora, fauna or ecosystem.
	19	Climate		The bridge reconstruction will not have an adverse impact on the local climate.
	20	Landscape		The bridge reconstruction will not have an adverse impact on the landscape.
	21	Global warming		The bridge reconstruction will not have an adverse impact on global warming.
Environmental pollution	22	Air pollution (dust emission)	B	The bridge reconstruction may cause some dust emission.
	23	Water pollution	B	Pollution of the river water may occur due to the inflow of earth and sand during the substructure work at the construction stage.
	24	Soil contamination		The bridge reconstruction has no relevance to causes of soil contamination.
	25	Solid wastes	B	Surplus soil and waste construction materials may be generated when the existing bridge is demolished.
	26	Noise/ vibration	B	Noise and vibration may be generated by the construction work at the construction stage.
	27	Ground subsidence		The bridge reconstruction has no relevance to causes of ground subsidence.
	28	Offensive odor		The bridge reconstruction has no relevance to causes of offensive odor.
	29	Sediment		The bridge reconstruction will not change the river sediments.
	30	Accidents	B	Flooding and other disasters may occur as a result of rainfall during the rainy season at the construction stage.

Assessment types: A: Likely to have a critical impact
B: Likely to have a moderate impact
C: Unknown
No mark: No impact

Table 2-13 Scoping Results for Kela Bridge

Environmental parameter			Assessment	Rationale
Social environment	1	Compulsory relocation of residents		There will be no relocation of residents because there is no residence or private land at the site of the bridge reconstruction.
	2	Regional economy, including employment, means of livelihood,		The bridge reconstruction will not have an adverse impact on the regional economy.
	3	Use of land and regional resources		The bridge reconstruction will not have an adverse impact on the use of land and regional resources.
	4	Social capital and social organization, such as the community decision-making body		The bridge reconstruction will not have an adverse impact on social capital or social organization.
	5	Existing social infrastructure and services		The bridge reconstruction will not have an adverse impact on social infrastructure or services.
	6	The poor, indigenous people and minorities		There will be no adverse impact because there are no residents at the site of the bridge reconstruction.
	7	Damages and uneven distribution of benefits		This project will not give rise to damages or uneven distribution of benefits because it is a reconstruction project of an existing bridge.
	8	Cultural heritage		There is no cultural heritage around the site of the bridge reconstruction.
	9	Conflict of interest within the community		This project will not cause any conflict of interest because it is a reconstruction project of an existing bridge.
	10	Water use, water rights/common rights		There will be no impairment of water use or water rights around the site of the bridge reconstruction.
	11	Public health		The bridge reconstruction will not have an adverse impact on public health.
	12	Disasters, HIV/AIDS and other infectious diseases		The bridge reconstruction is unlikely to cause any disaster or outbreak of infectious diseases.
Natural environment	13	Geological and geographical features	B	Substructure work at the construction stage may cause topographic deformation.
	14	Soil erosion	B	Rainfall during the rainy season may cause an outflow of surface soil during substructure work at the construction stage.
	15	Groundwater		The bridge reconstruction will not have an adverse impact on the groundwater.
	16	Hydrological conditions		The bridge reconstruction will not have an adverse impact on the river flow.
	17	Coastal area (mangrove forest, coral reef and tidal flats)		Not applicable.
	18	Flora, fauna and ecosystem		The bridge reconstruction will not have an adverse impact on the flora, fauna or ecosystem.
	19	Climate		The bridge reconstruction will not have an adverse impact on the local climate.
	20	Landscape		The bridge reconstruction will not have an adverse impact on the landscape.
	21	Global warming		The bridge reconstruction will not have an adverse impact on global warming.
Environmental pollution	22	Air pollution (dust emission)	B	The bridge reconstruction may cause some dust emission.
	23	Water pollution	B	Pollution of the river water may occur due to the inflow of earth and sand during the substructure work at the construction stage.
	24	Soil contamination		The bridge reconstruction has no relevance to causes of soil contamination.
	25	Solid wastes	B	Surplus soil and waste construction materials may be generated when the existing bridge is demolished.
	26	Noise/ vibration	B	Noise and vibration may be generated by the construction work at the construction stage.
	27	Ground subsidence		The bridge reconstruction has no relevance to causes of ground subsidence.
	28	Offensive odor		The bridge reconstruction has no relevance to causes of offensive odor.
	29	Sediment		The bridge reconstruction will not change the river sediments.
	30	Accidents	B	Flooding and other disasters may occur as a result of rainfall during the rainy season at the construction stage.

