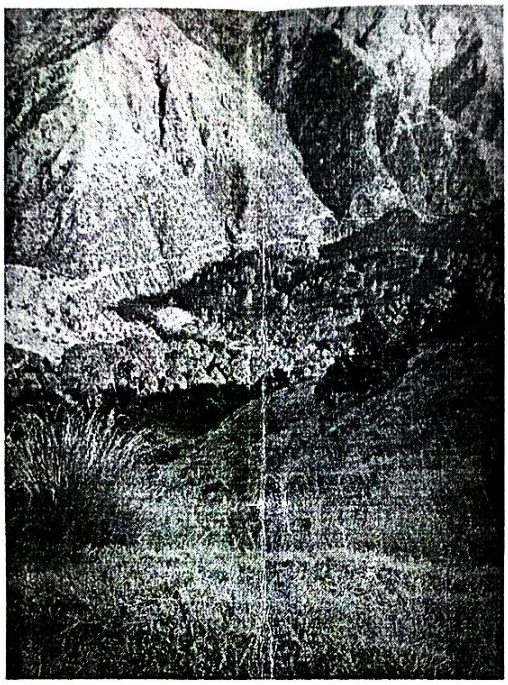
GEOLOGICAL FEASIBILITY REPORT



Of Proposed Village Road, Falling in Chopal Division of Shimla District, Himachal Pradesh

The Executive Engineer, Chopal Division (B&R), HPPWD, Rampur vide letter no. PW.CHD.CB.FCA-Kufar Kanda/2021-12047 on dated 18/11/2021, requested the State Geologist Himachal Pradesh to provide the geological feasibility reports of the areas falling in the alignment of

1. C/o Kufar to Kanda Road Km 0/0 to 4/0

In the view of above, the State Geologist Himachal Pradesh deputed the undersigned to inspect the area and submit the report. The area under question was inspected by the undersigned on dated 22nd December 2021 and the following report has been prepared as follow:

Geological Feasibility Report

OF PROPOSED VILLAGE ROAD, FALLING IN CHOPAL DIVISION OF SHIMLA DISTRICT, HIMACHAL PRADESH

1. Location of the Area: -

The Kufar to Kanda Road which is about 4 kilometers in length originates near at Kima Chandrauli (Kufar) and is about 23 Kilometers from Nerwa 11 kilometers form Banipul and passing the proposed culverts over Makhranli Nalaha and Aar Nalaha having spatial location of origin at latitude 30°51'48.61"N and longitude 77°42'34.06"E.The alignment area encompasses highly dissected hills of Higher Himalayas with deep valleys and high mountainous peaks. The said road covers the villages Kima Chandauli, Aar and Kanda and having 1 number of Horse Shoe turn. The road runs along the hill slope to an elevation of 1771 meters from 1627 meters. Following is the location map of the road: -

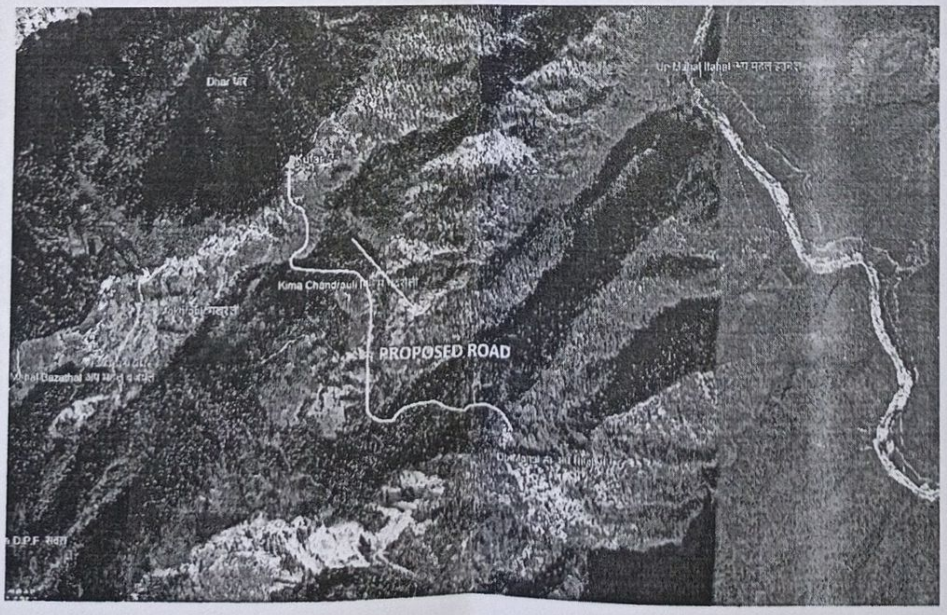


FIGURE 1 PROPOSED ROAD (COURTESY GOOGLE EARTH)

