Chapter 6 Engineering Approach

6.1 Geological and Hydrological Investigations

6.1.1 Geological Investigation

The result of geological investigation conducted on the optimum route, the Alternative-C is briefly discussed in this section.

(1) Geological Reconnaissance Survey

Surface geological reconnaissance survey was conducted along the earthen section (approach road L=approx.2.225km) of the proposed road using a 1:25,000 scale topography map. The result of the survey is shown in the geological plan and profile Figure 6-1

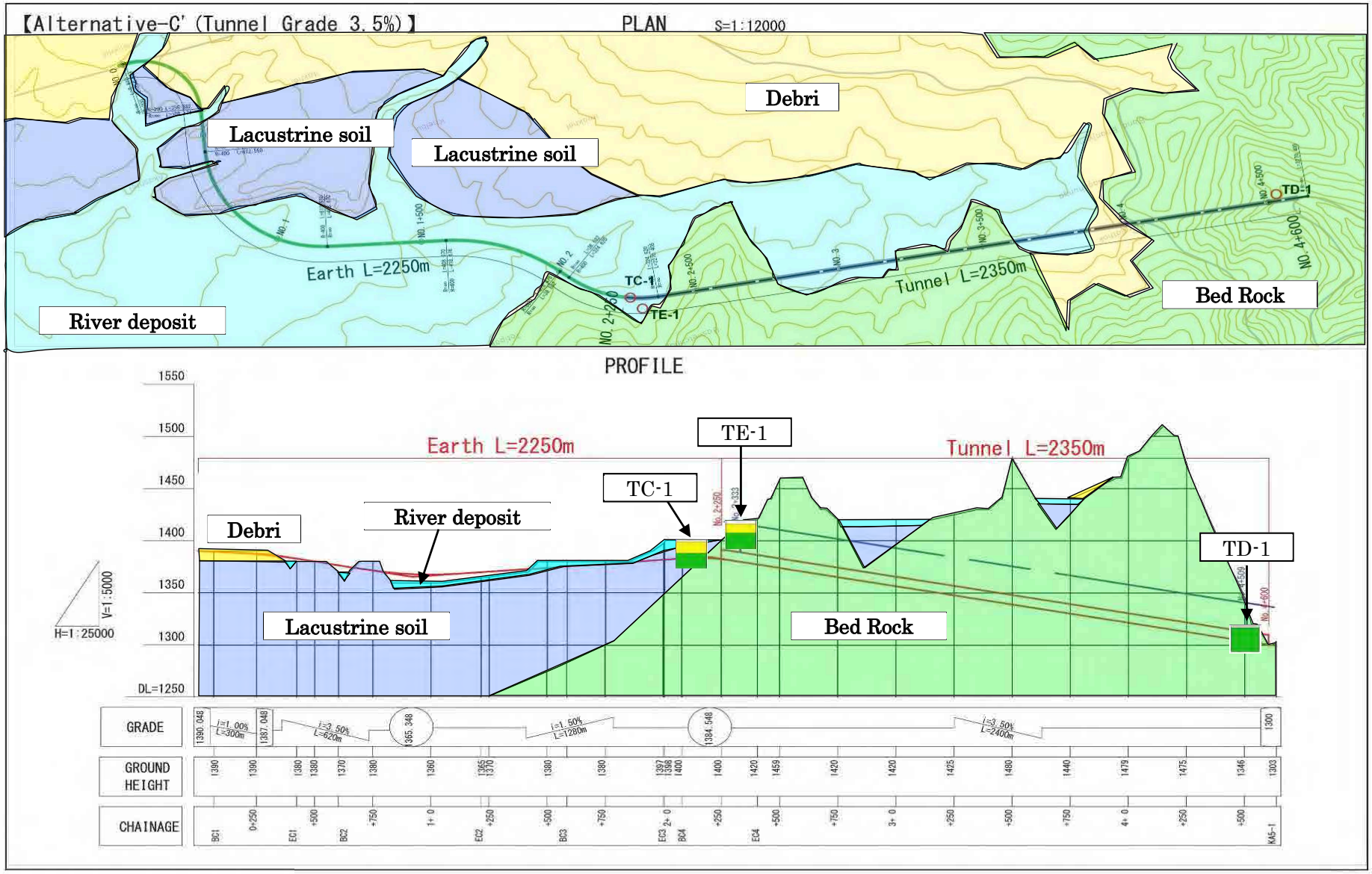
1) Approach Road

The geology along the approach road consists of lacustrine soil and debris sediment which covers the lacustrine soil layer. Furthermore, soft clay layer is found distributed along the river bed.

- Lacustrine soil has been reported to be up to 125m or more in the vicinity of the study area. This layer is assumed to consist of alternate layers of gravel, clay layer and organic clay layer including a portion of soft soil, where high embankment may encounter potential land subsidence. In addition, discharge of groundwater has also been confirmed from existing boreholes.
- The debris flow is mainly carried down from the Chandragiri Mountain on the east side and the debris flow consists of gravel containing withered or unconsolidated rock mass. The thickness of the layer is assumed to be 10-30m and the material is suitable to be used as fill material.
- The river bed sediment is formed from unconsolidated clay and the layer thickness is assumed to be within several meters.

2) Bridge site

There are three locations where bridges are proposed. Out of the three, the geology of the first two locations near to the divergence point from existing road at Kisipindi, about 4.8km from Kalanki, consists of consolidated sandy soil and the bearing layer at these locations are considered to be relatively shallow. The other bridge located on the bottom of the basin, has its surface composed of bed sediment containing clay or gravel. The geology deep below the surface is unknown and drilling is unavoidable to confirm the bearing layer.



Source: JICA Study Team

Figure 6-1 Geological Plan and Geological Profile along C route

3) Tunnel Section

The geology along the tunnel section is as follows;

- The earth at the east side tunnel portal is made of colluvial soil from the surrounding mountain.
- Large portion of the section including the west side tunnel portal consists of interbedded sandstone/phyllite. The inclination of the strata is in the same direction of the tunnel, which is about 50-70 degrees sloped to the south.
- The thickness of sandstone is about 5-30cm, and interbedded phyllite is 1-10cm.

Photo 6-1 Outcrop at Tunnel Exit

4) Fracture Zone and Faults

According to the previous geological survey, Existence of an active fault (Kathmandu South Fault) in the southeast direction has been reported in previous geological survey report (Gekkan Chikyu No. 31,200). Similarly, linear pattern of fault through Dahachowk and BadBhanjyang has also been reported (Engineering and Environment Geology).

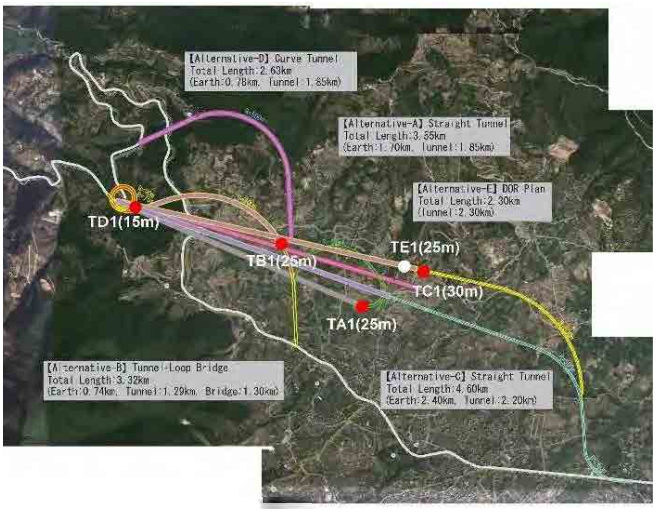
Fractured zone was confirmed at the west ridge of east side (Kathmandu side) tunnel portal during the field survey. However the direction and length of the fault is unknown at present and further needs a detailed geological survey.

5) Groundwater

There are several settlement areas along the proposed route. The source of water for drinking as well as for other domestic use for these areas is basically a well dug in front of a house. Also, surface runoff is used for irrigation water for paddy fields around the area. Therefore, ground water is a very valuable asset. Tunnel for the proposed route is planned at the north side of the valley (basin). The west side tunnel portal is about 80-100m lower than that of the elevation of this basin. The leakage of groundwater from the tunnel is anticipated to have an impact on the groundwater of the above-mentioned settlement areas and even contribute in decreasing the groundwater level. Therefore, a detailed groundwater survey and management plan will be required in the further studies.

(2) Drilling and Laboratory Test

Drillings were carried out at tunnel portals (east side and west side) on all proposed alternatives to identify and confirm the topographic condition of the area. An additional drilling was conducted on the east side tunnel portal on Alternative-C due to the fact that the core samplings were not properly extracted as the bedrock was highly weathered. As a result, altogether drilling was conducted at 5 locations as depicted in Figure 6-2. The total length of drilling was 120m. By TC-1, permeability test was conducted three times. k = 2.26E-6 ~ 1.69E-7 m/sec is obtained that the permeability of the ground normal.



Source: JICA Study Team

Figure 6-2 Drilling Locations

Log tables in Figure 6-3 show the results of drilling. The details are attached in the appendix. Laboratory soil tests were also conducted on the core samples collected. The results of the tests are summarized in Table 6-1. Both the unit weight and water content showed an average value. However, the unconfined compressive strength one of the indicators for performance of tunnel excavation showed a maximum value of 135kg/cm3. Incapability to extract rock samples properly or development of the bedding plane in 20-30 degrees with respect to vertical direction is possible reasons. In normal condition, the value is expected to be larger.

Table 6-1 Laboratory Test Results

Bore Hole	Depth	Laboratory Test Results							Remarks
	m	Unit.Wt (gms/cc)	Mois.Con.(%)	Sp.Gr.	LL/PL/PI (%)	UCS (kg/cm^2)	Sulphate as SO_3 %	pH value	
TA-1	4.00 – 5.00						< 0.01	7.4	
	5.00 – 6.00			2.557					
	8.00 – 9.00						< 0.01	6.3	
	12.0 – 13.0	1.81	20.97	2.557	26/20/6 25/19/6 25/18/7	1.08	< 0.00006	6.8	UD – sample
	13.0 – 14.0				20/NP/NP				
	18.0 – 19.0	1.76	22.28	2.579	28/21/7 30/23/7	1.81	< 0.00006	6.2	UD – sample
	20.0 – 21.0	2.48					< 0.01	6.9	
	22.0 – 23.0			2.602					
TB-1	1.00 – 2.00				25/NP/NP				
	2.00 – 3.00			2.624			< 0.01	6.7	
	10.0 – 11.0	2.74							
	11.0 – 12.0					80.23			
	15.0 – 16.0	2.71							
	18.0 – 19.0					135.23			
	24.0 – 25.0	2.64				57.87 / 73.21			
TC-1	4.00 – 5.00			2.557	21/18/3		< 0.01	7.2	
	9.00 – 10.0			2.579	22/NP/NP		< 0.01	7.2	
TD-1	1.00 – 2.00						< 0.01	6.8	
	2.00 – 3.00			2.648					
	5.00 – 6.00	2.79							
	6.00 – 7.00	2.83							
	13.0 – 14.0	2.70							
	14.0 – 15.0			2.671			< 0.01	6.9	

Source: JICA Study Team

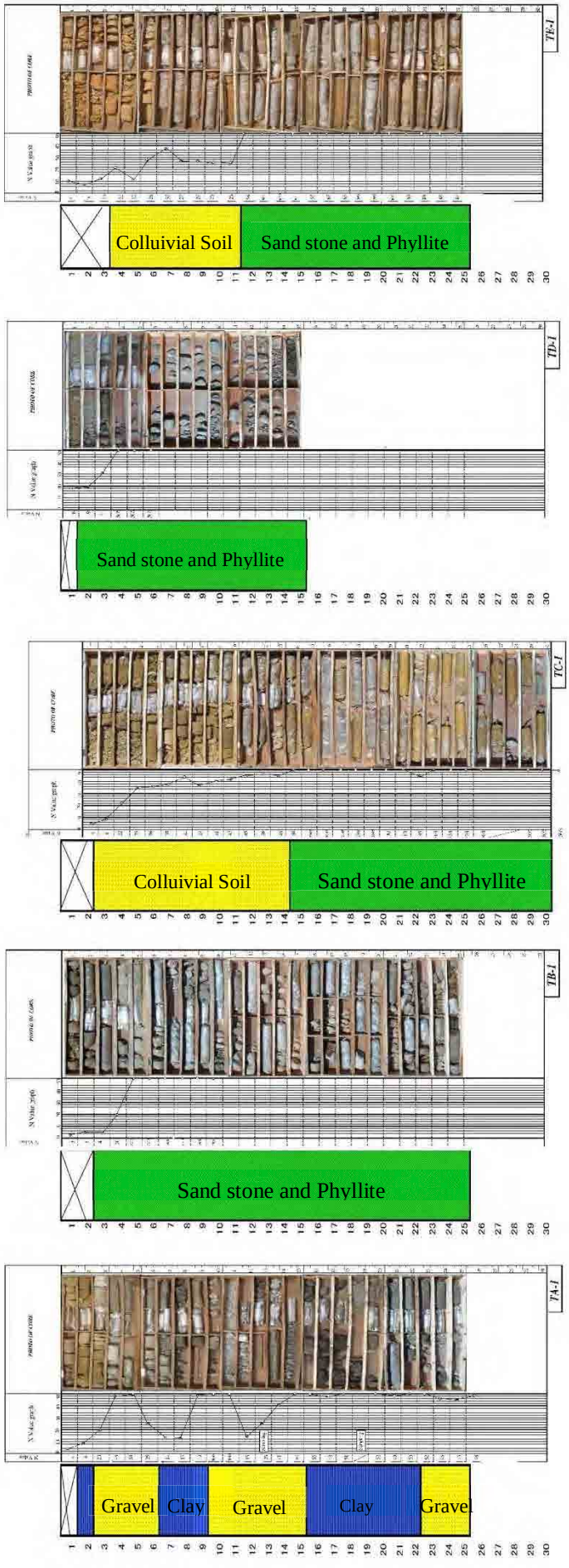


Figure 6-3 Simple Boring Logs

Source: JICA Study Team

(3) Further Necessary Investigations

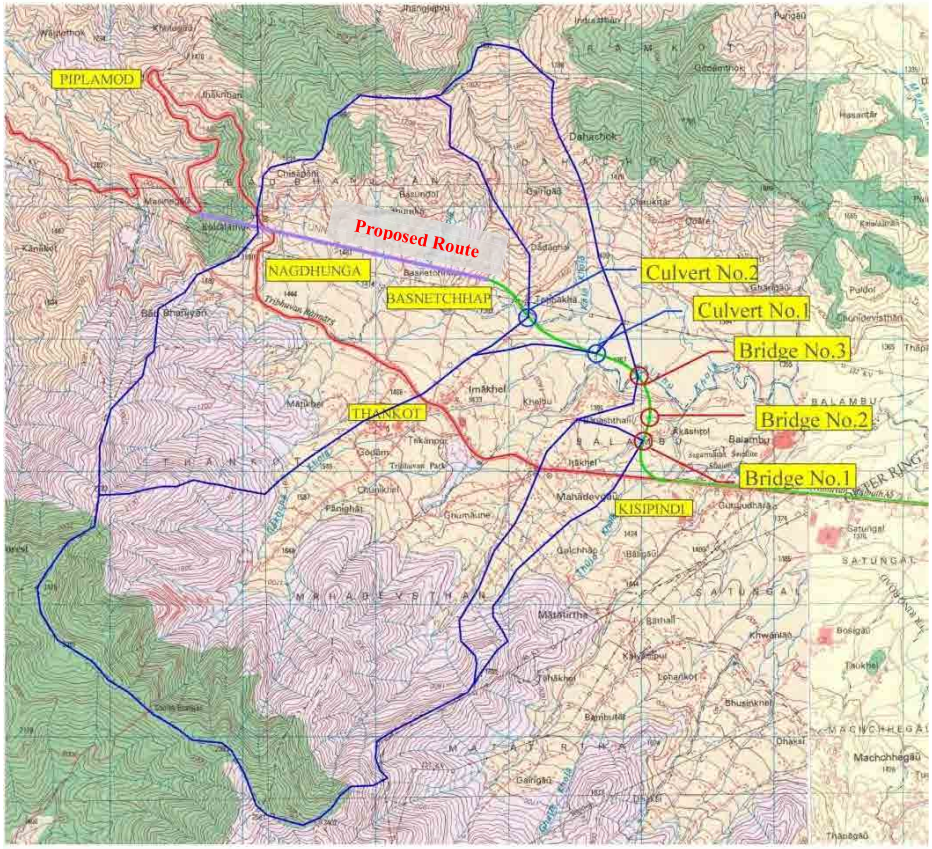
From the result of drilling at the east side tunnel portal, distribution of hard rock was not confirmed. Therefore, the distribution is judged to be heavily weathered and softened bedrock. Even though the consideration was taken to shift the alignment towards the north so that the tunnel section will pass through bed rock foundation, the geological distribution of the basin at the west of the portal is unknown. Therefore, the Study Team recommends reviewing the alignment after confirming the location of the bed rock foundation by conducting more detailed (highly accurate) drilling together with reference to the results of the electrical resistivity tomography test performed by DOR during its Feasibility Study in 2013. A set of tests such as seismic refraction tomography, electrical resistivity, advanced drilling also are considered to be inevitable.

Furthermore, a detailed hydrological investigation is also deemed necessary to avoid the potential impact on the groundwater of the surrounding areas during excavation of the tunnel. This will include continuous observation of groundwater level in wells and the overflow of the discharges of the rivers into the surrounding areas.

6.1.2 Hydrological Examination

The proposed route takes off towards north side, from the existing Tribhuvan Highway at Kisipindi, about 4.7km from the Kalanki junction and heads northwards following a curved path and crosses a small tributary of Balkhu khola and again heads north until it crosses Balkhu khola just downstream of the confluence of two other tributaries of Balkhu khola. The proposed route then takes a turn towards West and crosses two of the tributaries of Balkhu khola before entering the tunnel inlet portal. The approximate length of this surface road is about 2.5km.

The Watershed map comprising the catchment basins and sub-basins corresponding to the proposed route and location for the proposed cross drainage structures are shown in Figure 6-4.

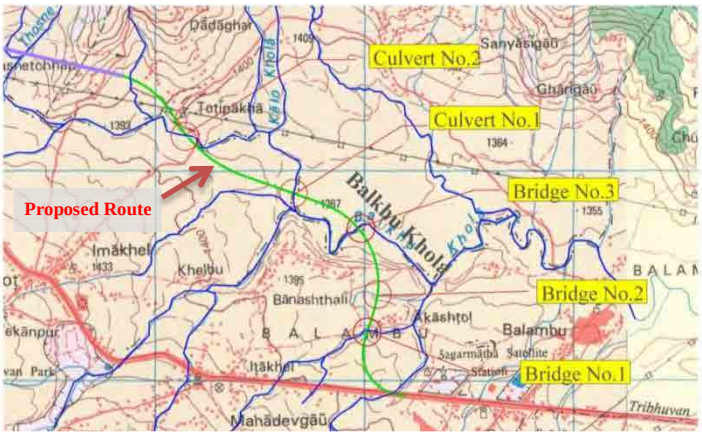


Source: JICA Study Team

Figure 6-4 Proposed Route and its Corresponding Catchment Basins and Sub-Basins with Proposed Cross Drainage Structures

All the basins and sub-basins lie below the Mahabharat range of mountains and hence none of the rivers have contribution of melting snow in their flow. They have a very low flow during the dry season and high flood during monsoon. In the upper areas of the catchment, the average gradient is quite high but decreases significantly where the small tributaries meet to form the Balkhu khola.

The area of the map showing the Balkhu khola and its tributaries are shown in the Figure 6-5.



Source: JICA Study Team

Figure 6-5 Topographic Map showing Balkhu khola and its Tributaries near the Proposed Route

At one of the tributary of Balkhu khola that the route crosses, a deep gorge of about 15m exists and a bridge has been proposed (Bridge No.1). Likewise, another bridge is proposed at a land depression area of about 10m and is approximately 25m wide (Bridge No.2).

In the present sites, the road geometric requirement has become the dominant parameter in deciding the sizes of the cross drainage structure, both in span and height rather than that hydrological requirements. Thus, because of the road gradient requirements, the height of bridges/culverts has becomes more deciding than that is required from hydrological consideration.

(1) Study of Major Crossings within the Proposed Route

1) Proposed Bridge Site for Bridge No.1

The proposed bridge site for Bridge No.1 is over a small tributary of Balkhu Khola. The stream is in a deep gorge of about 15m. At this site, in the dry season, the waterway of the stream is narrow, about 7m only and the depth of water is shallow. By contrast, the width of the stream at the formation level of the proposed road is about 40m. Hence, the length of bridge has been estimated as 20m at this site.

Source: JICA Study Team

Photo 6-2 Proposed Bridge Site for Bridge No.1

Moreover, a lot of vegetation covers the drainage line of the stream and also on the adjacent terraces many trees are present as seen in Photo 6-2. Land, on the right bank of the stream, has been used for mushroom farming and on the left bank there is a stone paved road. As per the local residents of the area, during monsoon season the water level in the stream rises to about 2m from the stream bed level. Therefore, the proposed deck level of the bridge is at a very safe height. Also, in this case, the geometrical requirement of the road design has acted as a dominant factor in setting the profile of the road.

2) Proposed Bridge Site for Bridge No.2

The proposed bridge site for Bridge No.2 is not a stream, it is a valley. However, very small surface discharge is observed during monsoon as a result of water draining from the surrounding. The depression is about 10m deep and 30m wide. This patch of land is usually used for grazing purpose by the locals. Also, at certain intervals in the depression, projection of manhole covers could be seen which confirms the existence of underground drainage system, which ultimately drains into the Balkhu Khola.

A dry bridge of about 10m has been proposed at this site. Since it is a dry bridge, the HFL determination is not needed. The upstream section of the bridge site is shown in Photos 6-3.

(a) Proposed Bridge Site

(b) Up Stream View

Source: JICA Study Team

Photos 6-3 Proposed Bridge Site for Bridge No.2

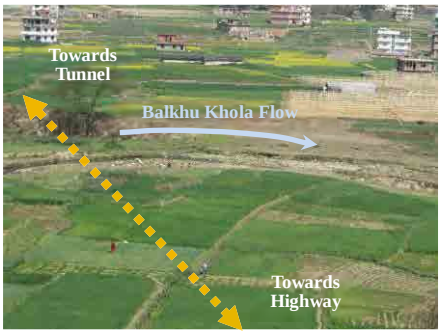
3) Proposed Bridge Site for Bridge No.3

The proposed bridge site for Bridge No.3 is over the main Balkhu Khola. The proposed bridge axis lies in the meander of the stream. The river is shallow during the dry period with very little flow but at the time of flood, the river spreads laterally and linear waterway reaches almost 50m, inundating the nearby flood plain, which in dry season is used for cultivation. The lateral spread of the flood is more prominent on the right bank than on the left as the elevation of right bank is lower than that of the left bank.

In addition, river bank cutting is also prevalent in this river near the bridge site. The bridge axis, being in the meander of the river, needs special protection as the concave banks are prone to erosion. Bridge of about 50m has been proposed at this site and associated river

training works are also needed for the safe passage of flood. According to the local people the rise in water level is about 2.5m from the bed level, during flood. Hence the proposed deck level should be well above this elevation including adequate room for freeboard.

(a) Proposed Bridge Site



(b) Bird's Eye View

Source: JICA Study Team

Photos 6-4 Proposed Bridge Site for Bridge No.3

4) Culvert No.1

The stream is one of the tributaries of Balkhu Khola draining from the north of the watershed of Balkhu Khola. A little upstream of the proposed culvert site, there exists a slab culvert of about 5m length and having an opening of approximately 2m depth. Just upstream of the bridge site the stream takes a sharp curved path and also the stream has been heavily channelized to approximately 50-60m upstream.

At this section of the stream, the flood has not exceeded the banks, according to the local residents. However, the increasing trend of channelizing the stream into a narrower width and encroachment of the nearby lands fuelled with increased surface flow due to rapid urbanization could significantly raise the water levels in the stream during flood time. Therefore the design level should be adequately high such that passage of flood is safe. Consequently, high flood level, at least 1.5m higher from the current stream bed level is suggested for this stream. Also, standard freeboard height should be provided for the culvert.

(a) Proposed Culvert Site

(b) Upstream Channelized Section

Source: JICA Study Team

Photos 6-5 Proposed Culvert Site No.1

5) Culvert No.2

This stream is also one of the tributaries of Balkhu Khola. The proposed section is about 5m wide and the stream has a low flow during dry season. The stream is extremely polluted with stagnant heaps of garbage in the waterway. Either banks are used for cultivation. It is suggested to keep the HFL at least 1.5m above the current bed level at the proposed site.

Source: JICA Study Team

Photo 6-6 Proposed Culvert Site No.2

(2) Discharge Estimation

For the present phase of the study, discharge in the streams where cross drainage structures are required, has been calculated using two methods, namely, WECS/DHM method and Rational Method. The former is a local empirical formula widely used in Nepal. Brief description of each method is given below.

1) Water and Energy Commission Secretariat (WECS/DHM) Method

The WECS/DHM method, based on flood frequency analysis, is recommended for the context of Nepal after performing few case studies. In this method, the most significant independent variable is the area of the basin below 3000m elevation. This area represents the portion of the basin that is influenced by monsoon precipitation. The results of this method are not applicable to basins located entirely above 3000m elevation. Also, even if the proportion of a basin lying below 3000m is very small, the results of this method will not be particularly reliable.

As per the recommendation of the Water and Energy Commission Secretariat / Department of Hydrology and Meteorology (WECS/DHM) of Nepal, the flood flows of any river of catchment area A (km²) lying below 3000m elevation are given by:

Instantaneous Peak flood for a return period of 2 years, $\mathbf{Q_2 = 1.8767\ (A + 1)^{0.8783}}$
Instantaneous Peak flood for a return period of 100 years, $\mathbf{Q_{100} = 14.63\ (A + 1)^{0.7342}}$
The flood flow for any other return period, T years, can be found as:

$$\mathbf{Q_T = \exp\ (\ln Q_2 + s\sigma)}$$

Where,

A = area below 3000m elevation

σ = standard deviation of natural logarithms of annual floods = $\ln (Q_{100} / Q_2) / 2.326$

s = Standardised normal variate from a particular return period

= 0, 0.842, 1.282, 1.645, 2.054, 2.326, and 2.576 for T = 2, 5, 10, 20, 50, 100, and 200 years, respectively.

2) Rational Method

The design intensity of rainfall corresponding to the time of concentration is determined from IDF curve. The time of concentration is determined using Kirpich equation. Most of the catchment area lies in hilly terrain and covered by vegetation. So the average coefficient of runoff is taken as 0.4 for the application of Rational method.

$$\mathbf{Q_t = \frac{C * I_{Ct} * A}{3.6}}$$

Where, Q_t= discharge at return period t years in m^3/s

C = Average Runoff coefficient

I_{ct}= Intensity of rainfall corresponds to t years return period in mm/hr

A = Catchment area in sq. Km

3) Results of the Estimated Discharge

In Nepal, for the design of major bridge, 100 year return period flood value is taken as the design discharge and for the culverts 50 year return period flood is taken as the design discharge. Therefore, for all the basins, 50 year and 100 year return period flood has been computed and presented in the following table.

Table 6-2 Results of Estimated Discharge for Each Basin

Hydrologic element	Basin area (km^2)	100 years return period flood (m^3/s)		50 years return period flood (m^3/s)		Recommended Design Discharge (m^3/s)
		WECS method	Rational	WECS method	Rational	
Bridge 1	0.72	21.81	10.52	17.31	9.39	10.52
Bridge 3	15.03	112.24	146.88	92.50	131.08	146.88
Culvert 1	7.2	68.61	84.19	55.91	75.14	75.14
Culvert 2	5.65	58.83	71.08	47.77	63.44	63.44

Note: Site for Bridge No.2 is not a stream
Source: JICA Study Team

The discharge calculated using Rational Formula has been recommended because; this method takes into account the rainfall data in the vicinity/or of the watershed. Also it considers the runoff coefficient accounting for all differences between the rainfall intensity and the flood peak which gives a more reliable result.

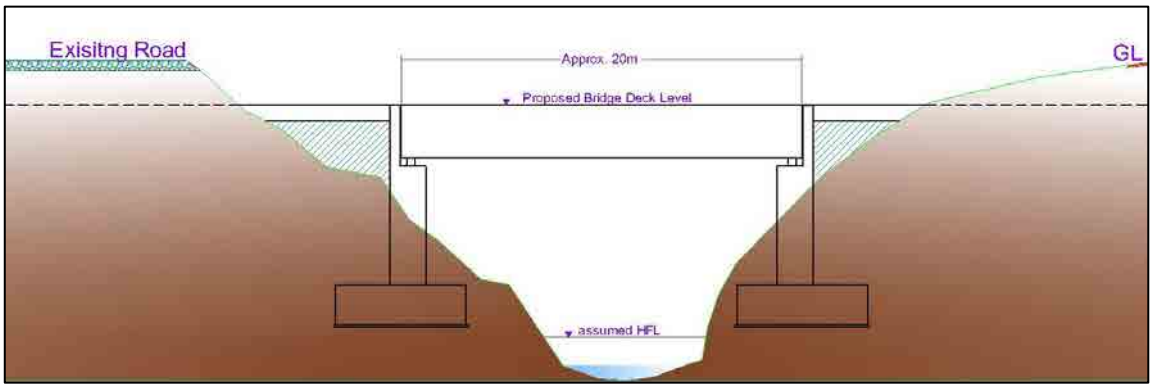
(3) High Flood Level Estimation

For the present phase of the study, High Flood Level (HFL) was estimated by inquiring the knowledgeable local people at the site. In Bridge No. 1 and Bridge No. 3, where there is water flow, the proposed road alignment profile significantly exceeds the assumed HFL. Also, in case of the Culvert Nos. 1 and 2, the proposed profile is in embankment, rising approximately 10m

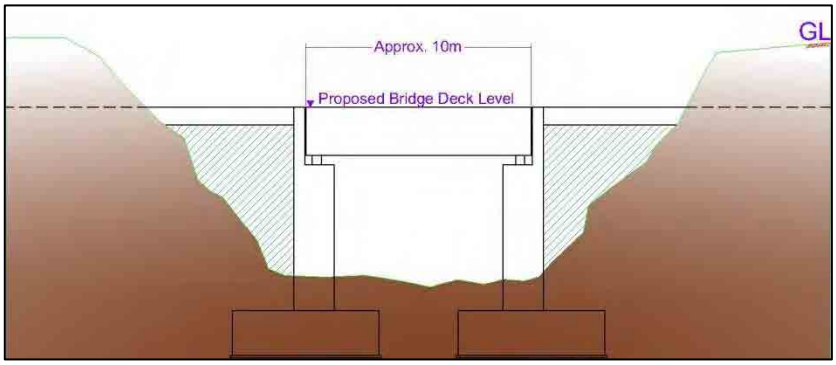
from the current ground level, which further reassures that the alignment is at a safe height, markedly exceeding the hydrological requirement.

However, for the proposed Bridge No. 2, there is no water flow and is only a dry bridge, thus HFL consideration is not relevant.

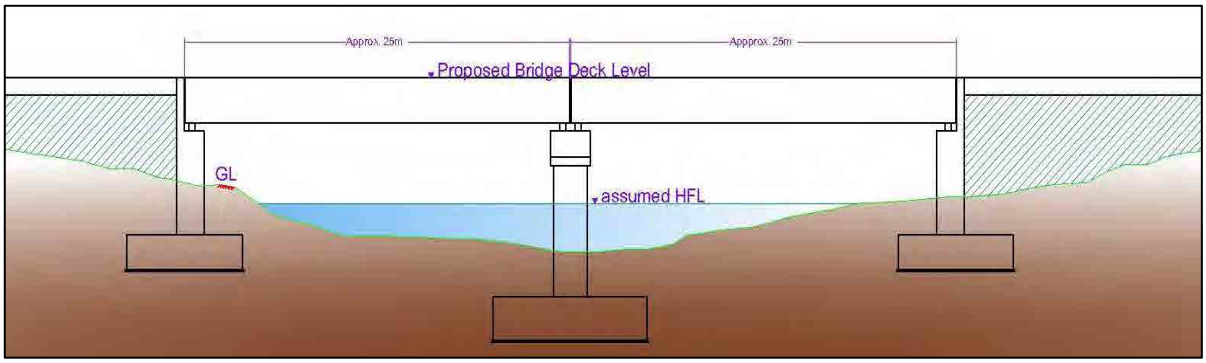
Schematic cross sections of the bridge sites are shown below.



(A) Schematic Cross-Section at Bridge Site No.1



(B) Schematic Cross-Section at Bridge Site No.2



(C) Schematic Cross-Section at Bridge Site No.3

Source: JICA Study Team

Figure 6-6 Schematic Cross-Section at Bridges

(4) Limitations and Future Recommendation

The main objective of the above hydrological study was to verify the different locations of major river crossings along the proposed route. The hydrological study is concentrated in estimating the approximate High Flood Levels (HFL) at the stream crossings for the judgment of bridge deck levels. However, there are no gauging stations in any of the streams within the Project Area. In the absence of flood data of the rivers the flood determination has been estimated by empirical methods and Rational Method only. For the present phase of the study, HFL was also verified by inquiring the knowledgeable local people at the site. However, in the higher stages of the study, different methods of rainfall-runoff analysis is recommended to be carried out to determine flood of various frequencies and based on the actual cross-sectional surveys of the waterway corridor.

(5) Ground-WaterInfiltration into the Tunnel

The proposed route of the Thankot tunnel is seen passing through highly weathered metasandstone and partly through soft ground of valley fills material or colluvium materials. There are total five number of drill holes (TA-1, TB-2, TC-1, TE-1 and TD-1) has been drilled along the alignment or nearby proposed tunnel route.

The ground water table measured during the drilling in the drill holes is observed at the surface in drill hole TA-1, TB-2, TC-1 and at 2.20m in TE-2, similarly there was no ground water table encountered in the drill hole TD-1 (Outlet portal side). Pizometric Level reading on the Standing Pipes and the results of the falling head permeability test is shown in the Table below.

Table 6-3 Ground Water Table , Permeability and Pizometric Level Readings of Boreholes

Borehole No.	Borehole Depth	Ground Water Table	Pizometric Level	Average Permeability
TA – 1		0.00m	*NP*	*NP*
TB – 1		0.00m	*NP*	*NP*
TD – 1		Dry	*NP*	*NP*
TE – 1		2.20m	*NP*	*NP*
TC –1		0.00m		
	11.1m		+0.4m	1.69×10^{-7} m/sec
	18.0m		+1.92m	8.2×10^{-7} m/sec
	30m		+3.00m	2.26×10^{-6} m/sec

NP: Not Performed

Source: JICA Study Team

The information of ground water condition obtained during the drilling is clearly indicating that the beginning section (from Kathmandu Valley side) of tunnel route is passing through below the ground water table. The topography of the alignment is along the toe of the mountain which is the groundwater recharge line of the valley therefore the ground water inflow inside tunnel can be assumed relatively high. Hence the vertical grade of the tunnel alignment is downwards (-3.5%) from valley side (Inlet) to the outlet (other side of the valley). In this condition the possibility of ground water drainage towards outside the valley is very high.

It is generally very difficult to predict the location and quantity of the potential water leakage in a planned underground excavation. Permeability testing may give certain indication. A technique is developed by Tokheim and Janbu (1984) for the leakage analysis along the tunnel alignment is called Tokheim and Janbu (1984) method. The method is based on the flow theory and consists of input parameters; i.e., rock mass permeability, geometric factor, hydraulic water head, etc. (equation 1).

It is interesting to note that the estimation of hydraulic conductivity is crucial in this method since the hydraulic conductivity values are mostly estimated in power of $10^{(-x)}$. An increase in power value by one the leakage will increase by almost 10 times. Therefore, leakage analysis is very sensitive with the use of this method. Still, this approach of leakage estimate is used so that it is possible to see the sensitivity of the method.

$$\mathbf{Q_w = 2\pi \times K \times L \times p / \mu_w \times G} \qquad \textbf{(equation 1)}$$

Where Q_w = inflow rate (m3/s)
K = Specific Permeability (m2)
L = Length of tunnel (m)
P = potential (active head (Pa)
μ_w = dynamic viscosity of water (KG/m) = density x cinematic viscosity
G = Geometry factor

The Geometry factor (G) describes the flow pattern relatively to the geometry of the tunnel or cavern, and is given

$$\mathbf{G = \ln (2D - r)(L + 2r) / r (L + 2 (2D - r))} \qquad \textbf{(equation 2)}$$

Where D = distance between the center line of the excavation and the ground water table
r = "equivalent radius" of idealized geometry, i.e., the radius of a cylinder with a surface area equal to the that of actual excavation

As indicated by the inflow equation, information about permeability is needed for Tokheim and Janbu's method to be applied. Hence, to be obtained reliable input, permeability testing in boreholes has to be carried out.

The main uncertainty when applying this method is generally represented by the geometry factor (G). The question presented by Tokheim and Janbu were designed originally for a three dimensional flow pattern. In rock mass however, one single joint set often completely dominates the water flow. To compensate the potential error due to anisotropy a L >> r should always be used when evaluating the geometry factor.

The water infiltration into tunnel and underground openings can greatly affect the stability, working condition inside the tunnel and environmental impact on the surface. Close to the surface the rock mass is more jointed and weathered and the joints are generally more open then deeper in the rock mass. Most infiltration therefore occurs in the part of the tunnel which is closest to the surface. However the most serious water leakages are often experienced in the deeper part of the tunnel where water may inflow into the tunnel under high pressure.

Presently there is very limited permeability test data (data from only one drill hole TC1 about K = 1.6×10^{-7} to 2.26×10^{-6} m/sec) (refer to Table 6-3 above) along the proposed route of the tunnel to calculate the possible groundwater inflow inside the tunnel.

Therefore during the detail investigation in the future it should carried out several test and obtained more data along the tunnel alignment to calculate the possible ground water inflow inside the tunnel. But the preliminary information indicating that there might be significant ground water inflow inside the tunnel particularly around the valley side and possibility of the drainage outside of valley might be a serious issue.

Tunnels below the ground water table can be either sealed or drained. The hydrostatic pressure can be relieved if the tunnel is drained. Drainage can influence the surrounding ground water considerably. The drainage effect the distribution of hydraulic head by attracting by ground water flow path. Sealed tunnels do not influence the ground water but their lining has to be supported the full water pressure.

At present, the density of human dwellings around the proposed tunnel alignment is not too dense. However, the sparse settlement at present all basically depend on shallow wells for everyday water use. The construction of tunnel excavation, especially in the inlet areas, is likely to cause draining of underground water into the tunnel and thus lowering the natural water table.

A detailed study and mapping of the underground water level and its possible underground water movement during construction and after the sealed tunnel is constructed need to be modelled and analyzed. A year-long pizometric water levels data at several locations would be necessary, along with water conductivity recordings. These data can be started to be recorded during the borehole drilling for tunneling works.

6.2 Road Plan

The optimum plan, Alternative C has an approach road, which is approximately 2.2km long. The approach road begins at the Tribhuvan Highway near a place called Kisipindi, about 4.8 kms from Kalanki Intersection. This section covers the classification and engineering approach such as determination of cross section, pavement type and composition, ancillary facilities etc.

6.2.1 Road Classification

The Study Road will be a part of Tribhuwan Highway. In this regard, the newly proposed route is recommended to be classified administratively into National Highway. For design purpose, the functional classification of the road is recommended as Class II based on its ADT.

6.2.2 Standard Cross Section

(1) Design Criteria

The design criteria to be applied for the design of the objective road are summarized in Table 6-4. This is the reviewed version of the design criteria of the DOR.

Table 6-4 Proposed Design Criteria for Highway Design

SN	Items		Parameters	Reference	Remarks
1	Highway Classification		National Highway Class II		
2	Design Speed (km/h)		60.0		5000-20000 PCU/day
	Cross section	No of lane	2.0		
		Formation Width (m)	12.0		
		Lane Width (m)	7.0		
		Outer Shoulder Pavement Width (m)	1.5		
		Outer Shoulder Earthern Width (m)	1.0		
		Camber/ Crossfall (%)	2.5		
		Slope of Earthwork			
		Fill	V:H = 1:1.5	JRA	
		Cut	V:H = 1:1.2 to 1.8	JRA	
3	Sight Distance	Stopping Sight Distance (m)	65	NRS	
4	Overtaking	Overtaking Distance (m)	300		
5	Horizontal Alignment	Minimum Radius of Horizontal Curve (m)			
		Desirable Minimum (m)	150		
		Absolute Minimum (m)	100		
		Unavoidable condition (m)	90		
		Maximum superelevation (%)	6		
		Minimum Length of Transitonal Curve (m)	50	JRA	
6	Vertical Alignment	Maximum Average vertical grade (%) section	4	NRS	
		Maximum Average vertical grade (%) in limited length	6	NRS	
		Critical Length of grade (m)			
		For less than equal maximum average	No limit	NRS	
		For greater than maximum average	210	NRS	
		Minimum Radius of Vertical Curve (m)			
		Crest / Summit Curve	1000		
		Sag / Valley Curve (m)	1200		

Note: Please refer the above table with Table 4-4 of Chapter 4.
Source: JICA Study Team

(2) Right-of-Way (ROW)

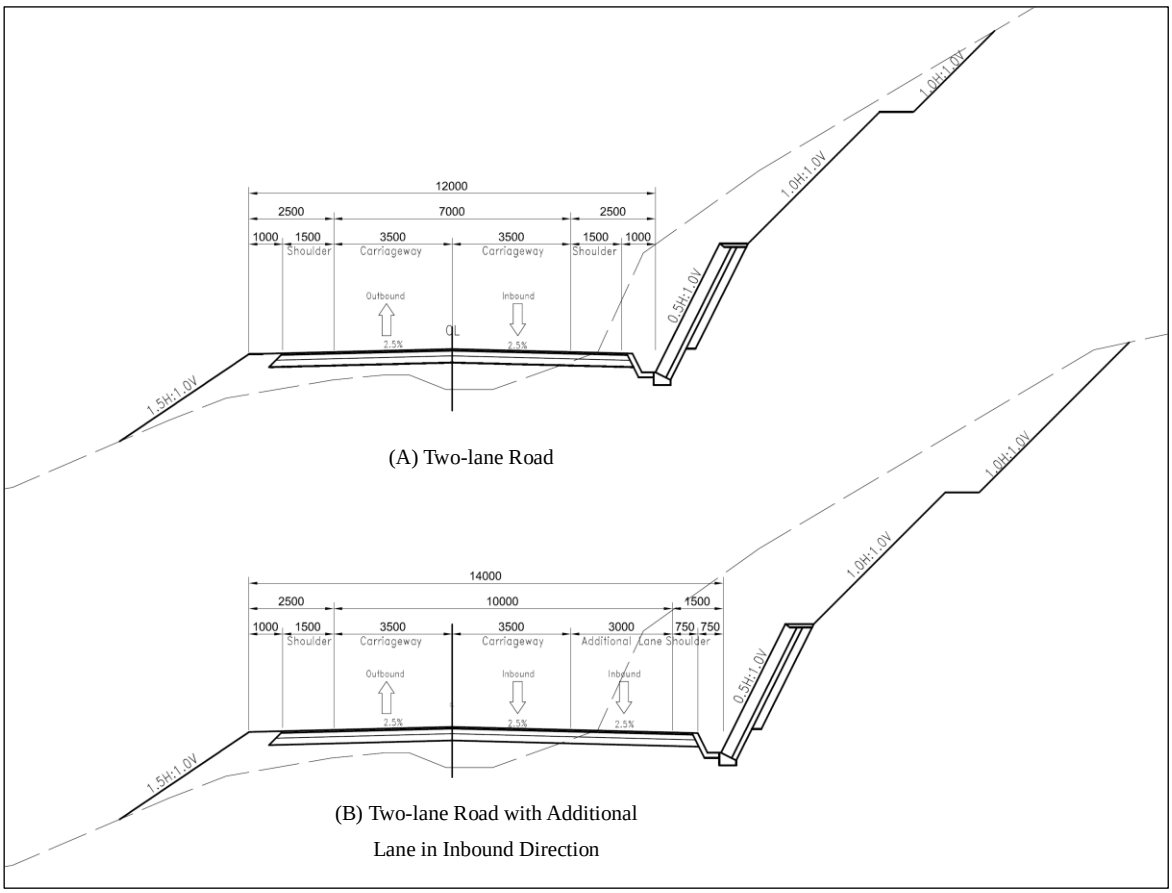
The ROW for the proposed approach road is 50m as according to the standards of Nepal.

