Chapter - V

GEOMORPHOLOGY AND URBAN ACTIVITIES

A. INTRODUCTION

The location of settlements and their internal structure are often influenced to a considerable degree by their terrain configuration. This is particularly clear in the case of a hilly urban settlement like Darjiling. The construction of a town creates a new landscape, which involves a massive modification of the circulation of energy in the form of water and materials. The foundation of the buildings and roads, the cliff-faced slabs and elongated plains of the town have to be designed to be stable on the rocks and soils beneath them. Thus, the site of a town may be due to a combination of landscape factors (Chandler, 1976; Douglas, 1983; Legget, 1973 and Coates, 1974).

The evolution and development of Darjiling began as a British Colonial town over 150 years ago, to serve certain special functions, i.e. as a hill resort for the British Indian Army personal and for British Civil Officers. The site was selected by J.W. Grant in 1835 along the ridge from Ghum to Birch Hill, upto Lebong spur. The saddle of Jalapahar-Birch Hills was the nucleii of urban development throughout its history. Geomorphologically, these areas are ideally suited for such a development, atleast from the point of view of slope stability and gradient. However, with the increase in population the urban centre grew, as a result more and more of the less suitable hill-slopes were occupied and finally the urban expansion even took place along the susceptible slopes. Today a lot of residential, commercial or even governmental buildings are being constructed on such slip zones.

1. Aims :

The aim of this study is to examine (a) the geomorphic limitations of urban development, (b) the landforms that are modified by urban development; (c) the landforms that are created by urban activities. The investigator has tried to reconstruct the pre-urban landform and its modification through urbanization.

2. Methods :

To investigate the above mentioned objectives, the methodology adopted in the present study are as follows :

i) A brief survey of the evolution of the urban centre along with the site selection for the different important public utility buildings. This has been done mainly based on the existing published documents and other sources.

ii) The geomorphic limitations of urban development in Darjiling town has been examined based on the extensive field work, and is based on the model developed by Douglas (1980).

iii) The investigator has tried to reconstruct the pre-urban/ pre-modified landscape of Darjiling town, based on the extensive field survey - large scale contouring, the reconstruction of levelled grounds, terraced slopes etc.

iv) Old published maps, particularly that of the Survey of India and Municipality and various other documents have also been consulted for the estimation of the extent of man-made landforms of the study area.

v) Landform of accumulation and the landform of removal have also been studied based on the extensive field survey.

vi) Finally, in order to apprehend the consequences of such man-made

landforms, the investigator has selected two case studies for landforms of accumulation and removal, during the development of urban centre.

B. GEOMORPHIC LIMITATIONS OF URBAN DEVELOPMENT

The question of suitability of any piece of urban land for any specific development may be determined by a variety of landforms and soil characteristics. (Douglas, 1983). In the urban centre of Darjiling town, the steepness and stability of the hill-slopes may be regarded as the most important geomorphic limiting factors for the urban development. Nature of parent materials, legacies from the past as well as the level of human interference seem to be the important limitations. Such limitations may be overcome by using the appropriate engineering techniques. However, if the limitations are not recognised before construction commences, the new structure may later be damaged or even destroyed, with great costs to the occupants, land-owners, neighbouring properties and the community at large. For proper recognition of foundation sites and soil limitations these ought to be a vital part of urban planning as a natural component of the urbanisation processes.

Some of the major geomorphic limitations on urban land-uses in Darjiling town has been tabulated in the following Table (5.1) :

From the analysis in table-5.lit has been revealed that among the various geomorphic limitations, the following are more important.

Table No. 5.1

Geomorphic Limitations On Urban Land-Use In Darjiling Town

		COMMUNITY DEVELOPMENT							SANITARY FACILITIES			TRANSPORT			RECREATIONAL				
		Residential	Commercial Buildings	Multi-storied Buildings	Hospital	Schools and Community Centres	Local roads & streets	Shallow excavation	Septic tanks	Sanitary way	Sanitary land fill	Railways	High ways	Minor roads and lanes	Play grounds	Camping ground	Picnic areas	Parks and trails	Recreational lodges
LANDFORM AND SOIL FACTORS — Climate induced processes	Rain-erosion risk	x	x	x	x	x	x		o	o		o	o	o	o	o	x	x	o
	Forest action								o			x							
	Snow fall																		
Stability Factors	Earthquake risk	o	o	o	o	o	o	x	o	o	o	o	o	o		x			x
	Landslide risk	o	o	o	o	o	o	x	o	o	o	o	o	o		x			o
	Subsidence risk	x			x		x	o	x	x	x	o	x	x	x	x			
	Creeps risk	x					x	o	x	x	x	o	x	x					x
Landform Characteristics	Slope angle	o	o	o	o	o	x	o	o			o	o	o	o	x	x		
	Contour curvature	x	x	x	o	x	o	x			o	o	o	o	x	x	x		
	Drainage density		x	x	x	x	x					x	x						
	Slope length									o		o	o	o	x	x			x
Soil Characteristics	Depth of bed rock	x	o	o	o		x		o			x	x	x	x				
	Texture						o												
	Present of stone						o		o						x	x		x	
	Permeability								o	o	o	x	x	x	x	x	x	x	x
	Org. matter content														x	x	x		x

