

## ABSTRACT

It is proposed to construct 12.7 km section of motorable road from Lohali to Thuwathok, Block - Betalghat, Dist. Nainital, by Public Works Department. It was required as per the work order to conduct a detailed geological investigation along the proposed alternative alignments to select the best alignment on the basis of the said investigation. The aim of geological investigation is to collect suitable data and information regarding general topography and geology of the area including type of rock formation along the alignment. The location and direction of faults and joints if any, have also been recorded. On the basis of the data collected from the site, best alignment has been selected considering the stability as the prime requirement. While selecting the alignment, it has been kept in mind that ecological and environmental balance is not caused in the concerned area during the construction of the road and even afterwards when the road becomes operational. Necessary precautions to be taken along with some suggestions have also been mentioned so as to facilitate the construction of motorable road on this part of the nation.

## LOCATION

1. This road alignment starts from km 8 of existing Khama - Lohali motor road.
2. As per Survey of India, Station 5000, Thuwathok is situated at  $25^{\circ} 30' 51''$  and  $78^{\circ} 24' 21''$ .

# Geological Investigation Report

## GENERAL GEOLOGY AND TOPOGRAPHY:

### REGIONAL GEOLOGY AND STRUCTURE OF THE HIMALAYAS:

The geological formation in Himalayas takes sharp turn forming hair pin bends at the Eastern and Western extremities of the arc and continue Southwards into Burma and Baluchistan arcs respectively. These two points of acute inflexion constitute the major structural bands in the Himalayas.

The Lesser Himalayas are composed of tectonically compressed blocks of Palaeozoic and Mesozoic crystalline, metamorphic and sedimentary rocks. The main central thrust is a major tectonic feature of the Himalayas and has brought the crystalline rocks of higher Himalayas over the younger Sedimentaries.

The higher Himalayas consists of a single range with an average height exceeding 5,000m. The bulk of this range, mostly composed of Granite and Gneiss, is older. The central crystalline groups the core of the axis of the range and are considered as primary intrusive accompanying the tectonostructural movements responsible for the uplift of the Himalayas.

### THE KUMAON HIMALAYAS

The Kumaon Himalayas lies between the Yamuna to the East and Satluj River in the West.

**Geological Investigation Report of 12.7 km long road alignment from Lohali to Thuwa, Block - Betalghat, Dist. Nainital.**



**ABSTRACT:**

It is proposed to construct 13 km section of motorable road from Lohali to Thuwablock, block- Betalghat, Dist. Nainital, by Public Works Department. It was required as per the work order to conduct a detailed geological investigation along the proposed alternative alignments to select the best alignment on the basis of the said investigation. The aim of geological investigation is to collect suitable data and information regarding general topography and geography of the area including type of rock formation along the alignment. The location and direction of faults and joints if any, have also been recorded. On the basis of the data collected from the site, best alignment has been selected considering the stability as the prime requirement. While selecting the alignment, it has been kept in mind that ecological and environmental imbalance is not caused in the concerned area during the construction of the road and even afterwards when the road becomes operational. Necessary precautions to be taken along with some suggestions have also been mentioned so as to facilitate the construction of motorable road on this part of the nation.

**LOCATION:**

1. This road alignment starts from km 8 of existing Khairna - Lohali motor road.
2. As per Survey of India records, Gram Sabha Thuwablock is situated at  $N29^{\circ} 29' 51''$ , and E  $79^{\circ} 29' 21''$ .

**GENERAL GEOLOGY AND TOPOGRAPHY:****REGIONAL GEOLOGY AND STRUCTURE OF THE HIMALAYAS:**

The geological formation in Himalayas takes sharp turn forming hair pin bends at the Eastern and Western extremities of the arc; and continue Southwards into Burmese and Baluchistan arcs respectively. These two points of acute inflexion constitute the major syntaxial bends in the Himalayas.

The Lesser Himalayas are composed of tectonically compressed blocks of Paleozoic and Mesozoic crystallines, metamorphic and sedimentary rocks. The main central thrust is a major tectonic feature of the Himalayas and has brought the crystalline rocks of Higher Himalayas over the younger Sedimentaries.