(3) Standard Cross Section

The standard cross section to be applied to the Study Road is shown in Figure 6-7 (A). However, considering the fact that there are vehicles often stranded on the road due to failure of engines or other problems, provision of an additional lane on the inbound side, as shown in Figure 6-7 (B), is desirable near the tunnel and where or if the vertical grade is higher than 3.5%.

The standard cross section is based on the NRS-2070. It will have lanes 3.5m wide with a hard shoulder of 1.5m wide and an earthen shoulder 1m wide. Side ditch is provided at the cut sections. However, in urban areas, it is suggested to be provided on both sides of the road. The cross-fall of 2.5% has been applied for the paved section.

The slopes for fill and cut will be as shown in the figure. These slopes have been referred from the Japanese Standard. A slope of 1.5H:1V is recommended for fill sections and a slope of 1.0H:1V is recommended for cut slopes. The slopes will be essentially provided with berms, if the vertical height exceeds 5m.



(A) Two-lane Road

(B) Two-lane Road with Additional Lane in Inbound Direction

Source: JICA Study Team

Figure 6-7 Standard Cross Sections

6.2.3 Alignment

The Minimum horizontal curves and the minimum length of horizontal curvature will be as mentioned in the design criteria shown in Table 6-4.

Vertical grades have significant effect on heavy vehicles. The vertical grades are desirable to limit to the possible smallest value given that it is practical from the topography. Particularly, in case of the Study Road, the length of tunnel and road will be proportional with the vertical grade; the steeper the grade, the longer the tunnel and the road.

But, there are many old and heavily loaded vehicles presently plying on the Study Road. The number of such vehicles is expected to increase, if nothing changes for a period of time in the future. Therefore, in order to allow the comfort of smoother driving for these vehicles, use of low grades is desirable. Also, smaller vertical grades are preferred inside tunnels from ventilation point of view. As stated earlier, both AASHTO and NRS mention that the maximum grade for tunnels is 4%. But according to the standards for Tunnel in Japan, the maximum vertical grade is around 3%. Therefore, a vertical grade of 3.5%, in consideration to secure smooth flow inside the tunnel and also to minimize the effect from the emission of gas, has been applied in the optimum alternative route.

6.2.4 Pavement Design

(1) Design Guideline

Method of pavement design for roads had not been the same in Nepal due to the fact that most roads were constructed under the assistance of donors applying pavement design method on its own convenience.

However, now a pavement guide is available in Nepal. “Pavement Design Guideline (Flexible Pavement)” prepared under Planning, Monitoring and evaluation Unit, DOR, in 2013 is awaiting final approval from the concerned authorities. This guideline incorporates the design procedures of various standards such as the AASHTO’s Pavement Design Guidelines, Indian Road Committee (IRC 37-2001) Guidelines, Transportation Research Board (TRB), Federal Highway Administration Publication (FHWA), Pavement Structural Design of the AUSTROADS and Road Note 31 (UK). However, the method is close to the AASHTO procedure. It is therefore recommended that further studies in the pavement design should be conducted based on the above Nepali guideline or its equivalent.

(2) Pavement of the Study Road

Design of pavement essentially requires various data such as the traffic volume including the expected growth rate of vehicles, soil strengths of sub-grade, drainage condition, availability of the material etc. The detailed design of pavement is not under the scope of this Study. However,

taking into consideration that most of the paved roads in Nepal use flexible pavement (asphalt concrete), it is recommended that the study road be equipped with flexible pavement as well. This does not include the single or double bituminous surface treatment (SBST or DBST). In order to conduct a pavement design, it is recommended to conduct all surveys and investigation that are required for understanding the above requirements. These surveys include, traffic count for future demand forecast, CBR tests of the road bed and fill and base material.

6.2.5 Intersection Design

There are two locations where the study road will form an at-grade intersection with the existing Tribhuvan Highway.

(1) Start Point of Study Road

The starting point of the study road diverges from the existing Tribhuvan Highway near Sagarmatha Satellite Center, at about 4.8km from Kalanki. Considering that the study road after construction will have the main flow of traffic, it is suitable to modify the alignment of the existing road so that it intersects perpendicularly with the study road. Three types of control system can be applied; i) Traffic signal type, ii) Roundabout type, and iii) Yield type (traffic on existing road will yield to traffic on main road).

Application of control system needs to be determined during the next stage taking into account the traffic volume on each road, availability of land and impact to abutting properties.

(2) End Point of Study Road

The study road will merge with the existing road near the west side tunnel portal. A traffic signal intersection is recommended at this intersection for the following reasons;

- The distance from the tunnel portal to the intersection is short (only about 100m) which is not enough for the drivers on the existing road to notice the vehicles coming out from the tunnel,
- Increasing distance of intersection from the tunnel portal is difficult as this will require modification of the existing road alignment, which is not practical as that would increase the already steep grade (change of grade from present 6% to about 10%) of the existing road.
- There is no sufficient and suitable space for providing a roundabout,

6.2.6 Ancillary Facilities

Ancillary facilities of a road refer to facilities for protection and maintenance of the road as well as for streamlining and safe guarding smooth and safe transportation. The study road is a

highway, which emphasize the mobility function of a road. Therefore, the road should be necessarily provided with the ancillary facilities and road safety facilities. Some of the major facilities are;

i) Ancillary facilities
Bus lay-bys (bus bays), bus stand, information signs, guide post, side ditch, cross-drainage culverts/pipes etc.

ii) Road safety facilities
Guardrails/safety barriers, guard posts, traffic signs, traffic lights, traffic signals, road markings

6.2.7 Road Safety facilities

Facilities for road safety such as guard rails, safety barriers, delineators, guide blocks, crush barrier, road traffic signs and markings, in accordance with the existing traffic and safety manual and the road safety notes of the DOR.

6.2.8 Slope Protection

As have been mentioned in Chapter 4, most part of landslides and collapses along the road can be found along the road to Naubise from Nagdhunga pass. Landslide or collapsed occur during the rainy season mainly, causing road closures for certain days and interrupting the traffic. As a measure for protection of collapse, gabions are observed to be placed at the bottom of the slope. However, it is limited at the bottom part only and is not provided up in the slopes. In order to establish proper measures against collapse of slopes, detailed investigation including survey of the geological conditions and topography of the site is indispensable. But if/where large scaled slope measures are required, road widening by using land bridge at the valley side can be effective and economical in the long run.

In the section from 9km ~ 12km, in addition to sediment collapse, the sandstone rock failure is also anticipated as shown in the geological map in Figure 6-1. At other locations, it is judged from the facts that as the slopes consist of thin alternating layers of sandstone and significantly weathered phyllite bedrock, collapsed soil will not contain a large mass of rock.
Therefore, in order to prevent the collapse accident, it is necessary to make or assign a small mass of rock that is exposed to the mountain slope at 9km ~ 12km, to stabilize, with the use of rope (wire) or concrete.

Also, at other locations, free frame of engineering, which can be constructed in any kind of slope, is recommended for stabilization of collapsed slope. Sustainable management of slopes is required for both methods. Therefore, as already mentioned, it is rather desirable to provide land bridge at the valley side, if the road needs to be widened.

6.2.9 Other Considerations

Further discussions with concerned authorities are deemed necessary to determine on the following facilities.

(1) Check Posts

There are points designated as check posts for checking vehicles coming into and going out of Kathmandu. Recently it exists in Nagdhunga crossing. After construction of the study road, almost all traffic is expected to use this road, which will necessitate provision of similar location for the said purpose. Provision of such location at Naubise side is difficult unless it is provided near Khanekhola or Naubise where the topography is relatively flat. Candidate location is available at the Kathmandu Valley on the approach road. However, consideration is required to avoid any possible adverse effect inside the tunnel section.

(2) Weighing Scales

At present, there are no weighing scales used for checking and controlling the loads of a vehicle. Checks, mostly manually by police are conducted but irregularly. This needs to be intensified to preserve and maintain the roads. Particularly, it is important to control such vehicles from passing the tunnel section. Therefore, provision of weighing scales and its location should be considered in the next study.

6.3 Tunnel Plan

6.3.1 Tunnel Cross Section

Cross section of tunnel section is dependent on the method of operation after its construction. The alternative route that has been proposed can function as a bypass for the existing road. Once this route is constructed, then in reality there will be two roads within this section. In such case, there are seven possible different methods that could be applied for operation of the proposed road in combination with the existing road. They are;

Method-1: Two-way use of proposed route and two-way use of existing road

Method-2: One-way inbound use of proposed route and two-way use of existing road

Method-3: One-way outbound use of proposed route and two-way use of existing road

Method-4: One-way inbound use of proposed route and one-way outbound use of existing road

Method-5: One-way outbound use of proposed route and one-way inbound use of existing road

Method-6: Two-way use of proposed route and one-way inbound use of existing road

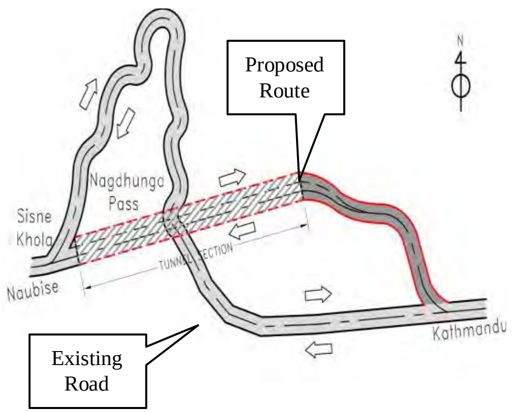
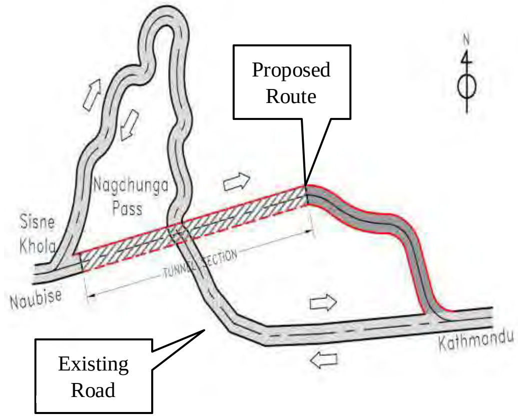
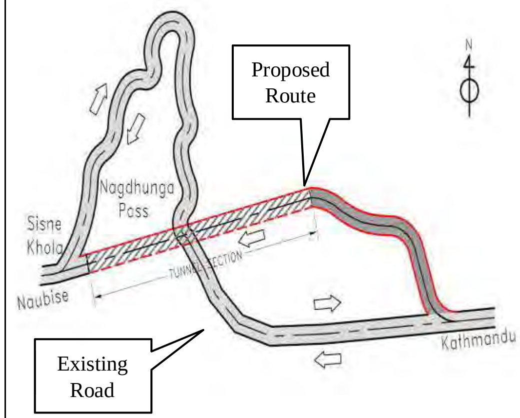
Method-7: Two-way use of proposed route and one-way outbound use of existing road

However, it is clear that the bottom four methods (Method-4 to Method-7) are impractical as the use of existing road is limited to one-way traffic only. If the road is regulated as one-way road, then it will be very inconvenient for the community people living in this area as they will have to take a long detour to access to their houses. Therefore, the methods that limit the existing road to one-way traffic are dropped out from the conceivable operation methods. The remaining three methods are selected for a comparative study. Table 6-5 shows the comparison of these operation methods.

According to the results, Method-1 has more merits in comparison to other methods. However, it is costly than other methods as it will have three lanes (an additional lane for slower vehicles and mal-functioned vehicles. The rough estimation of the construction cost is about 1.2 times higher than other methods. But, considering the number and the capacity of the vehicles plying this road, application of Method-1 is recommendable as it can;

- ✓ retain its function even if vehicles occupy a lane due to mechanical mal-functioning,
- ✓ differentiate slower vehicles from faster ones using the additional lane for climbing lane,
- ✓ generate more revenue if toll fee is to be collected, and
- ✓ be enjoyed by all traffics, regardless of the direction, and the communities along the existing road will have a better environment; clean and quiet.

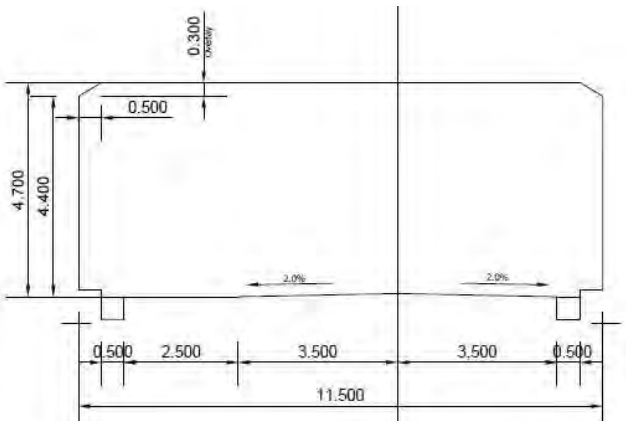
Table 6-5 Comparison of Operation Methods

<table>
<tr><td>Methods</td><td>Methods-1
Proposed Route:2 - way
Existing Road : 2 - way</td><td>Method-2
Proposed Route : 1- way (Inbound)
Existing Road: 2 - way</td><td>Method-3
Proposed Route : 1- way (Outbound)
Existing Road: 2 - way</td></tr>
<tr><td>Schematic Diagram</td><td> 
</td><td> 
</td><td> 
</td></tr>
<tr><td>Merits</td><td>• Benefits (smooth and safety travel, reduction of travel time and vehicle operating cost) can be enjoyed by both direction vehicles
• Improve access to communities along the route
• Improve environment of abutting communities along existing road
• Toll revenue is highest if toll system is applied
• Traffic accidents at built-up areas be reduced</td><td>• Benefits (smooth and safety travel, reduction of travel time and vehicle operating cost) can be enjoyed by inbound vehicles
• Gas emission is less than Method-1. Ventilation easy.
• Cost 1.2 times lower than Method-1.(additional lane on proposed route not required)</td><td>• Additional lane on proposed route for overtaking not required
• Gas emission is least. Ventilation is easy</td></tr>
<tr><td>Demerits</td><td>• Additional lane on inbound direction required on proposed route to facilitate overtaking and to secure space for stranded vehicles
• Construction cost and maintenance cost will be 1.2 times higher than other methods
• Ventilation is complicated than other methods</td><td>• Emission of gas larger than Method-3
• Access to new communities limited in inbound direction only
• Toll revenue half of Method -1
• Traffic accident risk at built-up areas remain high</td><td>• Toll revenue is lowest (vehicles may not use)
• No contribution in environment improvement of abutting communities on existing road</td></tr>
</table>

Source: JICA Study Team

6.3.2 Section of the Roadway

The section of the roadway within the tunnel of the proposed road is indicated in Figure 6-8. AASHTO recommends the minimum width and height for two-lane tunnels as 8.8m and 4.7m respectively. However, as explained in the previous section, the tunnel is recommended to have three lanes; two-lanes in the inbound direction (going towards Kathmandu) and one-lane in the outbound direction. Therefore, in this context, the minimum required width of the tunnel is 11m. This includes two 3.5m wide lanes, a 2.5m wide additional lane on the inbound direction (going towards Kathmandu) and a 0.5m wide shoulder on both sides of the road.



Source: JICA Study Team

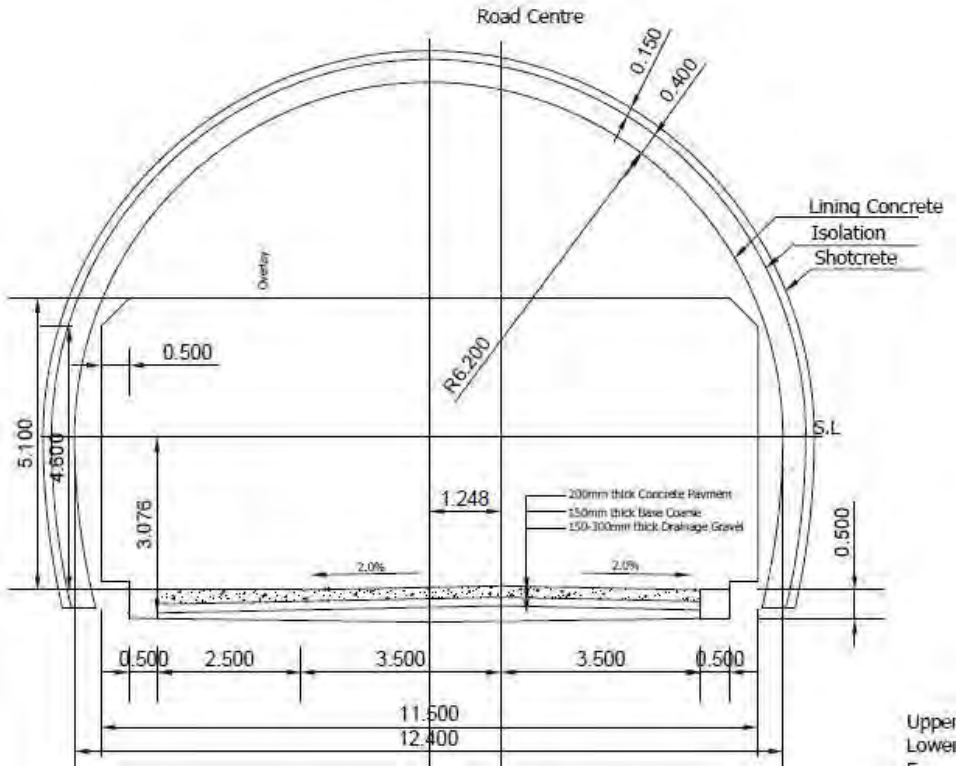
Figure 6-8 Dual Carriageway Roadway Section

6.3.3 Cross Section of Tunnel

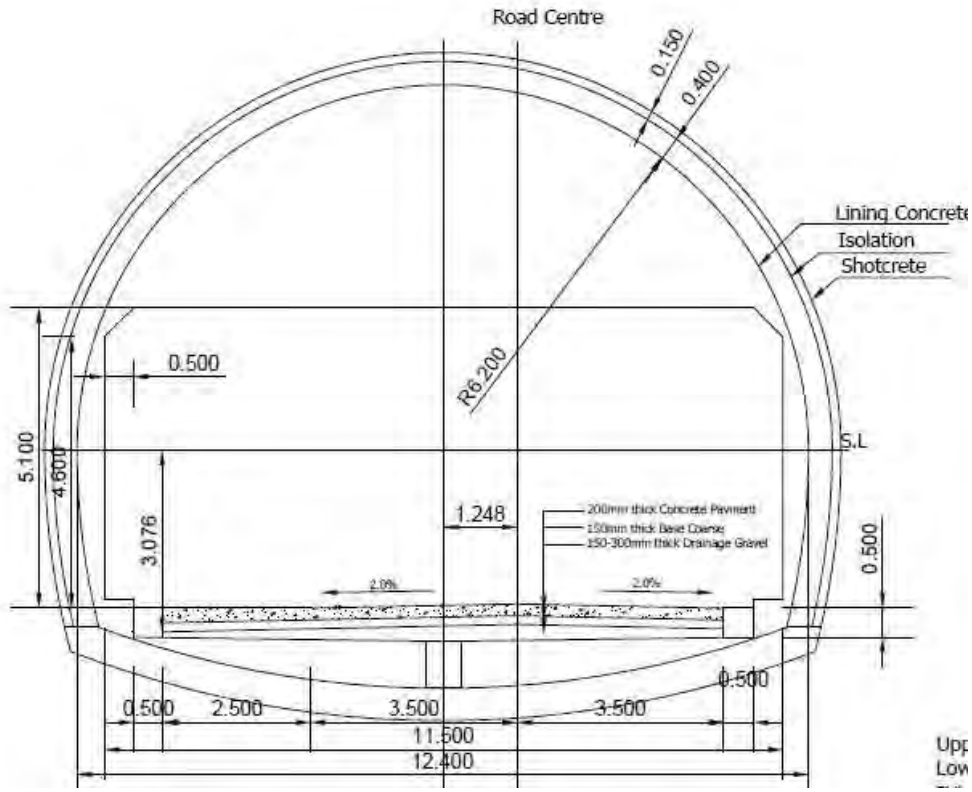
The cross section of the tunnel is determined to satisfy the requirements mentioned above and NATM is applied for its construction. The NATM requires the minimum clearance from the critical points to the tunnel lining to be more than 50mm as it consists of the Shotcrete with bolts and steel support, the isolation and the lining concrete.

The cross section of the proposed tunnel is shown in Figure 6-9. Figure a) shows the cross section for an assumed geological distribution of medium-hard or hard rock. Figure b) on the other hand shows the cross section for a withered rock distribution. The type of rock was not able to confirm from the drilling conducted this time as the samples were not properly extracted. Therefore, the cross section to be applied should be determined in the next study after identifying the distribution of the rock bed. The excavation area required is about 111 m2.

The section with invert concrete for the weathered rock ground, shown in Figure 6-9 b) is also applicable to a water-tight lining. This can help avoid flowing of groundwater into the tunnel and minimize the impact to the wells of the surrounding areas (lowering the groundwater level).



a) Medium-Hard/Hard Rock



b) Medium-Hard/Hard Rock

Source: JICA Study Team

Figure 6-9 Cross Section of Proposed Tunnel

6.3.4 Vertical Grade

The vertical grade of 3.5% has been applied for the tunnel. The maximum longitudinal gradient of the tunnel is 4% in AASHTO, preferably 3% for Japanese Highway. When it exceeds 5%, the distance of the gradient is limited to about 250m. In the recent High Standard Highway Project by Ministry of Land Infrastructure and Transportation in Japan, a 4% longitudinal gradient has been adopted, though the tunnel is longer than 4km.

Application of a vertical grade of 4% will obviously shorten the tunnel length compared to 3.5%. However, as the east side portal has a sloped topography, the change in the grade will not shorten the tunnel length significantly. In the case of the proposed route (Alternative C), the difference in the tunnel length is only about 100m. Therefore, a vertical grade of 3.5% is recommended.

6.3.5 Minimum Coverage of tunnel at Flat Area

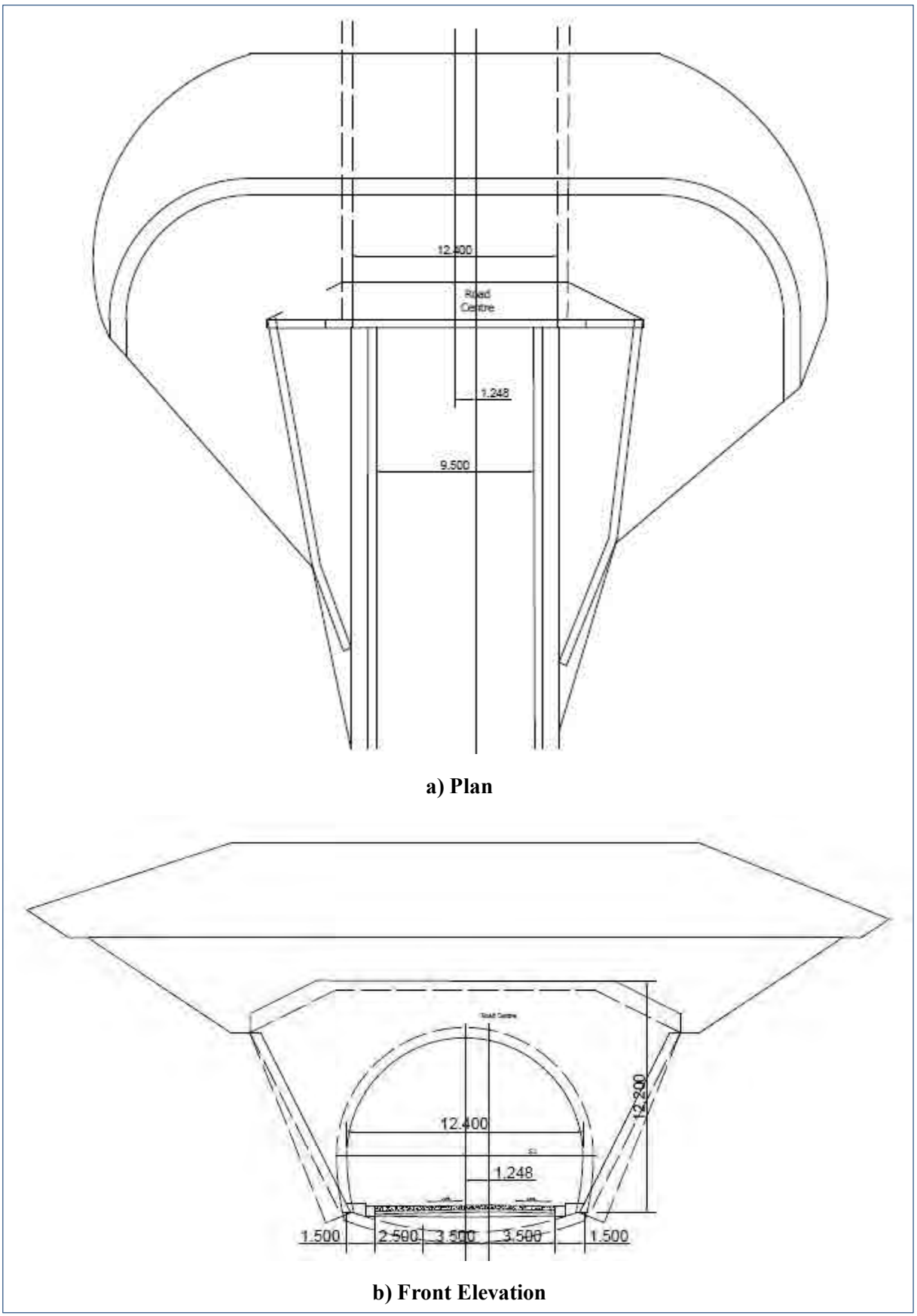
The east side portal of the tunnel (Kathmandu-side) is located in flat area of the valley as shown in Photo 6-7. As the topography is relatively flat, the crown of the tunnel needs to be about 10m below the surface so that certain coverage (overburden) at the portal is secured.

Source: JICA Study Team

Photo 6-7 Location of Start Entrance of Tunnel

6.3.6 Tunnel Entrance

The tunnel entrance is planned to have about 12m overburden to the surface at the entrance. Therefore, the slope on the tunnel at the entrance is about 10m high, and simpler structure of wall type entrance, as shown in Figure 6-10 is considered as suitable to both entrances.



a) Plan

b) Front Elevation

Source: JICA Study Team

Figure 6-10 Tunnel Entrance

6.4 Plan of Bridges and Other Structures

6.4.1 Review of Design Standard

Nepal Road Standards (NRS 2027) contained the standard design for various kinds of bridges in Nepal published in 1988. However, this is too old to adopt to design bridges in Nepal now. Department of Road (DOR) has formulated these standards with a view to establish a common procedure for design and construction of road and bridge in Nepal. It is called "Nepal Bridge Standards-2067 (2010)".

However, the above standard is not practical enough for design all kinds of bridges at the construction site, therefore, IRC (Indian Roads Congress), AASHTO (Standard Specifications for Highway Bridges) and Japanese Standard shall be applied for the items not covered by the above NBS 2067.

6.4.2 Bridge Classification

Classification of bridges shall be as follows:

- Culvert : Length up to 6m
- Minor Bridge : When length ≤ 50m (with span ≤ 25m)
- Major Bridge : When span > 25m or length >50m (with smaller spans)
- Special Bridge : Bridge that require special design considerations, whose construction features (e.g. concrete girder bridges with >50m span, steel truss >100m span, arch bridges, suspension bridges, cable-stayed bridges and other non-standard bridges).

6.4.3 Clearances

(1) Vertical Clearance

The vertical clearance of structures shall be:

- For all roads not less than 4.75m for through structures.
- Overhead wires, poles etc. shall be at least 7.0m above the highest point of the road surface.

(2) Horizontal or Lateral Clearance

The horizontal clearance is the clear width available for the passage of vehicles. For culverts, the full roadway width as well as width of shoulders shall be carried through.

6.4.4 Minimum Free Board

In case of bridges over water bodies, the free board from the design HFL (Highest Flood Level) with afflux to the lowest point of bridge superstructure shall not be less than 1.0m. The minimum freeboard shall be as shown on the following Table 6-6.

Table 6-6 Minimum Free Board

Discharge (m^3/sec)	Minimum Free Board (mm)
Less than 200	1,000
201-500	1,200
501-2,000	1,500
2,001-5,000	2,000
5,000 and above	More than 2,000mm (depending on the reliability of the available data for the calculation of discharge)

Source: JICA Study Team

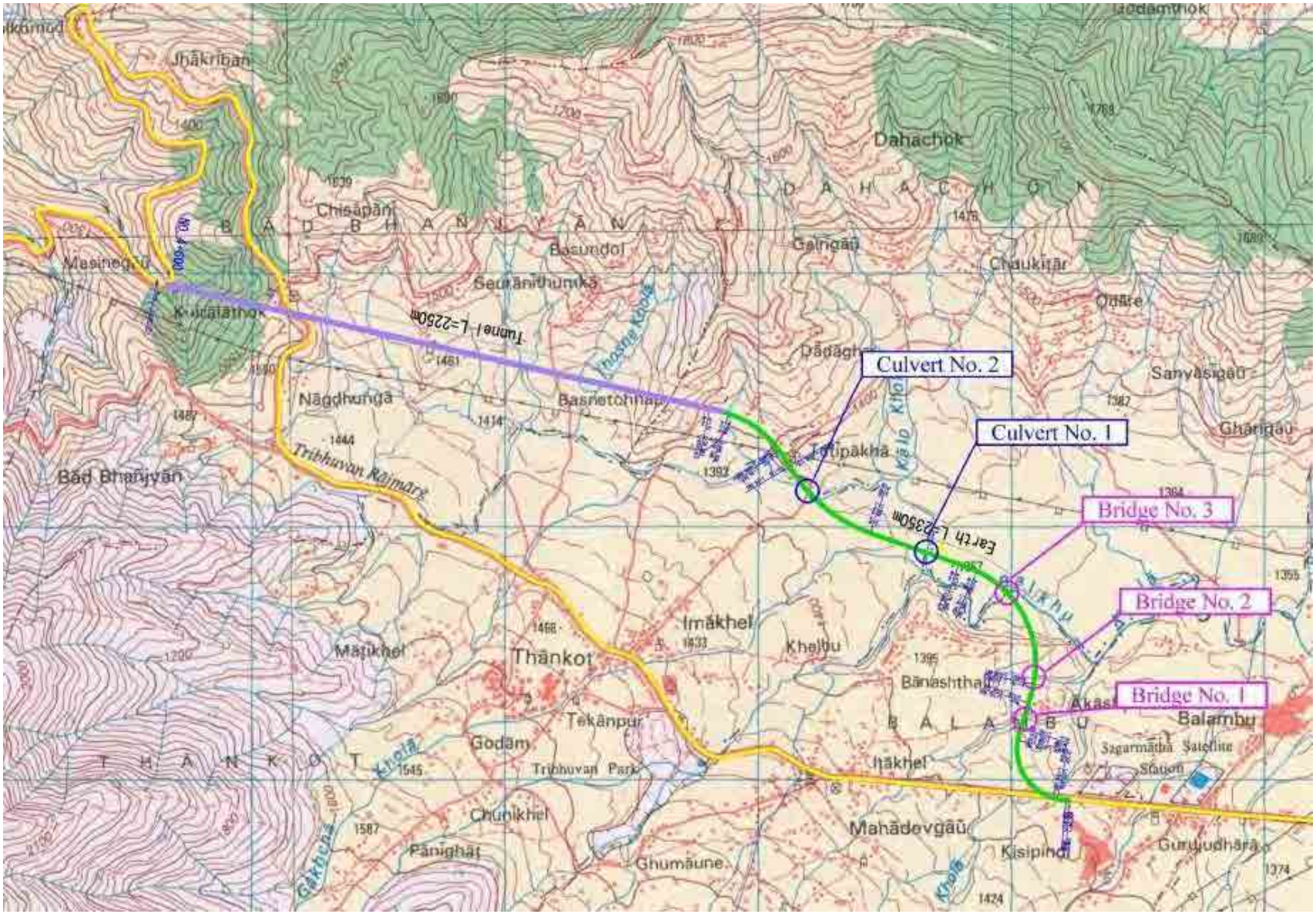
6.4.5 Bridge Loadings

All permanent road bridges in Nepal shall be designed per IRC loadings or AASHTO loadings. All design shall be carried out in accordance to IRC standards for bridges unless otherwise specified in the project documents. There are various kinds of bridge loadings such as dead load, live load, impact friction, pre-stress, creep and shrinkage of concrete, dynamic water pressure, earth pressure, buoyancy, wind load, thermal effects and seismic force are considered in design of bridges and culverts.

6.4.6 Location of Structures

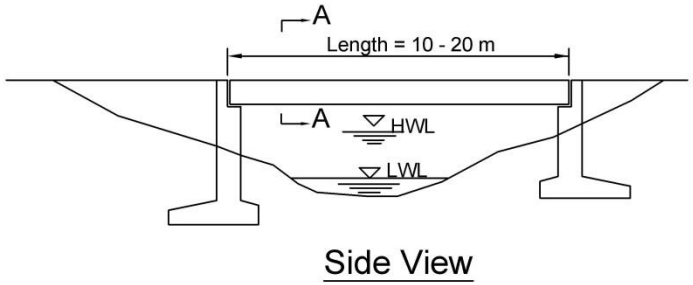
There will be several structures along the proposed route. Bridges and culverts will be located on Figure 6-11 as typical bridges and culverts for the optimum rote. Tree bridges are shown on Figures 6-12 and 6-13 and two culverts are shown on Figures 6-14 and 6-15.

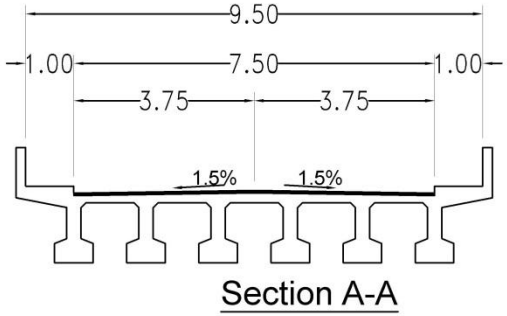
However, the above drawings of Figure 6-12 to Figure 6-15 are only assumptions, more detail drawings will be finalized in the course of the land survey.



Source: JICA Study Team

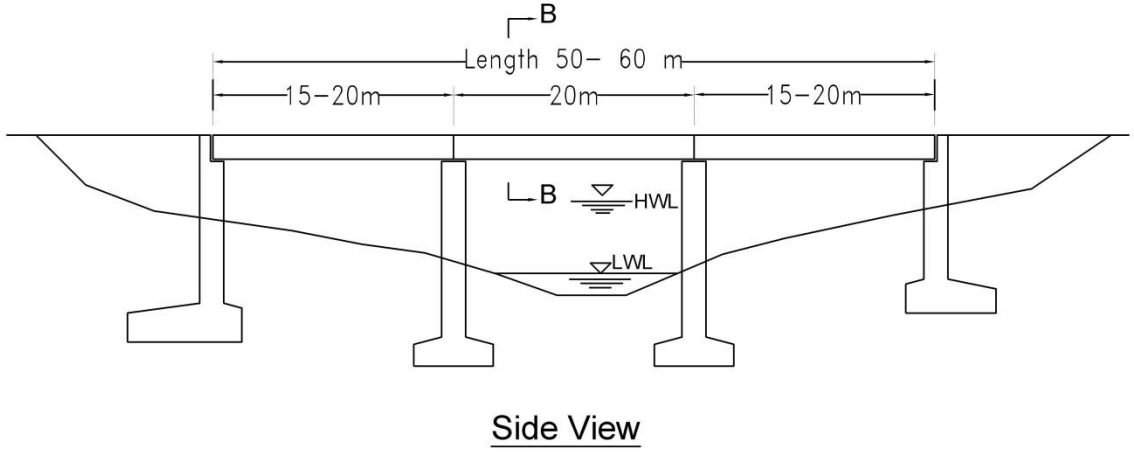
Figure 6-11 Location of Structures

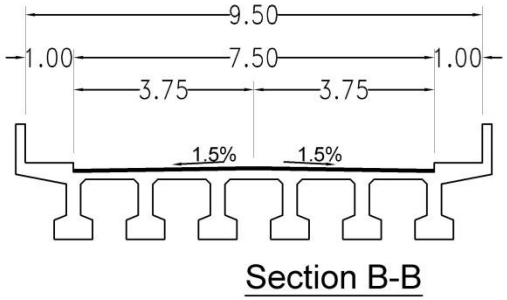




Source: JICA Study Team

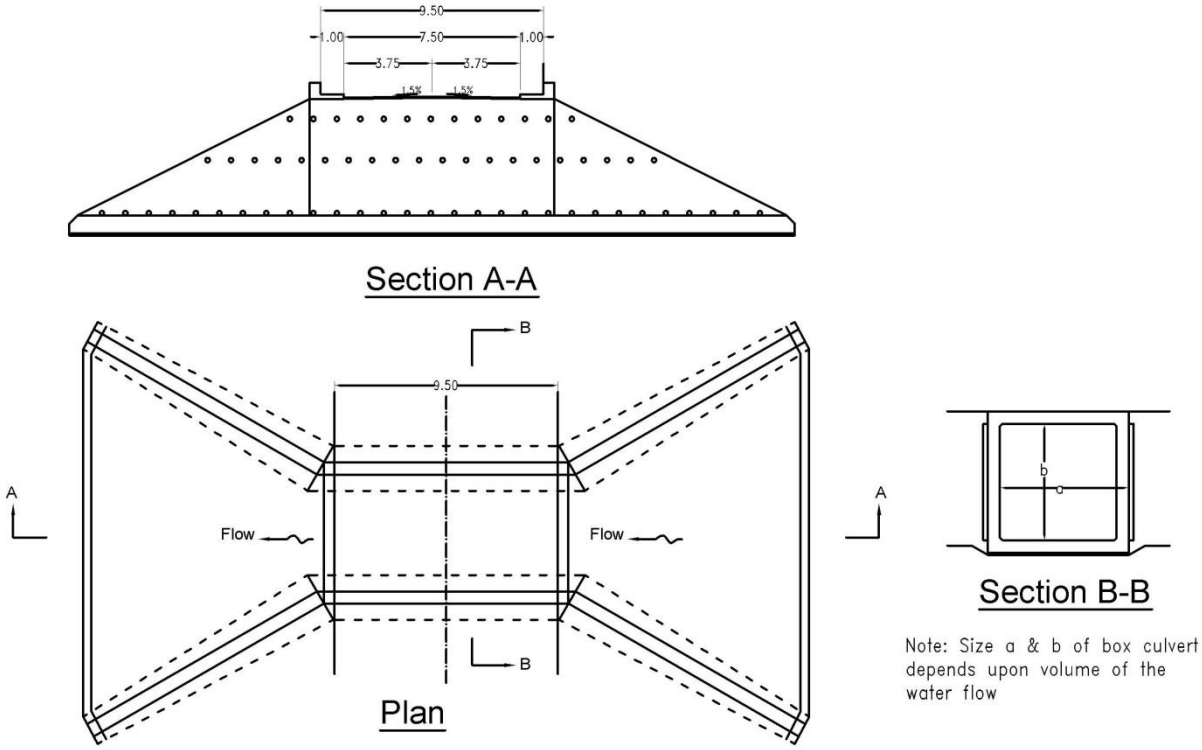
Figure 6-8 Bridge No.1 and No.2





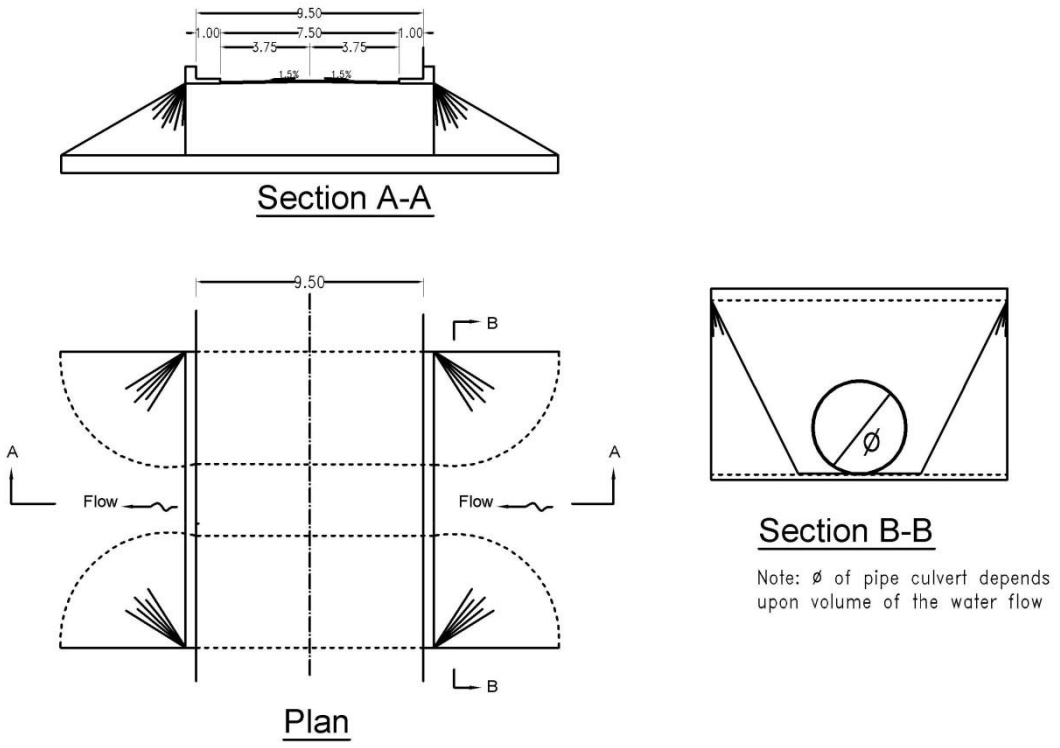
Source: JICA Study Team

Figure 6-9 Bridge No.3



Source: JICA Study Team

Figure 6-14 Culvert No.1



Source: JICA Study Team

Figure 6-15 Culvert No.2

Chapter 7 Construction Plan and Cost Estimation

7.1 Construction Plan of Road

Construction of a road is relatively simple compared to construction of a tunnel. Particularly, the Study Road section is planned on relatively flat ground and is not in the steep mountains. In this regard, no special technology, special equipment or material that will have substantial influence on the project cost is deemed required. However, there are some rivers running near the proposed routes. Provision of bridges to span the rivers will be required. Also, there is a possibility for a need to divert the existing river. In such case, a simple construction plan including procurement methods of construction equipment and material is required, which is briefly discussed hereunder.