o Major, x Minor

SAFE ZONE MAP OF DARJILING TOWN

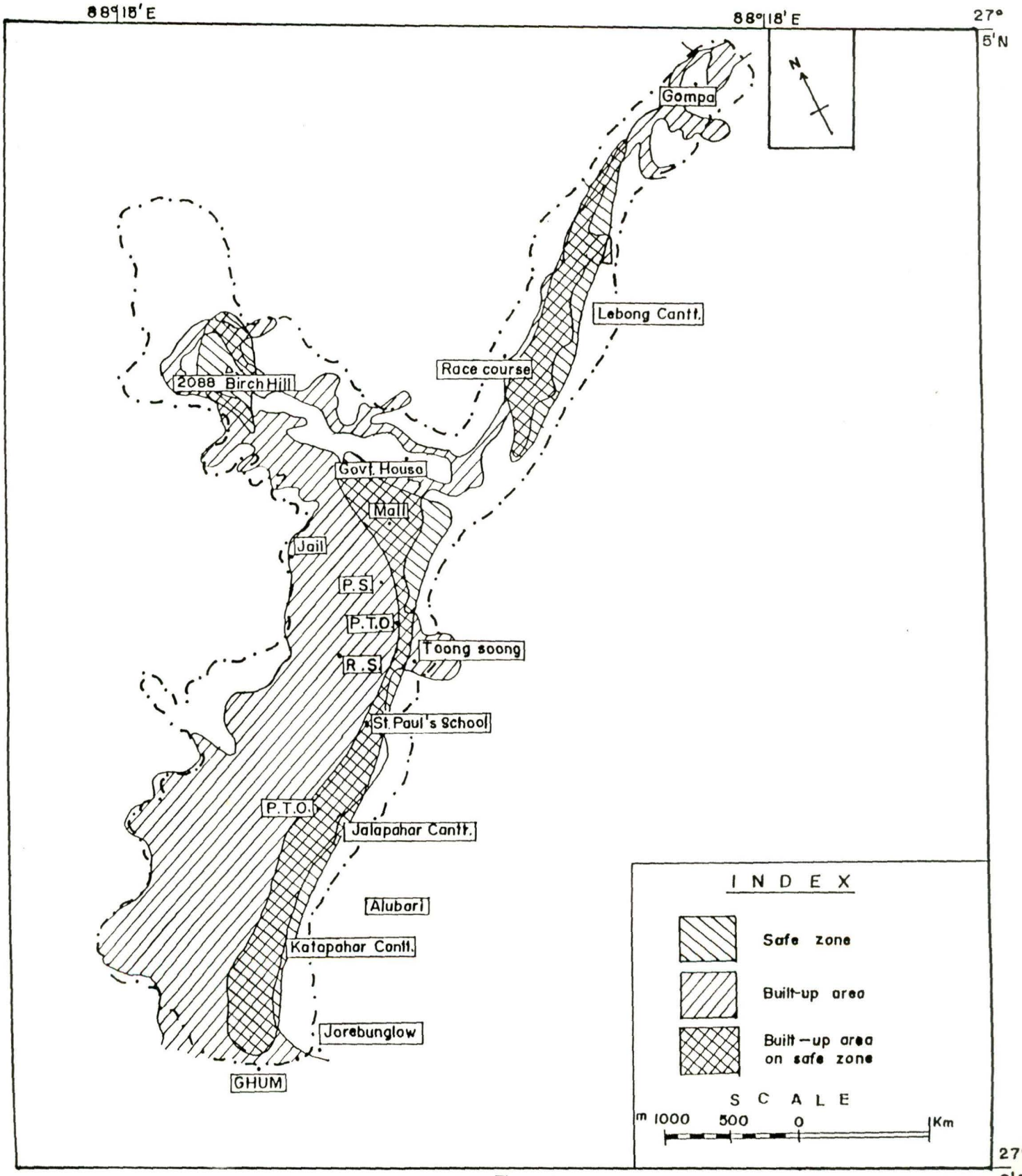

Fig-5.1

1. Slope stability vis-a-vis landslips :

Occasional changes in hill slopes can cause serious problem for any town (Chandler, 1976). Darjiling's most threatening problem today is the acuteness of slope failure and in fact, it has almost threatened its very existence. Table 5.2 and Fig.4.2 show the occurrences of various changes in slope due to mass-movements, its nature, process and effect during the last hundred years.

Water-assisted flow occur naturally when masses of rock debris are loosened by extremely intense rainstorms. However, some slopes may be so inherently unstable that when urban development changes the pattern of infiltration over the surface of the slope, by paving some areas and interrupting the run-off of water on to the other, increases the sheer stress so much so that water-assisted flows occur (Leighton, 1974).

The present investigator has carefully examined one specific case of the direct consequence of a man-induced landslip. On September 1980, landslip activity, developed on a 13 m high terrace slope near Victoria Falls (Fig.6.6). Later on people came to settle on them and have houses built on several terraces fashioned on it. Thus the slope became over steepened and congested and large volumes of steam-water discharge over it which has induced landslips since 1989. The dislodged materials form large bulges at the toe of the slope, virtually obliterating some of the artificial cuts. High concentration of seepage water into the soils of terraces and the disturbances of the slope by construction activity jointly contributed to such slips. (Photo 5.1) A similar case of man induced landslide has been found near Glenry's Restaurant on Nehru Rd. Here

5.1

Building of houses on terraced slopes following cut-and- fill process.