Assessment types: A: Likely to have a critical impact
B: Likely to have a moderate impact
C: Unknown
No mark: No impact

Table 2-14 Scoping Results for Jangbi Bridge

Environmental parameter			Assessment	Rationale
Social environment	1	Compulsory relocation of residents		There will be no relocation of residents because there is no residence or private land at the site of the bridge reconstruction.
	2	Regional economy, including employment, means of livelihood,		The bridge reconstruction will not have an adverse impact on the regional economy.
	3	Use of land and regional resources		The bridge reconstruction will not have an adverse impact on the use of land and regional resources.
	4	Social capital and social organization, such as the community decision-making body		The bridge reconstruction will not have an adverse impact on social capital or social organization.
	5	Existing social infrastructure and services		The bridge reconstruction will not have an adverse impact on social infrastructure or services.
	6	The poor, indigenous people and minorities		There will be no adverse impact because there are no residents at the site of the bridge reconstruction.
	7	Damages and uneven distribution of benefits		This project will not give rise to damages or uneven distribution of benefits because it is a reconstruction project of an existing bridge.
	8	Cultural heritage		There is no cultural heritage around the site of the bridge reconstruction.
	9	Conflict of interest within the community		This project will not cause any conflict of interest because it is a reconstruction project of an existing bridge.
	10	Water use, water rights/common rights		There will be no impairment of water use or water rights around the site of the bridge reconstruction.
	11	Public health		The bridge reconstruction will not have an adverse impact on public health.
	12	Disasters, HIV/AIDS and other infectious diseases		The bridge reconstruction is unlikely to cause any disaster or outbreak of infectious diseases.
Natural environment	13	Geological and geographical features	B	Substructure work at the construction stage may cause topographic deformation.
	14	Soil erosion	B	Rainfall during the rainy season may cause an outflow of surface soil during substructure work at the construction stage.
	15	Groundwater		The bridge reconstruction will not have an adverse impact on the groundwater.
	16	Hydrological conditions		The bridge reconstruction will not have an adverse impact on the river flow.
	17	Coastal area (mangrove forest, coral reef and tidal flats)		Not applicable.
	18	Flora, fauna and ecosystem		The bridge reconstruction will not have an adverse impact on the flora, fauna or ecosystem.
	19	Climate		The bridge reconstruction will not have an adverse impact on the local climate.
	20	Landscape		The bridge reconstruction will not have an adverse impact on the landscape.
	21	Global warming		The bridge reconstruction will not have an adverse impact on global warming.
Environmental pollution	22	Air pollution (dust emission)	B	The bridge reconstruction may cause some dust emission.
	23	Water pollution	B	Pollution of the river water may occur due to the inflow of earth and sand during the substructure work at the construction stage.
	24	Soil contamination		The bridge reconstruction has no relevance to causes of soil contamination.
	25	Solid wastes	B	Surplus soil and waste construction materials may be generated when the existing bridge is demolished.
	26	Noise/ vibration	B	Noise and vibration may be generated by the construction work at the construction stage.
	27	Ground subsidence		The bridge reconstruction has no relevance to causes of ground subsidence.
	28	Offensive odor		The bridge reconstruction has no relevance to causes of offensive odor.
	29	Sediment		The bridge reconstruction will not change the river sediments.
	30	Accidents	B	Flooding and other disasters may occur as a result of rainfall during the rainy season at the construction stage.

Assessment types: A: Likely to have a critical impact
B: Likely to have a moderate impact
C: Unknown
No mark: No impact

2) Overall Evaluation

On the basis of the scoping results, policies for future examination were developed forming an overall evaluation, which is shown in "Table 2-15 . Outline of Impact on Major Environmental and Social Consideration" and "Table 2-16 Overall Evaluation".