7.1.1 Major Construction Material

The basic construction material such as fill material, rocks, cement, reinforcement bars, asphalt material and steel structures are basically available locally but are manufactured and imported from the neighboring country India. There are sufficient amount of these materials at the wholesalers and need not be imported by an individual. However, the steel structures and some large- sized pipes need to be imported for a particular project. The list of major materials and its procurement condition is summarized in Table 7-1.

Table 7-1 List of Major Construction Materials and its Procurement Conditions

No.	Major Construction Material	Specifications	Local Procurement	Import	Remarks
1	Cement		○	○	Low quality
2	Reinforced Bars		○	○	
3	Steel Material(Sheet-piles)			○	
4	Formworks Material		○		
5	Scaffolding/ Supporting		○		
6	Aggregate, Sand, Borrow Soil		○		
7	Ready Mix Concrete	18N～24N/mm2	○		
8	Concrete Pipes	φ600 to 900mm	○		
9	Bitumen		○	○	

Source: JICA Study Team

7.1.2 Major Construction Equipment

Most of the major construction equipment used for the construction of roads except for piling rigs for bridge construction is available locally. Asphalt paver is owned by some of the construction companies. The list of major construction equipment and its procurement conditions are summarized in Table 7-2.

Table 7-2 List of Major Construction Equipment and its Availability

	Major Construction Machinery	Specification	Local Procurement	Import	Remarks
1	Excavator (Back Hoe)	0.45, 0.8m3 bucket	○		
3	Bull Dozer	21ton	○		
4	Giant Breaker	1,300kg	○		
5	Dump Truck	4 ton, 10ton	○		
6	Truck Crane	4.9ton	○		
7	Motor grader	W=3.1m	○		
8	Tire Roller	8-20ton	○		
9	Vibration Roller	10ton	○		
10	Concrete Pump	90-110m3/hr	○		
11	Crawler Crane	50ton	○		
12	Generator	10-100KVA	○		
13	Asphalt paver		○		Local Contractors

Source: JICA Study Team

7.1.3 Borrow Pits, Quarry Sites, Disposal Area

Borrow pits and quarry sites are readily available near the project site as shown in Figure 7-1. There are several quarry sites operated by the local people. These sites are believed to be under operation without proper permit from the government. Therefore, it is important to confirm the legally permitted quarry sites in order to avoid unexpected circumstances.

There are no legally designated disposal sites near the project area. According to the hearings with the DOR, the candidate disposal areas are proposed by the consultant during feasibility study. DOR then conducts a study to check the suitability of the locations and undertake measures required, if any from the social and environmental consideration point of view before declaring them as designated disposal sites. The Study Team has confirmed three candidate locations for disposal of soil, as shown in the figure below

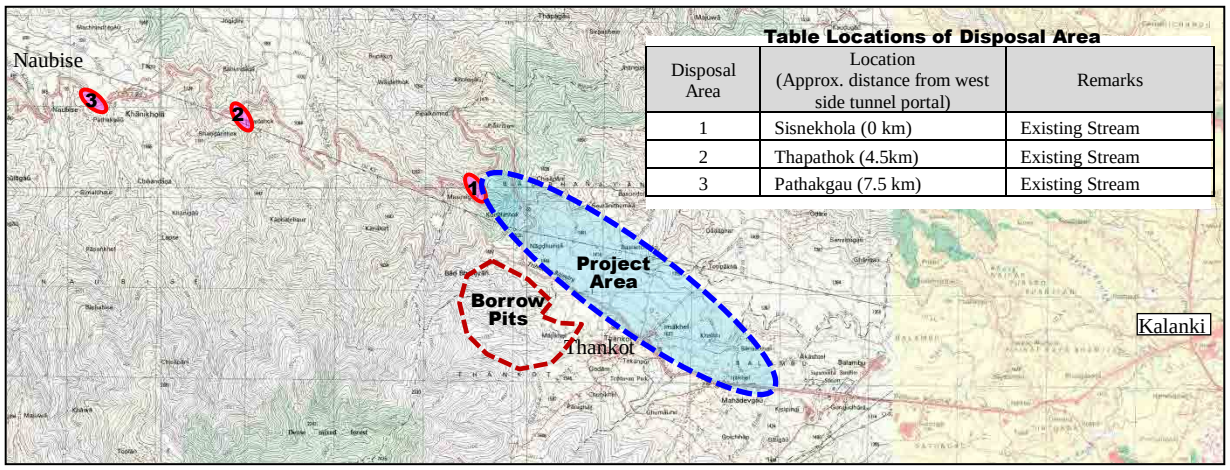


Table Locations of Disposal Area

Disposal Area	Location (Approx. distance from west side tunnel portal)	Remarks
1	Sisnekhola (0 km)	Existing Stream
2	Thapathok (4.5km)	Existing Stream
3	Pathakgau (7.5 km)	Existing Stream

Source: JICA Study Team

Figure 7-1 Locations of Disposal Area

7.1.4 Construction Method

The construction works of the road sector will include excavation of earth, hauling, placement and compaction of embankment materials, pavement, bridges, culverts, and other structural works and installation of road facilities and traffic signals. To minimize the hauling of borrow materials, excavated soil within the project shall be utilized as much as possible and the remaining volume will be hauled from borrow pits close to the embankment site.

The proposed bridges and culverts are mostly reinforced concrete type of structures. They will be constructed basically by cast-in-place with all staging method using falseworks and formworks. All material, cement, reinforced bars, aggregates for concrete, bitumen, pipes etc. are available locally.

7.1.5 Capacity of Local Contractors

In the last decade, considerable progress has been made in the construction of roads. Recently, there are roads being constructed at many places. According to the Federation of Contractors Association of Nepal, there are more than 250 contractors registered as members. Some of the contractors now have sufficient knowledge, technology and equipment for construction of roads. However, maintaining quality and schedule still remain as major concerns.

In 1974, The Industrial Enterprises Act, which is the first act to define 'Contractor' in Nepal. It made provision for the classification and registration of contractors. According to this act all construction firms must register themselves with the Ministry of Works and Transport in class A, B, or C contractors depending upon the technical manpower, value and number of works done, machinery and liquid assets available. The capacity of these contractors in terms of bidding limits is shown in Table 7-3.

Table 7-3 Bidding Limit by Classification

Classification	Build Limit (1975) (Million Nepali Rupees)	Build Limit (1999) (Million Nepali Rupees)
A	Above 10	Above 20
B	Less than 10	Less than 20
C	Less than 3	Less than 6
D	Less than 1	Less than 3

Source: HP, Federation of Contractors Association of Nepal

Compared to international contractors, the level/capacity of these local contractors is relatively low. This is because the major works these contractors undertake are limited to repairs and rehabilitation and those do have experience in constructing new roads, in most cases they work as a sub-contractor.

This project is scheduled to be implemented under a consortium with a Japanese construction company. The local contractor(s) involved in this project can have technical transfer from the Japanese company in terms of quality control, schedule control and safety control and

environmental mitigation measures. This will contribute in enhancing the capacity of the contractors which will be beneficial to the GON.

7.2 Construction Plan of Tunnel

7.2.1 Major Construction Material

Construction material to be used for tunnel is basically concrete, shotcrete and rock bolt. However for temporary support, H-beams will be required. The availability of the material is as shown in Table 7-1.

7.2.2 Special Construction Equipment

Special equipment used for NATM is Rock Drilling Machine, Shotcrete mixing plant, Shotcreting Machine, Side-dump Loader and Ventilation Fan. Photos 7-1 shows the equipment. These material are neither available locally nor can be procured from India. Therefore, all these equipment are required to be procured from Japan. The concrete lining equipment such as sliding form is also required to be procured from Japan. In addition, the deficiency of power supply, which is evident from the everyday load shedding in the Kathmandu Valley, necessitates some special engine air compressor also to be procured from Japan.

(a) Rock Drilling Machine

(b) Shotcrete Mixing Plant

(c) Shotcreting Machine

(d) Side-dump Loader

(e) Ventilation Fan

Source: JICA Study Team

Photos 7-1 Special Equipment for Tunnel Construction

7.2.3 Capacity of Contractors and Human Source

Although there are a number of hydro-tunnels in Nepal, the number is nil when it comes to road tunnels. Therefore, the contractors involved in hydro-tunnel projects might have some knowledge and experience in the conventional method. But there are no contractors that have experience of NATM tunnels.

On the other hand, the workers involved in the construction of a tunnel needs to have knowledge and skill to work in a narrow space and are also required to be familiar with the safety issues as it requires blasting. Human resources with such skill and experience are hardly available in Nepal. Therefore, a tunnel excavation team which consists of tunnel foremen, tunnel special worker, and tunnel regular worker is desirable to be procured internationally. However, concrete lining team and other maintenance specialists such as electrician, mechanics in addition to ordinary worker are available in Nepal.

As a mountainous country, needs for tunnels to ensure faster and safer transportation of people and goods is expected to increase in the future. Implementation of this project can provide an opportunity to enhance the capacity of local contractors in this field thru technical transfer on application of NATM, quality, schedule and safety control including deformation check during tunnel excavation etc. from Japanese contractors, which in a long run is deemed to be beneficial to Nepal.

7.2.4 Construction Yard and Water Treatment Plant

An empty space available near the west side portal (exit toward Naubise) of the proposed tunnel is a suitable candidate for construction yard. The location of the yard is shown in Photo 7-2 (a). The treatment of drainage during excavation is easier if excavated from the west side portal. As such, availability of a yard at this location is favorable for the construction. On the other hand, a muddy water treatment plant is used to treat the muddy water discharged from the tunnel during construction. This will remove the sediments and neutralize the discharged water. Photo 7-2 (b) shows the treatment plant. Adding to the tunnel portal, about 2 ha of national forest in this area shall be cleared for the construction.

(a) Location of Construction Yard

(b) Muddy Water Treatment Plant

Source: JICA Study Team

Photos 7-2 Construction yard and Water Treatment Plant

7.2.5 Disposal Area

Considering the excavation volume of rock material, the disposal area the volume of which is about 350,000m^3 is required for the project. The disposal area of each project is indicated by DOR during the design stage, before the start of the work.

In the region of the project, the environment team of DOR will indicate the location and appropriate EIA is obtained when required. The candidate locations of disposal area are shown in Figure 7.1. These areas after fill may be used for the additional lanes, for the control office of the tunnel and for the region development program such as "Michino-Eki".

7.2.6 Lighting

The lighting of the tunnel is very important for securing traffic safety inside the tunnel. The lighting must be planned such that both the initial cost and maintenance cost is economical. Recently, LED lighting is in common use whose overall cost is less than the conventional lighting. Therefore, it is recommended to use LED lightings inside the tunnel as far as possible.

7.2.7 Safety Facilities

The tunnel length of 2.35km and the daily traffic of 7,500 classify the tunnel class B in Japanese road tunnel safety standard. The class B tunnel requires provision of;

- Emergency telephone in the tunnel
- Push button report facility in tunnel
- Emergency alarm at the entrance of tunnel
- Portable fire extinguisher in tunnel
- Evacuation guide panel on tunnel wall

On the other hand, a class A tunnel that has low traffic volume, in addition to the above safety facilities, the following facilities for safety reasons are required.

- fire hydrant
- evacuation route or smoke removal equipment/system (ventilation system can be designed that will function as smoke removal system)

7.2.8 Ventilation

From the tunnel length (L) of 2.35km and the recent traffic volume (N) of 7,500 per day excluding motorbikes, the limit of the natural wind ventilation estimated, in accordance with Japanese Road Tunnel Ventilation Standard, is as follows:

1) Design Hourly Traffic Volume in City/Rural Area and Flat Topography
   N= 0.090 × 7,500 = 675 vehicles per hour
2) Two (2) directions Traffic Tunnel
   L・N = 675 × 2.35 = 1,586 over 1,000
   Hence, Natural Wind Ventilation is not applicable, and provision of ventilation system is required. The typical ventilation by the Jet Fans will be most simple and applicable among various ventilation systems.
3) One (1) direction traffic tunnel
   L・N = 666～888 < 3,000
   Hence, Natural Wind Ventilation is effective up to the maximum traffic volume of the project road.

7.2.9 Power Supply Facilities

One of the prerequisites in connection to the implementation of this project is assurance of power supply and backup system. Stable and continuous electricity supply will be critically required during operation and maintenance, particularly inside the tunnel section to keep the ventilation and lights adequately functioning.

The total electric power demand of the tunnel will reach to 1,000 kw. Supply of this power in a stable and continuous manner can be made available from Nepal Electric Authority (NEA). However, a minute of understanding (MOU) has to be signed between MOPIT and MOE for this provision. This is possible if the project road is enlisted in the National Priority Project List. The power supply line to the tunnel from the transmission line or directly from the nearby substation of NEA needs to be maintained as well as the provision of power supply system inside the tunnel is required.

7.3 Project Cost

7.3.1 Basic Assumptions

The project cost is estimated under the following assumptions;

- The consultant/engineering fee (detailed design fee and construction supervision fee) is taken as 25% of the direct cost.
- The contingency fee is taken as 15% of the construction cost.
- The construction of approach road (length 2.25km) including the bridges, culverts and other structures will be undertaken by a Japanese contractor.
- The construction of the tunnel section (length 2.35km) will be undertaken by a joint venture consortium between a Japanese contractor(s) and Nepali contractor(s).
- The facilities to be provided inside the tunnel are also constructed by a Japanese contractor.
- The maintenance cost of the tunnel is estimated mainly based on the repair or exchange of the equipment of the such facilities as Lighting, Safety Facilities, Ventilation and Power Supply Facilities

7.3.2 Construction Cost

The construction cost estimated under the above assumption is summarized in Table 7-4. The project cost will be the sum of this construction cost and other essential costs such as the annual maintenance cost, consultant fee, contingency fee, price escalation fee, taxes, land acquisition fee etc. is the project cost.

Table 7-4 Rough Estimation of Construction Cost

No.	Item	Scope	Estimated Amount (Japanese Yen)	Remarks
1	Approach Road	L=2.25km, earth section	0.5 billion	Asphalt pavement
2	Structures	3 bridges and 2 culverts	0.6 billion	Reinforced concrete
3	Tunnel	L=2.35km	10.3 billion	NATM
4	Tunnel Facilities	1 set	1.5 billion	
Total			**12.9 billion**	

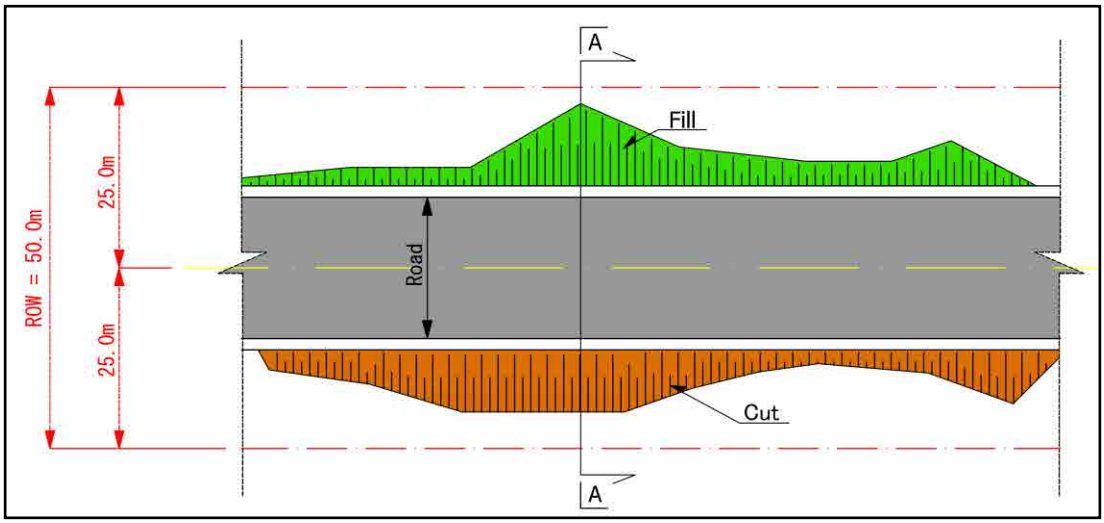
Source: JICA Study Team

7.4 Land Acquisition Cost

7.4.1 Target Area for Land Acquisition

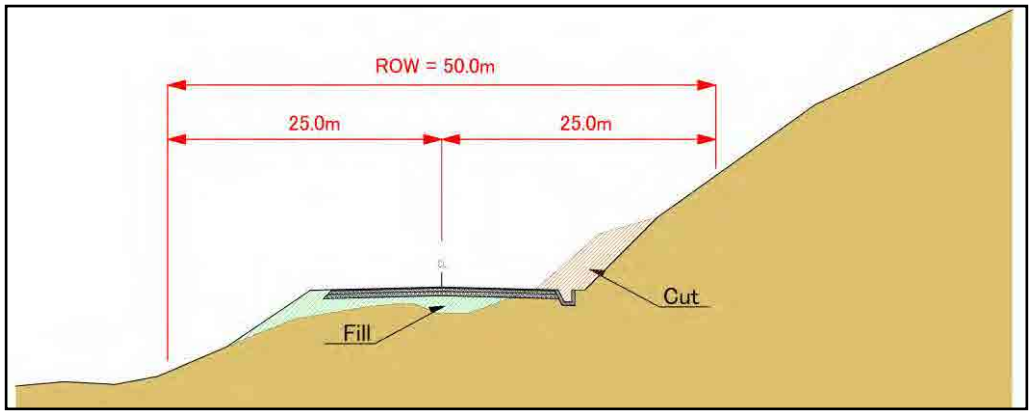
(1) Road

According to the Standards of Nepal, the ROW of a national highway is 50m (25m on either side from the road center line). Therefore, it is fundamentally desirable to acquire the stipulated area for the approach road. However, in case of difficulties in doing so due to topographic or financial constraints, the width of the acquisition area can be minimized to the width required for constructing the approach road. Figure 7-2 and Figure 7-3 show the basic concept of land acquisition for road sections.



Source: JICA Study Team

Figure 7-2 Limits of Land Acquisition at Road Section



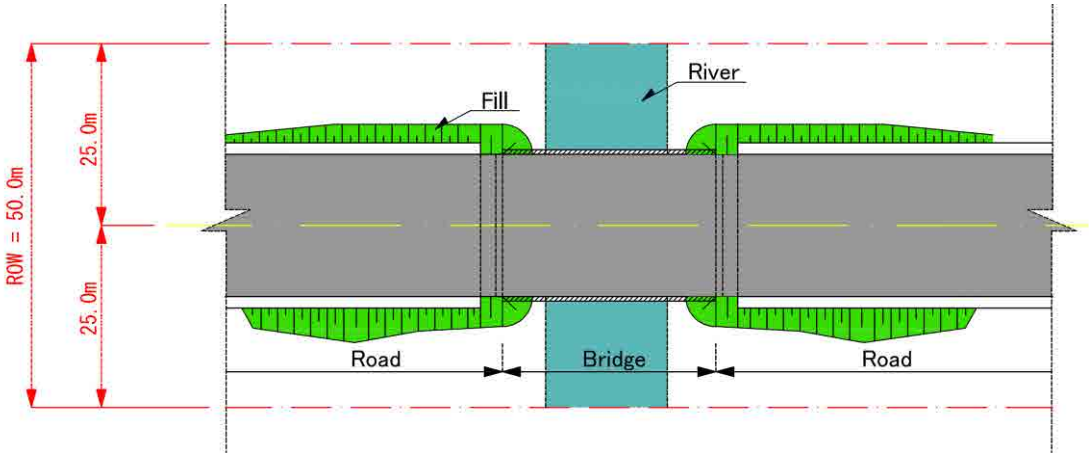
Source: JICA Study Team

Figure 7-3 Cross Section (A-A)

(2) Bridge

The concept of land acquisition at water channel, rivers is shown in Figure 7-4. ROW of bridge section is 50m (Both sides 25m from the road center line). However, as the river land is owned by the

government, it is not necessary to be acquired.



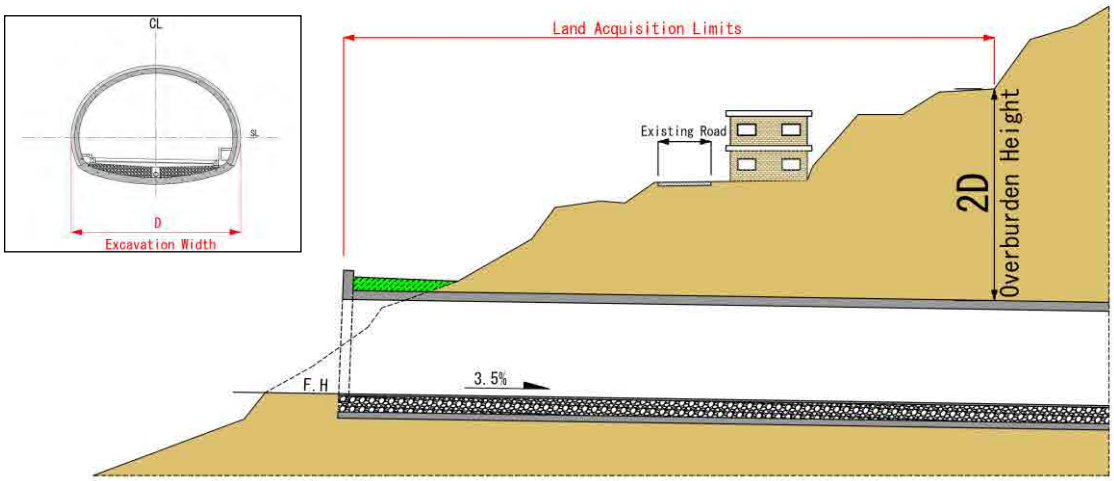
Source: JICA Study Team

Figure 7-4 Limits of Land Acquisition at Bridge Section

(3) Tunnel

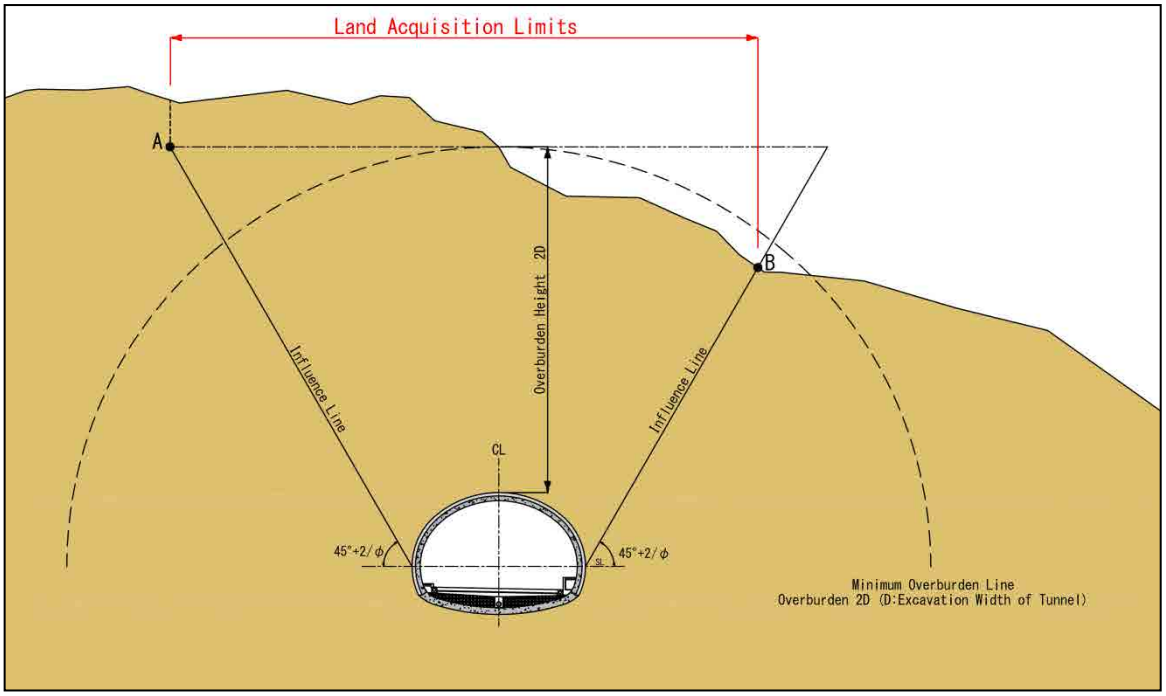
Considering the geological condition of the portal sites, the areas recommended for the land to be acquired are;

- until the overburden of 2 times the diameter of the tunnel is secured in longitudinal direction, and
- for an area where the influence line (45°+φ/2, φ: internal friction angle of soil) from the edge of the excavation width meet with the surface. (However, when the earth surface is higher than the minimum overburden height, it should be up to the point where the influence line meets with the overburden line of twice the diameter of the tunnel from the crown of the tunnel.



Source: JICA Study Team

Figure 7-5 Limits of Land Acquisition at Tunnel Portals



Source: JICA Study Team

Figure 7-6 Land Acquisition in Transverse Direction

7.4.2 Land Acquisition Area

Based on the explanation of Section 7.4.1, land acquisition area was calculated. The location and land acquisition area of Alternative-C are shown in the Figure7-7.

Source: JICA Study Team

Figure 7-7 Land Acquisition Area

7.4.3 Preliminary Estimation of Land Acquisition Cost

As explained in Section 3.5, the preliminary unit price of the land for the Project was set as Nepali Rupees 9,430 per square meter, based on the unit price used in the DOR F/S Report 2013, and with comparative study of prices in classified advertisements and the governmental minimum price published by Land Revenue Office of Kathmandu District.

Table 7-5 Samples of land prices in the Project Area

Source	NRs./Aana	NRs./m^2	Location
Unit Price used in the DOR F/S Report 2013 (p. 83)	-	**9,430**	Between Imakhel and Sisne Khola
Land Price in Classified Advertisement, April 2014	500,000	15,725	Swarswatisthan height, Thankot (Residential)
	375,000	11,794	Thankot (Residential)
	700,000	22,015	Balambu, Behind the Nepal Telecom Station (Residential)

Source: Feasibility Study of Tunnel Roads (Nagdhunga-Naubise Tunnel Road), DOR, 2013,
http://www.nepalhomesearch.com/ (Retrieved on April 18, 2014)

Table 7-6 Governmental Minimum Price in the Project Area (Kathmandu District 2013/14)

Access Road	Maximum Price		Minimum Price	
	NRs./Aana	NRs./m^2	NRs./Aana	NRs./m^2
1. Main Tribhuvan Highway	320,000.00	10,064	170,000.00	5,347
2. Black topped sub- road	170,000.00	5,347	60,000.00	1,887
3. Earthen Road	100,000.00	3,145	30,000.00	944
4. Trail only	88,000.00	1,384	15,000.00	472
5. Other (Out from road touch)	32,000.00	1,006	10,000.00	315

Source: Lowest land price evaluation booklet, Land Revenue Office, Kalanki, Kathmandu, Department of Land Reform and Management, Ministry of Land Reform and Management, 2013/2014

Using the Unit Cost, the Land Acquisition Cost is calculated as follows.

Table 7-7 Preliminary Estimation of Land Acquisition Cost for 50 m ROW

	Area for Acquisition m2	Unit Price NRs.	Land Cost Total NRs.
Approach Road and Tunnel Portal	120,000	9,430	1,132,000,000
Soil Disposal Area	15,000	9,430	141,450,000
Total			1,273,450,000

Source: JICA Study Team

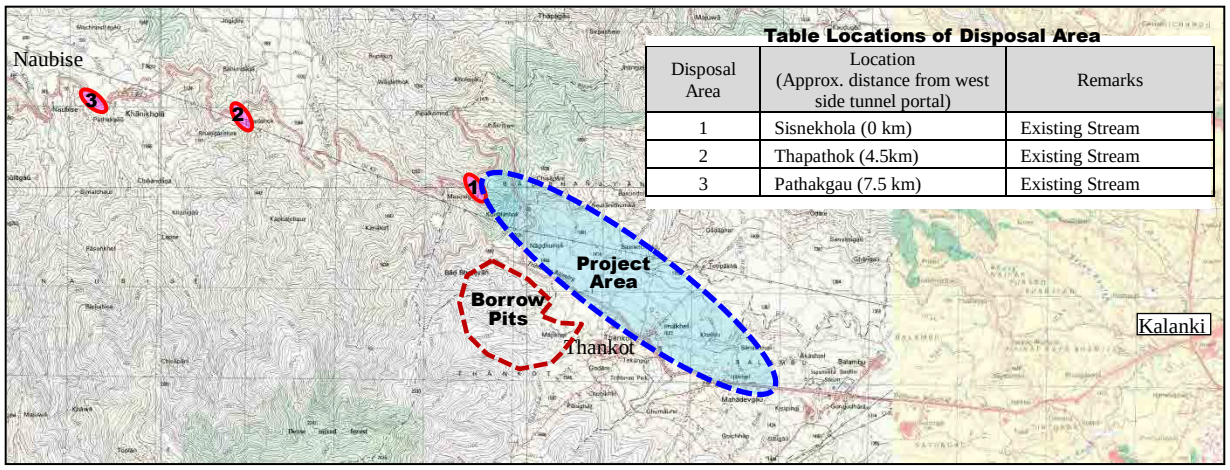


Table Locations of Disposal Area

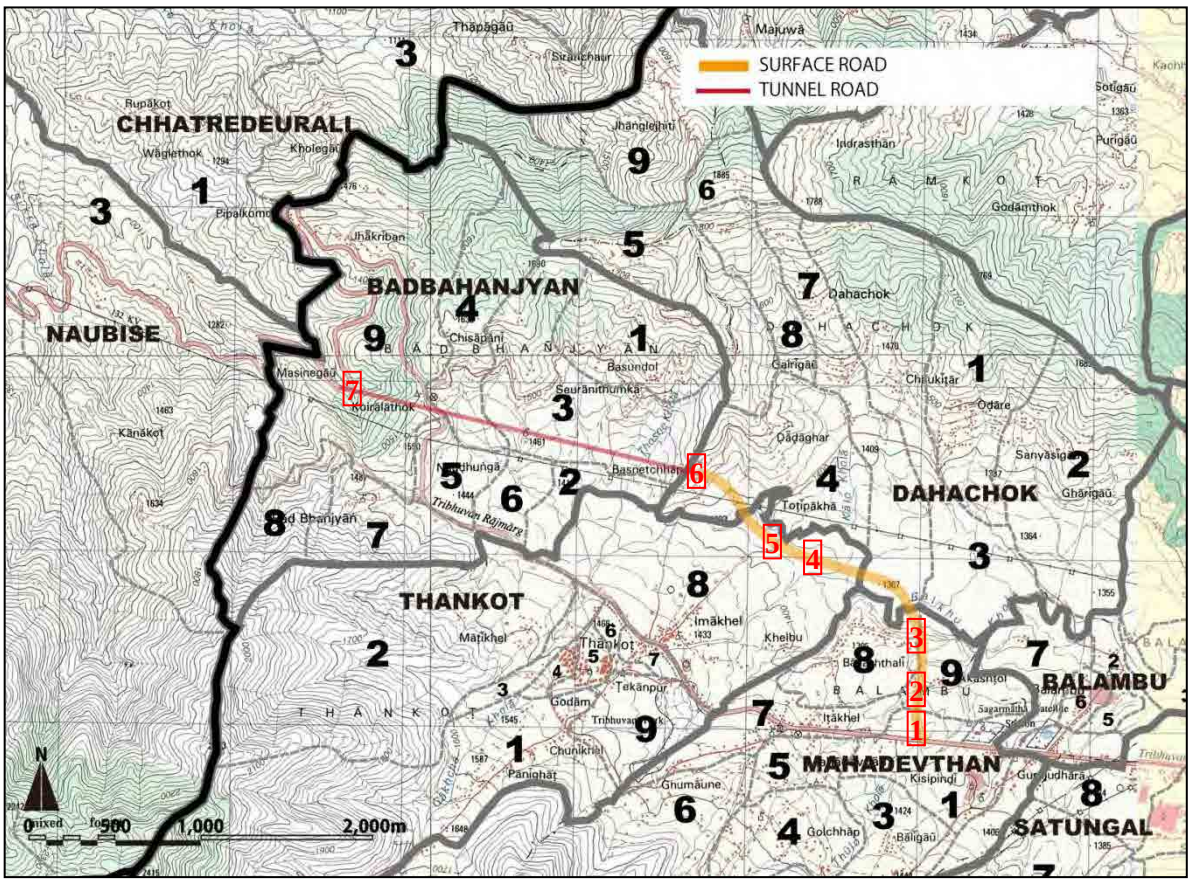
Disposal Area	Location (Approx. distance from west side tunnel portal)	Remarks
1	Sisnekhola (0 km)	Existing Stream
2	Thapathok (4.5km)	Existing Stream
3	Pathakgau (7.5 km)	Existing Stream

Source: JICA Study Team

Locations of Disposal Area (Already shown on Figure 7-1)

7.5 Preliminary Estimation of Resettlement Impacts

The 50 m ROW alignment affects structures in mainly 7 places as indicated in Figure 7-8.



Source: JICA Study Team

Figure 7-8 Locations of the Structures to be Affected within 50 m ROW

Preliminary count of the structures to be affected was conducted as shown on Table 7-8.

Table 7-8 Preliminary Count of the Structures to be Affected within 50 m ROW

Date:	February 2014.
Area:	Within the 50 m ROW
Number of counted structures:	27 (out of 27, 3 are solely used for businesses)
Estimation method of the number of residents:	(1) 15 structures (15/27=56%) were interviewed to confirm the number of the residents. (2) For the remaining 12 structures (44%), the number of the residents are estimated. <Estimation method> 1) Household is defined as a group of people who shares one cooking stove. 2) In a large house with more than two stories, different household occupies each floor. 3) The average size of one household is 4.63 as the average of Kathmandu District.
Estimated number of the residents to be resettled	36 households, 160 persons. 5 business entities.

In summary, there are 27 structures within the 50 m ROW, 24 are residential, and the number of households and people who may need to resettle is estimated as 36 households with 160 persons. Also, 5 structures are for business use, including one brick kiln management compound. These structures and the number of residents is listed in Table 7-8, while the structures are depicted in Figure 7-9.

Other cost for asset compensations, including lighter structures and properties, and resettlement assistances are to be surveyed. According to DOR/GESU, the cost for asset compensations and resettlement assistances shall be smaller compared to the cost for land acquisition.

Potential impacts at the proposed disposal sites shall also be studied in the EIA Survey.

Table 7-9 Number of Structures and Estimated Number of Residents within the 50 m ROW

Area	Location	ID	HH	HH Unit	No. of Residents	Use		Note
						Residential	Business	
1	East access point	1					X	Two business entities
		2	2	4.36	8.72	X	X	Under construction
		3	4	4.36	17.44	X		
		4	2	4.36	8.72	X		
		5	2	4.36	8.72	X		
		6	1	4.36	4.36	X		
		7	3	4.36	13.08	X		
		8	1	4.36	4.36	X		
		9*	1		7	X		
		10	1	4.36	4.36	X		
2	Southern village road	1*	2		8	X		
		2*	1		3	X		
		3*	1		4	X		
		4*	1		3	X		
		5*	1		3	X		
		6*	1		5	X		
		7	2		9	X		
		8	2		8	X		
3	Northern village road	1	2	4.36	8.72	X		
4	Brick kiln	1*					X	15 day-workers, 1 night-caretaker
5	West of the kiln	1*					X	1 night-caretaker
		2*	1		4	X		
6	East portal	1	1	4.36	4.36	X		
		2	1	4.36	4.36	X		
		3*	1		6	X		
7	West portal/	1*	1		7	X		
	West access point	2*	1		5	X	X	Eatery operated by the residents
	Total	27	36		159.2	24	5	

* : The structures with an asterisk at ID were interviewed to confirm the number of residents in February 2014.
HH Unit : Average number of persons per household was taken from the average of Kathmandu District in the Census 2011.
Source: JICA Study Team

Figure 7-9 Residential Structures within the 50 m ROW

Area/ Location	ID	Photo	ID	Photo
1 East access point	1		2	
	3		4	
	5		6	
	7		8	
	9		10	

Area/ Location	ID	Photo	ID	Photo
2 Southern village road	1		2	
	3		4	
	5			
	6			
	7	(No photo)	8	(No photo)
3 Northern village road	1			
4 Brick kiln	1			

Area/ Location	ID	Photo	ID	Photo
5 West of the kiln	1		2	
6 East portal	1 2		3	
7 West portal/West access point	1		2	

Source: JICA Study Team

7.6 Legal and Administrative System Necessary for Tunnel Construction and Safeguard

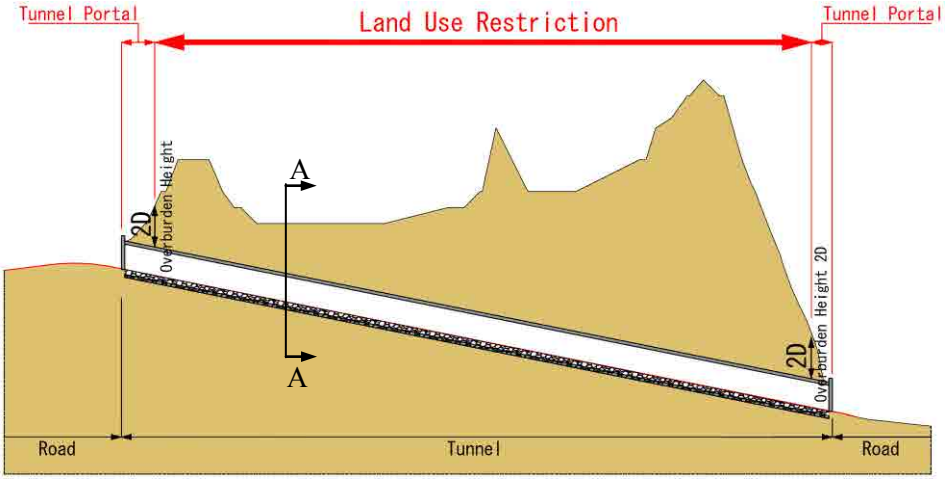
7.6.1 Purpose

Land use above the tunnels need to be monitored and restricted to safeguard the structures. For example, a deep well boring or very heavy structure on soft or fragile soil may affect the stability of tunnel structures.

7.6.2 Target Area

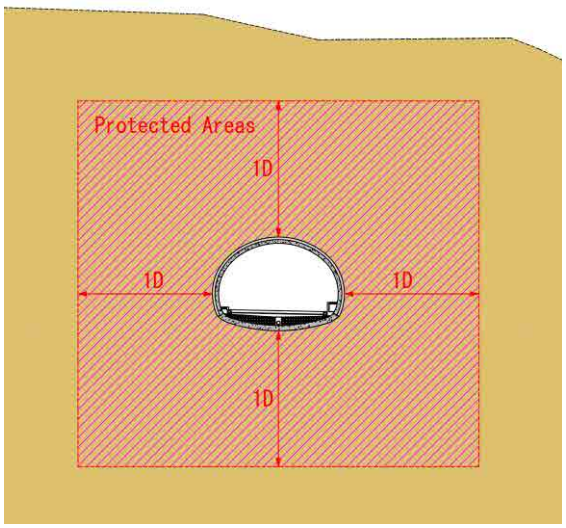
In Japanese Design Standard, tunnel easement area is defined as follows.

- In land use restriction areas, it covering a distance of 1D from the edge of the tunnel in all directions should be designated the protected area of tunnel.
- The area where the height of the overburden is less than 10m is subject to acquisition.



Source: JICA Study Team

Figure 7-10 Tunnel Profile Showing the Section of Necessary Land Use Restriction



Source: JICA Study Team

Figure 7-11 Cross Section of Protected Area (A-A)

7.6.3 Activities Necessary to be Restricted

Land owner in the Tunnel Easement, public or private, shall be subject to following restriction in their activities.

Table 7-10 Activities to be Restricted and not Restricted in the Tunnel Easement

	Building Activities	Excavation Activities
RESTRICTED (Need monitoring)	1. New construction of building that exceed the existing size or design 2. Total or partial renewal of building to exceed the existing size or design	3. Boring, excavation, or clay collection that reach the depth of the PROTECTED AREA
NOT Restricted	4. Use of existing building 5. Total or partial renewal of building that does not exceed the existing size or design	6. Use of existing water wells 7. Boring new wells that does not reach the depth of the PROTECTED AREA 8. Excavation or clay collection that does not reach the depth of the PROTECTED AREA

Source: JICA Study Team

7.6.4 Legal and Administrative System Necessary

(1) Legal base

In Nepal, land use restriction under the electricity transmission lines has already been made legal by the Electricity Regulation 2050 (1993). It is desirable to prepare similar legal base for the land use restriction in the Tunnel Easement.