5.2

Extension of Bell-View Hotel disregarding the landslip scar at the back.

Table 5.2

Characteristics of Major landslips in Darjiling Town (1899-1993)

Year	Type of movement	Rate of movement	Characteristics of deposites and associated landforms	Remarks (loss of life and property)
1899	Torrential mud cascades	$1000m/hr^{-1}$	Surge of soil and rock debris in a water stream down a narrow pathway producing a large lobe of debris at the end of the flow. Large blocks carried among ill-sorted material.	72 lives lost within the town. The value of property destroyed amounted to lakhs of rupees. The precipitous eastern slope from Toongsoong busty to Observatory Hill experienced a series of devastating landslips. Most of the houses were destroyed.
	Debris slide	Rapid, but involving different quantities of materials from single rock particles to whole mountain sides.	Rolling of sliding of material parallel to the slope. Innumerable scars developed in and around the town and in the near by tea gardens.	
1934	Debris slide	Rapid movement of slope materials.	Slide materials rolled down the slope and were deposited along the suitable places and thereby formed small terraces.	No less of life, but severe damage of buildings viz. Burdwan Maharaja' palace, Govt. School, Governor's House and Jalapahar & Lebong cantonment.
1950	Torrential mud-cascades	$1000m/hr^{-1}$	Surge of soil and rock debris in a water stream down a narrow pathway producing a large lobe of debris at the end of the flow. Large blocks carried among ill-sorted materials.	Heavy loss of life and property. The loss of life in the Sadar sub-division was reported to be 100. The slips breached the main arterial roads and the

Year	Type of movement	Rate of movement	Characteristics of deposites and associated landforms	Remarks (loss of life and property)
	Debris slide	Rapid, but involving different quantities material from single rock particles to whole mountain sides.	Rolling or sliding of material parallel to the slopes. Innumerable scars developed in and around the town and in the nearby tea gardens.	town was cut-off for about five days from the outside world. Large portions of Darjiling-Siliguri railway line was washed away. Total stoppage of water and electricity.
	Slumps	Variable	Slumping of surface often producing depression and terrace like topography.	
1968	Debris slide	Rapid	Slide materials rush down-slope producing scar and lobe of debris.	Hill Cart Rd. was blocked at 18 different points with heavy loss of life and property within the town.
	Slumps	Variable	Small depressions and terraces were formed.	
1980	Torrential mud-cascades	$1000m/hr^{-1}$	Surge of soil and rock debris along the channels producing a lobe of debris at the break of slope.	Heavy loss of lives, damage of dwelling houses and disruption of communication. Large scale damage of water supply, electricity, agricultural fields & Tea gardens.
	Debris slide	Rapid movement of slope material.	Rapid movement of slope materials producing innumerable scars along the hill slopes.	
	Slumps	Variable	Slumping of road segments and constructed sites were very common.	
1991	Debris slide	Rapid movement of materials, small-scale phenomena mainly triggered by unscientific human interference.	Rapid movement of slope materials mainly displaced in and around the Batasia area and along the different road segments of Darjiling town, producing small scars and lobes.	Loss of life and property. Damaging the water pipes especially around Toongsoong, Manpari busty, Singamari and Mary villa.

a slope covered with Cryptomaria Japonica had been cleared in 1980 for the extension of the Bell-View Hotel. As the soil below such vegetation is always acidic, with the completion of the ground floor of the Hotel building during monsoon with a rainfall of 50 mm within 24 hrs, the whole slope together with the building collapsed on the 25th August 1980 (Photo 5.2) (Fig. 5.2).

These direct consequences of urban activity have contourparts in all environments. Mass-movement is a natural phenomena that can not be halted everywhere by expensive engineering works. Some structures can be permitted on potentially unstable ground if foundations are designed properly, others would only aggravate the problems (S.O.C.L, 1971; Swain, 1959; 60 and Wayne, 1968). Careful evoluation of ground conditions and assessment of the relative risks and the cost of their avoidance are necessary whenever urban construction is planned on unstable ground.

2. Steepness and length of Hill slopes :

This is perhaps the fundamental limiting factor in the urban development, because most of the other limitations stem from this (Swain, 1959-60). The average slope of this urban centre is 25-30°, while, the gentle slope has been encountered along the ridges of Jalapahar-Birch Hills (3-10°) while, the steepest part have a gradient varying from 35-45°. The average length of the slope is also very large which vary from 500 to 1200 m. (Fig.2.2).

Except the narrow tracts along the Ghum-Jalapahar-Birch Hill-Lebong ridges and the Jalapahar-Birch Hill saddle, the rest of the town have a moderate to severe limitations for urban growth (Fig.5.1).