Observations: -

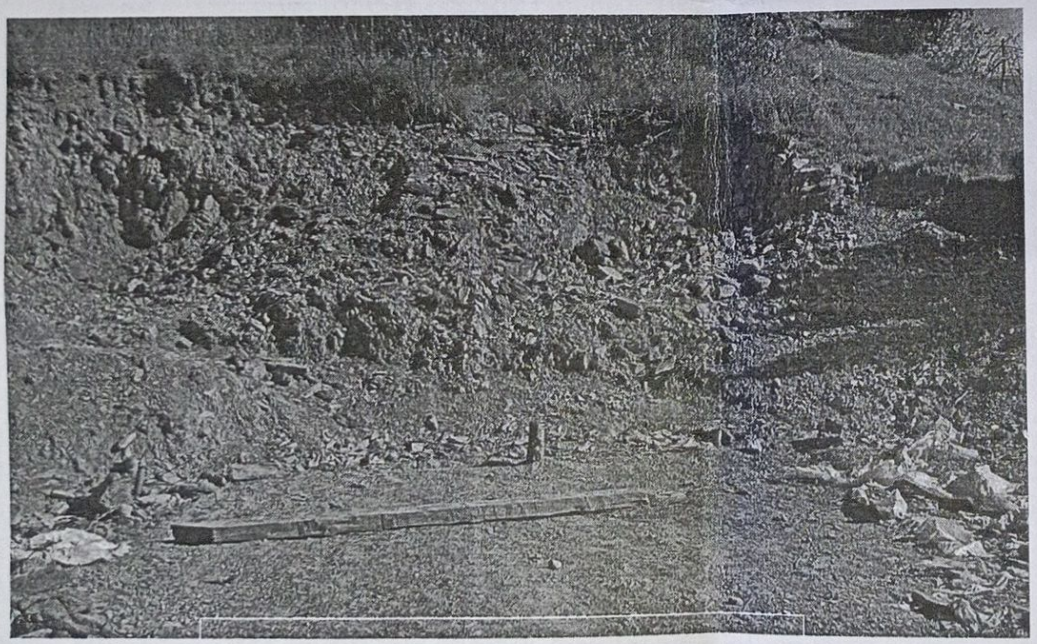
During the geological inspection of the alignment area of the said road the undersigned was accompanied by Smt. Reena Sharma, Ward member 3 kanda and other locals of the locale. However, no HPPDW Member was present during the course of inspection. The entire track of alignment was followed and following observations were made: -

1. The alignment of road encompasses 4 kilometers length and 7-meter width with one horse shoe turns andtwo proposed culverts over Makhranli Nalaha and Aar Nalaha. These both nalahas are rain fed, therefore, based on the rainfall data of the area, the foundations of culverts need on strong stratum. The same is visible during the course of inspection.
2. The alignment is mostly in the forest land with partly private lands and the NOC from the private land owners has to be obtain for fair construction of the road. The forest is mostly coniferous with little local shrubs and scrubs.
3. The alignment area encompasses various geologically week shear zones especially on the south eastern and south-western part of the hills and having chances of land sliding or rock toppling because of freezing and thawing effects after toe cuttings. The slope under reference is dissected by the two nalahas which are mostly seasonal. Further, the problem of cloud bursts is also observed in the area.
4. The rocks in the area are mostly of shale with upper most horizon of weathered rock blanket. The regional attitude of strata in the area is as follows:

Strike S50°E to N50°W Dip N70°E with dip angle 38-40°

The images of the strata in the above said area are shown below: -

Exposed Shaleobserved during the course of inspection



Exposed Shale at the very beginning of the road

2. Geology of the Area

The regional geological succession of the area is shown below in the table

Era	***Period***	***Formation***	***Litho logy***
Quaternary	**Recent**	**Alluvium**	**Sand with pebble and clay, medium to coarse grained sand with pebble of sandstone and lenses of clay**
Proterozoic	**Neoproterozoic**	**Simla group**	**Siltstone, greywacke, sandstone, quartzite, conglomerate, Shale, slate, Phyllite, dolomite and meta-volcanics**
		Kullu group	**Schist, quartzite, banded gneiss, carbonaceous slate, limestone etc.**
		Rampur group	**Phyllite, schist, quartzite, dolomite, and basic flows**
		Jutogh	**Shale, phyllite, schist, staurolite quartzite, dolomite, Limestone, and amphibolites**
	Mesoproterozoic	**Vaikrita Group**	**Biotite schist with kyanite, gneiss and migmatite**
	Palaeoproterozoic	**Granite of Himalayas**	**Granites**

The inspected areas mainly occupy NeoproterozoicJutogh and Rampur Group.

The local geology of the area occupies the Rampur and Jutogh Group. The former group presents an association of metabasalts and metasediments dominated by clastics. It tectonically transgresses over the younger Larji Group of platformal type carbonate rocks along a major thrust. The Rampur group is divisible in three formations vis. Bhallan Formation, Banjar Formation and Manikaran Formation.

a) *Bhallan formation*

This Formation mainly composed of slates, greenish phyllites schists with interbeds of white flaggy quartzarenite.

b) *Banjar Formation*

This Formation mainly occupies matabasalts as green phyllites and interbeds of white massive quartzite and grey phyllites.

c) *Manikaran Formation*

It is top most unit of Rampur Group comprising dominantly of quartz arenites. It is very conspicuous litho-stratigraphic unit with grey and white massive quartzarenite having a great areal extent from Parvati Valley in the north to Rampur in the south and beyond a

narrow zone towards Karcham in the east. The quartzarenite being a thick resistant rock type forms high ridges and peaks along escarpments and constitutes prominent topographical features in the eastern part of larji-Rampur window zone. The area is prominently marked with the out crop of grey and white quartzarenite.