Table 2-15 Outline of Impact on Major Environmental and Social Consideration

Environmental parameter	Summary	Target bridge
Regional economy, including employment, means of livelihood, etc	Temporary traffic regulation due to the construction work may slightly affect economic activities at the construction stage.	Dolkhola Bridge Jigmiling Bridge
Existing social infrastructure and services	Temporary traffic regulation due to the construction work may slightly affect regional traffic at the construction stage.	Dolkhola Bridge Jigmiling Bridge
Geological and geographical features	Substructure work at the construction stage may cause topographic deformation.	All bridges
Soil erosion	Rainfall during the rainy season may cause an outflow of surface soil during substructure work at the construction stage.	All bridges
Air pollution (dust emission)	The bridge reconstruction may cause some dust emission.	All bridges
Water pollution	Pollution of the river water may occur due to the inflow of earth and sand during the substructure work at the construction stage.	All bridges
Solid waste	Surplus soil and waste construction materials may be generated when the existing bridge is demolished.	All bridges
Noise and vibration	Noise and vibration may be generated by the construction work at the construction stage.	All bridges
Accident	Flooding and other disasters may occur as a result of rainfall during the rainy season at the construction stage.	All bridges

Table 2-16 Overall Evaluation

Environmental parameter	Evaluation	Assessment policy	Target bridge
Regional economy, including employment, means of livelihood, etc.	B	Study how to minimize regulation of traffic due to the construction work.	Dolkhola Bridge Jigmiling Bridge
Existing social infrastructure and services	B	Study how to minimize regulation of traffic due to the construction work.	Dolkhola Bridge Jigmiling Bridge
Geological and geographical features	B	Select an appropriate location for the bridge abutment, consider construction methods and design so as to minimize topographic deformation accompanying the substructure work at the construction stage.	All bridges
Soil erosion	B	Determine an appropriate construction period, consider construction methods and countermeasures to avoid soil erosion caused by rainfall during the substructure work at the construction stage.	All bridges
Water pollution	B	Determine an appropriate construction period, study construction methods and water quality conservation measures to prevent pollution of the river water at the construction stage.	All bridges
Solid waste	B	Study the method of reuse, recycling and final disposal of the solid wastes resulting from the demolishing of the existing bridge at the stage of construction.	All bridges
Noise and vibration	B	Study an appropriate construction method and countermeasures to control the generation of noise and vibration at the stage of construction.	All bridges
Accident	B	Conduct studies to set an appropriate construction period to prevent damages caused by flooding and other disasters resulting from rainfall in the rainy season at the stage of construction.	All bridges

Judgment classification: A: Likely to make a critical impact
B: Likely to make a moderate impact
C: Unknown
No mark: No impact

3) Results of an IEE-Level Survey on the Environmental and Social Considerations

The surveys carried out so far have revealed that the environmental legislation of Bhutan makes a prerequisite for the implementation of any bridge reconstruction project for acquisition of environmental approval. In the bridge reconstruction projects that have been implemented so far, the environmental approval has been granted within several months after the application and the EIA survey has not been required. However, since environmental category classification has not been carried out with respect to this project, it was decided that it should be carried out during the IEE-level survey on the environmental and social considerations.

The results of survey showed that the population density of the areas around the bridges is extremely low, and the bridge reconstruction will not involve the relocation of residents and expropriation of private land. Therefore, it is considered that the social impact will also be extremely small.

With respect to Kela Bridge and Jangbi Bridge, although these bridges face onto a national park (Jigme Singye Wangchuck National Park), the impact on the natural environment is considered minimal because these bridges are not located in the park and there are no rare fauna or flora nearby. However, in view of the fact that the bridges face onto a national park, due consideration should be given to the natural environment in the development of the design and the construction plan.

As the project of Mandechhu (Reotala) Bridge is to reconstruct the bridge that was damaged by the cyclone, it will not make any environmental impact greater than what the area has suffered so far. Nevertheless, it is necessary to ensure that the design and construction plan will be developed with due consideration of the environment, as is the case with Kela Bridge and Jangbi Bridge.