LANDFORMS OF ACCUMULATION AND REMOVAL IN AND AROUND DARJILING TOWN

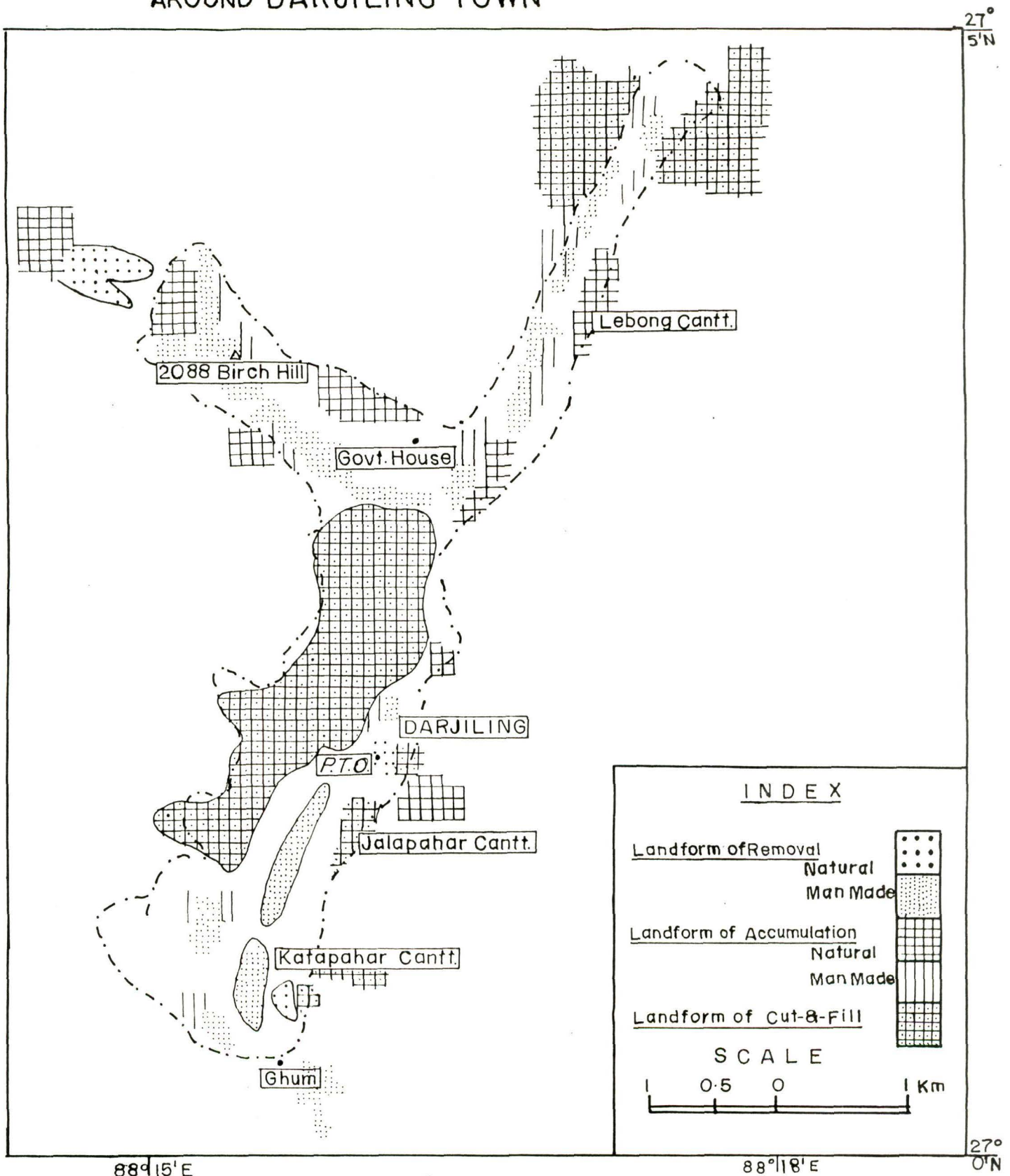

Fig — 5.2

3. Soil Erosion :

Soil erosion and related phenomena seem to be one of the major geomorphic limitation in the urban growth of Darjiling town. Quantitative analysis of soil loss of the study area show that the average soil loss vary from 500-2000 $ton/h^{-1}/y^{-1}$ (Fig.3.7). Steepness and length of slope, rainfall intensity, conspicuous weathering processes and the level of human interferences seem to be the important factors responsible for such severe soil erosion.

The study area has some severe geomorphic limitations for the various land-use. Among these climate induced processes, stability, landform and soil characteristics are important. If we consider the individual limitations the erosion risk, landslip risk, slope angle, slope length, depth of bedrock, contour curvature etc. seems to be more important. However, landslips and related phenomena seem to be the most destructive geomorphological limitations that threaten the over-all quality of urban environment of Darjiling town.

Thus, it is high time for the planning authority and/or local urban government to have a general regulations prohibiting building on slopes exceeding a certain gradient. They should have slope stability maps to indicate the relative extent of landslip hazards and the cost of the consequences of slope instability in the areas for which they are responsible.

C. LANDFORMS CREATED BY HUMAN ACTIVITY

New landforms are created in urban areas by the dumping of materials, filling the depressions, extraction of materials and by terracing hill-slopes for various urban uses. There are two types of

land-forms created by such activities : Landforms of accumulation that are created by dumping or filling of materials; and Landforms of removal, those created by extraction or cutting of hill-slopes. (Legget, 1973 and Douglas, 1983). In Darjiling town, the latter seems to be more widespread than the former. Activities like railways, roads, involve both accumulation and removal in a succession of embankments, cutting of terraces. Construction of houses commercial and administrative and various other urban attendent structures involve massive cut-and-fill processes and thereby create new landforms. New landforms or modifications are also made to cope up with the effects of urban activity or other landforms such as the man-made channels or modification of the existing channels to carry the extra run-off to new channels. (Coates, 1974 and 1976). Thus huge amounts of materials were either removed or redeposited during the different phases of urban constructions in Darjiling town (Fig.5.3). These definitely invite adverse effects on the delicate geo-environmental processes operating in the Darjiling Himalaya. The different landforms created and/or modified by different urban activites are discussed under the following headings :