The latter Group,the Jutogh Group occur as a regional thrust sheet, separated by erosion in two belts viz. the Simla Klippe and the Chaur Mountain Belt. The latter extends up to the Pabbar Valley and beyond to the Satluj Valley. The Jutogh Group is divisible into 11 formations, which in ascending order are (i) Panjerli, (ii) Manal, (iii) Bhotli, (iv) Khirki, (v) Taradevi, (vi) Kanda, (vii) Naura, (viii) Badrol, (ix) Rohru, (x) Chirgaon, and (xi) Jaknoti. The Panjerli Formation is mainly carbonaceous schist with limestone and quartzite bands. The Manal, Khirki, Kanda, Badrol and Chirgaon are mainly quartzitic sequences with local schist bands, while the Bhotli, Taradevi, Naura, Rohru and Jaknoti chiefly comprise Shale, Phyllite schist, selectively carbonaceous, with limestone/marble, quartzite and gneiss bands. The Chaur and Kainchwa Granitoid complexes occur within the Naura Formation. The Jutogh Group is succeeded by the Vaikrita Group along a thrust. Only one formation (Sundru) of the Vaikrita Group-- a mixture of quartzite and schist with gneissic bands is exposed in the area. The Pabbar Granitoid Complex is associated with the Sundru Formation. The metamorphism in the Jutogh and the Vaikrita rocks varies from low grade to medium-high grade. The greenschist facies is displayed by the Panjerli and Manal formations. The Bhotli and Taradevi formations where occur at the sole of the Jutogh Thrust Sheet (JTS) due to recumbency also display greenschist facies. Greenschist-amphibolite transitional facies is reflected in the Bhotli, Khirki, and parts of the Taradevi and Badrol formations. Typical amphibolite facies is observed in parts of the Taradevi, Kanda, Naura, Rohru, Chirgaon, Jaknoti and Sundru formations. Amphibolite-Granulite Transition Facies is locally present in the Naura and Sundru formations and the associated coarse granitoid gneisses. Xenoliths of the Naura schist are present in the non-foliated granite. The rocks of the Vaikrita Group are quite similar to those of the Jutogh Group and these may represent a deeper digitation of the JTS. The Jutogh rocks bounded by the synformally folded Jutogh Thrust represent the most southerly transgressed thrust sheet in the Western Himalaya. Five generations of fold have been reported in the Jutogh rocks. The first two folds (reclined/recumbent) are

oriented in E-W direction. These being athwart the structural trend in the Western Himalaya are possibly of pre-Himalayan age. The third (reclined/recumbent, syn-transport) and fourth (mostly upright to overturned) folds have a NW-SE trend. The fourth NW-SE folds are of regional dimension and have determined the trend of the structural belts and even that of the orographic axes. The fifth-generation folds are NE-SWtrending cross- folds. High-angled faults having affected all the folds constitute the last tectonic event in the area.

3. Recommendations: -

Keeping in the view, the geology and environmental conditions in the area under question, the alignment of the above said road is good for the construction. Further, based on our survey on the site mentioned above, the main causes of deterioration of this mountain road are roadside vegetation, cracks, landslides, avalanches, water logging, potholes, and freezing and thawing effects etc. Cracks in roads develop due to overloading, seepage, improper or poor road surface drainage, lack of proper road maintenance, lack of proper design, adverse climatic conditions and geological factors. Landslide is a geological phenomenon which includes a wide range of ground movements, such as rockfalls, deep failure of slopes and shallow debris flows. Waterlogging is caused due to inadequate capacity of drainage facilities to withstand storms and heavy rainfall while the potholes are depressions in roadways that can range from a few inches wide and a few inches deep, to several feet wide and sometimes a foot deep. Potholes jar the tires of cars driving over them sometimes causing handling and suspension problems. Such problems should be properly monitored and controlled along with following recommendation during construction:

1. The geology of the area includes various shear zones along with weathered and jointed rocks along the alignments of the proposed roads. These week zones must be strengthened with proper geo-engineering methods before paving the roads.

Further, the overhanging week parts must be removed to mitigate the rock toppling and accidents. In said road alignment, the most of the land encompasses shale and phyllites which must be properly vibrated or strengthened properly before paving the road.

2. It is noted that roads proposed are mostly by cut and fill method, during such method steep cutting must be avoided and filing zones must be guarded with proper breast/step walls having complete required engineering parameters. Further, the step/breast walls must be reinforced with the plants and bushes to keep aesthetic view and durability of land as well.

3. The rain water drains must be constructed properly along the hill slope to keep a check on water logging and stagnancy in the alignment area and un-obstructed flow of rain and stream water if any to the nearby gullies.

4. The above said areas falls under the 'earthquake IV zone', therefore, keeping in view the severity of the earthquakes in the area, safety factors must be in accordance.

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