Table 7-11 Linear Infrastructures and Safeguard Actions in Nepal

Example	Administration	Easement/Restriction	Legal Base
High Voltage Electricity Transmission Line	Nepal Electricity Authority	● Height and width clearance from the center of the transmission line is defined. ● Basically, the land under the line may be used for crop farming, but construction of structures shall be restricted. ● The Compensation Determination Committee orders the NEA to pay certain percentage of the land value to be affected to the land owner. ● The percentage differs depending on the severity of the impact, but in general between 10 to 25 % of the land value of the affected area.	Electricity Regulation 2050 (1993)[1]
Hydropower Plant Water Tunnel	N/A	● Most part of the water tunnels pass through national forests without road access. ● No urban development is expected above the tunnels. ● Therefore, no tunnel easement has been considered so far.	N/A

Source: JICA Study Team

[1] Source : Nepal Electricity Authority, http://www.nea.org.np/images/supportive_docs/Electricity_Regulation_2050-english.pdf (Retrieved on April 4, 2014) The contents of Schedule 12 differs from the results of the interview. The amended, newest version of the regulation must be cited in the later phase of the Project.

In Japan, the area of tunnel easement is made public as a part of City Plan or Land Use Plan. Those who apply for legally required construction permission are instructed by municipality staff about acceptable and non-acceptable activities.

Since such land use plan or construction permission system do not exist in the Project Area, the control power specific for road tunnels, at least in the starting phase, shall better be held by DOR or MOPIT.

In near future, similar legal safeguards shall become necessary for underground facilities related to electricity, drinking water, and sewerage in Municipalities in Nepal.

Table 7-12 Excerpts of Electricity Regulation 2050 (1993)

CHAPTER 5 SAFETY MEASURES REGARDING ELECTRIC DEVICES

48. Minimum Distance from Ground to the Electric Wire: (1) Distance between the electric wire of different volts of the distribution and transmission system and the ground shall not be less than as prescribed in Schedule 12.

(2) In case where electric line is to be installed by the side of the road or along it, it shall be done by adopting appropriate technological measures.

(3) If it is necessary to install electronic line of more than 33,000 volts, it shall have to be done by adding 0.305 meter for each 33,000 volts on the distance as prescribed for 33,000 volts in Schedule 12.

49. Regarding the Installation of Electric Line Across the Road: While installing electric line of more than 211,000 volt across the road in a densely populated area, the double insulator system shall have to be used.

50. Distance to be Maintained on either side of the Electric Line: (1) While installing electric line of distribution and transmission system, it shall not be installed in a distance lower than the distance as prescribed in Schedule 13 from the house or tree.

(2) If it is necessary to install electric line of more than 33,000 volt, it shall have to be done by adding 0.305 meter for each 33,000 volts on the distance as prescribed for 33,000 volts in Schedule 13.

Schedule 12 (Relating to Rule 48) Distance which ought to be from wire to the ground

S. No.	Standard of voltage of electricity	While crossing the road (m)	On the side of the road (m)	In other places (m)
1	In between 230/400 and 11,000	5.8	5.5	4.6
2.	In between 11,000 and 33,000	6.1	5.8	5.2

Schedule 13 (Relating to Rule 50) Minimum distance which ought to be from the wire to the house or tree.

S. No.	Standard of Voltage of Electricity	Minimum Distance to be from house or tree
1.	Standard 230/400 to 11,000	1.25 meter
2.	From 11,000 to 33,000	2.00 meter

Note: While determining the minimum distance as above maximum deflection of wire arising due to air pressure shall also have to be considered.

Source: Nepal Electricity Authority, http://www.nea.org.np/acts-regulations.html (Retrieved May 9, 2014)

(2) Monitoring

The necessary tunnel easement and related restrictions must be explained to the related land owners and other stakeholders well before the implementation of the restrictions.

In the operation phase of the tunnel, continuous patrol and monitoring activities are necessary to prevent any breach of the restriction, until the system for building construction permit become popular in the Project Area. Since the legal base is expected to reside with DOR or MOPIT, the responsibility of the patrol and monitoring shall also be bore by those, most probably DOR Division Office, which is currently hiring the daily maintenance workers on National Highways.

Kathmandu Metropolitan City is already administrating the building construction permit. In the long term, such governmental control is expected to be popular and mandate for all the area in Kathmandu District.

(3) With or without compensation

The Japanese Land Acquisition Ordinance for Public Works states that when the use of underground space restricts the surface use, the Project Owner shall compensate depending on the significance of the restriction.

Therefore, when tunnel is very deep and no restriction is expected for the surface use, or when the area is very remote and no urban development is expected, the Project Owner, with the consent from land owners, shall be waived from compensation.

In Nepali condition, the land acquisition procedure led by the CDC is well known and generally accepted by the society. Using this existing social system in the Project regarding the tunnel easement may help smooth promotion of the Project.

Chapter 8 Operation and Maintenance Plan

8.1 Operation and Maintenance Plan of Road

8.1.1 Existing Maintenance System

(1) Responsible Organization

The organization responsible for maintenance of roads and bridges for the Strategic Road Network is the DOR. Other organizations are Municipalities for municipality roads and District Development Committees for district and agricultural roads. The maintenance of the study road is responsibility of the DOR. The organization responsible for financing is Roads Board Nepal (RBN) and DOR. RBN also conducts monitoring and evaluation of road maintenance works executed by road agencies through outsourcing to local consultant as it has limitations from the size of the RBN Secretariat.

1) Department of Roads

The Department of Roads is the agency that is responsible for repair and maintenance of the roads in the SRN. These roads are consisted of highways and feeder roads. The Maintenance Branch directly under the DG undertakes the maintenance activities. However, the actual works are conducted by the Division Offices under the Regional Directorate. There are 5 regional directorates; i) Eastern, ii) Central, iii) Western, iv) Midwestern, and v) Far western, and 25 division offices.

The maintenance within the stretch of the study road (Kalanki to Naubise) is presently being undertaken by two divisional offices under the Central Regional Road Directorate (CRRD). The section within Kathmandu District (Kalanki to Nagdhunga) is looked after by Kathmandu Division and the stretch beyond that is looked after by Bharatpur Division.

2) Roads Board Nepal

Roads Board Nepal (RBN) was established under the Roads Board Act 2058 (2002). It has been established to carry out the routine, recurrent, periodic and emergency repair and maintenance of the road and make arrangement for imposition on and collection of toll from the motor vehicles plying on the road for maintenance purpose. Its present source of revenue and other possible resources yet to be tapped are as follows;

Present Resources

- Fuel levy on diesel and petrol for vehicles
- Toll collections (collected at three stretches; Naubise-Mugling on Tirbhuvan Highway, Narayanghat-Hetauda and Narayanghat-Butwal on East-west Highway)
- Vehicle registration fees

Resources to be tapped

- Fee for vehicles registered abroad but used in Nepal,
- Subsidies and grant from GoN and support from donors and internationals

The collected fund in RBN account is mobilized through DOR for maintenance of SRN and through DoLIDAR to concerned Municipalities and District Development Committees (DDC) for urban, district and agricultural roads. 70% of the fund is allocated to the maintenance of the SRN and remaining 30% to the maintenance of LRNs. However, the road agencies have to provide a minimum committed counterpart fund of 30% for Municipalities and 20% for the DDC's from its portion.

The revenue collected from fuel levy and vehicle registration tax and the actual budget allocated to RBN from MoF for the last 5 years is listed in Table 8-1. Similarly, the toll collection for a period of fiscal year 2065/66 to 2067/68 is shown in Table 8-2.

Table 8-1 Budget of Roads Board Nepal for the previous 5 years

(Figures in Thousand NRs.)

Fiscal Year	Collection from NOC & DOTM		Sub-Total (NOC+DOTM)	Actual Budget Allocated (MoF)	Deficit as per collection
	Fuel Levy	Vehicle Registration			
2065/66 (2008/09)	741,108	688,439	1,429,547	664,500	765,047
2066/67 (2009/10)	926,556	1,458,641	2,385,197	1,314,500	1.070,697
2067/68 (2010/11)	1,758,821	1,597,623	3,356,444	2,518,000	838,444
2068/69 (2011/12)	2,097,860	1,439,784	3,537,644	2,768,000	769,644
2069/70 (2012/13)	2,332,714	2,572,775	4,905,490	2,573,700	2,331,790

Source: Roads Board Nepal (RBN)

Table 8-2 Amount of Toll Collected in the Period of 2065/66 – 2067/68

Toll Roads	Collected Amount in Fiscal Years (in thousand NRs.)		
	2065/66 (2008/09)	2066/67 (2009/10)	2067/68 (2010/11)
Naubise-Mugling	28,937	36,274	36,817
Hetauda – Narayanghat	19,660	15,704	24,821
Narayanghat - Butwal	16,284	117,693	15,099
Total	64,881	69,671	76,737

Source: Annual Progress report 2067/068, Roads Board Nepal (RBN)

The figures in both the tables show increment every year. In connection with the budget, there was a significant increment fiscal years 2009/10 and the following year. Yet, there is no controversy that the budget for maintenance is not enough to address all the maintenance work required.

(2) Types of Maintenance and Funding

The maintenance of a roads and bridges is divided into the following categories.

1) Routine Maintenance

Maintenance activities carried out routinely and continuously in order to prevent the damage to road pavement and other ancillary structures due to environmental effects.

2) Recurrent Maintenance

All scale maintenance activities, which are carried out recurrently at different times in a year in damaged road surface/pavement due to traffic pressure/load from vehicles plying on roads.

3) Periodic Maintenance

This is defined as large scale maintenance of road surface/pavement, which should be carried out at a given interval of defined number of years.

4) Emergency

Those maintenance activities which are carried out in case the traffic is disrupted and road closed due to any type of unexpected damage on the roads.

5) Rehabilitation, Reconstruction and Upgrading

These maintenance works are those works that have exceeded the limits of periodic maintenance. In other words, all those roads that are no more maintainable and needs an overall repair to revive the expected function is defined here.

Routine, recurrent, periodic and emergency repairs and maintenance is financed by RBN. However, limited financial grant is allocated for other higher category of maintenance works such as rehabilitation, reconstruction and upgrading. Only when the resource remains surplus after allocating funds for priority or pre-determined maintenance works will this category be considered. Other maintenance categories are financed by the responsible authorities.

(3) Maintenance Procedure

A simplified maintenance procedure is shown in Figure 8-1 and summarized below.

i) Road agencies prepare and submit annual road maintenance plan to RBN. DOR prepares for highways and feeder roads in the SRN and DoLIDAR and VDCs prepare for local and agricultural roads.

ii) Upon receiving ARMPs from DoR and DOLIDAR, RBN prepares integrated annual plan by end of Shrawan, the first month of a fiscal year (mid-August).

iii) Regarding road rehabilitation, reconstruction, upgrading and road safety, RBN may

prepare and implement a periodic integrated plan for either 3 or 5 year period.
(Provision of periodic annual plan)

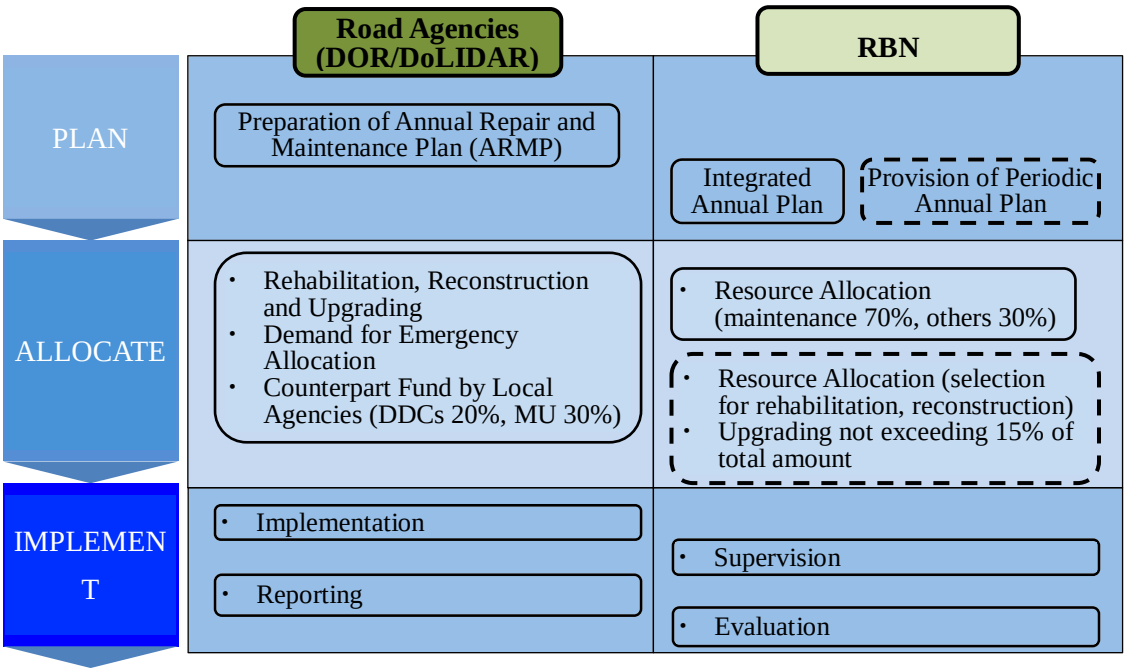
iv) After reduction of administrative amount from the budget, 70% of the remaining budget is allocated to maintenance and 30% to other works related to maintenance.

v) Demand for allocation of emergency fund, if any be DOR to RBN..

vi) As a contribution to maintenance resource, concerned local agencies allocate certain amount. DDC minimum 20% and Municipalities minimum 30%

vii) Selection of roads for rehabilitation and reconstruction is made based on priorities. National highways and feeder roads have top priority.

viii) In case extra fund is available, upgrading of existing roads is funded but with the provision that allocation for such upgrading does not exceed 15% of total revenue



Source: JICA Study Team

Figure 8-1 Procedure of Maintenance

8.1.2 Proposed Maintenance Plan

No new plans for establishing an organization or procedure for the maintenance of the road section including structures of the proposed route is required.

However, as the present maintenance system is not able to fully address the maintenance issues of entire roads of the country, it is necessary that the project road be classified into the top

priority road so that the maintenance work of the road is more attentively addressed and emphasis is given to allocation of budget for sustainable maintenance.

8.2 Operation and Maintenance Plan of tunnel

8.2.1 Existing Organizations and Plans

There are no road/highway tunnels in Nepal. Therefore, no organization has ever been established for any kind of work in connection with the road/highway tunnels.

8.2.2 Proposed Maintenance Plan

(1) Operation and Maintenance Organization

The organization responsible for operation and maintenance of the tunnel is suggested to be a division office under Regional Road Directorate. Considering the location of the proposed route, Kathmandu Division Office under the Central Regional Road Directorate (CRRD) is deemed optimal candidate. Furthermore, being the first possible road tunnel in Nepal, which will require a new and different approach for operation and maintenance compared to that of a road, it is recommended the a special unit should be set up and entrusted all the task under stringent monitoring from the CRRD. The recommended aims and duties of the organization will be but not limited to;

1) Maintenance of the tunnel

- monitoring the traffic
- maintaining the tunnel facilities
- maintaining the tunnel structure

2) Control the fire and accidents and to avoid disaster

- recognizing the condition
- communicating and cooperating rapidly with relative organizations (fire station, traffic police)
- announcing to the public

Although the main responsible organization for the operation and maintenance is the DOR, close coordination with the police, fire department, hospital etc. will be required during disasters. Therefore, the responsibility of each relevant authority should be made clear and a communication system between these authorities should be established when preparing the maintenance plan.

8.2.3 Operation and Maintenance Systems

In order to operate and maintain the tunnel structures, facilities and safety, the following maintenance systems are required and recommended in the office of the organization;

- Tunnel Operation and Monitoring System
- CCD TV Monitoring System
- Emergency Notification System

(1) Tunnel Operation and Monitoring System

The system will consists of the data transfer equipment at tunnel entrance and the data monitoring equipment at the office of the organization. The data, which show how the lighting, ventilation and safety facilities are working, will basically be transferred to the receiver and monitored by the office of the organization by cell phone system. The emergency data, which come from the emergency telephone, emergency push button and emergency alarm signal, will also be transferred to the office by cell phone system in case of accident and/or fire, in order to enhance on time and speedy communication with relative organization to prevent a major disaster.

(2) CCD TV Monitoring System

Provision of TV cameras for the purpose of safety inside the tunnel is not required by the Japanese Standard. However, this can enable visual monitoring of traffics for obtaining prompt and reliable information of traffic condition inside the tunnel. Being the first tunnel for DOR, Provision of such system is instrumental and is thus recommended to be installed.

(3) Emergency Notification System

The emergent information such as accident and fire in the tunnel had better be notified to the public. In addition to the traffic condition in the tunnel, the emergent information can be provided to smart phones form web-site of the Operation and Maintenance Organization by this system.

8.2.4 Recommended Additional Support

(1) Disaster Prevention Program with Operation Training

This program aims to contribute to the staffs of operation and maintenance organization (special unit) to recognize the significance of the disaster in and around the tunnel and to minimize the cause and effects of accident and fire in the tunnel, based on the past experiences and the prevention/minimization of the disaster methods practiced in Japan. This may also include the lecture of the actual activities which the staff of the Organization should take and the operations of the Systems above.

This support may be provided by the consultant as soft component to the organization responsible for maintenance of the tunnel in the after completion of installment of the maintenance and operation systems and prior to commencement of service to the public.

(2) Procurement of fire engine

Fire stations exist only in the Municipalities. The nearest fire station from the project site is the one in Kathmandu or Lalitpur Municipality, both in an approximate distance of 10km. Accidents inside tunnels sometimes cause fire and could be very fatal. Therefore, it is very important to assure availability of fire engines in such cases. The Study Team recommends provision of a fire station near the proposed tunnel. As the proposed tunnel is about 2km long, it is desirable to have such facilities at both sides of the tunnel. One method to procure fire engines could be from the Japanese Assistance through a technical cooperation project.

This support may be achieved by provision of fire engine (new or used). The engines those are procurable from Nepal are suggested to be procured as a part of cooperation of Japan such as under a grass-root scheme and grant to the concerned organization for use during disasters.

8.3 Maintenance of Structures

8.3.1 General

The maintenance of the structure needs to be operated in accordance with the maintenance guidelines established. The operation of the maintenance work should be performed in accordance with relative rules and laws, and the safety of the passengers and the workers must be well examined under careful consideration.

8.3.2 Cleaning

The Cleaning of the tunnel needs to be operated effectively and efficiently as planned, considering the condition of the dirt and the traffic. The periodical cleaning should be performed in principal.

8.3.3 Road Surface

The condition of the road surface needs to be constantly checked visually. When any unusual matters are observed, the appropriate prompt actions should be taken.

8.3.4 Lining

The condition of the lining needs to be checked constantly. When unusual matters such as cracks, leakage of water or other disorders are observed, the appropriate prompt measures should be taken promptly and adequately.

8.3.5 Safety Facilities

The safety facilities need to be checked and maintained in order to demonstrate the sufficient abilities to control the fire and accidents inside the tunnel.

8.3.6 Lighting Facilities

The lighting facilities needs to be checked and maintained, in order to maintain the safe and smooth visibility in the tunnel, particularly during night time as the road has traffic volume at

night time almost equal to the traffic volume of the day time. The maintenance of the lighting facilities will include checking, cleaning, repairing, replacing and recording.

8.3.7 Ventilation Facilities

The ventilation facilities of the tunnel needs to be checked and maintained constantly, including the reactive function of the relative machines, meters and so on.

8.3.8 Electricity Supply

The electricity for the tunnel facilities needs to be obtained from Nepal Electricity Authority (NEA). However, according to the results of the hearings conducted with the NEA official, it is necessary that the proposed road be designated as the National Priority Project and a memorandum of understanding (MOU) be signed between MOPIT and MOE, which will make DOR eligible for receiving stable and continuous electricity supply from NEA.

8.4 Maintenance Resource

The maintenance cost is required for the periodic exchange and repair of the equipment of the electrical and mechanical facilities. As mentioned before, the routine, recurrent, periodic and emergency maintenance is financed by RBN. There is no controversy that the budget for maintenance is not sufficient. Under such circumstances and conditions, there is no guarantee that these works will be covered by the RBN budget. Therefore, one of the most important responsibilities of the newly established operation and maintenance organization (special unit) is to make arrangements and plan for allocation/securing of maintenance budget. It is also desirable that the organization make effort to ascertain that the proposed road is designated as the national priority project so that it could be entitled as top priority road for maintenance. Therefore, further study and investigation is deemed necessary on determining the specific method for allocation of the required budget.

8.5 Maintenance Cost

(1) Routine maintenance cost

One main maintenance cost is required for the repair/change of the equipment of lighting and safety facilities as short/medium term periodic maintenance due to the lifetime of the equipment. This is estimated at about 4 million NRs in annual average.

(2) Periodic maintenance cost

The other main maintenance cost is Periodic required for the renewal of the ventilation and electric supply systems as long term maintenance due to the lifetime of the system and for the pavement overlay. This is predicted about 400 million NRs in 50 years in total.

Chapter 9 Environmental and Social Considerations

9.1 Summary of Scoping of Impacts based on the JICA Guideline

9.1.1 Title of the Project

Thankot Area Road Improvement

9.1.2 Outline of the Project

Issue	Condition	Original Reference
Project Sector:	Road, with short bridges	
Scale of the project:	(1) Approach road (surface) : Length 2,250 m, width (ROW) 50 m. (2) Tunnel road : Length 2,350 m, width (excavation) 13 m (3) Soil disposal : 350,000 m3	(1)(2) Table 5-4. Alternative C (3) 7.2.5
Cost for land acquisition	(1) Road : 1,132 million NRs. (2) Soil disposal : 141 million NRs. (15,000 m2) (3) The unit cost, 9,430 NRs/m2, was taken from the DOR Feasibility Study Report, 2013. The number was authorized as realistic price for project formation. Compensation Determination Committee, established based on Land Acquisition Act, shall conduct survey of recent transactions and determines the price of land. The project owner shall follow the decision. The governmental minimum price in the Project Area varies between 315 to 10,064 NRs/m2, depending condition of road access. Advertised prices on internet varied 11,794 to 22,015 NRs/m2 in April 2014. The unit cost is considered rational because it is close to the advertised prices and far larger compared to the governmental minimum price.	7.4.3
Other cost for asset compensations and resettlement assistances	To be surveyed. DOR/GESU explained that the cost shall be smaller compared to the cost for land acquisition.	7.5
Name of Project Execution Organization :	Department of Roads, Ministry of Physical Infrastructure and Transportation	
Address of the project site :	Kathmandu District (Mahadevsthan, Dahachok, Thankot, Baad Bhanjyang VDCs) Dhading District (Naubise VDC)	

Source: JICA Study Team

9.1.3 EIA status

Issue	Condition	Additional Information
EIA Status Based on the Nepal Laws and Regulations	Required (Under planning)	Full EIA and approval of MOSTE for new construction of National Highway
Status of other necessary environmental permit(s)	Required but not obtained yet.	
Name(s) of required permit(s) :	Forest clearance permission from Ministry of Forest and Soil Conservation	

Source: JICA Study Team

9.1.4 Environmental Categorization According to the JICA Guideline and Reasoning

(1) Category

Category B

(2) Reasoning

The project is to construct about 5 km bypass of existing National Highway in the suburb of the Kathmandu Capital Area. The Project Area does not include or near the Protected Areas. The negative impacts during the construction and operation phases will be limited to the area in and along the work areas. The number of project affected people who are expected to resettle is 160. The other impacts are not to surpass the severity or size of what is observed along the existing Highway.

The bypass road will stay in the area permanently and its impacts will stay in the area. Therefore it is reasonable to categorize the Project in Category B.

Differences between Categories

Category	Severity	Uncertainty	Size of the Impact	Irreversibility	Transboundary
A	The negative impacts are severe on environment and social condition.	The negative impacts are complicated or unprecedented, and the prediction and management of the impacts are difficult.	The negative impacts from the project affect large population or large area, or long period of time.	Most of the negative impacts are irreversible.	Negative impacts affect outside of the site, and work areas, and reaches far beyond.
B	Compared to the negative impacts from the Category A project, the impacts are not severe.	Negative impacts can be avoided, minimized, or mitigated using already known measures.	Compared to the negative impacts from the Category A project, they affect small population or small area, or short period of time.	Irreversible negative impacts are small.	Negative impacts affect only on site and neighboring area.
C	No negative impacts or minimum negative impacts are expected for environment and society.				

Source: JICA Study Team

9.1.5 Outline of the Project and Project Area

Issue	Condition	Additional Information	Reference in this Report
Environmentally sensitive area in and around project site	(1) No protected forests and conservation areas are located within or near the Project Area. (2) During the interviews with MOSTE, MOFSC, Department of Forests, Kathmandu District Forest Office, and Forest Ranger Points in Kathmandu District, potential occurence of endangered species in the Project Area was denied except Simal trees (***Bombax ceiba***), which is located a few places along the existing highway, but not in the work areas of the Project.	(1) The distance to the nearest Conservation Area is more than 2 km, and it is located in different watershed. (2) Red List of Nepal (IUCN, 2012), CITES-List of Animals and Plants in Nepal (CITES, 2012), and the National Parks and Wildlife Conservation Act, 1973, either do not include information of habitat locations for the listed species, or states that Kathmandu Valley is included in the habitats of mammals such as Himalayan Black Bear and Leopard. During the field survey of the EIA Study of the Project, in future phase, it is expected to clarify the occurrence or non-occurrence of those listed species in the Project Area.	(1) Figure 3-24 (2) 3.5.3
Sensitive elements	(1) Involuntary resettlement : YES. Number of resettlers : 160 persons, 36 households. (2) Pumping of groundwater : No (3) Land reclamation and/or development : No (4) Deforestation : Clearance of existing forest. about 2 ha		(1) 7.5 (4) 7.2.4
Socially and economically vulnerable population to be affected	To be surveyed in the next phase of the Study. During this Study, DOR/GESU and MOSTE (EIA) confirmed that no significant accumulation of those population is expected in the Project Area. DOR/GESU explained that the cost for assistance for those population shall be smaller compared to the cost for land acquisition. In the next phase of the Study, 1) interviews to the affected VDC Secretaries, 2) public consultations, 3) census survey of the households within the ROW shall be conducted to clarify the existence and needs of socially and economically vulnerable population to be affected.	VDC-wise, about 30 % of the population belong to Dalit or indigenous group. The same is expected in the Project Area.	9.7

Source: JICA Study Team

9.1.6 Gaps between JICA and GON Resettlement Policy

Gaps listed in the M/M dated April 17, 2014			Typical operation of DOR based on ESMF	Remaining GAP and/or survey
Key Policy Gaps	JICA Guideline (World Bank O.P.4.12)	Government Laws		
Compensation Principle	All the compensation is based on the principle of replacement cost	Compensation rate will be determined by CDC, consisting of CDO, (ii) representative from DDC (iii) Chief of Land Revenue Office (iv) Project Manager, (Land Acquisition Act Clause 13) The Land Acquisition Act 1977, also mention the need of considering periodic circulations issued by the GoN while fixing compensation for the affected assets (Land Acquisition Act Clause 16)	DPs are allowed to take salvaged materials. CDC will make final decision on the compensation rates after viewing and verification of affected.	1) Whether the provisions be made for the replacement cost for the loss of land, houses/ structures by CDC is under survey. 2) There is no official license for real estate appraiser/valuer for land, houses/ structures. Most transactions are conducted face to face of selling and buying side. Real estate broker industry is not licensed without any common professional rules. How to determine rational replacement cost is under survey.
Compensation for Non-titleholders	Squatters/ vulnerable encroachers/non- title holders are entitled to the payment for affected structures/ houses/ business/ crops, trees, and other assistance	Do not consider squatters/ encroachers/ non-titled land users for compensation	ESMF (p. 7-9, 10) provides encroacher/ squatter and non-registered tenant/renter/lease holder does not qualify for compensation for land losses; however they will be entitled to compensation for crops, and compensation for full or partial loss of house and other structures at full replacement cost of materials and labor according to house/structure type, with no deduction for depreciation. Every displaced household will receive transportation allowance on actual cost basis.	None. (Refer 9.3 of this report)
Relocation Assistance	Aall the eligible DPs including tenants, employees are entitled to receive financial assistance to cover physical and economical displacement	LA Act Clause 16-2 provisions to consider extent of losses caused due to relocation/ shifting of Displaced people, while fixing the compensation rate (LA Act Clause 16-2.	ESMF (p. 7-11) provides Displacement Allowances; 1) each displaced household will receive equivalent to 2 months poverty line income, 2) Renters will receive 35 days notice or rental stipend equivalent to 0.5 month poverty line income plus transportation assistance; 3) every household of displaced businesses will be entitled to a business displacement allowance for loss of commercial establishment.	None. (Refer 9.3 of this report)
Income Restoration	Income restoration program such as training and other measures to restore and improve the standard of living of the displaced households of those having more than 10% of the total landholdings and income	Apparently, the Land Acquisition Act 1977, do not consider for income restoration.	ESMF (p. 7-11, 12) requires assistance with training in life skills, preferential access to road construction employment for 1) households/APs having significant impacts, 2) households of the vulnerable categories, 3) APs family members over 16 years of age.	None. (Refer 9.3 of this report)

Source: JICA Study Team

9.2 Laws, Rules and Standards

Following table is the list of laws, guidelines and reviewing institutions the Project need to consult with. For EIA review procedure, both the EPA/EPA of MOSTE and the ESMF of DOR/GESU shall be the legal base. For detailed technical guidance of EIA survey and review procedure, the ESMF shall be the main resource.

Table 9-1 National laws and others Related to Environmental and Social Impacts Control

Topic		Name of Laws and Regulations	Reviewing Institution
Development review and permission	EIA/IEE	Environmental Protection Act (1997) Environmental Protection Rules (1997)	MOSTE
		Environmental and Social Management Framework (2007)	DOR/GESU
Power generation licensing		Electricity Act (1993)	Ministry of Energy Nepal Electricity Authority
Pollution prevention	Environmental Standards	Nepal Gazette B.S. 2060/4/19 (4 August, 2003) (Air) Nepal Gazette, BS 2054-9-8 (Gas emission from vehicles)	MOSTE Ministry of Works and Transport
	Soil disposal	Environmental and Social Management Framework (2007)	DOR/GESU MOSTE District Village
	Waste control	Environmental and Social Management Framework (2007)	DOR/GESU MOSTE District Village
Natural environment	Forest clearance Biodiversity conservation	Nepal Forest Guidelines (2006)	MOFSC
	Underground water	None	
	Rivers	None	
	Nature conservation	National Parks and Wildlife Conservation Act (1973)	MOFSC
Cultural heritage		Ancient Monument Preservation Act, Ancient Monuments Preservation Rules 2046 (1989)	Ministry of Culture, Tourism and Civil Aviation
Social considerations	Community forest	Forest Act (1993)	MOFSC District Forest users' group
	Drinking water	Water Resources Act (1992)	District Irrigation Office
	Indigenous groups	National Foundation for Upliftment of Aadibasi/Janjati Act 2058 (2002)	DOR/GESU
	Dalit groups	Caste-based Discrimination and Untouchability (Offence and Punishment) Act (2011)	DOR/GESU
	Land acquisition and compensation	Land Acquisition Act 2034 (1977)	DOR District
	Additional assistances	Environmental and Social Management Framework (2007)	DOR/GESU
	Underground property right	None	
	Land use change (agriculture to urban)	No governmental procedure is required.	N/A (Land owner's consent)

Source: JICA Study Team

The Environmental and Social Management Framework (ESMF) (2007, DOR) was developed to implement the World Bank supported 'Road Sector Development Project (RSDP)'. Then in

2012, the ESMF was made as Ministry-approved policy and since then the ESMF is the guideline applied for all the DOR projects. The reviewing institution for the ESMF is the Geo-Environmental and Social Unit (GESU) of DOR. The English and Nepali versions of the ESMF are available at the web site of DOR.[1]

The EPA and the EPR went into practice in 1997. The EPR was amended in 1999. The electric files of English version of the 1997 EPA and the 1999 EPR are the only version available from the web site of the Nepal Law Commission. The EPA and the EPR are, however, have been amended 9 times in total, as shown in the next Table. The amended Section 14 of the EPA is in Annex-3. The amended Schedule 2 of the EPA is in Annex-4.

Table 9-2 History of Amendments of EPA and EPR

Amendments			1	2	3	4	5	6	7	8	9
Date			2007. Aug.20	2009. Feb.2	2009. Feb.16	2009. Mar.9	2009. May.4	2010. Jan.27	2010. Aug. 12	2010. Oct.14	2012. Oct.29
EPA	Sec.14	Power to constitute Environment Protection Council			X						
EPR	Sec.15	Prevention and control of pollution					X		X		X
	Schedule 1 (Re: Sec. 3)	IEE target project Under Rule Section 3	X	X		X		X			
	Schedule 2 (Re: Sec. 3)	EIA target project Under Rule Section 3	X	X		X				X	

Source: JICA Study Team, Nepal Gazettes

(3) Projects required IEE and EIA review

The list of the projects which are required impact review are summarized in the Schedule 1 (IEE) and Schedule 2 (EIA) of the Environmental Protection Rule.This Project is subjected to EIA study because it is a construction of new alignment of national highway, and because the investment shall surpass NRs. 250,000,000.

Also, the Project is required to apply for MOFSC Project Approval since the western portal of the proposed tunnel is located in national forest. It is not yet known whether the clearance of the national forest is more than 5 hectares.

[1] http://www.dor.gov.np/documents/8.%20Environmental%20and%20Social%20Management%20Framework.pdf
http://www.dor.gov.np/publication/index_category.php?cat=ESMF Nepali

Table 9-3 Eligibility of This Project for EIA Review

	Target Project	Eligibility of this Project
A. Forest Sector:	12. Proposal implementing through other organization instead of forest related government agencies clearing more than 5 hectares of forest.	Yes (national forest) Unknown (area of clearance)
D. Road Sector:	1. Construction of the following roads: (a) National highways.	Yes
L.1.	Operation of any plan, project or programme relating to any developmental work physical activity or change in land use except the proposals mentioned in Clause (a) to Clause (K), and those below the standards of such proposals, as well as the proposals below the standards of those mentioned in schedule -1, with a cost of more than Two Hundred Fifty millions Nepali Rupees (Rs. 250,000,000.).	Yes

Source: Schedule 2, Environmental Protection Rule (2012)

9.3 Gap between Local System and the Requirements of JICA Guidelines

The compensation and assistance requirements of the ESMF are prepared for the WB-assisted project, the Road Sector Development Project, in 2007, and are used for all the projects of DOR since 2011.

The DOR projects, therefore, are implemented according to the framework which is equivalent to the requirements of the JICA guidelines, including in the area such as calculation of compensation amount, additional assistances for resettlement of residents without legal ownership of lands, and assistances for business losses. Such conditions are confirmed by interviews with DOR/GESU, and by the existing reports listed in the following Table. The Entitlement Policy Matrix in the Resettlement Action Plan, Narayanghat- Mugling Road, Nepal India Trade and Transport Facilitation Project (NITTFP), January 2013, is shown in Table 9-5.

Table 9-4 Recent Cases of the ESMF-Applied Projects

Project	Report Title	Dated
Nepal India Trade and Transport Facilitation Project(NITTFP)	Vulnerable Community Development Plan, Narayanghat- Mugling Road	January, 2013
	Resettlement Action Plan, Narayanghat- Mugling Road	January, 2013
Road Sector Development Project (New Project Preparation and Supervision Services) (IDA grant NO: H339 – NEP)	(Draft) Review and update of initial environmental examination study report for upgrading of Gokuleswor to Thaktholi (chainage: km 54+000 – km 92+400)	August 2010
	(Draft) Initial Environmental Examination Study Report for Upgrading of Thaktholi to Darchula (Chainage: km 92+400 – km 126+000)	August 2010
Road Sector Development Project (AF) (IDA GRANT NO: H629 – NEP) (IDA CREDIT NO: 4832 – NEP) (New Project Preparation and Supervision Services)	Resettlement Action Plan, Gokuleshwor- Thaktholi-Darchula Road	January 2011

All the above reports were prepared by;
MMM Group ltd. (Canada), in JV with Sai Consulting Engineers (p) Ltd. (India), in association with Iteco Nepal (p) Ltd. (Nepal) & Total Management Services (Nepal)

Source: http://www.dor.gov.np/publication/index_category.php?cat=RSDP-RESETTLEMENT ACTION PLAN
http://www.dor.gov.np/publication/index_category.php?cat=Nepal India Regional Trade and Transport Project NIRTTP
http://www.dor.gov.np/publication/index_category.php?cat=Supplementary Resettlement Action Plan SRAP
http://www.dor.gov.np/publication/index_category.php?cat=ADB reports
http://www.dor.gov.np/publication/index_category.php?cat=Updated ESMF

Table 9-5 The Entitlement Policy Matrix in the RAP, Narayanghat- Mugling Road, NITTFP

Type of Loss	Entitlement Unit	Description of Entitlements	Implementation Measures
1. House and Other Structure			
1.1 Loss of own house and residential plot	• Titleholder	• Cash compensation for full or partial loss of house at replacement cost, according to house type. • Where displaced, cash compensation (at replacement value) for residential plot, or provision of suitable replacement residential plot in the vicinity, if available.	• Compensation rates of land and structures negotiated by Compensation Determination Committee (CDC) taking reference to succeeding bullet 2 and 3 (which is legal authority), • Land valuation undertaken by DLRO (mostly negotiated) on the reference of local market price and government rate fixed for land registration; • Building valuation undertaken by project authorities (on the basis of standard norms of Department of Urban Development and Building Construction and existing local market price) ; Material may be salvaged with no deduction from compensation. • Displaced households will receive a housing displacement allowance. • Notice to vacate will be served at least 35 days prior to acquisition • An appropriate compensation advance and housing displacement allowance to be paid at time of notice to vacate; balance payable prior to possession of property. • Compensation for partial losses payable prior to acquisition • To ensure fair compensation, determination of rates will be done not more than one year prior to property acquisition.
1.2 Loss of commercial establishment	• Titleholder • Non-titleholder	• Cash compensation for full or partial loss at replacement cost, according to building type.	• Compensation determination, notice to vacate and compensation payment as for 1.1. • Owners of displaced commercial establishments will receive a business displacement allowance
1.3 Loss of other private structures	• Titleholder	• Cash compensation for full or partial loss at replacement cost, according to structure type.	• Other structures include: sheds, water mills, etc • Loss of structures other than houses and commercial establishments does not entail payment of a displacement allowance. • Compensation determination, notice to vacate.
2. Land			
2.1 Loss of private land	• Titleholder	• Provide compensation at full replacement cost, or • Provide full title to land of equal area and productivity acceptable to owner in the vicinity. • Provide cash compensation at full replacement cost based on current market rate or Government rate which ever is higher. • Resettlement assistance in lieu of compensation for land occupied (land, other assets, employment) at least restore their livelihoods and standards of living to pre-displacement levels. • In the case of farmland, the PAP will be entitled the cultivation disruption allowance equal to one-year production.	• A list of affected and entitled persons and the area of land loss is required. • Notice to vacate will be served at least 35 days prior to acquisition date. • Case-wise compensation will be either by cash or cheque, depending on the owner's preferences. • To ensure fair compensation, determination of rates will be established not more than one year prior to property acquisition.
2.2 Temporary loss of private land	• Titleholder	• Compensation for crop, land productivity and other property losses for the duration of temporary occupation. • Compensation for other disturbances and damages caused to property. • Contractor to negotiate a contract agreement on the rental rate with the owner for temporary acquisition of land. • Land should be returned to the owner at the end of temporary acquisition period, restored to its original condition or improved as agreed with owner.	• A temporary occupation contract will be signed with the affected landowner, specifying. ◦ Period of occupancy ◦ Formula for the calculation of production losses (the market value of crops normally produced on the land) and annual inflation adjustments; ◦ Frequency of compensation payment; and ◦ Land protection and rehabilitation measures. • The land will be returned to the owner at the end of temporary acquisition, restored to its original condition.
3. Other Privately Owned Resources			
3.1 Loss of non perennial crops	• Titleholder; other evidence of ownership	• Advance notice to harvest crops. • Net value of crops where harvesting is not possible.	• Crop market values will be determined by the CDCs.
3.2 Loss of privately-owned trees and perennial crops	• Titleholder; other evidence of ownership	• Advance notice to harvest crops. • Net value of crops where harvesting is not possible. • Compensation for future production losses, based on 5 years annual net production for fruit/fodder trees and 3 years annual net production for timber/fuelwood trees and other perennial crops. • Right to all other resources from privately owned trees	• Crop market values and production losses will be determined by the CDCs with assistance from a local resource specialist. • The Department of Agriculture and Forestry will be requested to assist affected owners and communities with the reestablishment of new trees and other perennial crops.
4. Community Structures and Resources			
4.1 Community buildings and Structures	• Local Community	• Restoration of affected community structures to at least previous condition, or replacement in areas identified in consultation with affected communities.	• Community buildings and structures include: schools, temples, health posts, water points, irrigation canals, water mills, trails and bridges.
4.2 Land and trees	• Local community or user groups	• Assistance with improvement of remaining grazing areas. • Restoration of access to community resources.	• The Department of Agriculture and Forestry will requested to assist communities so that benefits from grazing areas are adequately mitigated.
5. Rehabilitation Assistance			
5.1 Displacement of household	• Titleholder • Non-titleholder	• Housing displacement allowance for loss of own residential accommodation. • Rental stipend for loss of rented accommodation.	• The housing displacement allowance will be based on two months per capita poverty level income (PLI), as established by the Nepal Living Standards Survey, for a household of 5.5 members. The value of the allowance will be adjusted annually for price escalation. • The rental stipend will be based on 0.5 months PLI as defined above. • Allowances will be paid at the time of serving the notice to vacate. • Displacement allowances (housing, business and cultivation) will be paid severally.
5.2 Displacement of commercial enterprise	• Titleholder • Non-titleholder	• Business displacement allowance for loss of commercial establishment.	• Calculation as for housing displacement allowance. • Payment as detailed in 5.1.
5.3 Severe disruption to cultivation	• Titleholder • Tenant	• Cultivation disruption allowance for severe disruption to household cultivation levels.	• Thefollowing cultivation disruption allowances will apply to ◦ Households with total landholdings of 0.25 ha and smaller who loose more than 10 percent of their landholdings; ◦ Households with total landholdings above 0.25 ha who loose more than 25 percent of their landholdings; ◦ Households whose production levels are to be severely affected. • The cultivation disruption allowance will be equal to one season's

Source: Resettlement Action Plan, Narayanghat- Mugling Road, Nepal India Trade and Transport Facilitation Project (NITTFP), January 2013

Table 9-6 The Entitlement Policy Matrix in the Resettlement Action Plan, Narayanghat-Mugling Road, NITTFP (Contd.)