1. Landforms of Accumulation :

These are some of the important landforms that were produced during the various phases of urban activities in Darjiling town. The construction of different urban structures need level ground which is not found in this hilly tract. To overcome this problem, large scale cut-and-fill processes along the ridges and spurs of Darjiling hill were performed since the time of British Annexation and is still under progress. During the extensive field survey, the

CONTOUR PLAN AND GEOLOGY OF THE LANDSLIP OPPOSITE GLENERY'S

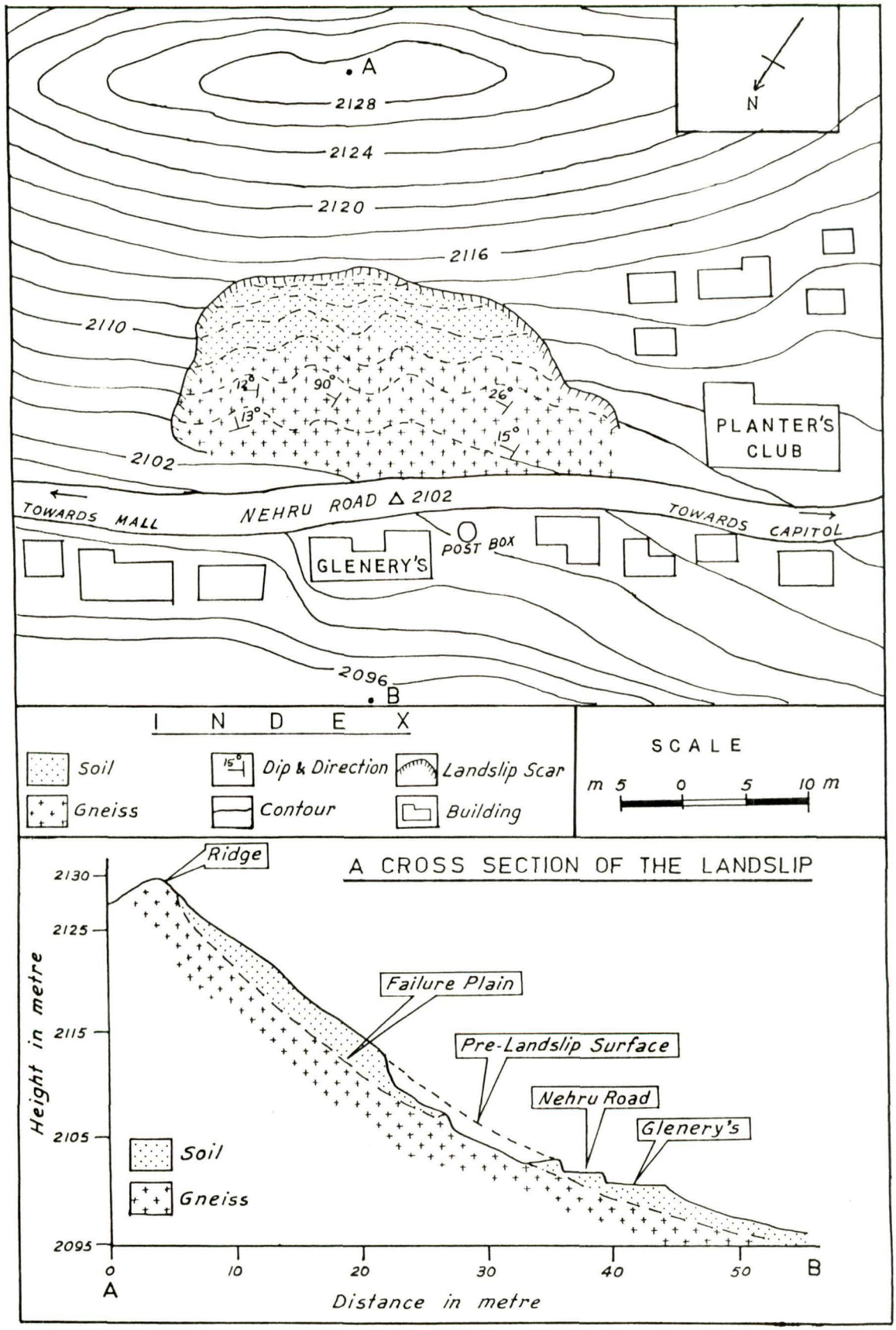

Fig-5.3

investigator has noticed, that, the present construction of each and every house, road and other urban utility structures invariably involves the cut-and-fill processes along the slopes. Accumulative landforms have also been created by natural processes and in the study area landslips and storm-water deposites are found to be more important processes for the creation of such landforms (Fig.5.3). Thus, the landforms of accumulation in Darjiling town may be divided into two major groups :

a) The Natural Landforms of Accumulation

Landslips and related phenomena are common natural processes operating in the Darjiling Himalaya. The displaced materials of such mass-movements are often deposited at a suitable site below the scar and thereby produce a landform of accumulation. This type of landform often looks like a tongue of a slip. The landform thus produced is often short-lived as the various natural agents try to make an adjustment. Natural vegetation grows under favourable environment and gradually the landform of accumulation becomes a part of the regional landscape (Verstappen , 1983 and Douglas, 1983).