The Higher Himalayas consists of a single range with an average height exceeding 6,000m. The width of this zone, mostly composed of Granite and Gneisses, is 24km. The central crystalline occupy the core of the axis of the range and are considered as tertiary intrusive accompanying the compressional movements responsible for the uplift of the Himalayas.

**THE KUMAON HIMALAYAS**

The Kumaon Himalayas lying between the Kali river in the East and Sutlej River in the West include a 320 km stretch of mountaneous terrain.





The Lesser Kumaon Himalayas include a Thrust – Bound sector delineated by the tectonic planes - the main boundary fault of the South and the Main Central Thrust to the North. There are two elongate tectonic belts of Sedimentary/meta – sedimentary rocks separated by an ESE – WNW trending Almora – Dudhatoli crystalline zone. The outer sedimentary belt of the South of the crystalline mass is the Krol Belt while the inner Sedimentary Belt to the North constitutes the Deoban – Tejam zone of the Jaunsar – Berinag nappe.

### Inner Sedimentary Belt

This extends from Garhwal region in the west to beyond Kali river making the Eastern boundary of the Kumaon Himalayas. The oldest rock unit of this belt is termed as the Hasthila Formation. This formation is created with Rautgara Quartzite and Rameshwar formation.

The topmost horizon of the inner sedimentary belt is the Berinag formation. The lithology consists of fine to coarse grained massive quartzite, often sericitic and schistose with pebble beds, chlorite beds and interbedded metabasites.

The inner sedimentary belt has been folded into a few E – W to ESE – WNW trending folds. At places, there is a strong evidence of thrusting and dislocation by a number of faults.

### Outer Sedimentary Belt

Delineated in the South by MBF (= Krol Thrust) and in North by the Ramgarh Thrust, the outer sedimentary belt rests conformably over the inner sedimentary belt. Hence, the inner sedimentary belt is considered youngest between the two.

The stratigraphic unit forming the base of the outer sedimentary belt is Nagthat formation, which appears to correlate well with the Berinag formation. It consists of the conglomeratic and pebbly protoquartzites, Shales, slates and basic rocks.

Overlying the Nagthat is the Blaini formation which consists of two typical types of rocks: one is the boulder beds, the other the lime stones overlying the former.

### GEOLOGY OF NAINITAL

The geology of Nainital is extremely complex characterised by landslide scarps and fans, and debris cover mostly associated with the Nainital fault that separates lakes and watershed into two roughly equal parts. The watershed includes three lithostratigraphic units of Karol Napp. The geomorphological features are many and include tectonic scarps with 25-100m heights, landslide scars, landslide fans and debris cover. Scarps are mostly associated with the Nainital fault. Lithology generally consists of Shales, Marls Limestones, Dolomites and Sandstones.

Bhimtal falls in Himalayan foothill zone. This zone runs in NW – SE direction with a maximum elevation of 1677m above msl. The lower Shiwaliks are truncated forwards to



South by major/minor structural discontinuities. The slopes are relatively moderate with flat topped hills. This zone can be classified into Lower Shiwaliks, Middle Shiwaliks and Upper Shiwaliks.

Lower Shiwaliks – these are characterised by hard massive, grey to brownish grey sandstones interbedded with grey to maroon clays. They form the outermost zone in the Nainital Himalayas and occasionally exhibit local structural discontinuities. The dip is usually northwards.

Middle Shiwaliks – middle Shiwaliks are characterised by massive light grey micaceous sandstones. They exhibit sporadic patterns of cementations at different stratigraphic intervals.

Upper Shiwaliks – the upper Shiwaliks are constituted of pebbles, cobbles, boulders, conglomerate and clay lenses. The pebbles and boulders are mainly Quartzitic.