Type of Loss	Entitlement Unit	Description of Entitlements	Implementation Measures
			production on the area of land lost, based on published District/VDC production figures, land type and crop market prices for the year of acquisition.
5.4 Vulnerable social categories	▪ Adults 18 years and older in the vicinity of the COI	▪ Vulnerable social categories actually affected by the project will be identified. ○ Janajati groups ○ Dalit groups ○ Women headed households ○ Landless households	▪ Assistance in reestablishment and improvement of livelihood. ▪ Preferential employment on road construction and maintenance to the extent possible. ▪ Support allowances
6. Government Property			
6.1 Loss of infrastructure	▪ Relevant agency	▪ Facilities will be repaired or replaced.	▪ To be undertaken in consultation with the relevant department or ministry.
6.2 Loss of forest areas	▪ Department of Forest	▪ Mitigation by means of afforestation.	▪ An assessment for maintaining that kind of vegetation. ▪ To be undertaken in consultation with Department of Forestry.
6.3 Loss of Government land	▪ Relevant agency	▪ No provision of compensation.	▪ Consultation with relevant government agencies.
7. General Counseling			
7.1 All project impacts	▪ Persons within and adjacent to the road corriDoR	▪ General counseling on project impacts; construction schedules and acquisition dates; valuation, compensation and grievance resolution mechanisms; construction employment procedures; and local development initiatives.	▪ This will be achieved through the periodic distribution of information sheets and consultation with local officials. ▪ Cooperation with GoN ministries and departments such as Department of Agriculture, Forest Local Development to support effective resource utilization and community development.
8. Additional Assistance			
8.1 Preference in employment in wage labour in project activities	▪ All APs	▪ Vulnerable HH due to loss of physical assest.	▪ Construction contracts include provision that APs will have priority in wage labor on project construction during implementation. ▪ APs shall be given priority after construction for work as maintenance worker, mandated in local body agreement
8.2 Skill training and income generation support	▪ One member of each PAF belonging to vulnerable group/below poverty line.	▪ Vulnerable HH due to loss of physical assest.	▪ Skill training and income generation support financed by project ▪ RAP to include a need assessment and skill training program for APs.
8.3 Priority in poverty reduction/social development programs	▪ All APs	▪ Vulnerable HH due to loss of physical assest.	▪ Participation of APs with priority in saving credit scheme facilitated by the Project. ▪ Participation of APs with priority in life skills, income generation, and other entrepreneurship.

Source: Resettlement Action Plan, Narayanghat- Mugling Road, Nepal India Trade and Transport Facilitation Project (NITTFP), January 2013

Compensations and assistances in the following cases are paid by cash. In Nepal, so far, there is no practices of land-for-land type compensation nor provision of resettlement housing.

In terms of environmental impacts during the construction phase, governmental agencies may not have proper monitoring capacity, and most part of responsibility shall be on the contractor. Further study is necessary for the standard operation as well as the capacity of quantitative monitoring by private consultants.

9.4 Steps and Schedule of EIA Approval Procedure

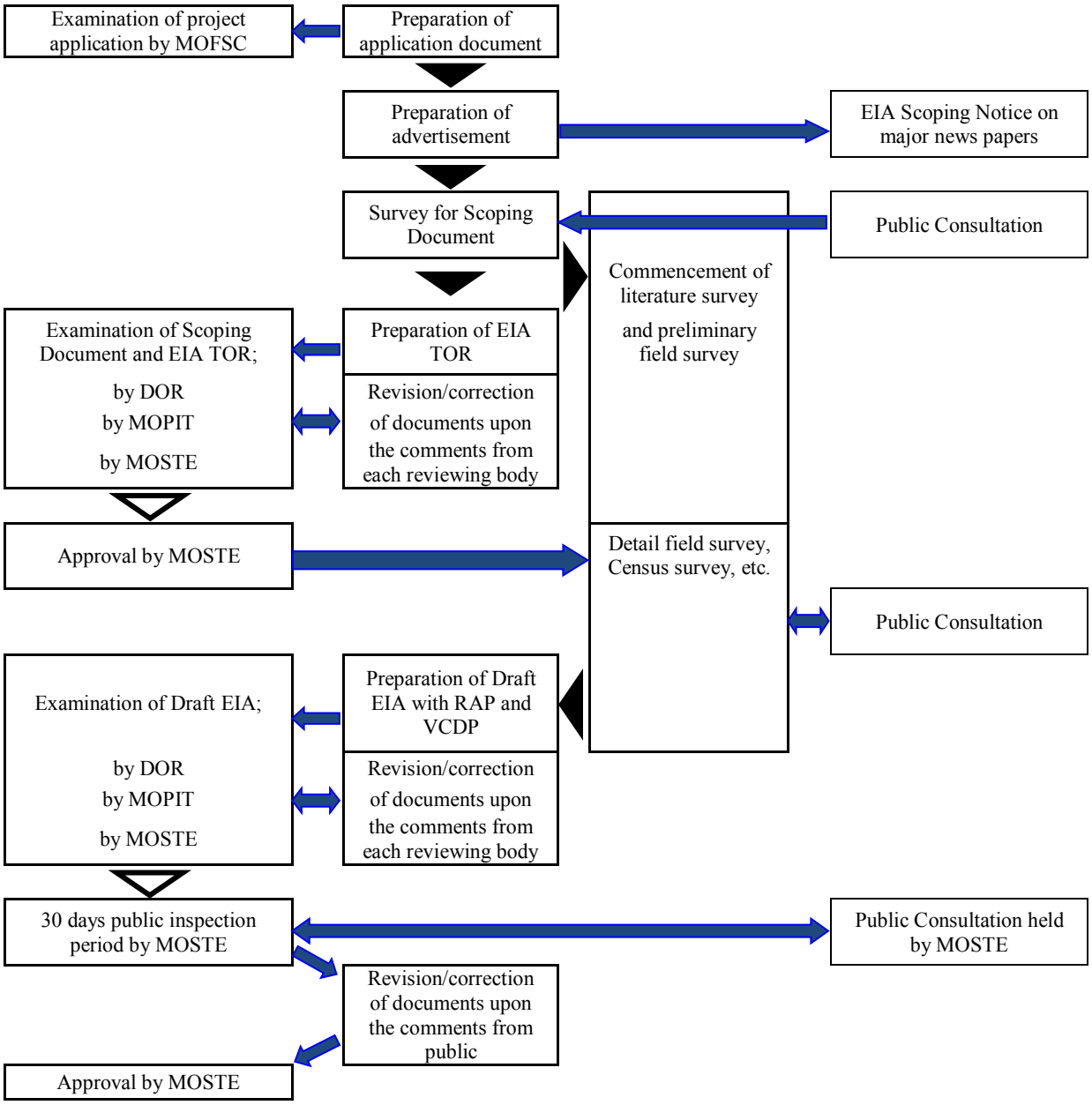
Based on the EPR, the ESMF, and interviews with DOR/GESU, MOSTE, MOFSC, and local consultants, the steps necessary in the Nepali EIA approval procedure are summarized in Table 9-7, 9-8 and Figure 9-1.

Table 9-7 EIA Approval Procedure (1)

CONSULTANCY WORK **ADMINISTRATIVE DURATION**

No.	Activities	Duration Month
1.	**MOFSC Permission**	
2.	Document preparation for MOFSC approval	
3.	Permission to start the EIA study is required from the Ministry of Forest and Soil Conservation (MOFSC) before executing Environmental Assessment	2 months
4.	**Scoping and TOR**	
5.	Publication of 15 days Scoping Notice (EPR, 2054- Rule 4.3)	0.5 month
6.	Preliminary field survey and investigation. Scoping Notice affix and collection of deeds of notice affix at local institutions	0.5 month
7.	Preparation and Submission of Scoping Report and TOR (In the format of EPR, 2054-Schedule 4) to DOR	1-1.5 month
8.	Review of the Reports by DOR	0.5 month
9.	Incorporation of suggestions and recommendations provided by the DOR and submission to MOPIT through DOR	0.5 month
10.	Review of Scoping and TOR by MOPIT	1 month
11.	PP Presentation of Scoping and TOR at MOPIT	1 day
12.	Incorporation of suggestions and recommendations provided during presentation in Scoping and TOR and submit to MOPIT through DOR	0.5 month
13.	Forward of Scoping and TOR to MOSTE from MOPIT	0.5 month
14.	Review of Scoping and TOR by MOSTE	0.5 month
15.	PP Presentation of Scoping and TOR at MOSTE	1 day
16.	Incorporation of suggestions and recommendations in Scoping and TOR provided by MOSTE and its resubmission	0.5 month
17.	Approval of Scoping and TOR from MOSTE	1 month
18.	**EIA Study**	
19.	Study Team Mobilization, Interaction with stakeholders and meetings at local level	0.5 month
20.	RAP Study, Cadastral Survey, Census Survey, Data Enumeration	1 month
21.	Literature Review, Review of Acts, Policies, Legislations and Guidelines and Analysis and prediction of impacts	0.5 months
22.	Propose Mitigation and Augmentation Measures and Preparation of Environmental Management Plan; Vulnerable Community Development Plan; Acquisition, Compensation and Resettlement Action Plan	1 month
23.	Preparation of Draft EIA Report as per Schedule 6 of EPR, 2054	2 months
24.	Publication of Notice for Public Hearing and Public Hearing as per EPR, Rule 7.2 at field sites	0.5 month
25.	Submission of Draft EIA Report to DOR with the incorporation of opinions and suggestions collected from Public Hearing and Recommendation Letters from affected VDCs.	0.5 month
26.	Review of the Draft EIA Report by DOR	0.5 month
27.	Incorporation of Suggestions and Recommendations provided by DOR in Draft EIA Report and Submission 10 copies to MOPIT through DOR	0.5 month
28.	Review of the Draft EIA Report by MOPIT	0.5 month
29.	Incorporation of Suggestions provided by MOPIT in Draft EIA Report and Submission of 10 copies to MOSTE through DOR and MOPIT	0.5 month
30.	Review of the Draft Final EIA Report by MOSTE	0.5 month
31.	PP Presentation of Draft Final EIA Report at MOSTE	1 day
32.	Incorporation of Suggestions provided by MOSTE during presentation in Draft Final EIA Report and Re-Submission to MOSTE through DOR and MOPIT	0.5 month
33.	Issuance of 30 day public notice in daily newspaper for public opinions and suggestions by MOSTE and Approval of EIA report by MOSTE as per EPR, Rule 11.2, 11.4, 11.5 and 11.6)	3 to 4 months

Source: JICA Study Team



Source: JICA Study Team

Figure 9-1 EIA Approval Procedure (2)

Table 9-8-1 EIA Approval Schedule with Priority Status of the Project

		June	July	*Aug.*	Sep.	Oct.	*Nov.*	*Dec.*
Meeting and coordination	1. Project approval application to MOFSC.							
	2. Project notification on major papers.							
	4. Public meeting for Scoping Document (SD).							
	5. Obtaining VDC Chairs' approval letters.							
	6. Presentation of SD and EIA/TOR to DOR.							
	10. Record of Item 4 (First Public Meeting)							
	13. Presentation of the SD and EIA/TOR to MOPIT.							
	14. Presentation of the SD and EIA/TOR to MOSTE.							
	23. Second public meeting.							
	24. Presentation of the Project to CDC.							
	31. Record of Item 23 (Second Public Meeting)							
	34. Presentation of the Draft EIA to DOR.							
	39. Presentation of the Draft EIA to MOPIT.							
	42. Presentation of the Draft EIA to MOSTE.							
	43. DOR to receive the EIA approval from MOSTE.							
Survey	3. General observation of the Project Area.							
	7. Literature survey.							
	8. General observation survey.							
	9. Cadastral survey.							
	15. Preparation of interview sheets							
	16. Field test of the interview sheets and amendment.							
	17. Field survey of air, noise, water quality etc..							
	22. Submission of reports and photos of Item 17							
	25. Commencement of the detailed field survey.							
	26. Land Survey (determination of the location of the public (road) / private boundary, determination of the severity of impacts of private land loss) .							
	27. Census survey, Property survey, Livelihood survey, and determination of the Cut-off Date.							
	33. Submission of reports and photos of Items 26, 27.							
Assessment	28. Environmental Impact Assessment.							
Planning	29. Formulation of Environmental Management Plan, including mitigation plan and monitoring plan.							
	30. Formulation of Resettlement Action Plan (RAP) and Vulnerable Community Development Plan (VCDP).							
Documenting	11. Preparation of the SD and the EIA/TOR.							
	12. Submission of the SD and the EIA/TOR to DOR.							
	18. Update of SD & EIA/TOR based on DOR comments.							
	19. Obtaining DOR approval and submission to MOPIT.							
	20. Update of SD & EIA/TOR based on MOPIT comments.							
	21. Obtaining MOPIT approval and submission to MOSTE.							
	32. Finalization of SD and EIA/TOR based on MOSTE comments.							
	32.5 Obtaining MOSTE approval of SD & EIA/TOR.							
	35. Submission of the Draft EIA Report with RAP and VCDP to DOR.							
	36. Submission of the E-files of Item 35 and other data collected and produced for the Project.							
	37. Update of the Draft EIA Report with RAP and VCDP based on DOR comments							
	38. Submission of the Draft EIA Report with RAP and VCDP to MOPIT.							
	40. Update of the Draft EIA Report with RAP and VCDP based on MOPIT comments.							
	41. Submission of the Draft EIA Report with RAP and VCDP to MOSTE.							
	41.5 Obtaining MOSTE approval of the Draft EIA Report with RAP and VCDP							

Items in *Italic* are the critical passes of the schedule.

Table 9-8-2 EIA Approval Schedule without Priority Status (preferred fast track procedure)

		June	July	*Aug.*	*Sep.*	*Oct.*	*Nov.*	Dec.	*Jan.*	*Feb.*	*Mar.*	*Apr.*
Meeting and coordination	1. Project approval application to MOFSC.											
	2. Project notification on major papers.											
	4. Public meeting for Scoping Document (SD).											
	5. Obtaining VDC Chairs' approval letters.											
	6. Presentation of SD and EIA/TOR to DOR.											
	10. Record of Item 4 (First Public Meeting)											
	13. Presentation of the SD and EIA/TOR to MOPIT.											
	14. Presentation of the SD and EIA/TOR to MOSTE.											
	23. Second public meeting.											
	24. Presentation of the Project to CDC.											
	31. Record of Item 23 (Second Public Meeting)											
	34. Presentation of the Draft EIA to DOR.											
	39. Presentation of the Draft EIA to MOPIT.											
	42. Presentation of the Draft EIA to MOSTE.											
	43. DOR to receive the EIA approval from MOSTE.											
Survey	3. General observation of the Project Area.											
	7. Literature survey.											
	8. General observation survey.											
	9. Cadastral survey.											
	15. Preparation of interview sheets											
	16. Field test of the interview sheets and amendment.											
	17. Field survey of air, noise, water quality etc..											
	22. Submission of reports and photos of Item 17											
	25. Commencement of the detailed field survey.											
	26. Land Survey (determination of the location of the public (road) / private boundary, determination of the severity of impacts of private land loss) .											
	27. Census, Property, Livelihood surveys, and determination of the Cut-off Date.											
	33. Submission of reports and photos of Items 26, 27.											
Assessment	28. Environmental Impact Assessment.											
Planning	29. Formulation of Environmental Management Plan, including mitigation plan and monitoring plan.											
	30. Formulation of Resettlement Action Plan (RAP) and Vulnerable Community Development Plan (VCDP).											
Documenting	11. Preparation of the SD and the EIA/TOR.											
	12. Submission of the SD and the EIA/TOR to DOR.											
	18. Update of SD & EIA/TOR based on DOR comments.											
	19. Obtaining DOR approval and submission to MOPIT.											
	20. Update of SD & EIA/TOR based on MOPIT comments.											
	21. Obtaining MOPIT approval and submission to MOSTE.											
	32. Finalization of SD and EIA/TOR based on MOSTE comments.											
	32.5 Obtaining MOSTE approval of SD & EIA/TOR.											
	35. Submission of the Draft EIA Report with RAP and VCDP to DOR.											
	36. Submission of the E-files of Item 35 and other data collected and produced for the Project.											
	37. Update of the Draft EIA Report with RAP and VCDP based on DOR comments											
	38. Submission of the Draft EIA Report with RAP and VCDP to MOPIT.											
	40. Update of the Draft EIA Report with RAP and VCDP based on MOPIT comments.											
	41. Submission of the Draft EIA Report with RAP and VCDP to MOSTE.											
	41.5 Obtaining MOSTE approval of the Draft EIA Report with RAP and VCDP											

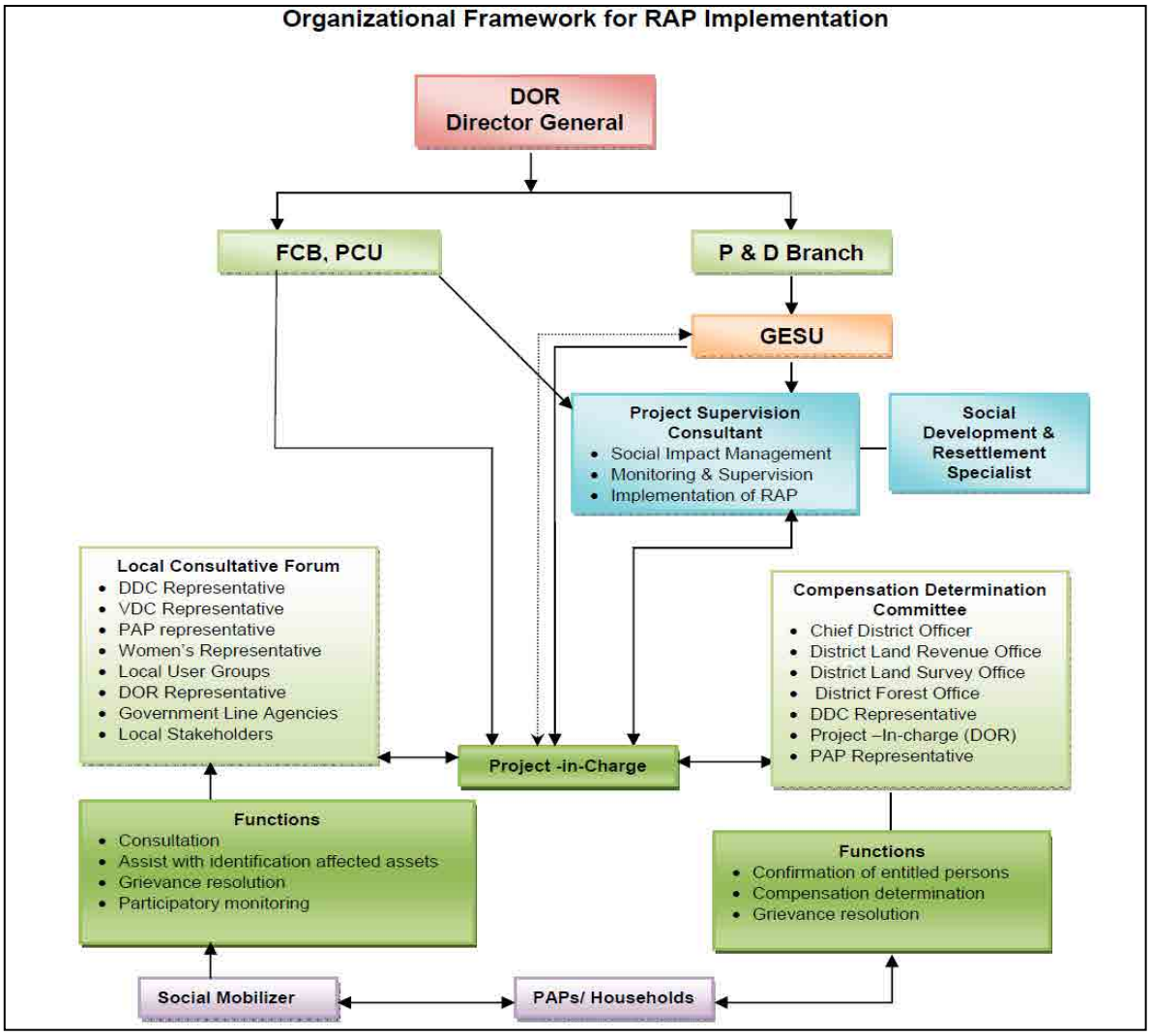
Nepali holidays or unexpected governmental holidays are not considered in the above chart.

In the WB assisted RSDP project, the budget for EIA approval procedure is allocated by WB to DOR for the whole project period of 5 years. DOR/GESU hires a team of consultants and the payment is made at each phase of achievement, first at the MOSTE approval of the Scoping and TOR documents, second at the submission of draft EIA to MOSTE, and final upon the approval of the EIA report by MOSTE.

Samples of table of contents of MOFSC Project Approval Request, EIA Scoping Document, and EIA Terms of Reference Document are shown in Annex-5, Annex-6, and Annex-7 respectively.

9.5 Organizational Framework for RAP Implementation

In the WB supported Narayanghat - Mugling Road project, the organizational framework in Figure 9-2 is proposed for RAP implementation.



Source: Resettlement Action Plan, Narayanghat - Mugling Road, Nepal India Trade and Transport Facilitation Project (NITTFP), January 2013

Figure 9-2 Organizational Framework for RAP Implementation

9.6 Monitoring

In the Draft Review and Update of Initial Environmental Examination Study Report for Upgrading of Gokuleswor to Thaktholi, costs for environmental and social monitoring, mainly the costs of hiring experts, are estimated and listed as shown in Table 9-9.

In terms of environmental impacts during the construction phase, governmental agencies may not have proper monitoring capacity, and much part of responsibility shall be on the contractor. Further study is necessary for the standard operation as well as the capacity of quantitative monitoring by private consultants.

Table 9-9 Costs for Environmental and Social Monitoring

Specifications	MM	Rate	Amount
Expert Team Monitoring Cost			
Environmental Management Specialist	2.5	100,000	250,000
Sociologist / Resettlement Expert	2	80,000	160,000
Biologist / Bio-Engineering Specialist	1	80,000	80,000
Stationary and Computer	LS		30,000
Printing and Photocopies	LS		30,000
Transportation	LS		60,000
Cost for Monitoring by GESU	LS		125,000
Cost for Monitoring by MoPPW	LS		75,000
SUB-TOTAL			**810,000**

Source: (Draft) Review and Update of Initial Environmental Examination Study Report for Upgrading of Gokuleswor to Thaktholi (chainage: km 54+000 – km 92+400), August 2010

Another recent example lists the cost items included in the expert fees in Table 9-10.

Table 9-10 Cost Estimate for RAP Implementation

Item	MM/Times	Rate in NRS	Total Cost (NRS)
A. Estimated cost for Social Development and Resettlement Expert			
Remuneration	5.5 man/month	250,000	1,375,000
Daily allowance	150 Days	3,000	450,000
Dashain allowances	Lump-sum		250,000
Transportation including air and vehicle	Lump-sum		980,000
Logistics and accessories	Lump-sum		135,000
Sub Total of A			**3,190,000**
B. Social Mobilizer			
Remuneration	15 MM	70,000	1,050,000
Field allowances	450 Days	2,000	900,000
Transportation including air and vehicle	Lump-sum		144,000
Sub Total of B			**2,094,000**
C. Estimated Cost for Deed Transfer			
Remuneration to Cadastral Surveyor	4 man/month	50,000	200,000
Remuneration to Assistant Cadastral Surveyor	4 man/month	30,000	120,000
Logistics and accessories	Lump-sum	25,000	25,000
Sub Total of C			**345,000**
D. Provisional Expenses (Orientation, awareness and training for stakeholders and PAPs)			
Remuneration for professional human resources		4 persons/day @ NRS 5,000 x 4 days x4 slices	320,000
Logistics and stationeries		NRS 100,000 for one training x4 training	400,000
Refreshment and transportation for participants		400 participants @ 500	200,000
Allowances to the participants		400 participants @ 500	200,000
Contingency 15 %			168,000
Sub Total of D			**1,288,000**
Grand Total (A+B+C+D)			**6,917,000**

Source: Resettlement Action Plan, Gokuleshwor- Thaktholi- Darchula Road, January 2011, Road Sector Development Project (AF) (IDA GRANT NO: H629 – NEP) (IDA CREDIT NO: 4832 – NEP) (New Project Preparation and Supervision Services)

Table 9-11 shows a sample monitoring plan, both internal and external, for RAP implementation in a DOR project.

Table 9-11 Sample Monitoring Plan for RAP Implementation

Table 28: Frameworks for Internal Monitoring

Type	Indicators	Issue	Procedure	Timing	Responsibility
Process level monitoring	RAP implementation in project works	Employment of local labor including women and children	Site observation, attendance record, interaction with laborers and contractors	Monthly	Project/social mobilizer /SDRS
		Campsite management including lodging arrangement and campsite facilities	Site observation, interaction with laborers, contractors	Monthly	Project/ social mobilizer/SDRS
		Use of health and safety measures	Site observation, interaction with laborers, contractors	Quarterly	Project/ SDRS
		Temporary leasing of private land and house	Site observation, contractors, check contract agreement	Monthly	Project/social mobilizer/SDRS
		Discrimination of wage rate between male and female workers	Interaction with laborers, labor survey, record of wage payment	Monthly	Project/social mobilizer/SDRS
Output level	Land Acquisition	Encroachment into public land like grazing land, temples etc	Visit the identified public land interact with local people, take photographs	Biannually	Project/social mobilizer /SDRS
		Development of new settlements/slum along the roadside	Observation, recording of sites, photograph	Quarterly	Project/social mobilizers/SDRS
		Migration to the road side/displacement of local people	Review of land holding records, discussion with local people	Quarterly	Project/social mobilizer/SDRS
		Incidence of road accidents	Discuss with local people, health institutions' records	Biannually	Project/SDRS
		Incidence of communicable diseases like respiratory, STD, HIV/AIDS etc.	Discuss with local people, health workers/ health post/ center records	Annually	Project/social mobilizer/SDRS
Impact level	Change in household level income and economic activities	Changes in the land price, land use and agricultural practices, productivity and crop export	Discuss with farmers and extension workers, agricultural statistics of District Agriculture Office	Annually	Project/social mobilize/SDRS
	Social safety	State of social harmony and social security like alcoholism, narcotism etc.	Police records, discussion with local residents	Annually	Project/SDRS
		Changes in the living standard of people	Interview with families, VDC records, discussion with local leaders, CBOs	Annually	Project/SDRS
	Cultural impact	Condition of cultural and historical areas and aesthetic qualities	Visit the area, discuss with people, observation and photographs	Annually	Project/SDRS

Table 29: Frameworks for External Monitoring

Indicators	Procedure	Timing	Responsibility
Employment of local labor including women and children	Site observation, attendance record, interaction with laborers and contractors	Annually	External Consultant
Campsite management including lodging arrangement and campsite facilities	Site observation, interaction with laborers, contractors	Annually	External Consultant
Use of health and safety measures	Site observation, interaction with laborers, contractors	Annually	External Consultant
Temporary leasing of private land and house	Site observation, contractors, check contract agreement	Annually	External Consultant
Discrimination of wage rate between male and female workers	Interaction with laborers, labor survey, record of wage payment	Annually	External Consultant
Encroachment into public land like grazing land, temples etc	Visit the identified public land interact with local people, take photographs	Annually	External Consultant
Development of new settlements/slum along the roadside	Observation, recording of sites, photograph	Annually	External Consultant
Migration to the road side/displacement of local people	Review of land holding records, discussion with local people	Annually	External Consultant
Incidence of road accidents	Discuss with local people, health institutions' records	Annually	External Consultant
Incidence of communicable diseases like respiratory, STD, HIV/AIDS etc.	Discuss with local people, health workers/ health post/ center records	Annually	External Consultant
Changes in the land price, land use and agricultural practices, productivity and crop export	Discuss with farmers and extension workers, agricultural statistics of District Agriculture Office	Annually	External Consultant
State of social harmony and social security like alcoholism, narcotics etc.	Police records, discussion with local residents	Annually	External Consultant
Changes in the living standard of people	Interview with families, VDC records, discussion with local leaders, CBOs	Annually	External Consultant
Condition of cultural and historical areas and aesthetic qualities	Visit the area, discuss with people, observation and photographs	Annually	External Consultant

Source: Resettlement Action Plan, Narayanghat- Mugling Road, Nepal India Trade and Transport Facilitation Project (NITTFP), January 2013

9.7 Detailed Information on Social Conditions in the Project Area

9.7.1 VDCs and Wards of the Project Affected Area

The Project Affected Area, including 500 m 'indirectly affected area,' includes lands in 7 VDCs in 2 Districts.

Table 9-12 The VDCs included in the Project Area

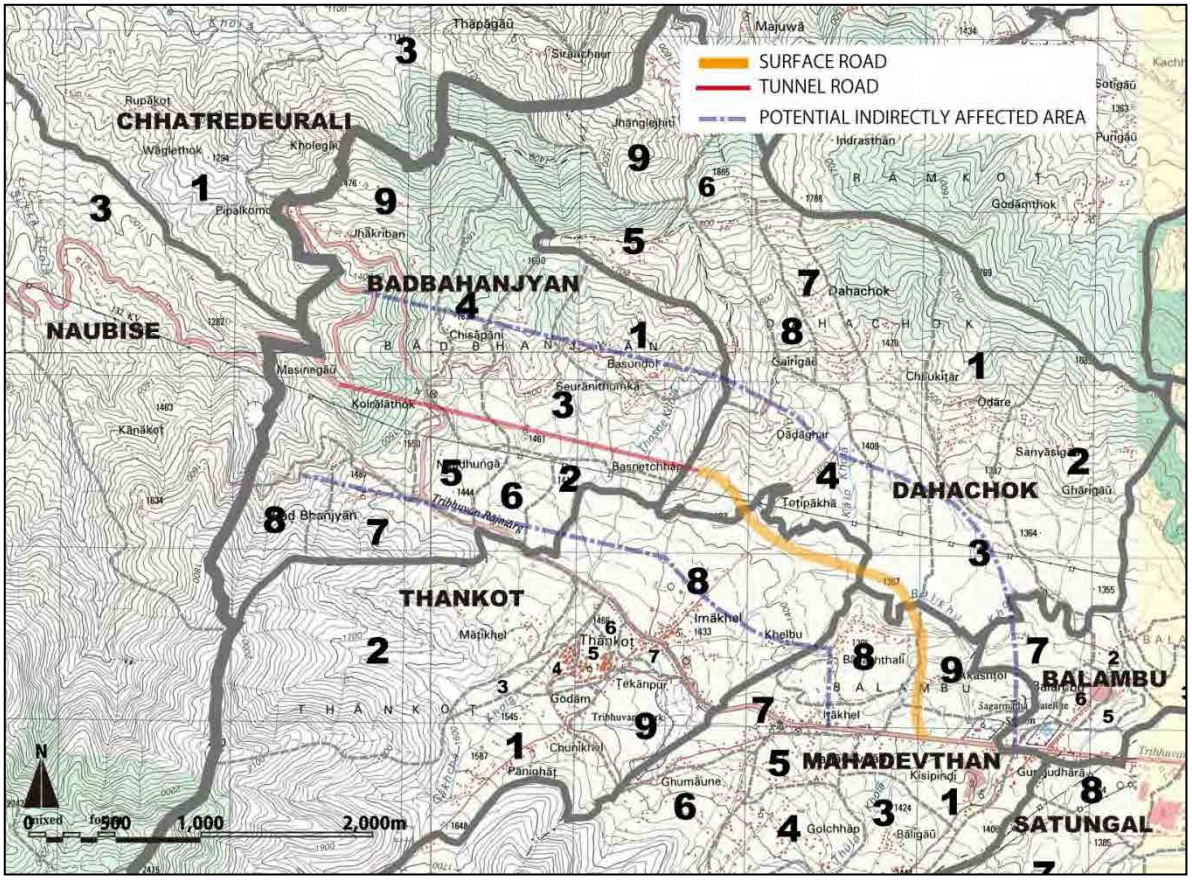
Region	Zone	District	VDC	Ward	Type of Impacts			
					1) Planned alignment			2) Existing road
					1)-1 Surface road	1)-2 Tunnel road	1)-3 Potential soil disposal	2)-1 Section of existing road to be bypassed
Central	Bagmati	Kathmandu	Balambu	1	*			
				7	*			
			Mahadevsthan	1	X			Y
				5				Y
				7	*			Y
				8	*			
				9	X			
			Dahachok	1	*			
				2	*			
				3	X			
				4	X			
				8	*			
			Thankot	2				Y
				3				Y
				6				Y
				7				Y
				8	X			Y
				9				Y
			Baad Bhanjyang	1		*		
				2		*		Y
				3		X		
				4		X		
				5		X		Y
				6		*		Y
				7		*		Y
				8		*		
				9		X		Y
		Dhading	Naubise	3			X	
				4			X	
				7			X	
			Chhatre Dyaurali	1			X	Y
				3				Y

Type of Impacts : See Table 9-12.
X : 50 m ROW for surface road, and tunnel alignment. Defined as 'directly affected area.'
* : Within 500 m from the boundary of the ROW. Defined as 'indirectly affected area.'
Source: JICA Study Team

Table 9-13 Type of Impacts

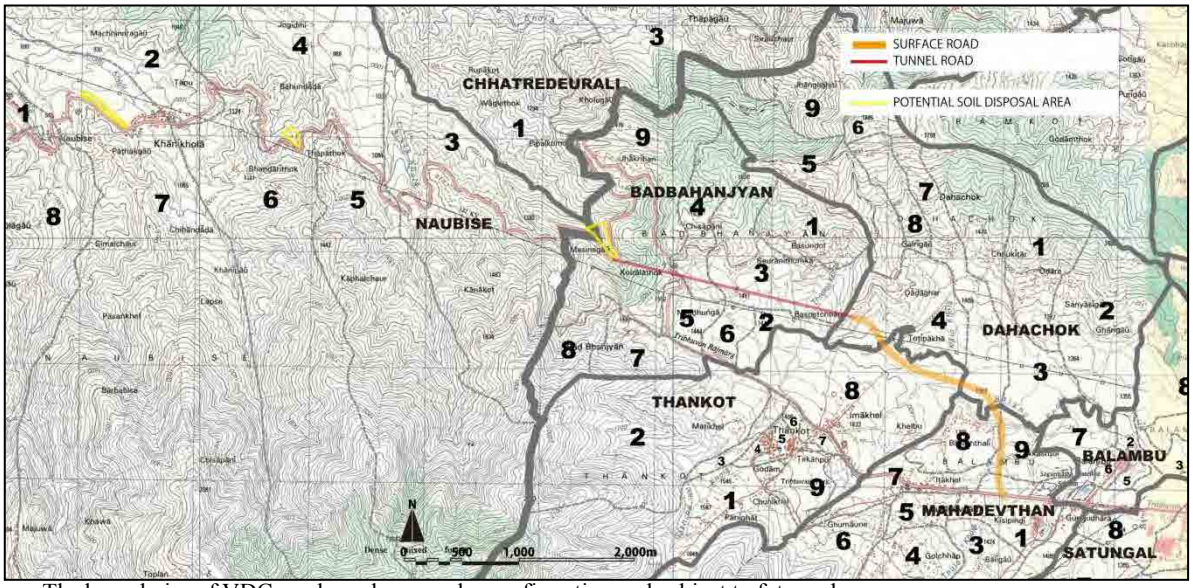
1) Area related to new bypass road	1)-1 Area to be trespassed by the new surface road 1)-2 Area to be trespassed by the tunnel road 1)-3 Area where soil disposal may be considered
2) Area related to existing road	2)-1 Area along the section of existing road which shall be bypassed, and may receive less traffic volume.

Source: JICA Study Team



The boundaries of VDCs and wards are under confirmation and subject to future change
Source: JICA Study Team

Figure 9-3 The Project Affected Area (Road and Tunnel)



The boundaries of VDCs and wards are under confirmation and subject to future change
Source: JICA Study Team

Figure 9-4 The Project Affected Area (Potential Soil Disposal Site)

9.7.2 Population and Ethnicity/Caste

(1) Population

The information of Ward-wise number of population and households in the Project Affected Area was collected from the National Population Census 2011.

There is possibility that the number in the following table does not include population and households who are renting rooms and houses. In the EIA Census Survey, it is necessary to include those tenants as stakeholder of the Project.

Table 9-14 Ward-Wise Number of Population and Households in the Project Affected Area

District	VDC	Ward	Type of Impacts				House Hold	Population		
			1) Planned alignment			2) Existing road				
			1)-1 Surface road	1)-2 Tunnel road	1)-3 Potential soil disposal	2)-1 Section of existing road to be bypassed		Total	Male	Female
Kathmandu	Balambu	1	*				287	1,202	604	598
		7	*				204	901	441	460
	Mahadevsthan	1	X			Y	541	2,265	1,133	1,132
		5				Y	407	1,595	813	782
		7	*			Y	775	3,193	1,617	1,576
		8	*				238	967	477	490
		9	X				87	478	236	242
	Dahachok	1	*				88	431	213	218
		2	*				274	1,306	631	675
		3	X				148	712	343	369
		4	X				111	534	279	255
		8	*				65	261	140	121
	Thankot	2				Y	216	948	492	456
		3				Y	197	943	466	477
		6				Y	164	735	374	361
		7				Y	328	1,356	684	672
		8	X			Y	1,126	4,615	2,396	2,219
		9				Y	137	604	300	304
	Baad Bhanjyang	1		*			127	580	282	298
		2		*		Y	122	525	268	257
		3		X			101	481	241	240
		4		X			42	195	99	96
		5		X		Y	108	479	241	238
		6		*		Y	50	245	118	127
		7		*		Y	153	685	337	348
		8		*			28	133	65	68
		9		X		Y	86	456	222	234
Dhading	Naubise	3			X		225	955	461	494
		4			X		350	1,606	763	843
		7			X		512	2,437	1,254	1,183
	Chhatre Dyaurali	1			X	Y	147	627	301	326
		3				Y	180	771	352	419

Type of Impacts : See Table 9-12.
X : 50 m ROW for surface road, and tunnel alignment. Defined as 'directly affected area.'
* : Within 500 m from the boundary of the ROW. Defined as 'indirectly affected area.'
Source: National Population Census 2011, Household and Population by Sex, Ward Level, Central Bureau of Statistics, November 2012

(2) Household Size

Calculated from ward-wise number of population and households, the average size of one household in the Project Affected Area is 4.36, as shown in Table 9-15.

Table 9-15 Average Household Size in the Project Affected Area

District	VDC	Ward	Household	Population	Average HH Size
Kathmandu			436,344	1,744,240	4.00
	Balambu	1	287	1,202	4.19
		7	204	901	4.42
	Mahadevsthan	1	541	2,265	4.19
		5	407	1,595	3.92
		7	775	3,193	4.12
		8	238	967	4.06
		9	87	478	5.49
	Dahachok	1	88	431	4.90
		2	274	1,306	4.77
		3	148	712	4.81
		4	111	534	4.81
		8	65	261	4.02
	Thankot	2	216	948	4.39
		3	197	943	4.79
		6	164	735	4.48
		7	328	1,356	4.13
		8	1,126	4,615	4.10
		9	137	604	4.41
	Baad Bhanjyang	1	127	580	4.57
		2	122	525	4.30
		3	101	481	4.76
		4	42	195	4.64
		5	108	479	4.44
		6	50	245	4.90
		7	153	685	4.48
		8	28	133	4.75
		9	86	456	5.30
Dhading			73,851	336,067	4.55
	Naubise	3	225	955	4.24
		4	350	1,606	4.59
		7	512	2,437	4.76
	Chhatre Dyaurali	1	147	627	4.27
		3	180	771	4.28
Project Affected Area Total			7,624	33,221	4.36

Source: National Population Census 2011, Household and Population by Sex, Ward Level, Central Bureau of Statistics, November 2012
District : National Population and Housing Census 2011 (Table 12), Volume 01, Central Bureau of Statistics, November 2012
VDC : National Population Census 2011, Household and Population by Sex, Ward Level, Central Bureau of Statistics, November 2012

(3) Ethnicity/Caste

The information of Ward-wise number of population and households by Caste/Ethnicity in the Project Area was collected from the VDC Profile documents of each VDC.

VDC Profile of Balambu and 2 others in Dhading District were not yet collected.

In the Project Affected Area in 3 VDCs shown in Table 9-16, population who belong to Dalit community consisted of 5.9%. In the Project Affected Area in Baad Bhanjyang shown in Table 9-17, households that belong to Dalit community consisted of 10.6%.

During this Study, DOR/GESU and MOSTE (EIA) confirmed that no significant accumulation of those population is expected in the Project Area.

In the next phase of the Study, 1) interviews to the affected VDC Secretaries, 2) public consultations, 3) census survey of the households within the ROW shall be conducted to clarify the existence and needs of socially and economically vulnerable population to be affected.

Table 9-16 Ward-Wise Number of Population and Households by Caste/Ethnicity

VDC	Ward	Population by Ethnicity					
		Brahmin	Chhatre	Newar	Dalit	Others (Including indigenous group and others)	Total
Mahadevsthan	1	118	154	1,031	60	144	1,507
	5	139	140	436	100	90	905
	8	58	319	44	5	292	718
	9	18	139	172	82	191	602
Dahachok	1	79	505	20	3	82	689
	2	78	82	19	0	1,125	1,304
	3	46	402	14	185	13	660
	4	29	460	30	5	0	524
	8	86	66	0	0	26	178
Thankot	8	291	403	1,045	100	302	2,141
Total		942	2,670	2,811	540	2,265	9,228
(%)		10.2%	28.9%	30.5%	5.9%	24.5%	100.0%

Source: VDC Profile (Mahadevsthan 2068(2011/12), Dahachok 2069(2012/13), Thankot 2067(2010/11))

Table 9-17 Ward-Wise Number of Households by Caste/Ethnicity

VDC	Ward	Household Number by Ethnicity					
		Brahmin	Chhatre	Newar	Dalit	Others (Including indigenous group and others)	Total
Baad Bhanjyang	1	14	53	0	45	0	112
	2	53	19	0	1	1	74
	3	57	20	2	1	3	83
	4	6	19	0	0	16	41
	5	15	53	4	6	27	105
	6	14	17	1	18	0	50
	7	9	74	19	1	13	116
	9	0	0	0	0	98	98
Total		168	255	26	72	158	679
(%)		24.7%	37.6%	3.8%	10.6%	23.3%	100.0%

Source: VDC Profile (Baad Bhanjyang 2067(2010/11))

Chapter 10 Project Implementation Plan

10.1 Implementation Plan

10.1.1 General

Implementation plan for the construction, operation and maintenance of the optimum route mentioned in Chapter 5 is covered hereunder. This includes the development policy of the road, project prioritization, proposed implementing organization, financial source and implementing schedule.