In the Darjiling Himalaya, it has become very difficult to identify such landforms after 50-60 years, as the natural degradation processes particularly running water, slope-wash coupled with luxuriant vegetative growth often modify the landforms of accumulation beyond the level of identification. Moreover, such accumulation sites in and around Darjiling town often provide space for further urban expansion and thereby undergo considerable modifications.

The distribution of major landforms produced by accumulation

through natural processes are depicted in Fig.5.3 . It has been revealed from the map (Fig.5.3) that the major landforms produced by accumulation are situated along the eastern spur of the Jalapahar-Birch Hill ridge, Kagjhora, Toongsoong, Alubari busty, Bhutia busty.

b) Human Induced Accumulation Landforms

These types of landforms are found almost everywhere in the urban centre of the study area. Such micro-level landforms often cover an area between 100 to 2000 sq. m. During the construction period, for the creation of level or near level sites for public utility buildings, playground, Bazar, transport nodes,the Mall, and the Lebong race course etc., a massive amount of cut-and-hill processes were performed (Photo 5.3 & 5.4). The excess debris thus produced were thrown down to the lower slopes, sometimes along the natural drainage channels also. The impact of these debris is tremendous atleast from the point of view of local environment, as this ushered many episodes of slope instability along the slopes of Darjiling hills.

Some of the important effects of this human induced accumulation of waste debris are as follows :

i) The debris when thrown-out along a natural channel, often clogs the channel which ultimately invite tremendous rates of erosion during strom-water discharge and in fact many jhoras in and around Darjiling town have experienced many debris-flow since the last 40 years.

ii) The debris thus produced due to excavation, are more often thrown along the hill-slopes in Darjiling and these loose materials often allow the growth of full-fledged vegetation just within 40-50

years. Thus, these unconsolidated materials look apparently stable. Moreover, later on due to lack of extra space, the latter generation of people have utilised those slopes for residential or other purposes. This very practice disturb whatever apparent stability is achieved and the entire slope becomes an easy prey to mass-movements.

iii) The accumulation of debris also affects adversely, the delicate Hydro-geomorphological balance of the hill slopes. Because, of its unconsolidated nature and coarse texture, a huge amount of rain water gets infiltrated into the debris right upto the junction, in between the upper debris layer and the lower original hill-slope. Then the infiltered water tries to drag the upper part towards the lower slope, through viscous drag, and therby, causing landslips.

iv) It has also a detrimental effect in the organic components of the delicate hill ecosystem. Such accumulation often disturb the organo-mineral compounds of soil and thereby modify many organo-chemical processes of soil.

D. LANDFORMS OF REMOVAL

The supply of raw materials to the urban centre for various construction purposes, involve the quarrying of huge amounts of clay, sand, gravel and rock. Landscapes in and around Darjiling town are pock-marked by the pits from which these materials have been taken. Two such important sites have been identified during the field survey, of which the bigger one has been found near Batasia loop (i.e. between Ghum and Darjiling) and the other one in the northern spur of Jalapahar. However, the landforms of removal in and around Darjiling town are not limited to such quarries only. The

very creation of the town, its attendant urban structures i.e. buildings, roads, railways, playgrounds invite etc. the obliteration of some of the natural topography (Photo 5.5).

In fact, urbanisation in Darjiling town was only possible through the massive cut-and-fill of natural slopes. Since, the average slope of the urban area is between 20 to 30° none of the urban attendant structure can be possible without this cut-and-fill of natural slopes.

The physical structures of the town such as the buildings, roads, railways, pipe and conduit systems, require large quantities of materials for their construction. The raw materials thus required involve huge quantities of bulky materials, such as clay, sand, gravel, rubbles, building stones etc. that are often collected from the local sources. Thus, a number of suitable sites were chosen by the early builders of the town in and around Jalapahar, Katapahar and Birch Hill ridge. Local materials are so dominant in the urban fabric of early Darjiling, that the domestic, governmental, public utility architectures utilized stones for construction, mainly granite and gneiss, which are locally available. No doubt, these huge and bulky structures of the study area have a detrimental effect in the process of slope stabilisation.

The changing technology of building and transport has rapidly altered the dependence on local materials. Modern transport network altered the dependence on local materials. Nevertheless, local sources of sand, clay and stone still remain crucial for any further construction. Table 5.3 shows the major types and sources of building materials used at the different stages of urban development.

5.5

Slope cut for widening of road.

Table No. 5.3

SHOWING THE NATURE AND SOURCES OF MATERIALS USED IN DIFFERENT STAGES OF URBAN DEVELOPMENT IN DARJILING.*

Stages of urban development	Approximate period	Locality or site of development	Materials used	Sources of materials
Pre-Urban to early-urban	1835 to 1900	Along the ridges of Jalapahar, Birch Hill and Lebong & Tukvar spur	Stones-granite, gneiss, morter, rubble and wood. Corregated Tin, glasses and sand.	Local except corregated tin sheet & glasses.
Early-Urban to Middle-Urban	1900 to 1950	Along the ridges i.e. the Jalapahar-Birch Hill towards Tukvar spur & Lebong spur & the western spur.	Stones-granite, gneiss, Morter, rubble, wood, tin, cement, iron and sand.	Local except tin, cement and iron.
Middle-Urban to developed-Urban stage	1950 onwards	Along the western spur i.e. Kagjhora, Rajbari, Bazar, Singamari and eastern spur Alubari, Bhutia busty, Toongsoong.	Wood, cement, motor, rubble, iron, glass, bricks and sand.	Cement, iron glass and bricks imported rest local.
Developed-urban stage to the stage of urban explosion	1980 onwards	Mostly along the eastern spur, i.e. Toongsoong. Bhutia busty, Alubari busty, Hermitage and western spur i.e. Kagjhora, Rajbari, Victoria Falls, Dr. Zakir Hussin busty, Bazar, Singamari, Lebong, Bloomfield.	Bricks, wood, motor, rubble, iron, glass, sand and cement.	All imported.