Table: Stratigraphy of Nainital

AGE	FORMATION	LITHOLOGY
Quaternary	Alluvium	Clay, calcareous concretion, silt, sand, gravel, boulders etc.
Miocene to Pliocene	Sedimentaries	Sandstone, claystone, conglomerate, boulder beds etc.
Unclassified Mesozoic, Paleozoic and Upper Proterozoic	Sedimentaries and meta – sedimentaries	Shale, quartzite, slate, phyllite, sandstone, dolomite, limestone
Lower Proterozoic, Azoic	Crystalline and meta- sedimentaries	Gneisses complex and associated intrusives

### GENERAL TOPOGRAPHY:

The area where road is to be constructed is hilly. It falls under Kumaon range of Himalayas. Average height of the area is 1500 m above msl with maximum as 1850m and minimum as 1150m above msl. The alignment starts at about 1180m and ends at about 1840m above msl. The general hill slope ranges from  $35^{\circ}$  to  $75^{\circ}$ . Area is drained by number of nallahs which fall into big nallah which ultimately falls into River Kosi.

Nainital falls in seismic zone V which is considered as high risk zone. The young and rising Himalayan ranges are highly vulnerable to landslides and erosion. On hills slopping above  $45^{\circ}$ , rock fall is quite common.





**GEOLOGICAL STATE:**

This road alignment is spread over quartzite formation of Kumaun Himalayas. Quartzite rocks are clearly visible at site having layer of soil of varying thickness over them. These rocks have joints of three types with a direction of E and SW. There is also a layer of debris and soil over the rocks. The study of rocks exhibits that rocks are of sedimentary type with medium to high hardness.

Sequential Geological tectonic formation at the site under consideration is represented as follows:

Layer of soil

Debris (E&B)

Gneiss

Schist

Quartzite

The hill slope ranges from normal to medium in W-Eastern direction all along the alignment.

**STABILITY CONSIDERATIONS:**

Stability is the prime consideration while proposing and designing a hilly road due to tough weather conditions almost during the entire span of a year, sometimes due to rains and sometimes due to snow. On the basis of the finally selected and approved alignment, it is necessary to give due considerations to following points regarding construction of motorable road, keeping topographical, geological, ecological, seismic and environmental aspects in mind:

1. The site is in hilly terrain.
2. The area falls in the seismic zone V.
3. There are many villages situated all along the alignment.
4. Many dry nallahs are crossed by the alignment.
5. Alignment is crossing major nallah at Km 2.215.
6. Ecology and environment of the area should be kept in mind while construction of the road.
7. Most of the alignment falls in cultivated land.
8. One primary school and two inter colleges are situated along the alignment.
9. Few numbers of temples are also located along the alignment.
10. Slope of hill ranges from normal to medium.

**SUGGESTIONS:**

Keeping geological, seismic and ecological constraints in mind, and to ensure overall stability of the constructed road in particular and the concerned area in general, following suggestions are made for the construction of the proposed motorable road:

1. A drain should be constructed by the side of the hill all along the road in cutting.
2. Breast/retaining wall should be constructed as per shape of the rock and site requirement.

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3. Scrupper/double scupper /culvert/causeway should be constructed at the location of dry nallahs.
4. Outer edge of the road should be kept higher than the inner one at the locations of debris/mud, so that water does not cross the road during rainy season and road remains safe for driving.
5. Road should be constructed keeping ecology and environment in to consideration.
6. Use of Explosives should be avoided near villages.
7. Provisions should be made as per specifications set for construction of motorable road in hilly terrain.
8. Suitable provisions should be made for earthquake.
9. Other provisions as found necessary should be made.

#### CONCLUSION

Keeping the points discussed above into consideration, it seems advisable and feasible to construct a motorable road in this area along the proposed alignment.

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परियोजना का नाम :- जिला नैनीताल में प्रधान मंत्री ग्राम सड़क योजना के अन्तर्गत लोहाली से धुआब्लाक मोटर मार्ग निर्माण किमी 0 9.900

भू-वैज्ञानिक की संस्तुतियों/सुझावों का अनुपालन किये जाने का प्रमाण-पत्र

प्रमाणित किया जाता है कि विषयगत परियोजना के निर्माण हेतु भू-वैज्ञानिक द्वारा दिये गये सुझावों/संस्तुतियों का अनुपालन सुनिश्चित किया जायेगा।

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