10.1.2 Development Policy

The policies that apply for the smooth implementation of the project are listed here under;

i) The road will be developed as a bypass of the existing Tribhuvan Highway and will be similarly classified into national highway.

ii) The road will also be designated as a section of Mid-hill Highway and will be enlisted in the National Priority Projects to make it eligible for provision of stable and continuous power supply from Nepal Electricity Authority (NEA).

iii) The project road will be constructed under the soft loan from the government of Japan.

iv) The project will be implemented under the joint venture between a local and Japanese contractor(s) where the Japanese contractor will transfer knowledge and technology to local contractor.

v) Foreign Co-operation Branch, DOR will handle during the design stage of the project. A Project Management Unit will be established in the Bi-lateral Cooperation Unit under Foreign Co-operation Branch, which will handle the construction stage.

vi) Funding for the maintenance of the road and tunnel will be provided by Roads Board Nepal. However, for the operation of the tunnel, funding will be provided by DOR.

vii) A special unit will be established within the Kathmandu Division Office for handling the operation and maintenance of the project road.

viii) Special equipment and material required for construction of tunnel will be procured from Japan. Others will be procured locally or from a third country.

10.1.3 Project Prioritization

The 13th three-year plan (2013/14-2015/16) of Nepal has highlighted the importance of expansion of roadways and development of physical infrastructure for achieving the mid and long term goals and has given high priority for the development of Mid-hill Highway (also a part of Asian Highway)

On the other hand, the road project includes a 2.3km long tunnel, which demands continuous supply of power. It has been learnt from Nepal Electricity Authority (NEA), that provision of stable and continuous supply of electricity is possible, if the project (road) is a National Priority Project.

Therefore, for smooth implementation of the project and proper post-construction operation and maintenance, it is necessary that the road project be designated as a national priority project.

10.1.4 Financial Source

The DOR conducted the Feasibility Study of a tunnel road in the study area in 2013 under its own budget. In the Study, the construction of the proposed tunnel is concluded to be feasible. However, the project is not proceeding mainly because the DOR is facing financial difficulty for funding from its local fund and has sought financial help from International Donors including the government of Japan.

Under such circumstances, Japan has shown interest in offering financial assistance and took up the pre-feasibility study of the project. If agreed by the government of Nepal, financial assistance from Japan will be available as a soft loan, given that the project is economically feasible and the construction is implemented under the Joint Undertaking Mutual Partnership (JUMP) scheme of Japan. JUMP is a scheme where the construction work will be carried out under a joint venture between a local construction company and a Japanese construction company.

10.1.5 Application of Japanese Construction Technology

The problems of the existing road are as follows:

1) Steep vertical alignment
2) Poor horizontal alignment
3) Slope safety due to geological condition

There is no road improvement measure to solve these three problems at once and the only applicable method is to provide a tunnel. Therefore, the tunnel is planned to avoid the above-mentioned problems for the most critical sections.

The Japanese tunnel technology has been improved mainly to in order to conquer poor geological conditions in Japan. This experience and the technology obtained are both useful in the tunnelling which will be used in road construction in Nepal whose geological condition is complex and mostly weak as ground for tunnel.

The technology in common use in Japan consists of three methods. One is NATM for Mountains, the other is Shield Tunnel for soft flat area and another is Cut and Fill tunnel in shallow tunnels. Shield

is very expensive and not applicable in rocks. Cut and Fill is not applicable in steep mountains. Therefore only NATM is applicable to mountainous area.

Japan is a mountainous country similar to Nepal and it's geological and topographical condition is also identical. Under such similarities, application of Japanese technology is deemed to be most desirable from the following points of view.

1) Highly experienced: among technically developed countries, Japan stands on top in terms of experience (excavation volume)
   Japan: 15 million cubic meters
   Germany: 4 million cubic meters
   Norway: 1.8 million cubic meters
2) Export of Japanese tunnel technology:
   In recent decade, Japanese contractors had about 7.5billion NRs (25% tunnels abroad) contract.
3) Technical Backups by Industry, Academic and Government Cooperation, by Tunnel Technology Association etc. including technical standards and other publications.
4) Establishment of technical standards such as Tunnel design standards of Road Association and Ministry of Land Infrastructure, Transport and Tourism Technical specification of tunnel by Japan Institute of Civil Engineering, various technical reports by Tunnel Technology Association and so on.
5) Quality control based on the Measurement: the methods and systems of measurement, analysis, evaluation, feedback have been established.
6) Various innovation of tunneling such as:
   - Fore-piling and fore-poling
   - NATM constructed in Urban
   - Advanced Schedule and Safety Control.

The technology transfer of this tunnel project can be done in both the engineering and the construction stage to the local contractors of Nepal as well as the DOR. The Engineering of the tunnel is the essence of the established technical standards and their back grounds described in 3) and 4) above for the next road tunnel planning, construction and maintenance in Nepal. The construction of tunnelling is mainly the quality control of NATM and Road Section, which is absolutely larger than the conventional hydro-tunnels in Nepal, and is the various advanced tunnelling items as described in 5) and 6) above.

10.1.6 Transfer of Japanese Technology to Nepal

(1) Technical Explanatory Meeting

Japanese tunnel technology is the one of the most advanced countries in the world. To transfer the Japanese tunnel technology to local engineers is the very distinguished engineering education. From

such view point, the study team conducted the "Technical Explanatory Meeting" at DOR office on 20th April, 2014.

Technical explanatory meeting was held by DOR and supported by JICA study team. The participants were superior agencies and the relevant authorities to promote understanding to construction technology for the project implementation in the study area. The study team investigates the possibility of utilizing Japanese technology such as construction technology, tunnel equipment, safety management for construction and maintenance, and environmental measures. Also, it shall support Japanese industry group who has the effective technology for the project to hold a presentation.

Further details of the meeting are shown in "Annex-9".

(2) Observation Visit of Tunnel Construction

The study team supported the invitation of counterparts for observation to construction site in Japan. Construction site at the northern part of Japan was similar to the study area. The study team on behalf of JICA invited eight government officials who will engage in the project implementation in the study area to Japan. In this program, the study team managed the site inspection to the tunnel project which is constructed by Japanese techniques and the consultation with Japanese corporations.

The visit Japan program was held from 21 May to 27 May, 2014 and outline of the program was performed as follows:

1) Tunnel technology presentation held by Japanese constructors
2) Site visit 'Hanabuchiyama No. 2 Tunnel Construction' was under construction by NATM.
3) Site visit 'Raiden Todoroki Bridge' (spiral bridge)
4) Site visit 'Tokyo Bay Under Sea Bridge' and 'Ikejiri Spiral Bridge

Further details of the observation visit are shown in "Annex-10".

10.2 Proposed Implementing Organization

The organization responsible for implementation of this project is proposed as the Department of Roads (DOR), Ministry of Physical Infrastructure and Transport of the government of Nepal and Roads Board Nepal. Figure 10-1 illustrates the present organization chart of the DOR.

Normally, a Project Management Unit (PMU) is set up under Bi-lateral or Multi-lateral Cooperation Unit to implement a project. For example, as shown in the chart, Dhulikhel-Bardibas PMU was set up under Bi-lateral Cooperation Unit for implementing the Sindhuli Road, a grant aid Project of Japan. Similarly, RMWP PMU under Multi-lateral Cooperation Unit has been established for implementing the Road Maintenance and Development Projects under financial assistance from the World Bank. The main responsibility of the PMU is to facilitate the issues of environmental and social consideration

and coordinate with other concerned organizations.

After construction, generally the maintenance responsibilities of a road are handed over to the concerned division office under Maintenance Branch of the DOR. At present, the maintenance responsibility of the objective section lies under two division offices as shown in Table 10-1.

Table 10-1 Division Offices and Responsibilities

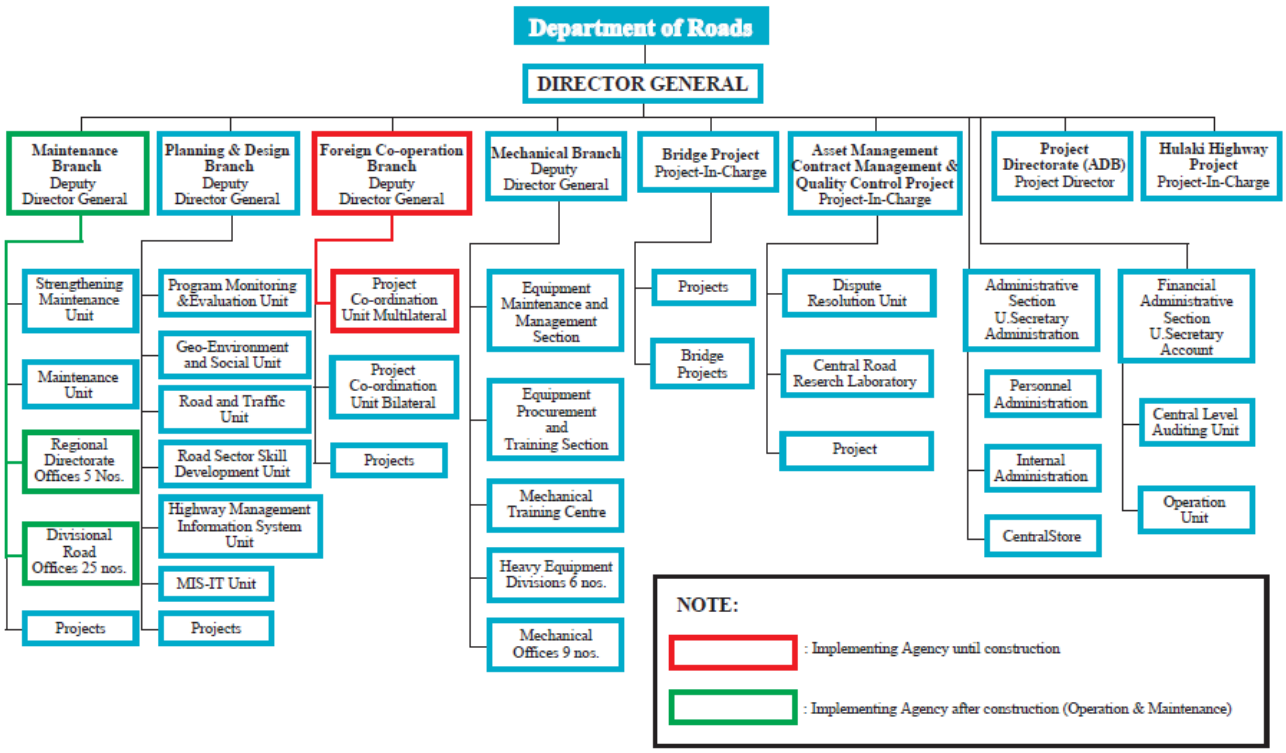
	Office Name	Responsible Stretch	Office Location (District)	Remarks
1	Kathmandu Division Office	Kalanki to Naghdhunda (Within Kathmandu District)	Gyaneswor (Kathmandu))	From next year, the division is planned to be divided into two. North and South Kathmandu Division
2	Dhading Division Office	Nagdhunga to Naubise (Gulmi) (Within Dhading District)	Bharatpur (Chitwan)	

Source: JICA Study Team

From this perspective, the operation and maintenance of the project road needs to be undertaken by these two division offices. However, instead of demarcating the responsibilities, it is proposed to establish a special unit within the Kathmandu Division under Central Regional Road Directorate and entrust the operation and maintenance work to that specific unit and have it monitored by the Central Regional Road directorate for following reasons;

i) The project road includes a tunnel which is apparently the first of its kind in the road network of Nepal and thus needs a different but extensive attention in its operation and maintenance,

ii) The division office looking after the section inside Dhading District is in Bharatpur, approximately 100km away from the project road, and is therefore physically difficult and impractical for conducting regular inspection of the project road. Kathmandu Division Office is in the perimeter of about 10kms.



Source: DOR

Figure 10-1 Organization Chart of Department of Roads

10.3 Organization Chart of Department of Roads

10.3.1 Project Implementation Activities

(1) Feasibility Study

Following this study, a Feasibility Study is recommended to be conducted to;

- prepare preliminary design to determine the project scope for budgetary purposes
- finalize the road alignment and tunnel and bridge location for preparation for right-of-way acquisition, staking of the road reserve limits and conducting cadestral surveys.
- prepare the construction plan including procurement plan, construction method and construction schedule.
- conduct environmental impact assessment including project affected persons and structures.
- determine the economic and financial viability of the project

(2) Commencement of the Project

Following estimation of the project cost, which is based on the preliminary design during the feasibility study, preparation of fund is required. DOR will prepare for funds for undertakings covered by the government of Nepal such as fund required for land acquisition, compensation, utility relocation etc.

(3) Consultant Selection

DOR will proceed to procure consultant for detailed design and construction supervision during the feasibility study.

(4) Environmental Impact Assessment

Environmental impact assessment report and resettlement plan will be prepared by GESU, DOR and submitted to MOSTE for its approval.

(5) Detailed Design and ROW Acquisition

Once the consultant is selected, the consultant will conduct the detailed design and prepare the design documents, construction drawings, prepare tender documents for bidding including specifications and project cost estimate. This is expected to take about a year. On the other hand, DOR will start preparing for land acquisition and resettlement of project affected persons identified by the feasibility study and detailed design prior to construction of road project.

(6) Bidding Process

After preparation and approval of the bid documents during the detailed design, DOR will call out for tendering. The consultant will assist DOR in short-listing the contractors, tendering and bid evaluation process. The tendering is expected to be divided into the following three components;

- Tunnel Civil Work with/without the Access Road
- Electrical Work of the Facilities
- Mechanical Work of the Facilities

If the tunnel civil work is excluded of the access road, then the tendering for the access road is required to be done independently.

(7) Construction and Supervision

During construction, the consultant will supervise the contractor's work to control the quality, cost and schedule for successful completion of the project.

(8) Hand-over

After completion of construction, the road will be handed-over to DOR. The road will then be open to traffic. As aforementioned, the maintenance of the road including operation and maintenance of tunnel will be carried out under the responsibility of Kathmandu Division, maintenance Branch, DOR. The Roads Board Nepal (RBN) will finance the routine and recurrent maintenance work.

10.3.2 Work

Major works assumed to be undertaken for tunnel work, electric work, mechanical work and for access road is as described below.

(1) Tunnel Work: tunnel work consists of the following;

- 3 months of Preparation including Mobilization
- Approximate 33 months of the excavation in the case of Medium-Hard Rock Ground or in 2 directions by 2 parties in case of Weathered Rock Ground
- Followed by 9 months of Concrete Lining
- 1 months of the preparation of Pavement
- 3 months of Pavement in tunnel

(2) Electrical Work

6 months after tunnel completion of tunnel one (1) year of Electric Work is finished

(3) Mechanical Work

6 months after tunnel completion of tunnel one (1) year of Electric Work is finished

(4) Access Road

During the Tunnel Work, Electrical Work and Mechanical Work, Access Road including 3 bridges are started and finished.

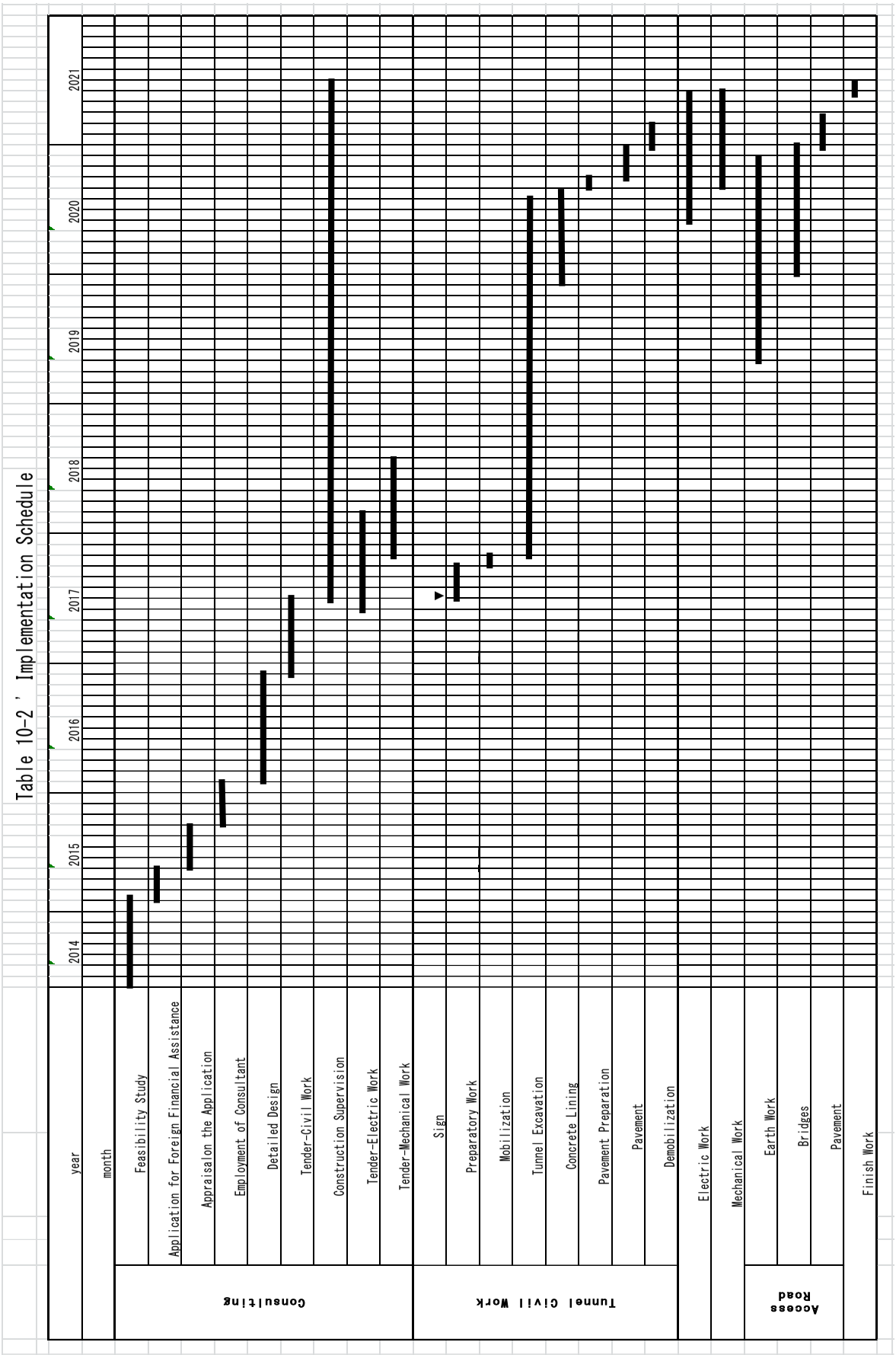
(5) Total Duration of the Project

As shown Table 10-2, the total project schedule is approximately 7 years.

10.3.3 Implementation Schedule

The proposed project implementation schedule is presented in Table 10-2.

Table 10-2 ' Implementation Schedule



10.4 Project Framework for Feasibility Study

As a preparation for the next phase study of this project, a framework briefly summarizing the technical requirements, like data and survey needs, design works, required expertise and institutions to be consulted is discussed hereunder.

10.4.1 Technical Requirement

(1) Review of Route Selection

Although the optimum route has been selected within the framework of this project, the review of the route selection needs to be carried out to minimize the project cost, adverse impact on natural environment and number of affected houses (affected persons) and from the perspective of the traffic volume including inter-connectivity between cities/towns.

(2) Traffic Demand Forecast

Future traffic volume shall be estimated based on the results of the traffic survey conducted and by taking the following items into consideration.

i) Land use and development plans of the study area
ii) Socio-economic framework
iii)Established target year

(3) Study of Basic Design Concept

It is necessary to establish basic concept for the design of the objective road by confirming the function and the designation of the road. In connection to this, collection and study of the prevailing laws, rules and acts including standards relevant to the transport infrastructure are suggested.

10.4.2 Data and Survey Needs

(1) Traffic Count

In order to understand the present traffic condition of the study area and to collect basic data such as the effectiveness indicator for estimation of future traffic demand as well as for the purpose of post evaluation, collection of present available traffic data together with conducting of following supplementary surveys are required.

i) Traffic count (1 weekday and 1 weekend, 24 hours, 2 locations)
ii) OD survey (1 weekday and 1 weekend, 12 hours, 2 locations)
iii)Travel time (1 weekday and 1 weekend, 2 trips)

(2) Natural Condition Survey

Following natural condition surveys are deemed necessary in order to secure the precision for the outline design of the road and the tunnel.

1) Geo-technical Investigation

Collection of topographical map, geological map and other relevant maps and implementation of geo-technical investigations are suggested for design purpose of road, structures (bridges, culverts) and tunnels. Some of the major investigations are as follows;

i) Standard Penetration Test
ii) Electric Resistivity Topography
iii) Seismic Refraction Topography
iv) Laboratory test for physical properties of soil

2) Topography Survey

Topography survey and route survey should be conducted for the purpose of identifying the area of land required for acquisition and for the design work of road, bridges and tunnel portal.

3) Climate and Hydrology Survey

In order to establish the design criteria for the outline design of the road, bridge and tunnel, collection of available documents and data, meetings and discussions with the concerned organizations and site reconnaissance should be conducted.

10.4.3 Preliminary Design, Construction Planning, Land Acquisition and Cost Estimation

The followings should be conducted;

i) Confirm the project financial source and determine the scope of the outline design accordingly,

ii) For bridges and tunnel, several alternatives should be considered followed by a comparative study with respect to construction, maintenance, and economical efficiencies and propose the design concept for the project,

iii) An outline design should be conducted in the following manner;

a) Route planning
b) Plan, profile and cross section of road
c) Pavement design
d) Structural design (Bridge and Culverts etc.)
e) Tunnel design
f) Other structural design (if any)
g) Preparation of Quantity spread-sheet
h) Unit rate investigation, procurement of material and equipment planning
i) Construction planning, Cost estimate
j) Implementation schedule

In particular, the following issues during construction of tunnel need special attention.

a) Understanding the topographic characteristics
b) Understanding the geological characteristics
c) Understanding the soil distribution condition based on the geo-technical investigation
d) Determination of tunnel portal location and length of tunnel (avoid tunnel portals at areas prone to slope failure or landslides or debris flow and Identify location to minimize the tunnel length)
e) The cross section of tunnel (trying to keep the cross section of the tunnel as small as possible)
f) Tunneling method suitable to the geological characteristics of the area (blasting, excavation etc.)
g) Geometric criteria of tunnel support structure
h) Lighting and safety facilities and ventilation facilities
i) Power supply facility

10.4.4 Project Evaluation

Both quantitative and qualitative evaluation of the project is suggested. Quantitative indicator (operation-effect indicator) should be established for a target year of 3 years after completion. Apart from this, beneficiary number, Equity Internal Rate Return (EIRR) should be calculated as the quantitative evaluation.

10.4.5 Operation and Maintenance Plan

Operation and maintenance plan as mentioned hereunder should be established.

i) Maintenance plan of road and structures
ii) Operation and Maintenance plan of tunnel
iii)It is also important to prepare the operation and maintenance plan of the tunnel in consideration with provision of full-time tunnel inspection system and emergency alert and preparedness system. Not to mention that study on subsidizing method of maintenance cost.

10.4.6 Organizational Arrangement and Implementation Schedule

i) Understanding the organizational framework, responsibilities, staffing configuration and technical level of the implementing organization. Additionally, check and confirm the capability of the organization in-charge of operation and maintenance after completion of the project and confirm the process required for transferring the responsibility to other organization or establishment of a new organization.
ii) Propose procurement method, construction packages and construction schedule.

iii)Propose the contents of consulting service to be rendered

iv) Establish land acquisition schedule, standard schedule for procurement as according to JICA regulation and prepare overall implementation schedule.

10.4.7 Rough Estimation of Project Cost

Estimate roughly the project cost in the following manner;

i) Construction cost
ii) Price escalation affecting the construction cost
iii) Contingency
iv) Consultant fee (including price escalation and contingency)
v) Others (land acquisition and compensation fee, taxes, general expenditure for implanting agency, interests etc.
vi) Contract out Fee for operation and maintenance
vii) Initial operation cost
viii) Cost for levelling the compensated land
ix) Expenditure budget for seminar and training
x) Other relevant expenses

10.4.8 Required Expertise

For smooth implementation of the next study, involvement of following expertise is recommended.

i) Team Leader (Road Planner)
ii) Tunnel Engineer (Planning)
iii) Highway Engineer (Design)
iv) Tunnel Structural Engineer (Structure design)
v) Tunnel Mechanical Engineer (Mechanical design)
vi) Bridge Engineer
vii) Natural and Social Environmentalist
viii) Geologist
ix) Engineer (Natural Condition Surveys)

10.5 Organizations to be Consulted

This project, being first of its kind in terms of road tunnel, it is expected that consultations will be necessary with various institutions and organizations. Some of the major relevant institutions and organizations are as listed in Table.

Table 10-3 List of Relevant Organizations

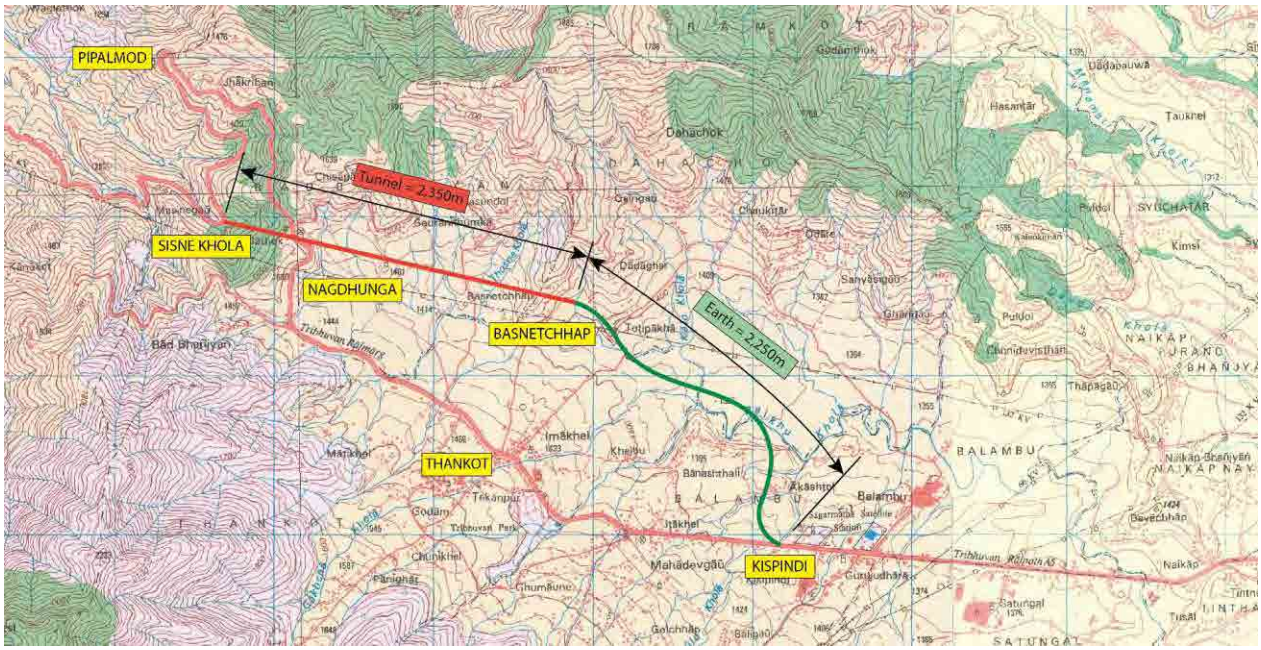
	Major Relevant Organization		Duties and Responsibilities
1	Department of Roads(DOR）		Implementing Agency. Foreign Co-operation Branch (Responsible Branch), Bridge Unit (design, construction and maintenance of bridge), GESU（review of EIA, RAP, approval of soil disposal are）
2	Ministry of Physical Infrastructure and Transport (MOPIT)		・ Ministry for approval of the Project ・ Approval of alignment determined in the feasibility study. ・ Inform and coordinate with concerned organization for relocation of affected utilities
3	Ministry of Finance		・ Ministry for approval of the Project ・ Decide acceptance/refusal of loan
4	Compensation Determination Committee		・ Committee to decide and conduct land acquisition and compensation
5	Ministry of Home Affairs		・ Ministry where claims connected to land acquisition are filed for hearings and judgment
6	Ministry of Science Technology and Environment		Approval of the EIA
7	Ministry of Forests and Soil Conversation (MOFSE)		Responsible for National forests and reserves
8	DOR	Division Office (KTM)	Responsible for construction and maintenance of roads within Kathmandu District
		Division Office (Bharatpur)	Responsible for construction and maintenance of roads within Dhading District
9	Roads Board Nepal		Responsible for routine and recurrent maintenance work
10	Nepal Electricity Authority (NEA)		Power supply (tunnel)
11	District Development Committee		District level matters (Land acquisition, EIA etc)
12	Village Development Committee		Village level matter (Land acquisition, EIA ets.)
13	Nepal Tunnel Association (NTA)		Standards and specifications for tunnels

Source: JICA Study Team

Chapter 11 Expected Outcome and Recommendation

11.1 Expected Outcome

Economic and trade activities are flourishing in Kathmandu through the network of roads connecting neighboring India and the Kathmandu Valley. However, the Kathmandu Valley itself is located in the basin within surrounding mountains, therefore, the transportation of goods and commodities from India have to inevitably pass through the steep slopes and sharp curves of the Thankot Pass. With the proposal of building a tunnel at Thankot Pass, this project will bear huge economic benefits as it will greatly relieve traffic congestions, reduce the number of accidents and decrease travel time.



Source: JICA Study Team

Figure 11-1 Location of Proposed Tunnel Map

11.1.1 Shortening of Travel Time

The most viable and effective factor among several other economic benefits for this project is the shortening of travel time. Due to the steep gradient of more than 10% and numerous sharp curves, every car, bus and truck has to significantly slowdown as they pass through Thankot Pass. As half of the vehicles passing through Thankot Pass are made up of heavy vehicles such as buses and trucks especially those that are ferrying goods and commodities from India, massive slowdowns are encountered by the rest of the other road –users. With the completion of the proposed tunnel, traffic flow will be smoother as well as travel time towards destination will be shortened.

In order to calculate the travel time before and after completion of the proposed tunnel, the study team has performed velocity survey. The result is that travel time could be reduced by about 20 minutes.

11.1.2 Shortening of Travel Distance

A road with steep slope and a sharp curve is naturally increased in distance. Therefore, the route of the tunnel of this proposed project is planned to be located directly below the steepest slope and curve at Thankot Pass. Thus the extended distance of the road will be shortened with the merging of the tunnel with a straight line distance. However, this project is formed with both tunnel and approach road. There are tunnel with a length of 2.35 km and approach road with a length of 2.25 km, a total length of 4.60 km.

Without the tunnel and approach road, the distance of the existing road is 7.60 km. Therefore, with the construction of a tunnel, the travel distance will be shortened by 3.0 km.

11.1.3 Saving of Vehicle Running Cost

As mentioned above, after completion of the proposed tunnel, it is possible to reduce travel time by about 20 minutes and to have travel distance shortened by about 3.0 km. This will result in less fuel consumption as well as longer engine life–span. Thus, this will contribute to both energy and cost-savings.

11.1.4 Reduction of Traffic Accidents

Due to the numerous steep slopes and sharp curves at Thankot Pass, the possibilities of road accidents are undeniable. Collisions between oncoming vehicles, vehicles falling off cliffs while avoiding oncoming vehicles and the sudden breakdowns of older vehicles that cause huge traffic congestions are some of the happenings at Thankot Pass. However, with the completion of the proposed tunnel, traffic accidents can be greatly reduced.

11.1.5 Application as a Model Case

Nepal is a landlocked country with around 60% of the country covered by mountains. Therefore, there are many places similar to Thankot Pass where steep slopes and sharp curves dominate the road system. However, with the introduction of tunnels these sharp curve and steep slope in the road system can be greatly countered. But due to huge construction costs, the requirement of special construction materials and equipment as well as special construction technology, a tunnel has never been built before in Nepal.

Therefore, it is favorable to introduce the first tunnel construction at Thankot Pass as it will serve as a model case for the future development of tunnel projects in Nepal.

11.1.6 Conclusion

As mentioned above, this tunnel project connecting Kathmandu and India through the Tribhuvan Highway will bring great economic prospects into Nepal. It is strongly believed that with the implementation of this project, the infrastructure development of the country will improve steadily whereby drawing strong foreign investments into the country. Although this

proposed tunnel project in Thankot Pass will be the first model case in Nepal, it will be a 'successful' model case as there are many places in Nepal where tunnel constructions can be implemented in the future.

As mentioned above, there are so many advantages for the country of Nepal to implement the tunnel construction at Thankot. They are not only district development and economics, but also technical transfer to Nepalese engineers of DOR or other related institutions. The tunnel construction starts from a planning, design, construction and inauguration. These processes contain a various modern civil engineering technologies.

It is a revolutionary project that a tunnel technology is introduced into Nepalese engineers, moreover, the technology transfer by this project will be enhanced the country of Nepal to develop more in the future.

11.2 Recommendation of the Project

11.2.1 Promotion of Proper District Development

Over the years, rapid urbanization of the Kathmandu Valley is taking place. By 1991, most of the inner sector of the Ring Road has become built-up areas and almost a decade later, around 2000 the expansion of urban areas has advanced to the feeder roads, extending radially and externally of the Ring Road. Presently, more than a decade later urbanization has sprawled to the suburbs without proper town planning or road networks. Due to lack of amendments in land use planning and archaic enforcements of land development regulations, Thankot area has witnessed especially rapid unregulated housing developments in area near the proposed tunnel portal. Therefore, using this proposed project as a turning point to propel proper and careful land use planning as well as proper housing development and proper road construction projects for the good prospects of the immediate future.

11.2.2 Inducement of Other Projects

Due to the close proximity with Kathmandu, Thankot could be a choice future business development region whereby the construction of commercial and residential buildings, logistic facility terminals, educational centers as well as other related concerns for the promotional of both home and foreign investments. Therefore, it is a necessity to prepare proper laws and regulations for land use legislation, for town planning development and road network planning.

The urban transport master plan (M/P) for Kathmandu Valley will be conducted by JICA soon. The preparation of the M/P includes Thankot area, so that both M/P and this tunnel projects should be harmonized with each other.

11.2.3 Preservation of the Existing Road

It is believed that traffic volume of the existing road will be greatly reduced after completion of the proposed tunnel. Nevertheless, the preservation and maintenance of the existing road should be pursued as inhabitants of the area especially those involving in farming activities as well as other businesses should not suffer nor should they be negatively affected by the tunnel project.

Moreover, if the maintenance of the existing road should be neglected, the deterioration of the pavement, depression of the road shoulder and induction of slope failures could cause serious problems including traffic accidents.

ANNEXES

ANNEX-1 Cost Benefit Flow for 2 Previous Projects

ANNEX-2 Traffic Count Data

ANNEX-3 Boring Data (FBC Report)

ANNEX-4 EPA Amendment (Gazette- Section 58, No. 44, Part 5)

ANNEX-5 EPR AMMENDMENT Schedule -2 (Relating to EPR SECTION 3)

ANNEX-6 Table of Contents of MOFSC Project Approval Request

ANNEX-7 Sample Table of Contents of EIA Scoping Document

ANNEX-8 Sample of Table of Contents of EIA Terms of Reference Document

ANNEX-9 Technical Explanatory Meeting

ANNEX-10 Observation Visit Tunnel Construction

ANNEX-11 Study Team Member List

ANNEX-1

Cost Benefit Flow for 2 Previous Projects

1. Feasibility Study on the Construction of Kathmandu-Naubise Road (2001 JICA)

Table 19.6 Cost Benefit Cash Flows

(Unit: Million US$)

Year	Capital Costs	O & M Costs	Total Costs	Benefits	B-C
2001	0.43		0.43		-0.43
2002	1.71		1.71		-1.71
2003	13.23		13.23		-13.23
2004	19.65		19.65		-19.65
2005	14.66		14.66		-14.66
2006	0.30	0.26	0.56	7.22	6.66
2007		0.35	0.35	10.21	9.86
2008		0.35	0.35	10.82	10.47
2009		0.35	0.35	11.47	11.12
2010		0.35	0.35	12.16	11.81
2011		0.35	0.35	13.13	12.78
2012		0.35	0.35	14.18	13.83
2013		0.35	0.35	15.32	14.97
2014		0.35	0.35	16.54	16.19
2015		0.35	0.35	17.87	17.52
2016		0.35	0.35	7.56	7.21
2017		0.35	0.35	8.17	7.82
2018		0.35	0.35	8.82	8.47
2019		0.35	0.35	9.53	9.18
2020		0.35	0.35	10.29	9.94
2021		0.35	0.35	11.11	10.76
2022		0.35	0.35	12.00	11.65
2023		0.35	0.35	12.96	12.61
2024		0.35	0.35	14.00	13.65
2025		0.35	0.35	15.12	14.77
2026		0.35	0.35	16.33	15.98
2027		0.35	0.35	17.64	17.29
2028		0.35	0.35	19.05	18.70
2029		0.35	0.35	20.57	20.22
2030		0.35	0.35	22.22	21.87

EIRR	18.1%
NPV	19.17
B/C	1.57

Table No. 8.15: Benefit Cost Analysis of Nagdhunga-Naubise Tunnel Road Project

(Rs. In Millions)

Year	Without Project				With Project					Net Cost	Generated Traffic Benefits	Net Incremental Benefit
	Maint. Cost	Total VOC	Total Value of Time	Total Cost	Capital Cost	Maint. Cost	Total VOC	Total Value of Time	Total Cost			
2014		0.000	0.000		1215.752		0.000	0.000	1215.752	-1215.752	0.000	-1215.752
2015		0.000	0.000		2836.756		0.000	0.000	2836.756	-2836.756	0.000	-2836.756
2016	2.175	2275.888	173.971	2452.034		202.625	1652.645	117.692	1972.963	479.072	16.997	496.069
2017	2.175	2465.429	190.379	2657.983		202.625	1790.183	128.792	2121.600	536.383	18.431	554.814
2018	2.175	2671.642	208.397	2882.214		202.625	1939.752	140.980	2283.358	598.856	19.994	618.850
2019	2.175	2896.050	228.185	3126.410		202.625	2102.443	154.366	2459.435	666.975	21.698	688.673
2020	2.175	3140.318	249.922	3392.415		202.625	2279.448	169.070	2651.144	741.272	23.557	764.828
2021	2.175	3406.270	273.802	3682.247		202.625	2472.069	185.224	2859.918	822.329	25.585	847.913
2022	2.175	3656.729	298.346	3955.250		202.625	2652.758	200.477	3055.860	899.390	27.513	926.902
2023	2.175	3926.435	320.797	4249.407		202.625	2847.208	217.020	3266.854	982.553	29.593	1012.145
2024	2.175	4216.923	347.319	4566.417		202.625	3056.507	234.985	3494.098	1072.320	31.839	1104.158
2025	2.175	4529.856	376.092	4908.123		202.625	3281.829	254.433	3738.888	1169.235	34.263	1203.498
2026	2.175	4867.033	407.308	5276.516		202.625	3524.446	275.555	4002.626	1273.890	36.881	1310.771
2027	2.175	5230.401	441.180	5673.756		202.625	3785.732	298.473	4286.831	1386.925	39.709	1426.634
2028	2.175	5622.070	477.937	6102.182		202.625	4067.175	323.344	4593.145	1509.037	42.764	1551.801
2029	2.175	6044.325	517.828	6564.328		202.625	4370.385	350.336	4923.347	1640.981	46.065	1687.046
2030	2.175	6499.640	561.125	7062.939		202.625	4697.104	379.633	5279.363	1783.576	49.632	1833.209
2031	2.175	6990.696	608.122	7600.993		202.625	5049.219	411.435	5663.280	1937.714	53.489	1991.202
2032	2.175	7520.398	659.143	8181.716		202.625	5428.771	445.959	6077.358	2104.360	57.658	2162.017
2033	2.175	8091.894	714.534	8808.603		202.625	5837.973	483.442	6524.040	2284.564	62.166	2346.730
2034	2.175	8708.597	774.677	9485.449		202.625	6279.218	524.140	7005.983	2479.466	67.042	2546.508
2035	2.175	9374.204	839.985	10216.364	-1337.328	202.625	6755.100	568.334	6188.732	4027.633	72.317	4099.949
PV		26063.82	2146.79				18880.68	1452.36		2915.95		
										NPV @ 12% Discount Rate (NRs in Millions)		3113.01
										EIRR (%)		19.65
										BCR		1.38

ANNEX-2

Traffic Count Data

1. Traffic Count Data Naubise to Kathmandu (Friday, 7th Feb, 2014)

Traffic Count Form (24 Hours)