* Information collected from Field Survey & Past Reports.

However, the most important and of course the largest landform of removal is gradually emerging in and around Tiger Hill in recent years. The controversial Tiger Hill tourist complex including the air-strip is one of the most ambitious so-called developmental project of Darjiling Gorkha Hill Council (Photo 5.6). The project involves the removal of millions of metric tons of materials from the hill-tops and slopes, some of which will be utilized as fill materials to level the land, but a major portion will be thrown along the hill-slopes. A detail study of the proposed man-made topography of removal in and around Tiger Hill has been shown as a case study in the following pages.

E. CASE STUDIES

In order to have a clear idea about the processes and mechanisms of the various modified landforms of both accumulation and removal, the following case studies are put forward. The individual cases have been surveyed in field-its present situation, use and the preception of local resident have been analysed.

The case studies are of :

i) Tiger Hill and

ii) St. Paul's School Tennis Court.

1. The Tiger Hill Project* :

This project is one of the most ambitious plan for the Tourist promotion and development of the DGHC (Photo 5.6). The project is yet to get its final clearance from various governmental agencies. Yet the 1993 Tea and Tourist Festival (October 21st-23rd 1993) revealed a tale of environmental degradation.

* Ref : The Statesman, November 21, 1993, Calcutta.

5.6

Ground levelled for air-strip at Tiger Hill

By cut-and-fill process.

St.Paul's School Tennis Court.

5.7

a) The hillocks immediately below the Tiger Hill view point were blasted and flattened for erecting structures as mundane as pavilions, stalls and car parking.

b) A wide road to the Tiger Hill sunrise point, less steep than the existing one was laid, its alignment, once again entailed the cut-and-fill of the hill slope.

c) All the existing roads were widened by cutting the hill-side.

d) Thousands of tons of loose soil have been deposited on the hill and hill-slopes disturbing the hill slope hydrological cycle.

These activities were let loose on the core area of the Senchal Wildlife Sanctuary, arguably one of the oldest high-altitude game sanctuaries in the country. If at all the plan to have an air-strip at Tiger-Hill materialises, then the sprawling green medow will have to disappear.

Moreover, the Senchal wildlife sanctuary - about 40 sq km in area makes up the entire catchment area of Senchal lake, the only major water supply source in the hill town that is facing an acute drinking water scarcity and will become even more worse.

2. St. Paul's School Tennis Court :

St. Paul's School was constructed by the Britishers in 1864 and this is situated on top of the Jalapahar ridge. The investigator has made a survey of the School's Tennis Court, which is above the main play ground. About 25,000 m^3 of materials were removed and about 1000 m^3 were deposited for the levelling of this ground (Photo 5.7). The eastern spur having a steeper slopes of 35-45°, is one of the least setteled tract of the town while, the western spur