In addition, since Dolkhola Bridge and Jigmiling Bridge are located on National Highway No. 5, which is the arterial road in the area, traffic regulation during the construction of these bridges may have some impact on the local community and economic activities. Therefore, adequate consideration needs to be given to this point.

In view of the circumstances described above, in spite of some adverse environmental and social impacts may arise from this project, it can be concluded such impacts would affect only the construction site itself and few of them would be irreparable. Therefore, it is considered that commonly employed measures would be enough to control these impacts.

Finally, it is determined that this project corresponds to category "B" of environmental and social considerations. Similar explanations regarding the impact on environmental and social considerations were given to the persons in charge at the DoR and DoA, to obtain agreement on categorization.

(3) Environmental Permit Application Procedure

1) Application Procedures for an Environmental Clearance

The organization at the highest level of environmental administration in Bhutan is the National Environment Commission (NEC). NEC is focused on the development of the national environmental policy

and plans as well as the implementation of environmental impact assessment for national projects that are considered important. The authority to issue environmental approval for the project fields in the environmental impact assessment manual, including the construction of roads and bridges, has been transferred to the ministries and agencies supervising each project, and the departments and bureaus in charge take responsibility for the implementation of environmental impact assessment.

"Figure 2-10 Application Procedures for an Environmental Clearance" shows the application procedures for an environmental clearance from the Ministry of Works and Human Settlement (MoWHS) and the Ministry of Agriculture (MoA).

In the case of the MoWHS, the Environmental Unit within the ministry carries out the environmental impact assessment. To obtain an environmental clearance for a bridge project, the DoR must prepare an environmental checklist for submission to the Environmental Unit. The Environmental Unit will then study and verify the details of the application at the proposed construction site before issuing the clearance to the DoR.

In the case of MoA, the department in charge of agriculture within the Dzongkhag (district) administration is responsible for carrying out the environmental impact assessment. To obtain an environmental clearance for a bridge project, the DoA orders the DAO, which is the ministry's office at the level of Dzongkhag, to prepare an environmental list. The DAO will prepare the list and submit it to the department in charge of agriculture in the Dzongkhag administration, which will study and verify the details of the application at the proposed construction site before issuing the clearance to the DAO. A duplicate of the clearance is retained by the DoA.

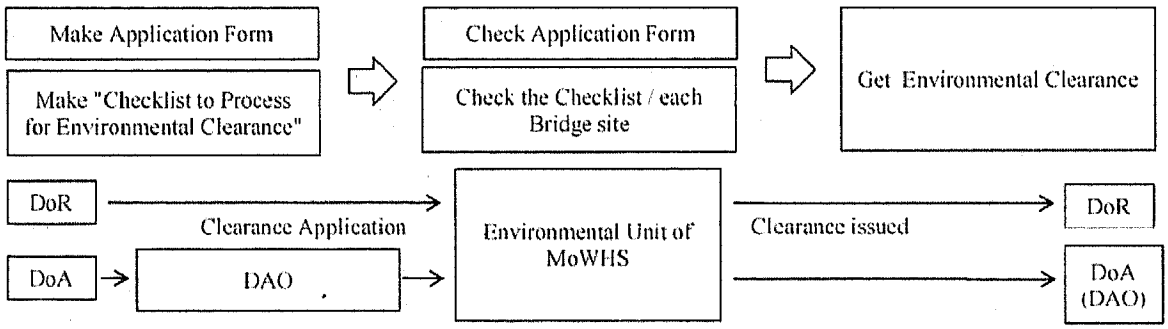


Figure 2-10 Application Procedures for an Environmental Clearance

2) Schedule for Environmental Clearance Application

In order to confirm the schedule for the acquisition of the environmental clearance, the consultant showed the schedule of the application procedures for the environmental clearance as shown in "Figure 2-11 Schedule for the Reception of the Environmental Clearance" to the DoR (accompanied by the staff of the Environmental Unit) and the DoA. As a result, the procedures had been completed as the schedule shown in "Figure 2-11 Schedule for the Reception of the Environmental Clearance" and the environmental clearance was issued in April 2011.