Road Number or Name: **Tribhuvan Highway**

Location: **Nagdhunga** Direction of Traffic: **Naubise to KTM** Day: **Friday**

Surveyor Name: Date: **07 February, 2014**

Type	Motorised												Non-Motorised			Total Motorized (1 to 9)
	Heavy Truck (>3 axle)	Heavy Truck	Mini Truck	Large Bus	Mini Bus	Micro Bus	Car Jeep Taxi/Van	Utility / Pickup	Auto rickshaw	Tractor	Power Tiller	Motor cycle	Animal Cart	Rick shaw	Bicycle	
	3 or more axles	2 axles			Max 35 Seats	Max 14 Seats			all 3-w heelers	With or WO Trailer						
Time	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
6:00 - 6:30	0	2	2	5	0	0	1	0	0	0	0	2	0	0	0	12
6:30 - 7:00	10	9	3	41	3	0	4	2	0	0	0	2	0	0	0	74
7:00 - 7:30	50	37	1	50	1	0	6	0	0	0	0	4	0	0	0	149
7:30 - 8:00	34	33	16	20	2	1	18	1	0	0	0	5	0	0	0	130
8:00 - 8:30	23	28	8	9	1	4	6	1	0	0	0	6	0	0	0	86
8:30 - 9:00	13	24	7	7	3	7	9	0	0	0	0	21	0	0	0	91
9:00 - 9:30	32	22	1	9	6	3	9	0	0	0	0	27	0	0	0	109
9:30 - 10:00	13	19	3	5	6	6	16	5	0	0	0	21	0	0	0	94
10:00 - 10:30	32	40	7	4	6	6	29	0	0	0	0	42	0	0	0	166
10:30 - 11:00	23	31	9	4	2	6	18	0	0	0	0	36	0	0	0	129
11:00 - 11:30	13	23	5	3	6	2	13	2	0	0	1	18	0	0	0	86
11:30 - 12:00	18	26	1	3	5	6	17	2	0	0	0	29	0	0	0	107
12:00 - 12:30	14	32	2	4	7	5	18	2	0	0	0	31	0	0	0	115
12:30 - 13:00	10	23	5	4	3	7	16	2	0	0	0	24	0	0	0	94
13:00 - 13:30	13	16	3	3	3	3	13	4	0	0	0	36	0	0	0	94
13:30 -14:00	9	28	9	15	9	3	30	6	0	0	2	36	0	0	0	147
14:00 - 14:30	8	19	5	13	9	9	28	4	0	0	0	29	0	0	0	124
14:30 - 15:00	15	12	4	13	18	9	32	8	0	0	0	32	0	0	0	143
15:00 -15:30	4	12	4	6	13	18	32	6	0	0	0	47	0	0	0	142
15:30 -16:00	11	11	4	9	30	13	51	5	0	0	0	46	0	0	0	180
16:00 - 16:30	8	16	4	8	15	30	35	4	0	0	0	35	0	0	0	155
16:30 - 17:00	5	20	3	15	13	15	37	5	0	0	0	49	0	0	0	162
17:00 - 17:30	1	13	7	4	13	26	24	3	0	0	0	65	0	0	0	156
17:30 - 18:00	1	15	1	7	8	11	36	3	0	0	0	38	0	0	0	120
	360	**511**	**114**	**261**	**182**	**190**	**498**	**65**	**0**	**0**	**3**	**681**	**0**	**0**	**0**	**2865**
18:00 - 18:30	4	29	2	8	13	19	43	8	0	0	0	48	0	0	0	174
18:30 - 19:00	9	18	5	7	2	17	25	10	0	0	0	27	0	0	0	120
19:00 - 19:30	10	20	5	5	4	10	22	9	0	0	0	14	0	0	0	99
19:30 - 20:00	11	18	5	11	2	30	34	4	0	0	0	18	0	0	0	133
20:00 - 20:30	12	17	4	3	0	3	17	4	0	0	0	8	0	0	0	68
20:30 - 21:00	13	19	2	2	0	12	16	1	0	0	0	10	0	0	0	75
21:00 - 21:30	8	15	2	5	2	7	21	3	0	0	0	2	0	0	0	65
21:30 -22:00	6	8	0	2	0	3	7	5	0	0	0	3	0	0	0	34
22:00 -22:30	4	15	0	1	0	1	8	1	0	0	0	3	0	0	0	33
22:30 - 23:00	4	9	2	0	0	2	9	6	0	0	0	2	0	0	0	34
23:00 - 23:30	6	9	1	3	0	0	4	5	0	0	0	5	0	0	0	33
23:30 - 24:00	3	10	3	0	0	0	9	0	0	0	0	0	0	0	0	25
00:00 - 00:30	5	6	0	1	0	0	3	2	0	0	0	1	0	0	0	18
00:30 - 01:00	8	11	4	0	0	2	4	4	0	0	0	0	0	0	0	33
01:00 - 01:30	19	9	8	0	0	1	5	5	0	0	0	4	0	0	0	51
01:30 - 02:00	11	19	5	0	0	1	2	3	0	0	0	1	0	0	0	42
02:00 - 02:30	9	10	4	2	0	0	8	12	0	0	0	0	0	0	0	45
02:30 - 03:00	14	15	4	3	1	1	5	5	0	0	0	0	0	0	0	48
03:00 - 03:30	3	18	4	9	14	0	2	5	0	0	0	1	0	0	0	56
03:30 - 04:00	7	11	2	30	0	1	2	5	0	0	0	1	0	0	0	59
04:00 - 04:30	13	15	2	52	0	1	1	3	0	0	0	0	0	0	0	87
04:30 - 05:00	15	16	1	70	0	1	2	3	0	0	0	1	0	0	0	109
05:00 - 05:30	11	16	0	55	0	0	2	1	0	0	0	2	0	0	0	87
05:30 -06:00	14	10	1	24	0	0	2	2	0	0	0	2	0	0	0	55
	219	343	66	293	38	112	253	106	0	0	0	153	0	0	0	1583
Total	939	1365	294	815	402	492	1249	236	0	0	6	1515	0	0	0	7313

2. Traffic Count Data Naubise to Kathmandu (Saturday, 8th Feb, 2014)

Traffic Count Form (24 Hours)

Road Number or Name: **Tribhuvan Highway**

Location: **Nagdhunga** Direction of Traffic: **Naubise to KTM** Day: **Saturday**

Surveyor Name: Date: **08 February, 2014**

Type	Motorised												Non-Motorised			Total Motorized (1 to 9)
	Heavy Truck (>3 axle)	Heavy Truck	Mini Truck	Large Bus	Mini Bus	Micro Bus	Car Jeep Taxi/Van	Utility / Pickup	Auto rickshaw	Tractor	Power Tiller	Motor cycle	Animal Cart	Rick shaw	Bicycle	
	3 or more axles	2 axles			Max 35 Seats	Max 14 Seats			all 3-w heelers	With or WO Trailer						
Time	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
6:00 - 6:30	15	21	3	33	5	1	1	1	0	0	0	3	0	0	0	83
6:30 - 7:00	14	15	8	14	3	1	3	0	0	0	0	4	0	0	0	62
7:00 - 7:30	14	16	4	18	1	0	0	1	0	0	0	4	0	0	0	58
7:30 - 8:00	11	20	1	16	2	1	3	1	0	0	0	7	0	0	0	62
8:00 - 8:30	15	26	3	17	6	3	3	10	0	0	0	19	0	0	0	102
8:30 - 9:00	11	17	4	4	6	5	3	0	0	0	0	9	0	0	0	59
9:00 - 9:30	5	32	6	2	3	9	7	3	0	0	0	14	0	0	0	81
9:30 - 10:00	11	28	9	2	8	12	11	4	0	0	0	12	0	0	0	97
10:00 - 10:30	13	26	7	3	7	7	7	1	0	0	0	16	0	0	0	87
10:30 - 11:00	10	20	0	2	3	10	11	2	0	0	0	25	0	0	0	83
11:00 - 11:30	7	26	7	1	9	12	18	6	0	0	0	38	0	0	0	124
11:30 - 12:00	8	14	2	4	5	9	17	4	0	0	0	28	0	0	0	91
12:00 - 12:30	10	12	2	1	2	7	12	1	0	0	0	21	0	0	0	68
12:30 - 13:00	6	14	3	2	5	13	22	3	0	0	0	24	0	0	0	92
13:00 - 13:30	2	22	5	3	8	14	25	4	0	0	0	28	0	0	0	111
13:30 -14:00	1	12	3	9	8	14	25	4	0	0	0	33	0	0	0	109
14:00 - 14:30	2	17	1	6	10	15	39	9	0	0	0	39	0	0	0	138
14:30 - 15:00	5	21	3	13	11	18	51	5	0	0	0	39	0	0	0	166
15:00 -15:30	5	17	2	6	17	20	40	2	0	0	0	50	0	0	0	159
15:30 -16:00	5	17	5	4	11	22	42	3	0	0	0	85	0	0	0	194
16:00 - 16:30	12	23	1	5	18	29	56	3	0	0	0	70	0	0	0	217
16:30 - 17:00	6	16	2	7	14	22	35	3	0	0	0	65	0	0	0	170
17:00 - 17:30	5	9	0	2	4	3	13	1	0	0	0	65	0	0	0	102
17:30 - 18:00	14	31	4	5	17	23	63	7	0	0	0	67	0	0	0	231
	207	**472**	**85**	**179**	**183**	**270**	**507**	**78**	**0**	**0**	**0**	**765**	**0**	**0**	**0**	**2746**
18:00 - 18:30	19	39	5	32	2	31	65	13	0	0	0	76	0	0	0	282
18:30 - 19:00	10	14	3	13	3	12	29	8	0	0	0	50	0	0	0	142
19:00 - 19:30	21	12	2	15	3	7	30	6	0	0	0	30	0	0	0	126
19:30 - 20:00	21	19	3	10	2	17	39	13	0	0	0	40	0	0	0	164
20:00 - 20:30	11	20	0	11	0	14	55	8	0	0	0	24	0	0	0	143
20:30 - 21:00	11	11	2	6	0	6	36	3	0	0	0	18	0	0	0	93
21:00 - 21:30	26	14	2	9	0	14	28	4	0	0	0	10	0	0	0	107
21:30 -22:00	10	8	1	3	0	8	15	4	0	0	0	12	0	0	0	61
22:00 -22:30	17	24	0	4	3	12	24	8	0	0	0	14	0	0	0	106
22:30 - 23:00	3	9	1	2	1	0	14	3	0	0	0	3	0	0	0	36
23:00 - 23:30	6	4	2	2	0	2	12	2	0	0	0	1	0	0	0	31
23:30 - 24:00	17	16	2	3	2	1	13	3	0	0	0	4	0	0	0	61
00:00 - 00:30	12	3	0	3	0	2	6	4	0	0	0	2	0	0	0	32
00:30 - 01:00	17	0	3	0	0	2	8	2	0	0	0	1	0	0	0	33
01:00 - 01:30	24	1	2	1	0	0	3	6	0	0	0	0	0	0	0	37
01:30 - 02:00	13	13	4	0	0	0	0	10	0	0	0	2	0	0	0	42
02:00 - 02:30	17	12	4	5	1	1	4	5	0	0	0	3	0	0	0	52
02:30 - 03:00	18	18	4	3	0	0	7	17	0	0	0	2	0	0	0	69
03:00 - 03:30	15	10	2	12	0	3	5	7	0	0	0	3	0	0	0	57
03:30 - 04:00	34	19	11	49	1	1	7	6	0	0	0	0	0	0	0	128
04:00 - 04:30	22	13	0	60	0	0	3	4	0	0	0	2	0	0	0	104
04:30 - 05:00	11	7	2	30	2	6	2	0	0	0	0	13	0	0	0	73
05:00 - 05:30	23	19	3	43	3	11	14	5	0	0	0	18	0	0	0	139
05:30 -06:00	26	44	5	82	2	17	28	13	0	0	0	47	0	0	0	264
	404	349	63	398	25	167	447	154	0	0	0	375	0	0	0	2382
Total	818	1293	233	756	391	707	1461	310	0	0	0	1905	0	0	0	10256

3. Traffic Count Data Kathmandu to Naubise (Friday, 7th Feb, 2014)

Traffic Count Form (24 Hours)

Road Number or Name: **Tribhuvan Highway**

Location: **Nagdhunga** Direction of Traffic: **Kathamndu to Naubise** Day: **Friday**

Surveyor Name: Date: **07 February, 2014**

Type	Motorised												Non-Motorised			Total Motorized (1 to 9)
	Heavy Truck (>3 axle)	Heavy Truck	Mini Truck	Large Bus	Mini Bus	Micro Bus	Car Jeep Taxi/Van	Utility / Pickup	Auto rickshaw	Tractor	Power Tiller	Motor cycle	Animal Cart	Rick shaw	Bicycle	
	3 or more axles	2 axles			Max 35 Seats	Max 14 Seats			all 3-w heelers	With or WO Trailer						
Time	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
6:00 - 6:30	2	9	2	7	4	6	17	3	0	0	0	7	0	0	0	57
6:30 - 7:00	2	10	0	9	11	21	30	3	0	0	0	15	0	0	0	101
7:00 - 7:30	5	9	2	5	4	21	31	5	0	0	0	20	0	0	0	102
7:30 - 8:00	5	12	1	20	13	26	37	16	0	0	0	27	0	0	0	157
8:00 - 8:30	4	28	1	32	10	33	40	13	0	0	0	34	0	0	0	195
8:30 - 9:00	7	14	13	19	16	31	39	6	0	0	0	29	0	0	0	174
9:00 - 9:30	3	8	14	12	13	23	31	6	0	0	0	33	0	0	0	143
9:30 - 10:00	5	19	4	6	14	17	25	8	0	0	0	44	0	0	0	142
10:00 - 10:30	4	10	5	4	12	13	20	8	0	0	0	35	0	0	0	111
10:30 - 11:00	14	14	2	3	13	19	25	9	0	0	0	39	0	0	0	138
11:00 - 11:30	11	18	4	2	11	15	35	3	0	0	0	34	0	0	0	133
11:30 - 12:00	24	38	6	0	11	19	29	5	0	0	0	47	0	0	0	179
12:00 - 12:30	33	15	7	3	12	21	27	4	0	0	0	39	0	0	0	161
12:30 - 13:00	24	30	5	1	12	23	27	3	0	0	0	60	0	0	0	185
13:00 - 13:30	16	22	2	2	11	17	34	3	0	0	0	53	0	0	0	160
13:30 -14:00	30	27	4	5	10	22	24	9	0	0	0	50	0	0	0	181
14:00 - 14:30	21	37	3	5	4	22	47	6	0	0	0	39	0	0	0	184
14:30 - 15:00	34	39	3	3	12	16	39	8	0	0	0	49	0	0	0	203
15:00 -15:30	30	27	1	3	8	11	29	3	0	0	0	49	0	0	0	161
15:30 -16:00	28	31	5	10	8	16	28	4	0	0	0	47	0	0	0	177
16:00 - 16:30	25	27	4	18	5	12	27	4	0	0	0	51	0	0	0	173
16:30 - 17:00	29	24	4	30	2	12	18	4	0	0	0	44	0	0	0	167
17:00 - 17:30	23	16	3	22	4	7	25	8	0	0	0	55	0	0	0	163
17:30 - 18:00	30	27	4	44	5	7	23	1	0	0	0	44	0	0	0	185
	409	**511**	**99**	**265**	**225**	**430**	**707**	**142**	**0**	**0**	**0**	**944**	**0**	**0**	**0**	**3732**
18:00 - 18:30	12	13	5	23	6	2	19	1	0	0	0	17	0	0	0	98
18:30 - 19:00	25	25	11	40	0	3	25	1	0	0	0	33	0	0	0	163
19:00 - 19:30	18	21	4	36	0	2	19	2	0	0	0	18	0	0	0	120
19:30 - 20:00	29	34	2	51	0	1	10	2	0	0	0	18	0	0	0	147
20:00 - 20:30	34	28	1	47	2	0	14	5	0	0	0	20	0	0	0	151
20:30 - 21:00	38	31	3	40	0	0	11	5	0	0	0	2	0	0	0	130
21:00 - 21:30	17	38	0	13	0	1	5	0	0	0	0	1	0	0	0	75
21:30 -22:00	30	24	0	10	0	0	8	2	0	0	0	1	0	0	0	75
22:00 -22:30	13	17	1	3	0	0	6	0	0	0	0	3	0	0	0	43
22:30 - 23:00	9	18	5	1	0	0	1	0	0	0	0	1	0	0	0	35
23:00 - 23:30	10	7	0	0	0	0	1	0	0	0	0	0	0	0	0	18
23:30 - 24:00	2	11	1	1	0	0	3	1	0	0	0	0	0	0	0	19
00:00 - 00:30	3	4	1	0	0	0	2	0	0	0	0	0	0	0	0	10
00:30 - 01:00	2	0	0	0	0	0	1	0	0	0	0	0	0	0	0	3
01:00 - 01:30	0	1	0	0	0	1	2	1	0	0	0	0	0	0	0	5
01:30 - 02:00	1	8	1	1	0	0	0	1	0	0	0	0	0	0	0	12
02:00 - 02:30	0	4	0	1	0	0	0	0	0	0	0	0	0	0	0	5
02:30 - 03:00	0	0	0	0	0	0	1	2	0	0	0	0	0	0	0	3
03:00 - 03:30	3	2	0	0	0	0	1	0	0	0	0	0	0	0	0	6
03:30 - 04:00	0	6	0	0	0	0	6	3	0	0	0	4	0	0	0	19
04:00 - 04:30	6	14	1	1	1	1	16	5	0	0	0	2	0	0	0	47
04:30 - 05:00	0	11	0	0	1	3	22	0	0	0	0	4	0	0	0	41
05:00 - 05:30	4	18	0	1	1	0	20	2	0	0	0	16	0	0	0	62
05:30 -06:00	1	22	3	10	2	6	26	1	0	0	0	14	0	0	0	85
	257	**357**	**39**	**279**	**13**	**20**	**219**	**34**	**0**	**0**	**0**	**154**	**0**	**0**	**0**	**1372**
Total	1075	1379	237	809	463	880	1633	318	0	0	0	2042	0	0	0	8836

4. Traffic Count Data Kathmandu to Naubise (Saturday, 8th Feb, 2014)

Traffic Count Form (24 Hours)

Road Number or Name: **Tribhuvan Highway**

Location: **Nagdhunga** Direction of Traffic: **Kathamndu to Naubise** Day: **Saturday**

Surveyor Name: Date: **08 February, 2014**

Type	Motorised												Non-Motorised			Total Motorized (1 to 9)
	Heavy Truck (>3 axle)	Heavy Truck	Mini Truck	Large Bus	Mini Bus	Micro Bus	Car Jeep Taxi/Van	Utility / Pickup	Auto rickshaw	Tractor	Power Tiller	Motor cycle	Animal Cart	Rick shaw	Bicycle	
	3 or more axles	2 axles			Max 35 Seats	Max 14 Seats			all 3-wheelers	With or WO Trailer						
Time	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
6:00 - 6:30	4	21	8	11	7	11	36	9	0	0	0	31	0	0	0	138
6:30 - 7:00	5	23	12	5	10	13	44	8	0	0	0	40	0	0	0	160
7:00 - 7:30	0	14	8	8	16	29	39	10	0	0	0	41	0	0	0	165
7:30 - 8:00	3	16	9	18	20	32	60	16	0	0	0	34	0	0	0	208
8:00 - 8:30	5	19	4	23	18	31	53	13	0	0	0	59	0	0	0	225
8:30 - 9:00	2	19	5	4	24	21	55	9	0	0	0	54	0	0	0	193
9:00 - 9:30	0	16	1	7	13	27	42	5	0	0	0	50	0	0	0	161
9:30 - 10:00	4	18	3	8	10	19	48	11	0	0	0	61	0	0	0	182
10:00 - 10:30	2	23	2	2	18	18	37	8	0	0	0	54	0	0	0	164
10:30 - 11:00	17	15	4	0	7	14	27	6	0	0	0	53	0	0	0	143
11:00 - 11:30	12	29	7	2	11	21	27	7	0	0	0	51	0	0	0	167
11:30 - 12:00	12	33	7	1	7	18	22	10	0	0	0	48	0	0	0	158
12:00 - 12:30	21	28	10	1	6	19	40	8	0	0	0	50	0	0	0	183
12:30 - 13:00	9	32	7	2	12	17	47	3	0	0	0	46	0	0	0	175
13:00 - 13:30	10	25	3	2	9	14	18	8	0	0	0	58	0	0	0	147
13:30 -14:00	15	22	5	3	3	15	17	6	0	0	0	55	0	0	0	141
14:00 - 14:30	18	19	4	2	13	8	21	7	0	0	0	42	0	0	0	134
14:30 - 15:00	22	17	4	4	2	11	24	4	0	0	0	41	0	0	0	129
15:00 -15:30	16	19	2	6	7	8	26	8	0	0	0	27	0	0	0	119
15:30 -16:00	12	16	2	4	5	5	11	4	0	0	0	31	0	0	0	90
16:00 - 16:30	12	21	1	21	1	6	15	6	0	0	0	22	0	0	0	105
16:30 - 17:00	14	18	2	33	6	8	12	3	0	0	0	26	0	0	0	122
17:00 - 17:30	15	21	2	36	6	8	16	3	0	0	0	29	0	0	0	136
17:30 - 18:00	13	17	1	17	3	3	12	3	0	0	0	12	0	0	0	81
	243	501	113	220	234	376	749	175	0	0	0	1015	0	0	0	3626
18:00 - 18:30	9	11	1	24	5	3	7	3	0	0	0	13	0	0	0	76
18:30 - 19:00	6	12	0	32	3	1	8	2	0	0	0	13	0	0	0	77
19:00 - 19:30	5	17	1	41	3	0	6	1	0	0	0	4	0	0	0	78
19:30 - 20:00	18	19	5	46	2	0	11	5	0	0	0	11	0	0	0	117
20:00 - 20:30	7	20	1	22	0	3	2	2	0	0	0	2	0	0	0	59
20:30 - 21:00	6	24	1	25	0	0	4	0	0	0	0	1	0	0	0	61
21:00 - 21:30	6	15	0	7	0	0	2	2	0	0	0	1	0	0	0	33
21:30 -22:00	5	8	0	2	0	1	4	1	0	0	0	0	0	0	0	21
22:00 -22:30	7	6	0	1	0	0	1	0	0	0	0	1	0	0	0	16
22:30 - 23:00	3	2	0	1	0	1	1	1	0	0	0	1	0	0	0	10
23:00 - 23:30	4	3	0	2	0	0	0	2	0	0	0	3	0	0	0	14
23:30 - 24:00	12	7	0	3	0	3	7	4	0	0	0	7	0	0	0	43
00:00 - 00:30	3	1	1	0	0	0	0	0	0	0	0	0	0	0	0	5
00:30 - 01:00	0	3	0	0	0	0	2	1	0	0	0	0	0	0	0	6
01:00 - 01:30	2	0	1	0	0	0	2	2	0	0	0	0	0	0	0	7
01:30 - 02:00	0	1	0	1	0	0	0	0	0	0	0	1	0	0	0	3
02:00 - 02:30	4	6	0	1	0	0	4	0	0	0	0	0	0	0	0	15
02:30 - 03:00	0	2	0	0	0	0	1	0	0	0	0	0	0	0	0	3
03:00 - 03:30	3	3	0	0	0	0	0	3	0	0	0	0	0	0	0	9
03:30 - 04:00	2	7	1	0	1	0	1	2	0	0	0	3	0	0	0	17
04:00 - 04:30	0	7	0	0	1	0	5	1	0	0	0	1	0	0	0	15
04:30 - 05:00	0	7	0	0	2	0	9	4	0	0	0	4	0	0	0	26
05:00 - 05:30	10	10	2	25	2	1	4	5	0	0	0	3	0	0	0	62
05:30 -06:00	26	28	4	12	4	13	16	0	0	0	0	13	0	0	0	116
	138	**219**	**18**	**245**	**23**	**26**	**97**	**41**	**0**	**0**	**0**	**82**	**0**	**0**	**0**	**889**
Total	624	1221	244	685	491	778	1595	391	0	0	0	2112	0	0	0	9030

ANNEX-3

Boring Data (FBC Report)

F

B

C

The JICA Study Team
Kathmandu, Nepal

COMPLETION REPORT

GEOTECHNICAL SURVEY

FOR

Data Collection Survey on Thankot Area Road Improvement in Nepal

28 April 2014

Submitted by:

Full Bright Consultancy (Pvt.) Ltd.
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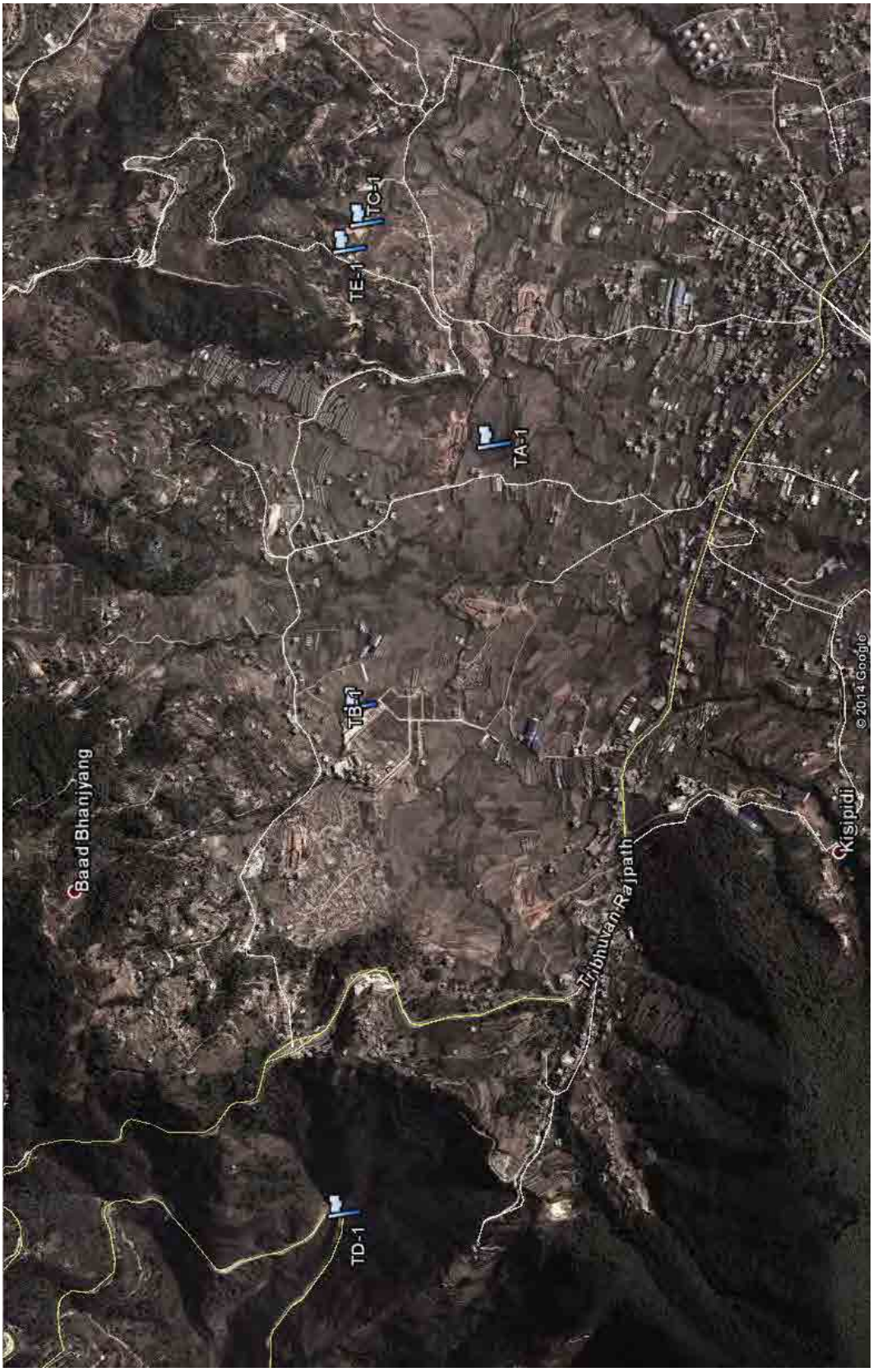


Figure A2-1 Location Map of Drill Hole Sites in Thankot Area

1. Boring Log at TA1

BORING LOG

PROJECT : **DATA COLLECTION SURVEY ON THANKOT AREA**
ROAD IMPROVEMENT IN NEPAL

SHEET NO : 1 of 1

BORING NO.	TA-1 **(Alternative A at Kathmandu side)**	PLACE	Imakhel, Thankot	NORTH LATITUDE	3,065,274
		DATE	**21.02.2014 to 03.03.2014**	EAST LATITUDE	324,292
COMPANY NAME	JICA (Japan International Cooperation Agency)	CHIEF ENGINEER	**F.NAKAJIMA**	Boring log prepared by **A. KOIRALA**	CHIEF OPERATOR **G. Giri**
GROUND ELEVATION	1403 (Handy GPS)	ANGLE Down Vertical	DIRECTION Down Vertical	SLOPE Flat	Final GWL 0.00 m
BORING DEPTH	25.0m				Boring Machine XUL - 200 Pump Koken

DATE	DEPTH (m)	ELEVATION	BORING LOG	TYPE OF ROCK OR SOIL	COLOUR	CORE	HARDNESS	JOINT SPACE	JOINT CONDITION	ROCK CLASSIFICATION	DESCRIPTION	N Value
	1.0			Fill	brown	-	-	-	-		Cultivated soil. Fill containing pieces of bricks in grey and brown sandy clayey silt	4
	2.5			clay	brown	C		IV	-	-	Alluvisal clay. clayey silt together with gravel size pieces of metasandstone.	9 20
	6.3			Gravel	yellowish grey	-		IV	-	-	Colluvial Soil. Grey gravel size pieces of metasandstone and sand collected from sludge	48 68 25
	9.5			clay	Dark greyand	C		IV	-	-	Lacustrine soil. Dark grey, grey and black clayey sandy silt with gravel size pieces of metasandstone impregnated in sandy silt.	14 13 49
	11.5			Gravel	Grey	-		IV	-	-	Colluvial Soil .Grey gravel size pieces of mainly metasandstone and some quartz together with silt and sand	50/12 50/10
	12.7			clay	Black	C		IV	-	-	sandy silt and carbonaceous stiff clay.	15
	15.			Gravel	Grey	-		IV	-	-	Frequent impregnation of grey gravels and cobbles of metasandstone observed.	25 41 100
	22.			clay	Grey and greenish to brownish grey	C		IV	-	-	Lacustrine Soil. sandy clayey silt together with gravel size fragments of metasandstone. Sometimes only sand could be collected from sludge.	65 48 51
	25.			Gravel	Grey	-		IV	-	-		52 49 50 52 46 45
											End of hole	48

N Value graph: 0 10 20 30 40 50

Sampling

Sampling

PHOTO OF CORE

TA-1

2. Boring Log at TB1

BORING LOG

PROJECT : **DATA COLLECTION SURVEY ON THANKOT AREA**

ROAD IMPROVEMENT IN NEPAL

SHEET NO : 1 of 1

BORING NO.	TB-1 (Alternative B at Kathmandu side)	PLACE	Bad Bhanjang	NORTH LATITUDE	3,065,693
		DATE	28.02.2014 to 05.03.2014	EAST LATITUDE	323,789
COMPANY NAME	JICA (Japan International Cooperation Agency)	CHIEF ENGINEER	F.NAKAJIMA	Boring log prepared by: A. KOIRALA	CHIEF OPERATOR: P. Shrestha
GROUND ELEVATION	1410 (Handy GPS)	ANGLE: Down Vertical	DIRECTION: Down Vertical	SLOPE: Flat	Final GWL: 0.00 m
BORING DEPTH	25.0m				Boring Machine: XUL - 100 Pump: Koken

DATE	DEPTH (m)	ELEVATION	BORING LOG	TYPE OF ROCK OR SOIL	COLOUR	CORE HARDNESS	JOINT SPACE	JOINT CONDITION	ROCK CLASSIFICATION	DESCRIPTION	N Value	N Value graph (0 10 20 30 40 50)	PHOTO OF CORE
	1.0			Fill	dark grey,		-	-	-	Cultivated soil. Fill containing pieces of bricks and plastic in grey and brown clayey silt.	3		
	2.5			Top soil			-	-	-	Pieces of root containing sandy silt	5		
	5.3			sandstone	Greenish to yellowish	B	III	c	CL	Greenish to yellowish grey sandy silty clay matrix and clasts of light grey sand with dark grey metasandstone. Bedrock at 5m depth	4 20 50/13		
	6.5					B	III	c	CL	Complete weathered sand as sludge and gravels of metasandstone	50/11		
	10.				grey to brown	A	III	c	CL	weathered metasedimentary rock mostly recovered as sand from sludge and gravel size pieces of metasandstone	50/8 50/14 50/8 50/9		
	15.				grey to brownish greywish grey	A	III	c	CL	Highly to moderately weathered metasandstone recovered together with brown sand collected from sludge. Foliation plane appeared 30o with the axis of drilling Tistung formation??			
	20.			Sandstone and phyllite alternation	Brown grey to yellowish grey	A	III	b	CM	moderately to highly weathered fine grained metasandstone recovered together with brown sand from sludge. A Joint plane prallel to drill axis and foliation planes 40o with axis observed.			
	25.					A	III	b	CM	highly to moderately weathered fine to medium grained metasandstone recovered together with brown sand from sludge. Joint planes parallel and making 30o with the drill axis observed. Foliation planes 20o to 30o with drill axis.			
										End of hole			

TB-1

3. Boring Log at TC1

BORING LOG

PROJECT : **DATA COLLECTION SURVEY ON THANKOT AREA**
ROAD IMPROVEMENT IN NEPAL

SHEET NO : 1 of 1

BORING NO.	TC-1 (Alternative C at Kathmandu side)	PLACE	Imakhel, Thankot	NORTH LATITUDE	3,065,441
		DATE	06.03.2014 to 13.03.2014	EAST LATITUDE	324,847
COMPANY NAME	JICA (Japan International Cooperation Agency)	CHIEF ENGINEER	F.NAKAJIMA	Boring log prepared by: A. KOIRALA	CHIEF OPERATOR: P. Shrestha
GROUND ELEVATION	1386 (Handy GPS)	ANGLE: Down	DIRECTION: Down Vertical	SLOPE: Flat	Final GWL: 0.00 m
BORING DEPTH	30.0m				Boring Machine: XUL - 200 Pump: Koken

DATE	DEPTH (m)	ELEVATION	BORING LOG	TYPE OF ROCK OR SOIL	COLOUR	CORE HARDNESS	JOINT SPACE	JOINT CONDITION	ROCK CLASSIFICATION	DESCRIPTION	N Value
	2.0			Top Soil		-	-	-	-	Top soil, brown, yellowish grey sandy silt together with some clay and clasts of metasandstone. Pieces of root observed.	5 9
	5.0			Colluvial Soil	Greenish, yellowish to	-	-	-	-	Greenish, yellowish to brown clayey silty sand and gravel with clasts of metasediment (sandstone and phyllite). Partly collected sand from sludge.	22 35
	10.				brown	-	-	-	-	Brown greenish and yellowish sandy clayey silt and gravel containing highly weathered clasts of metasediment (sandstone and phyllie). Partly brown sand cocollected from sludge	36 38 44 37 41 42
	14.0			Metasedimentary rocks of Tistung Formation	brown	-	-	-	-	Brown sandy silt with some clay and gravel of highly weathered brown metasediment (sandstone and phyllie). Major section of core recovered from sludge as brown sand. 11.5m and 14.5m SPT sample could not be recovered. Bedrock encountered at 14m depth.	45 46 45 50
	20.				brown	B	?	?	D	Brown sand recovered from sludge from 14-20m depth. SPT samples also could not be recovered..	80/15 85/15 83/16 80/16 80/15 ##
	25.			Sandstone and phyllite alternation	brown	B	?	?	D	Brown sand recovered from sludge from 20-21.5m depth. SPT samples was not recovered	1/1 45 1/1 2/1 7/1
					Green to brown	B	?	?	D	At 27m depth gravel size pieces of metasediment and the rest only brown sand recovered from sludge. SPT sample below 30m revealed brown and greenish fragments of metasediment	6/1 50/7 50/5
										End of hole	50/8

N Value graph: 0 10 20 30 40 50

PHOTO OF CORE

TC-1

4. Boring Log at TD1

BORING LOG

PROJECT : **DATA COLLECTION SURVEY ON THANKOT AREA**
ROAD IMPROVEMENT IN NEPAL

SHEET NO : 1 of 1

BORING NO.	TD-1 (Outlet of tunnel)	PLACE	Sisne Khola, Bad Bhanjang			NORTH LATITUDE	3,066,002
		DATE	07.03.2014 to 14.03.2014			EAST LATITUDE	322,652
COMPANY NAME	JICA (Japan International Cooperation Agency)	CHIEF ENGINEER	F.NAKAJIMA	Boring log prepared by	A. KOIRALA	CHIEF OPERATOR	P. Shrestha
GROUND ELEVATION	1308 (Handy GPS)	ANGLE	Down Vertical	DIRECTION	Down Vertical	SLOPE	Flat
BORING DEPTH	15.0m					Final GWL	Dry
						Boring Machine	XUL - 100 Pump Koken

DATE	DEPTH (m)	ELEVATION	BORING LOG	TYPE OF ROCK OR SOIL	COLOUR	CORE HARDNESS	JOINT SPACE	JOINT CONDITION	ROCK CLASSIFICATION	DESCRIPTION	N Value	N Value graph (0 10 20 30 40 50)	PHOTO OF CORE
	0.7			Colluvial Soil to Soil		-	-	-	-	Brownish grey Silty sandy gravel, clasts of metasandstone	18		
	2.5								D	Grey greenish grey to brown sandy silty on top and mainly gravel clasts of metasediment at lower part, partly recovered as sludge	19 31		
	5.0								CL	Bedrock at 3.5m moderate weathered metasediment (Phyl. and Sst.)	50/9 50/7 50/8		
	10.								CM	Slightly to moderately weathered fractured grey to bluish grey metasediment recovered as gravel and cobble size fragments. Shows traces of foliation plane 30-40o with axis of drilling. Core loss from 8.0-8.5m			
	14.								CM	Light grey to bluish grey slightly to moderately weathered metasediment recovered in gravel and cobble size fragments. Traces of foliation plane 20-30o with axis of			
	15.								CM	Grey to bluish grey silty sand and gravel size fragments of metasediment recovered			
										End of hole			

TD-1

5. Boring Log at TE1

BORING LOG

PROJECT : DATA COLLECTION SURVEY ON THANKOT AREA
ROAD IMPROVEMENT IN NEPAL

SHEET NO : 1 of 1

BORING NO.	TE-1 **(Alternative C at Kathmandu side)**	**PLACE**	Imakhel. Thankot	NORTH LATITUDE	3,065,490
		PERIOD	17.04.2014 to 21.04.2014	EAST LATITUDE	324,793
COMPANY NAME	JICA (Japan International Cooperation Agency)	CHIEF ENGINEER	**F.NAKAJIMA**	Boring log prepared by **A. KOIRALA**	CHIEF OPERATOR **P.Shrestha**
GROUND ELEVATION	1438 (Handy GPS)	ANGLE Down Vertical	DIRECTION Down Vertical	SLOPE Flat	Final GWL 2.20m
BORING DEPTH	25.0m				Boring Machine XUL 100 Pump Koken

DATE	DEPTH (m)	ELEVATION	BORING LOG	TYPE OF ROCK OR SOIL	COLOUR	CORE HARDNESS	JOINT SPACE	JOINT CONDITION	ROCK CLASSIFICATION	DESCRIPTION	N Value	N Value graph (0 10 20 30 40 50)	PHOTO OF CORE
	1.0			Top soil	Brown					Peieces of root containing and the rest sandy silty gravel with abundant clay. Gravel size clasts of greenish grey phyllite and metasandstone	11		
	3.5										8		
										Sandy silty gravel with some clay. Gravel size clasts of weathered metasediment	13		
	6.0				Yellowish						22		
											12		
				Colluvial Soil	Brown with some greenish and yellowish tint	C		C		Silty sand and gravel with or without some clay. At 9.5m depth clay content was higher. Majority of the sample was recovered from sand	28		
	11.50										37		
											27		
											27		
											26		
											26		
										(Bedrock encountered at 11.5m depth) Greenish grey sandy silty gravel probably recovered from the bedrock metasediment	58		
											84/28		
											96/20		
											50/12		
					Greenish grey	-			-		57		
											67		
											65		
	19.0										50/9		
					Brow	-			-	Brown silty gravelly sand size particles weathered metasediment	50/8		
				Metasediments									
					Greenish grey	-			-	Silty gravel and sand size particle recovered together with light brown sand from sludge from sludge	80/22		
											99		
											88		
					Green	-			-	Cobble and gravel size particles of metasediment (sandstone and phyllite)	95		
	25.0									Sandy silty gravel size matrial recovered together with sand from sludge	87		
										End of hole			

TE-1

ANNEX-4 EPA Amendment

(Gazette- Section 58, No. 44, Part 5)

Date-16th February, 2009 AD (2065/11/05)

The GON has established the following Environment Protection Council under the **Rule 14** of EPA, 2053 to provide policy guidance and suggestion and also to have cooperation between different agencies.

1. Establishment of Environment Protection Council: (1) Following will be the members in the Environment Protection Council:-

a)	Prime Minister	Chairman
b)	Minister, Ministry of Science, Technology and Environment	Vice Chairman
c)	Minister, Ministry of Finance	Member
d)	Minister, Ministry of Foreign Affaires	Member
e)	Minister, Ministry of Home	Member
f)	Minister, Ministry of Water Resource	Member
g)	Minister, Ministry of Local Development	Member
h)	Minister, Ministry of Health and Population	Member
i)	Minister, Ministry of Industry	Member
j)	Minister, Ministry of Forest and Soil Conservation	Member
k)	Minister, Ministry of Land Reform and Management	Member
l)	Vice Chairman, National Planning Commission	Member
m)	Chairman, Constitutional Committee (Environmental) Parliament	Member
n)	Secretary, Prime Minister, Office of Ministry Council	Member
o)	Seven Nominated persons including two women who had remarkable contribution in the field of environment	Member
p)	One representative from Political Parties of Constituent Assembly	Member
q)	Secretary, Ministry of Science, Technology and Environment	Member

2. The tenure of the members mentioned in section (o) will be two years maximum.
3. Meeting of the Environment Protection Council:
   (a) Meeting of the Environment Protection Council will be carried out minimum once a year.
   (b) Subjects related to Environmental Policies will be put forwarded in the meeting of Environment Protection Council.
   (c) Other work procedure regarding meeting of Environment Protection Council will be as determined by the council itself.
4. Dissolve: The Environment Protection Council established under the Ministry of Population and Environment with the announcement dated 1997 September, 8th (2054/5/23) in gazette-Section 47, Sub-number 24(Ga), Part 4 has been dissolved.