CONTOUR PLAN AND CROSS-SECTION OF A MAN MODIFIED LANDFORM NEAR ST. PAUL'S SCHOOL DARJILING

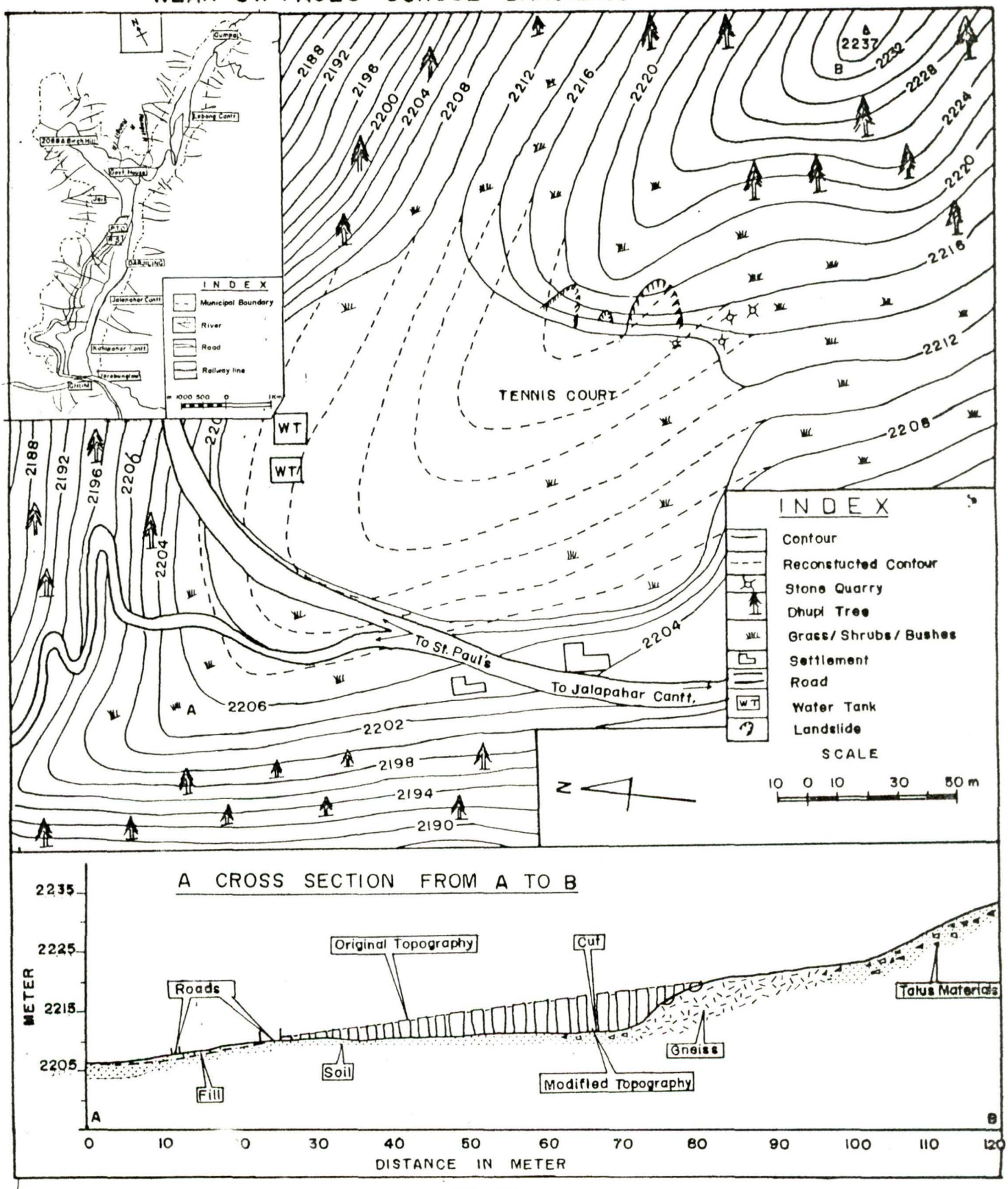

FIG —5.4

has a gentle to moderate slope varying from 10-20°, is partially covered by vegetation mainly Dhupi tree (Cryptomeria Japonica).

Geologically this area is composed of moderately jointed gneissic rocks. During the field study it had been found out, that the rocks had been widely used as building materials for the construction of houses mainly for St. Paul's School.

In order to have an idea about the rate and magnitude of cut-and-fill performed by the early developer, the investigator of the present study has tried to reconstruct the pre-urban landform and the present landscape of the study area (Fig.5.4). A study of this map (Fig.5.4) gives a good information about the magnitude of removal and accumulation and its impact on the environment. As it has been already mentioned that the Jalapahar ridge is one of the safest zone of the town, the original slope along the ridge was 8-10° towards NNW. A massive cut-and-fill was performed for the construction of a 150 x 100 m. (15000 sq. m.) tennis court along this ridge (Fig.5.4). Over steepening of slope becomes inevitable having a magnitude of 45-55°. This over steepening of slope eventually invites a decrease in shearing resistance and ultimately culminates into a series of small landslips along the cut wall, during the subsequent years.

Thus, the once considered the safest part of Darjiling town, tends to become an easy prey for uncontrolable disaster, due to unscientific use by human beings.

F. CONCLUSION

The evolution and development of Darjiling town has definately

modified many of its pre-urban geomorphological set-up. Consequently, the town has experienced a series of devastating episodes of wide spread landslips. In fact, the hill-slopes and crests of Darjiling town are out of adjustment with their present environment. During the different phases of development many hill-slopes were cut, dug and bulldogedinto new shapes, depressions were filled up with rocks and waste materials, terraced for cultivation and other usages, water and materials were extracted from the locality and of course heedless deforestation, modified the various geo-environmental processes. Some sites particularly, the eastern slope of Jalapahar (i.e. Alubari, Toongsoong, Bhutia busty) become more or less unsuitable or require special treatment if they are to be used for buildings and engineering structures, due to some severe limitations.

Urban development also changes geomorphic conditions and leads to changes in landforms. Among the various land forms created by urban activities the landform of accumulation and removal seems to be more important. It has been revealed that in the study area, landforms developed by cut-and-fill are most extensive. In fact, hardly any construction in Darjiling town is performed without cut-and-fill of hill slopes. Human induced landforms are most striking in and around the Mall, Bazar, Lebong Race Course, St. Joseph School ground, Stadium, Hill Cart Rd., Old military Rd., and the other important Rds., Tiger Hill etc. where large scale cutting were performed along with necessary filling for creation of level ground for urban activities.

The consequences of these urban activities seem to be unfortunately detrimental to the environment. Large scale mass-

wastings, water scarcity, unabated soil erosion are some of the major out comes. The situation has deteriorated further in the recent years - since the last decade, Darjiling has been experiencing landslips almost every year with just one heavy shower with an intensity of 20 mm/h^{-1} is enough for a series of landslips.

Thus, it is high time for the planning authority and/or local urban government to have general regulations prohibiting building on slopes exceeding a certain gradient. Detail geomorphological maps showing landform features, types of mass movements, break of slopes, bed rocks, sediments, drainage characteristics and slope length and gradient may be used to assess suitable sites for further development of Darjiling town, with its varied landfoms and a complex geomorphological history.

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