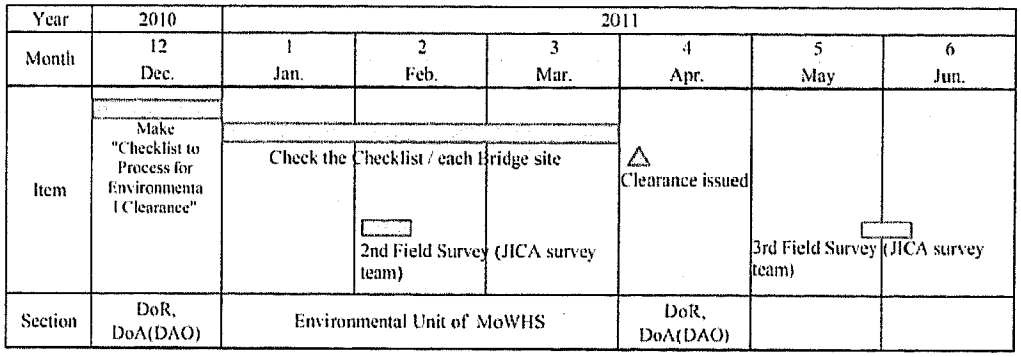


Figure 2-11 Schedule for the Reception of the Environmental Clearance

(4) Monitoring Program and Countermeasures

The environmental parameters shown in "Table 2-17 Monitoring Program and Countermeasures" need to be monitored during the implementation of the project as they were ranked "B (Moderate impact is likely)" with respect to the need to take them into consideration in the implementation of the project. For the monitoring, these parameters were reviewed, and monitoring program was made to reduce the environmental burden during the construction work. The parameters should be taken into consideration in the development of the construction method and the construction plan so as to reduce the environmental burden, and should be monitored during the implementation of the project.

Table 2-17 Monitoring Program and Countermeasures

Environmental parameter	Target bridge	Key point	Countermeasures	Monitoring measures		
				Before construction	During construction	After opening to traffic
Soil erosion	All bridges	Determine an appropriate construction period, consider construction methods and countermeasures to avoid soil erosion caused by rainfall during the substructure work at the construction stage	Adopt appropriate construction methods to prevent soil erosion	Confirmation of the construction method and plan	Visual inspection	–
Water pollution	All bridges	Determine an appropriate construction period, study construction methods and water quality conservation measures to prevent pollution of the river water at the construction stage	Adopt appropriate construction methods to prevent the outflow of wastewater from the construction site.	Confirmation of the construction method and plan	Visual inspection	–
Solid waste	All bridges	Study the method of reuse, recycling and final disposal of the solid wastes resulting from the demolishing of the existing bridge at the stage of construction	Request that the Bhutanese side makes sure that no waste material is left at the site when the existing bridge is removed. Ensure that solid waste from the construction work is disposed of at the designated disposal site.	Confirmation of the construction plan	Visual inspection	Confirmed during the after-opening inspection
Accident	All bridges	Conduct studies to set an appropriate construction period to prevent accidents caused by natural and man-made disaster during construction	Develop and implement an appropriate construction plan to avoid accidents	Confirmation of the construction plan	Confirmation of Monthly Progress Reports	–
Dust emission	All bridges	Study an appropriate construction method and countermeasures to control the dust emission at the stage of construction	Adopt an appropriate construction method and sprinkling water on the construction access road during construction.	Confirmation of the construction plan	Visual inspection	–

With respect to the implementation of the monitoring, an environmental monitoring program conforming to the Environmental Codes of Practice (ECoP) needs to be developed for environmental approval to be obtained. According to the ECoP, the monitoring and evaluation should be carried out by the DoR or an external organization. More specifically, the ECoP stipulates that daily monitoring should be carried out by the contractor, while the DoR should perform monitoring at regular intervals. Accordingly, DoR is

responsible for the appropriate implementation of the environmental monitoring. As described in the section on the results of the field survey, it has been confirmed that no socio-environmental problems will arise in regards to the expropriation of land or relocation of residents, as there are no residents around the bridges in question and the land is national property.