ANNEX-5

EPR AMMENDMENT

Schedule -2

(Relating to EPR SECTION 3)

Proposals Requiring Environmental Impact Assessment

Amendments 2010 October 4

A. Forest Sector:

1. Plantation of indigenous plants of a single species in a single block covering an Ares of more than 500 hectares in the Terai and more than 100 hectors in the hills.
2. Plantation of such imported species of plants as are deemed suitable for the purposes, following their test, in the concerned place, more than 100 hectares in the Tarai and more than 50 hectares in the Hills.
3. Handover of forests with as area of more than 200 hectares in the Terai and more than 50 hectares in the hill as leasehold forests.
4. Clear felling or rehabilitation of forests with an area of more than 30 hectares.
5. Rosin and turpentine, rubber, plywood and veneer, catechu, and timber-based matches, pulp and paper industries to be established within one Km. inside the forest area which depend on forests for their raw material and use processing techniques and cardamom and medium and large tea industries which use large quantities of firewood.
6. Commercial and industrial processing of medicinal herbs and aromatic plants which emit garbage and pollution.
7. Establishment of hotels, resorts, safaris with the capacity of 50 beds, or the construction of medium and large scale educational institution ,hospital and Industries of other construction activities inside forest areas, national parks, sanctuaries, conservation areas, buffer zones and environment conservation Zones.

Formulation of Watershed Management Plan of Protected Areas.

8. Collection of forest related products including NTFPs and roots of more than 50 ton per species per year in different period of time from a forest of a district or from different forest areas in a single time if the exact extraction amount is not mentioned in forest or protection area management plan.
9. Collection of forest related products such as tree bark of more than 100 ton per species per year in different period of time from a forest of a district or from different forest areas in a single time if the exact extraction amount is not mentioned in forest or protection area management plan.
10. Collection of more than 100 ton of root and bark form a district in single time or from time to time from a forest or forest area in a single or in many seasons if the exact extraction amount is not mentioned in forest or protection area management plan except for Salcid, Rittha, Amala,

Tendupat, Bhorla and Tejpat.

11. Collection and export of forest related products more than 50 ton per year of processed extracts of a species permitted as per prevalent laws from a forest or many forest areas in a single time or in different period of time in a single or in many seasons. Establishment of different invasive species of wildlife.

12. Proposal implementing through other organization instead of forest related government agencies clearing more than 5 hectares of forest.

13. Handover of more than 500 hectares of forest to a single community for its management.

B. Industrial Sector:

1. Establishment of breweries and wineries equipped with boiling and fermentation facilities with a production capacity of more than Fifty Hundred Thousand liter per day.

2. Production of primary chemicals such as corrosive, acid and alkali etc. (except citric Tartaric, acetic, acid.) with a production capacity of more than One Hundred metric tons per day.

3. Processing of hides more than 10,000 sq. ft. Per day.

4. Establishment of mineral based industries with a investment of more than Rs. Fifty millions fixed capital.

5. Production of petro chemical and processing (diesel, kerosene, lubricant plastics, Synthetic rubbers etc.)

6. Production of 50 ton per day of ferrous and non ferries metals (except resoling, re-melting and fabrication) by the process of primary smelting.

7. Establishment of industry producing more than Three Thousand metric ton of rude sugar and sugar per day.

8. Establishment of cement industries with a production capacity of more than Thirty metric tons per hour based on line stone and with a production capacity of more than Fifty metric tons per hour based on clinker.

9. Establishment of lime industries having production capacity of more than 500 metric tons per day.

10. Production of asbestos.

11. Establishment of radioactive emission (nuclear and automatic processing) industries.

12. Formulation of 50 metric tons of primary compound (Bulk drugs) for medicine daily.

13. Production of extremely hazardous Substances such as Isocyanine, mercury compound etc.

14. Production of ammunitions and explosives including gunpowder except than the production made by Nepal Army or Nepal police forever or to be established by them.

15. Establishment of industries of pulp or paper with a production capacity of more than One Hundred metric tons per day.

16. Establishment of brick and tiles industries with a production capacity of more than Twenty million pieces per year.

17. Chemical processing of bone, horn with 50 metric tons per day.

18. Establishment of sawmill with the use capacity of more than Fifty Thousand cubic feet of wood per year.

C. Mining Sector:

1. Relocation or resettlement of permanent residence of more than 100 people for the purpose of mine excavation.
2. Underground Mines:

a. Excavation of radioactive minerals in any scale.

b. Underground excavation of other minerals of 200 ton daily and surface excavation of 400 ton daily.

c. Underground extraction of non-metal minerals of 200 ton daily and 400 ton of surface excavation.

d. Extraction of simple construction related stones, decorative stones, sand, gravel and industrial soil of more than 300 cubic meters per day.

e. Underground excavation of 200 ton per day and surface excavation of 400 ton per day for the production of coal and crude coal.

f. Production of more than One Hundred Thousand cubic meter Biogenic natural gas per day.

g. Activities related to extraction of petroleum products and its processing.

h. Extraction of sand, gravel and soil at the rate of more than 250 cubic meters per day from the surface of river and revolute.

D. Road Sector:

1. Construction of the following roads:

(a) National highways.

(b) Main feeder roads.

2. Construction of more than 50 Km. long ropeway.
3. Construction of more than 5 Km. long cable car routes.

E. Housing, Building and Urban Development Sector:

1. Construction of Residential, Commercial and their Combination as a Built up Area or Floor Area in more than Ten Thousand Sq. Meter area.
2. Construction of Cinema Hall, Theater, Community Hall, Stadium, Concert Hall, Sport Complex with the capacity of entry and exit of more than 2000 people.
3. Development of Apartment in more than 4 hectare area or with a capacity of 50 households.
4. Operation of Land Development Project in more than 100 hectare.
5. Construction of 16 Storey building or more than 50 meter in height.

F. Water resources and Energy sector:

1. Operation of electricity generation project with a capacity of more than 50 mw.
2. Under Electricity Generation:

a. Operation of project that generates more than 1 mw electricity from coal and nuclear plant.

b. Operation of project that generates 5 mw of electricity from mineral oil or gas.

3. Under the new systems of irrigation:

(a) Irrigating more than 2000 hectares in the Tarai and inner Terai.

(b) Irrigating more than 500 hectares in the hill valleys.

(c) Irrigating more than 200 hectares in the hill areas with a steep gradient and Mountain areas.

4. Any water resources development activity which displaces more than One Hundred people with permanent residence.
5. Construction of multipurpose reservoirs.
6. Inter-basin water transfer and use from one watershed area to another.

F1.

a. Operation of electricity generation project from solar energy with a capacity of more than 10 mw.

b. Operation of electricity generation project from wind energy with a capacity of more than 10 mw.

c. Operation of electricity generation project from biomass energy with a capacity of more than 2 mw.

G. Tourism Sector:

1. Establishment and operation of hotels with more than One Hundred beds.
2. Establishment and development of new airports.

H. Drinking water:

1. Collection of rain-water in an area of more than Two Thousand hectares and use of water sources (springs/wetlands) located within the same area.
2. Surface water sources with more than 1cs. safe yield, and the use of its entire part during the dry season.
3. Recharging of more than Fifty percent of the total aquifer for the development of underground water sources.
4. Displacement of more than One Hundred persons for the operation of water supply scheme.
5. Settlement of more than Five hundred persons on the upper reaches of water sources.
6. Supply of drinking water to a population of more than Fifty Thousand.
7. Supply of drinking water to a population of more than One Hundred Thousand upon connecting of new sources.
8. Over mining of biologically or chemically polluted point and non-point sources or underground water sources that may be affected by them.
9. Operation of multi-purpose projects relating to sources of drinking water which consumes the

sources at the rate of more than 25 liters per second.

I. Waste Management:

1. Waste management activities to the undertaken with the objective of providing services to a population of more than Ten Thousand.
2. Following activities relating to waste emitted from houses and residential areas: -

(a) Filling of land with more than Five Thousand tons of waste per year.

(b) Activities relating of transfer station and resources recovery areas spread over an area of more than Ten hectares.

(c) Selecting, picking, disposing and recycling wastes through chemical, mechanical or biological techniques' in an area spread over more than Ten hectares.

(d) Activity relating to compost plans spread over an area of more than Ten hectors.

(e) Burying of waste emitted from an urban area with a population of at least Ten Thousand.

3. Following construction activities relating to hazardous waste of the following nature in any scale:-

(a) Construction of waste plant.

(b) Construction of waste recovery plant.

(c) Constructing of a site for filling accumulating or burying waste.

(d) Construction of a site to store the waste.

(e) Construction of a waste treatment facility.

4. Following activities relating to lethal waste:-

(a) Emission and management of any radioactive Substance with a half age exceeding Twenty Five years.

(b) Emission and management of any lethal chemical with Fifty lethal dose.

(c) Final disposal management of biological lethal Substances emitted from Health Center, Hospital, or Nursing Home with at least Twenty Five beds.

(d) Any activating relating to One hectors or more of land and energy for the purpose of incinerating or recycling any lethal Substance

J. Agriculture Sector:

1. Clearing of forest covering more than One hector in the Hills and Five hector in the Terai and using it for agricultural proposes.
2. Urbanization plan in cultivable lands.
3. Establishment of Plant for Toxic Pesticide (only those which are listed).

K. Health:

1. Operation of hospitals or nursing homes with more than Hundred beds, or medical profession (study and teaching also).

L. If any proposal is to be implemented in the following areas;

1. Historical, Cultural and archeological sites.
2. National Parks, wild life sanctuaries and conservation areas.
3. Areas with main sources of public water supply.

L.1. Operation of any plan, project or programme relating to any developmental work physical activity or change in land use except the proposals mentioned in Clause (a) to Clause (K) and those below the standards of such proposals as well as the proposals below the standards of those mentioned in schedule -1 with a cost of more than Two Hundred Fifty millions.

ANNEX-6

Table of Contents of MOFSC Project Approval Request

List of Documents required for the Permission from the Ministry of Forest prior to the commencement of EIA.

1. Name of the Project
2. Name of the Proponent and Address
3. Area and alignment coordinate (GPS Points) of the directly affected Forest area.
4. Name and Address of the project area.
5. Type of Forest Conservation Area according to the Forest Act and the Wild Life Conservation Act.
6. Main Flora and Fauna.
7. Estimated Area of the Forest (ha).
8. Sensitive area according to forest, plant resources, diversity and soil conservation, if any.
9. Other issues if any.

ANNEX-7

Sample Table of Contents of EIA Scoping Document

Source: Scoping Document for Environmental Impact Assessment of Kathmandu – Kulekhani – Hewauda Tunnel (KKHT) Highway Project, Nepal Purwadhar Bikash Company Ltd., January 2013

Annexes

1. Maps
2. Physical data
3. Biological data
4. Social data
5. Project information leaflet
6. Questionnaire for scoping
7. List of participants in interaction meetings
8. Public notice for scoping and notification evidence
9. Documentation of correspondence from stakeholders
10. Study team members and declaration
11. Photographs

ANNEX-8

Sample of Table of Contents of EIA Terms of Reference Document

Source: Terms of Reference for Environmental Impact Assessment of Kathmandu – Kulekhani – Hewauda Tunnel (KKHT) Highway Project, Nepal Purwadhar Bikash Company Ltd., January 2013

ANNEX 9

Technical Explanatory Meeting

1. Distribution of Invitation Letter to Concerned Institutions and DOR Staff

TECHNICAL PRESENTATION

ON

"THE PERSPECTIVE OF ROAD TUNNELS IN NEPAL"

April 20, 2014 (09:30 – 14:00)
DOR Conference Hall, Babar Mahal, Kathmandu

Organized by:
Department of Roads
Ministry of Physical Infrastructure and Transport (MOPIT)

Background

The need of a road tunnel in Nepal may have been felt since long time ago, but the extreme topography, fragile geology and lack of resources had been obstacles to overcome such needs. Today, Nepal is ready to address this need and the government has been taking promising steps ahead for its realization. However, Nepal has limited experience in the construction of road tunnels and thus needs to enhance understanding and knowledge of advanced technology regarding construction of road tunnels.

Objective

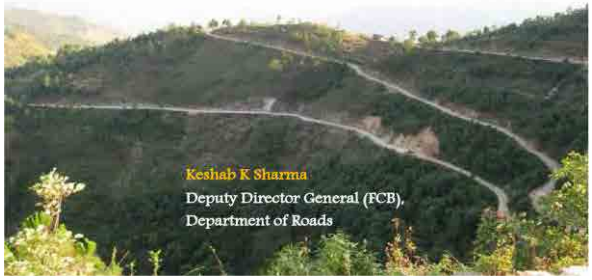
The objective of this presentation is to enhance understanding of the participants on the perspective of road tunnels in Nepal and to share knowledge on advanced technology in the field of road tunnel construction.

Program

09:30 –10:00	Participant's Registration	
10:00 – 10:05	Seminar Introduction	Mr. Rupak Rajbandari *Senior Divisional Engineer,* *Foreign Co-operation Branch, DOR*
10:05 – 10:10	Welcome Remarks	Mr. Keshab Kumar Sharma *Deputy Director General,* *Foreign Co-operation Branch, DOR*
10:10 – 10:15	Opening Remarks	Mr. Devendra Karki *Director General, DOR*
10:15 – 10:45	PRESENTATION: 1. **"Current Status and Issues in Road Sector in Nepal"**	Mr. Keshab Kumar Sharma *Deputy Director General,* *Foreign Co-operation Branch, DOR*
10:45 – 11:15	2. **"Geological Characteristics of Nepal and Issues on Civil Engineering"**	Dr. Tara Nidhi Bhattarai *Reader, Department of Geology* *Tribhuvan University*
11:15 – 12:15	3. **"Tunnel Construction Techniques in Japan with a focus on NATM"** • General Lecture on Tunnel Construction Method • Tunnel Construction technique and Special Construction Method for Mountainous Areas • Question and Answer	Mr. Kenichi Kinoshita *Tunnel Engineer* *Hazama Ando Corporation, Japan*
12:15 – 12:45	COFFEE BREAK	
12:45 – 13:45	4. **"Tunnel Construction Management in Japan: Quality Control, Safety Management, and Environmental Measures"** • Construction Supervision, Process Control, Quality Control, Safety, O&M Management • Question and Answer	Mr. Takayuki Sakai *Tunnel Engineer* *Shimizu Corporation, Japan*
13:45 – 14:00	Closing Remarks	Mr. Tulsi Prasad Sitaula *Secretary, MOPIT*

2. Status and Issues of Road Sector in Nepal

Status and Issues of Road Transportation in Nepal

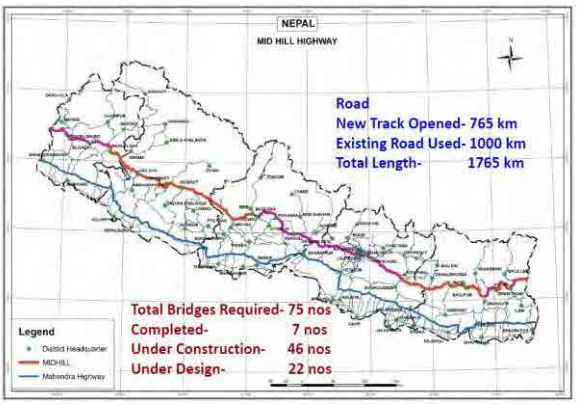


Keshab K Sharma
Deputy Director General (FCB),
Department of Roads

Historical Development in Road Construction

Fiscal Year		Black top	Gravel	Earthen	Total
1950	2007	Year of Democracy			360
1974-75	2031-32	1575	516	1182	3173
1979-80	2036-37	2044	564	2332	4940
1984-85	2041-42	2724	918	2283	5925
1989-90	2046-47	2899	1621	2516	7036
1994-95	2051-52	3553	2662	4529	10724
1999-2000	2056-57	4522	3646	7140	15308
2004-05	2061-62	4911	4707	7661	17279
2009-10	2066-67	4952.11	2065.15	3817.76	10835.02
2011-12	2068-69	5573.55	1888.49	4173.55	11635.58 + 50,994 (LRN)

Proposed and Existing North-South Roads



Key Issues in Road Sector

- Higher Transportation Cost
  - Topography (Length and gradient of roads), Road Condition, Fuel, Syndicate
- Higher Road Construction Cost
  - Geography, Lack of new technology, Traditional project delivery methods
- Lower Volume of Paved Roads
  - <50% in SRN, about 5% in LRN
- Lack of Integrated approaches in Plans/ Standards and Implementing agencies

Key Issues in Road Sector

- Poor Road Safety
  - Road crashes and fatality not decreasing, >1800
- Lower Focus on Road Maintenance
  - Maintenance budget for SRN<15% of total SRN budget and for LRN <_ 5% of total LRN budget
- Quality not up to the mark.
  - Low bid
  - Inadequate Supervision staff
  - Lack of Modern technology and Design
- Very less priority in Research and Development

Key Issues in Road Sector

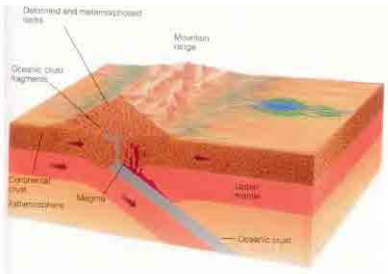
- Construction Industry
  - Poor performance of Contractors,
  - Low bid,
  - Lack of Sufficient Equipments,
  - Lack of Experts and professionals,
  - Lack of construction material both in quality and quantity
  - Traditional Construction Technology

Naubise- Thankot Road: Current Situation

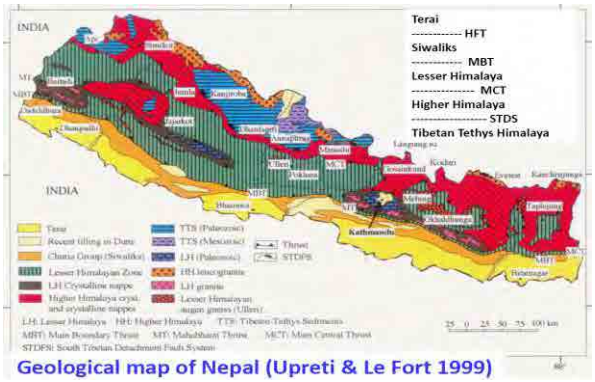
3. Geological Characteristics of Nepal and Issues on Civil Engineering

Geological Characteristics of Nepal and Issues on Civil Engineering

Tara Nidhi Bhattarai, Ph. D
Department of Geology
Tri-Chandra Campus
Tribhuvan University



Himalays marks Continent-Continent type of collision or convergent zone, where mountain building process is still active. It has resulted very complex geology.

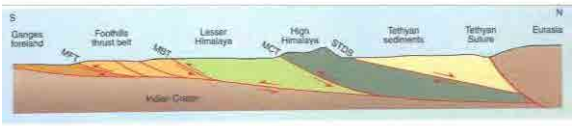


Geological map of Nepal (Upreti & Le Fort 1999)

The Main Frontal Thrust (MFT), and Main Boundary Thrust (MBT) are considered to be active now.

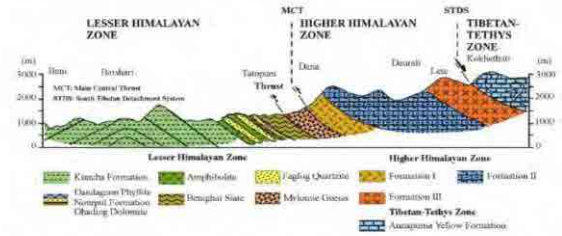
Main Central Thrust (MCT) is no more longer active.

Major transport infrastrures are to be constructed accross the MFT and MBT



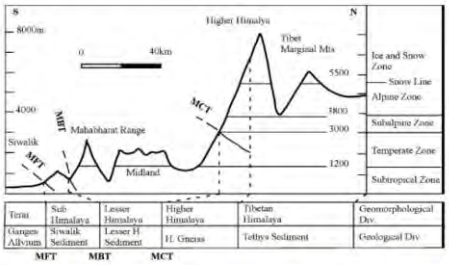
Geological cross-section of the Himalaya (Harris, 2001)

- In addition to various geological structures, frequent changes of litholgoy with granitic intrusions are common



Geological Cross section between Beni and Kokhethati showing the major structures of the Lesser, Higher and Tibetan-Tethys zones (Yoshida and Upreti, 2007)

- Complex geology, active mountain building process, steep topography, and heavy precipitation often results hazards like landslides, debrish flow and floods; which are serious threat to infrastructures development in Nepal.



Simplified physiographic and geological cross- section of the Himalaya (Kizaki 1994)

1) Issues on Construction Site Information

- Building on the available geological maps, detail engineering geological maps are to be prepared to reveal the engineering geological condition of the construction site.
- Fault, folds, joints, rock types, lithological contacts, etc should be revealed with acceptable accuracy.
- Extent of erosion, weathering grade and its vertical penetration is utmost important in transport infrastructure design.
- Groundwater and its possible consequences to construction works should also be worked out.

Conclusions

- Geological characteristic of Nepal is very complex, and it demands for preparing large-scale engineering geological maps, build on the exisiting geolgoical map.
- A well-equiped engineering geological laboratory is in urgent need.
- Because of complex geology, and steep topography one has to face several geotechincal problems while construcitng transport infrastructures like road and tunnel in Nepal.
- But these can be addressed with joint collaborative efforts from the Department of Road, Universityies, and donar communities.

4. Tunnel Construction Techniques in Japan with a focus on NATM

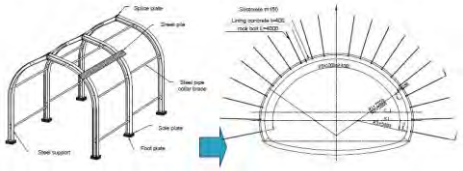
2014 Training

Construction Using Tunneling Method (NATM)

April 20, 2014

Hazama Ando Corporation

Changes in Mountain Tunnel Technology

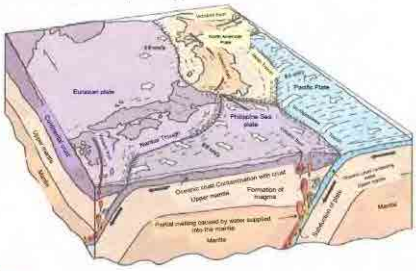


Sheet pile method
- Steel supports + Sheet piles
- 1950 to second half of 1970

NATM (standard method)
- Shotcrete + rock bolts
- Since second half of 1970

■ Makeup of Geological features of Japan

Distribution of Tectonic Plates around Japanese Archipelago

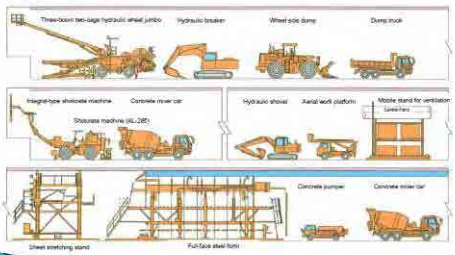


2. Construction Method

2.1 Order of Construction

• **Blasting Excavation** (Full-face Method with Auxiliary Bench)

Construction order chart



2. Construction Method

2.2 Excavation

• **Machine Excavation**

Free section excavator (Load header, 200 kW class)

2. Construction Method

2. 3 Mucking

• **Loader**

Side-dump wheel loader

Loading shovel

Electric loading shovel

2. Construction Method

2.4 Shotcrete

3) Shotcrete

Shotcrete is an important support member of a tunnel in coating the ground just after excavation to protect the ground and restrict the deformation of it at the same time.

2. Construction Method

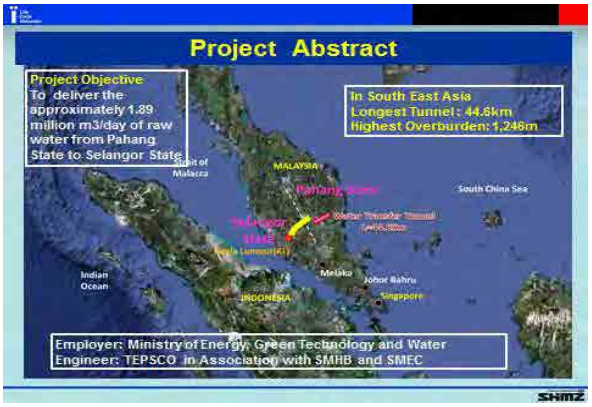
2. 6 Rock Bolts

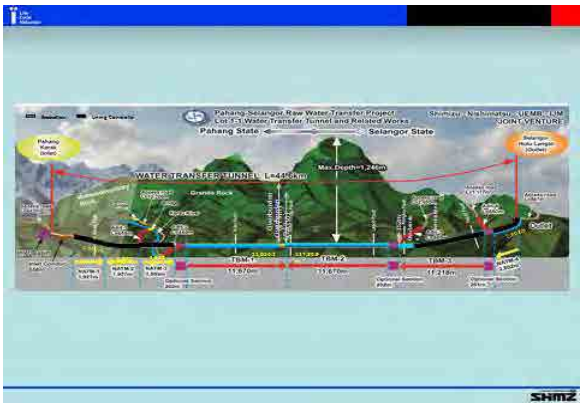
Rock bolts have effects of fixing the ground, providing internal pressures, forming arches, and preventing rock falls in the ground.

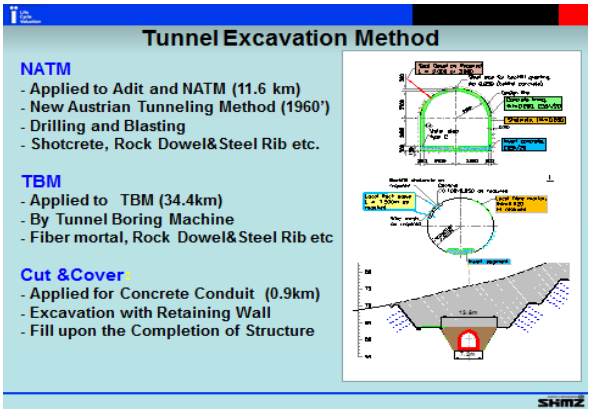
(1) Drill rock bolt holes using the jumbo.

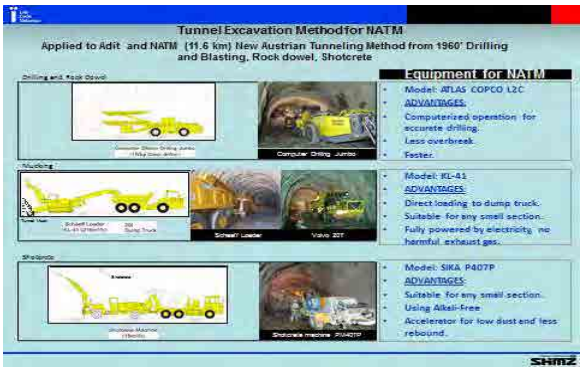
Approximate diameter of 42 - 45 mm; rock bolts generally have a diameter of 25 mm and a length of 3 - 4 m.

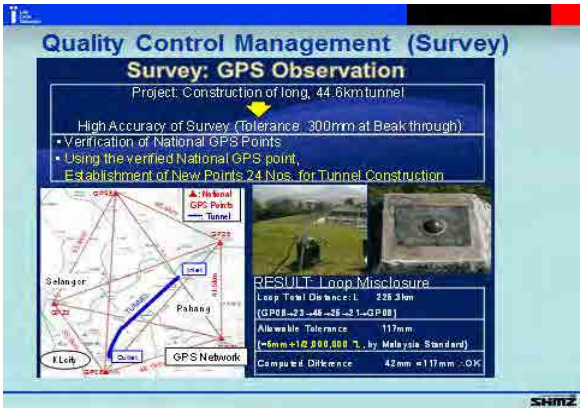
5. Tunnel Construction Management in Japan

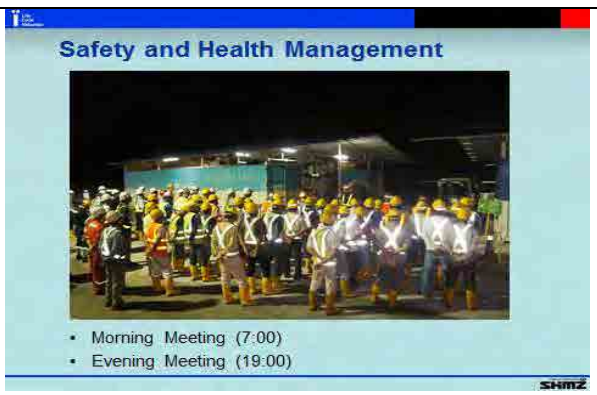




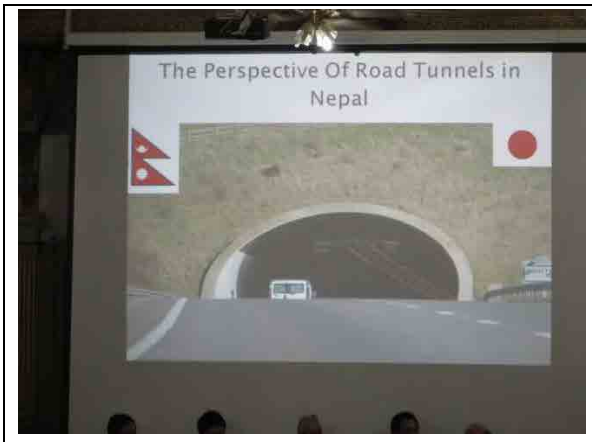








6. Photographs of Audiences



ANNEX-10

Observation Visit Tunnel Construction

1. Concept

Designated people from developing countries are invited to Japan to be given opportunities to visit the tunnel and loop bridge sites that help them useful construction information and techniques.

2. Purpose

・To provide Japanese knowledge and experience with designated people from Nepal.
・To develop an understanding of tunnel technologies, related Japanese techniques and its potentialities.
・To make the future vision of the road development more clear through the observation visit to sites.

3. Participants

Name	Organization	Position
Tulasi Prasad Sitaula	Ministry of Physical Infrastructure and Transport	Secretary
Rajendra Prasad Nepal	Ministry of Physical Infrastructure and Transport	Joint Secretary
Devendra Karki	Ministry of Physical Infrastructure and Transport, Department of Roads	Director General
Keahab Kumar Sharma	Ministry of Physical Infrastructure and Transport, Department of Roads	Deputy Director General
Daya Kant Jha	Ministry of Physical Infrastructure and Transport, Department of Roads, Central Regional Road Directorate	Regional Director
Rupak Rajbhandari	Ministry of Physical Infrastructure and Transport, Department of Roads	Senior Divisional Engineer
Ashok Tiwari	Ministry of Physical Infrastructure and Transport, Department of Roads	Senior Divisional Engineer
Satyendra Shakya	Ministry of Physical Infrastructure and Transport, Department of Roads	Senior Divisional Engineer

4. Tour Schedule

The observation visit started on 20th May, 2014. Four officials, Secretary and Joint Secretary MoPIT and Director General and Deputy Director General of DOR left Japan earlier than other officials because of their schedule. The tour schedule is described as follow.

Tour Schedule

Day	Contents
5/20	Leave Nepal
5/21	Arrive at Tokyo
5/22	NATM Technical Presentation, Courtesy Call at JICA HQ
5/23	Observational visit to the tunnel construction site (Hanabuchiyama 2nd Tunnel at Miyagi Pref.)
5/24	Observational visit to Karisaka Tunnel (Saitama and Yamanashi Pref.)
5/25	Observation of road network in Tokyo (four high officials leave Japan at night)
5/26	Observation of road network in Kanagawa
5/27	Leave Japan
5/28	Arrive at Nepal

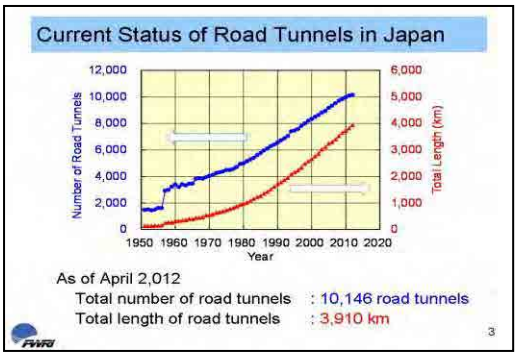
(1) NATM Technical Presentation

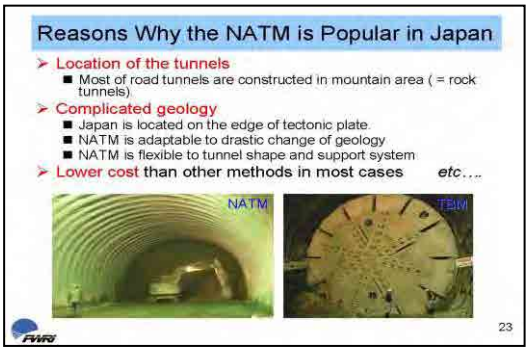
The purpose of NATM Technical Presentation is to introduce the Japanese advanced technology related to NATM. In contrast to the Technical Presentation held in Kathmandu on 20th April, the NATM Technical Presentation does not focus on the basic explanation about a series of procedure relating to NATM but Japanese technological capability for safe and high quality construction.

Time	Program
9:45-10:15	**Key-note speech: Tunnel Technology in Japan** Speaker：Atsushi Kusaka（Public Works Research Institute）
10:15-10:45	**Technical Expertise 1: Obayashi Corporation** ・Non-core Drilling Exploration Ahead of Face –Tunnel Navi- ・Application of CIM to Tunnel Construction
10:45-11:15	**Technical Expertise 2: Shimizu Corporation** ・Tunnel Boring Technology of Shimizu
11:15-11:25	Break time
11:25-11:55	**Technical Expertise 3: Kumagai Gumi Co., Ltd.** ・PSS-Arch Method ・*Magaru-Fu* Method
11:55-12:25	**Technical Expertise 4: Hazama Ando Corporation** ・3D-LSTM：3D Laser Scanner Tunnel Measurement System

・Key-note speech: Tunnel Technology in Japan

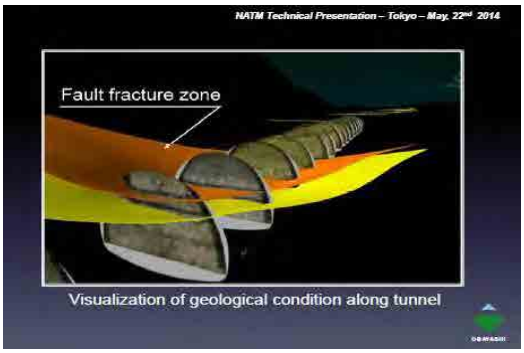
As the Key-note speech, Mr. Atsushi Kusaka from Public Works Research Institute provided presentation about Tunnel Technology in Japan. It summarized the history of NATM in Japan, Japanese record of NATM construction and latest technologies. It is useful information for Nepali officials to understand that Japan has the sufficient achievement for the tunnel construction.

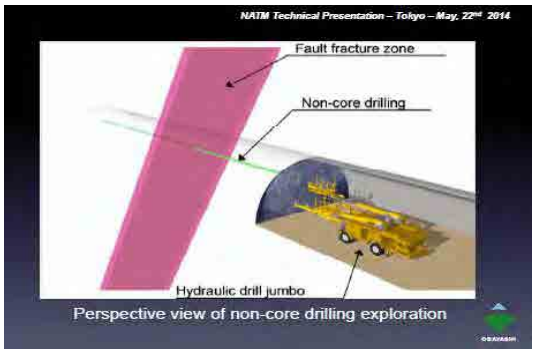




・Obayashi Corporation (Tunnel Navi and CIM)

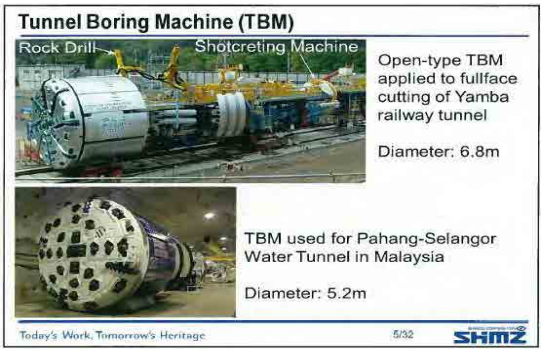
Obayashi Corporation provided the presentation about Non-core Drilling Exploration Ahead of Face "Tunnel Navi," and the application of Construction Information Modeling (CIM). Those are the exploration technique to predict the geological condition ahead of face and detect the water-bearing zone and dewatering, which contributes to the reasonable construction. This presentation provided the opportunity to know the effective use of the information technology.

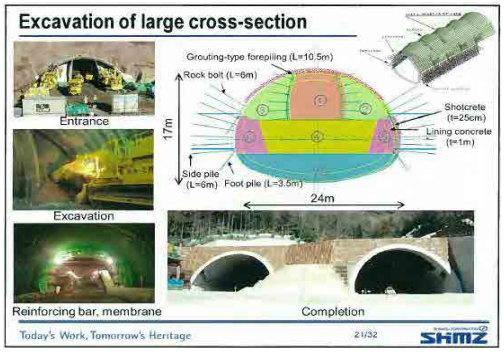




・Shimizu CorporationTunnel (Boring Technology of Shimizu)

Shimizu Corporation introduced the large tunnel construction projects implemented by its own tunneling techniques. Especially, The Pahang Selangor Raw Water Tunnel is the impressive project that the three tunnels, totaling 44.6 km, will address projected water shortages. It is an example which certifies that Japanese companies have the capability to construct a large-scale tunnel by high technologies.





Kumagai Gumi Co., Ltd. (PSS-Arch Method and *Magaru-Fu* Method)

Kumagai Gumi Co., Ltd. introduced two types of the supplementary construction method which is usually used for measures against the face instability, spring water and ground surface subsidence. For the tunnel construction in Nepal where the geological condition is complicated and weak, it has the importance for the safe construction. Therefore, this presentation provided the opportunity to know how to do reasonable design and construction by the usage of the supplementary construction method.

・**Hazama Ando Corporation (**3D-LSTM)

Hazama Ando Corporation introduced the 3D Laser Scanner Tunnel Measurement System (3D-LSTM). This system is the methodology for tunnel displacement tracking based on three dimensional laser scanning. It can measure the cross-sectional shape of tunnels, and it can also detect the direction and the amount of displacements at any point of tunnel wall. 3D-LSTM is an effective tool for the expectation of deformation risk. This presentation provided the practical example of the 3d application for NATM construction.

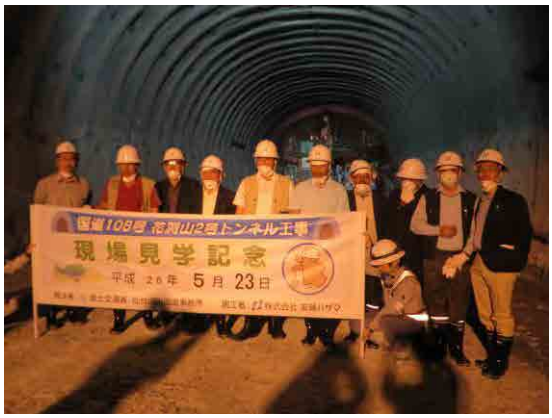
Output of 3D-LSTM (3-D representation of displacement distribution)

3-D laser scanner

(2) Observational Visit

Hanabuchiyama Second Tunnel (Miyagi Pref., Tōhoku region)

The Hanabuchiyama Second Tunnel (1,194m in length) is a part of Hanabuchiyama Bypass. On the observational visit, the construction manager gave the detailed explanation about the construction method "NATM" and the safety management. This visit provided the opportunity to understand a series of procedures relating to NATM construction and the importance pf the safety management.



Karisaka Tunnel (Saitama Pref. & Yamanashi Pref.)

Karisaka Tunnel (6,625m in length) is a Japanese toll tunnel that opened 1998. It is the longest mountainous tunnel of Japanese National Route. The serious accident still has not occurred since the inauguration because of thorough safety operation and management. On the observational visit, the director of the Karisaka Tunnel Office provided the detailed explanation about the operation and management system and related devices. The knowledge obtained through this visit is expected to contribute the prevention of the accident in a tunnel.

Characteristic other structures

Observational visit was implemented at other characteristic structures. These structures are not tunnels, but there are suitable examples to experience the Japanese technology for road construction.

・Ōhashi Junction (Tokyo)

Ōhashi Junction is the reinforced concrete structure which connects the underground tunnel and elevated road. This structure applies the unique design, a tunnel with the shape of quadruple loop bridge To reduce the impact on the surrounding environment, such as air pollution and noise pollution, the ground area is covered by wall (Tunnel).

Port of Tokyo Connector Bridge (*Rainbow Bridge*, Tokyo)

Port of Tokyo Connector Bridge, known as *Rainbow Bridge*, is composed of the suspension bridge and both approach sides. One side of approach section is constructed with a loop bridge to secure the height for ship crossing under the bridge. Thus, the length of the loop bridge reaches more than 1,000m.

Tokyo Bay Aqualine (Tokyo and Chiba Prefecture)

The Tokyo Bay Aqualine, is a 15.1 km marine crossing through the middle of Tokyo Bay connecting Kawasaki City in Kanagawa Prefecture with Kisarazu City in Chiba Prefecture. The Aqualine consists of a 9.5-km shield tunnel (the Tokyo Bay Tunnel) and a 4.4-km bridge from an artificial island to the Kisarazu landing. The tunnel diameter is the world's largest for an underwater shield tunnel used for motor vehicle traffic.

Saitama Raiden Todoroki Bridge (Saitama Pref.)

Saitama Raiden Todoroki Bridge is constructed as a divided road, prior to the construction of Takizawa Dam. This bridge is composed of three sections, such as, Otaki bridge section, Todoroki bridge section, and the intermediate section (curving section). These structures are connected by solving the height difference about 125m.

ANNEX-11

Study Team Member List

Data Collection Survey on Thankot Area Road Improvement in Nepal

List of JICA Study Team MemberS

Name:	**YAJIMA Hiroshi**
Company:	TONICHI ENGINERRING CONSULTANTS, INC.
Assignment	Team Leader / Alignment Planning 1 (Structure) / Transportation Planning
Name:	**SHRESTHA Robinson**
Company:	CTI Engineering International Co., Ltd.
Assignment	Subleader / Alignment Planning 2 (Road) / Road Planning
Name:	**MORI Shinsuke**
Company:	CTI Engineering International Co., Ltd.
Assignment	Tunnel Planning
Name:	**NAKAJIMA Fumiki**
Company:	CTI Engineering International Co., Ltd.
Assignment	Geology / Slope Stabilization
Name:	**IDE Kakiko**
Company:	CTI Engineering International Co., Ltd. (POLYTECH ADD)
Assignment	Environmental and Social Consideration
Name:	**CHIBA Nobuyuki**
Company:	TONICHI ENGINERRING CONSULTANTS, INC. (TOSTEMS, INC)
Assignment	Hydrological Survey / Recommissioning