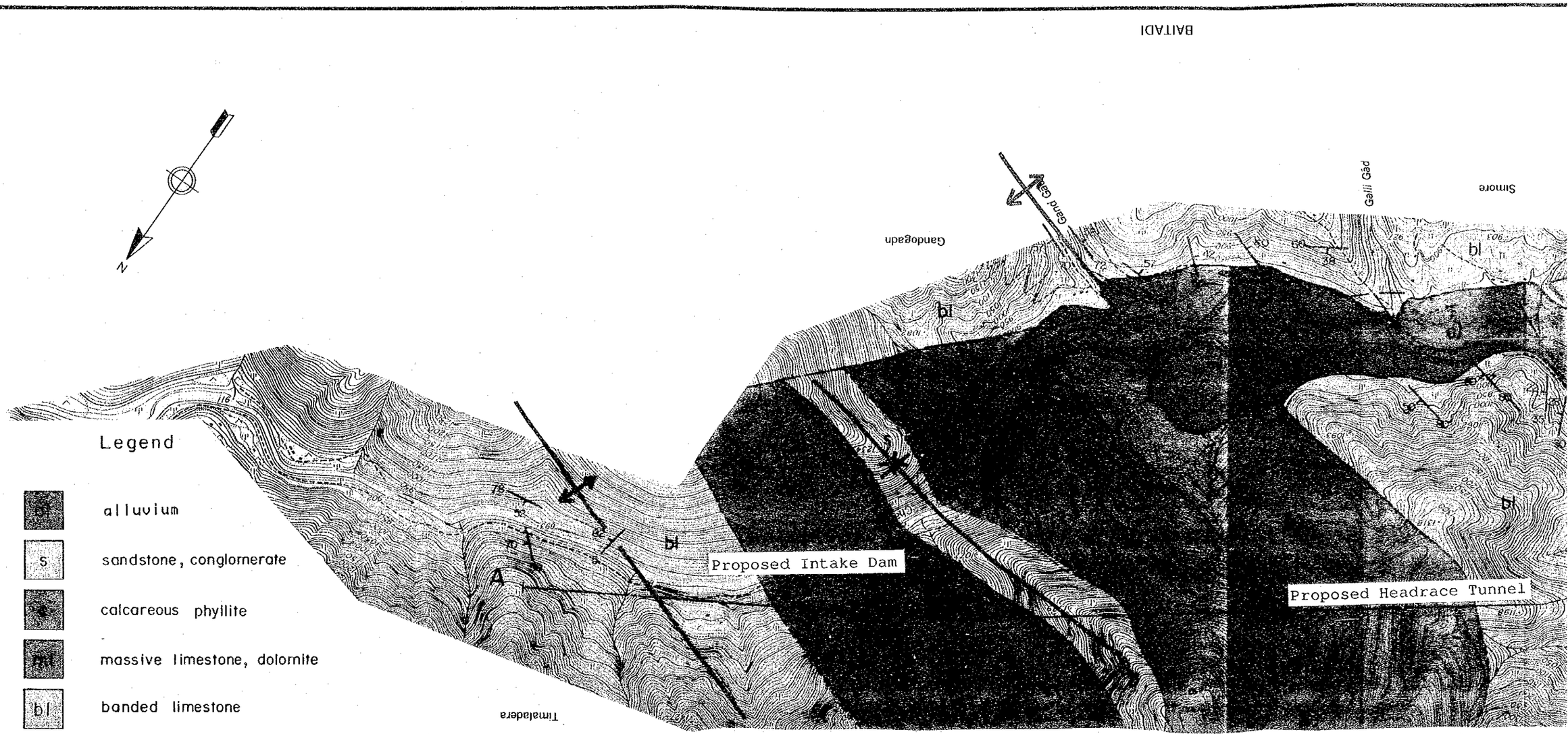
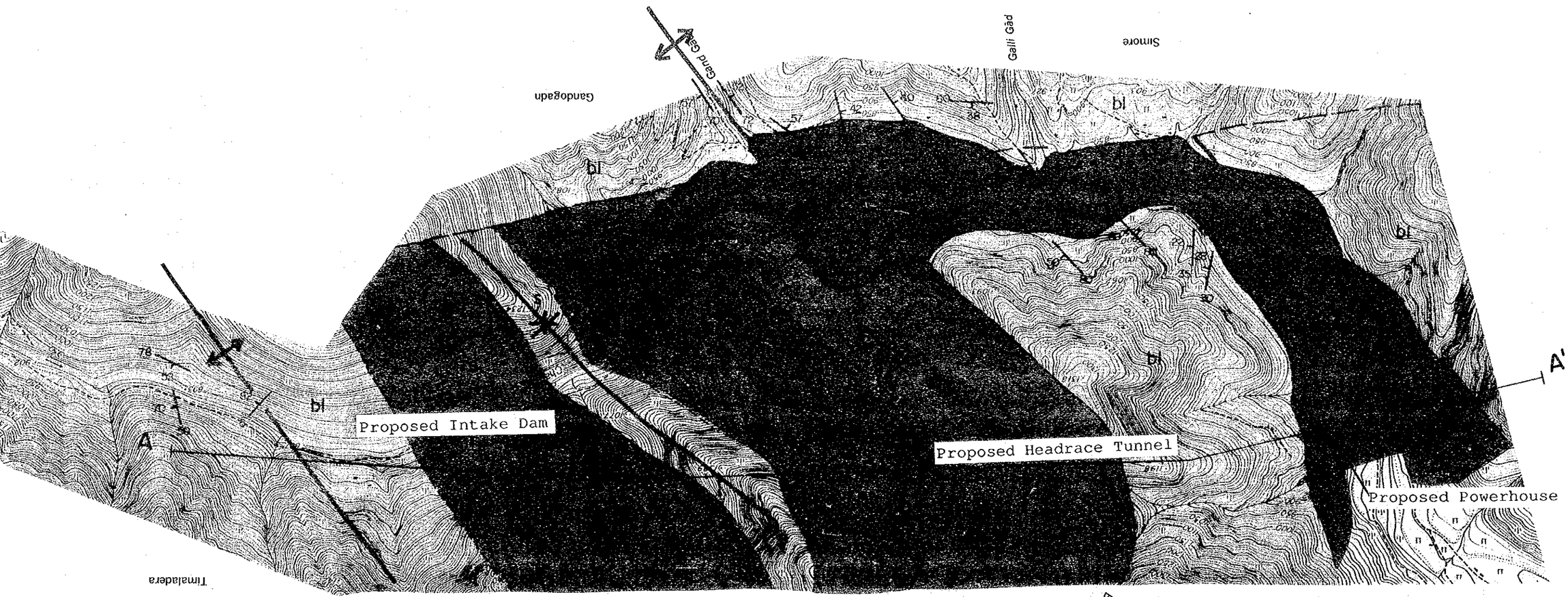


Figure 5.1.8 Geological Map of CR-2 Scheme Site



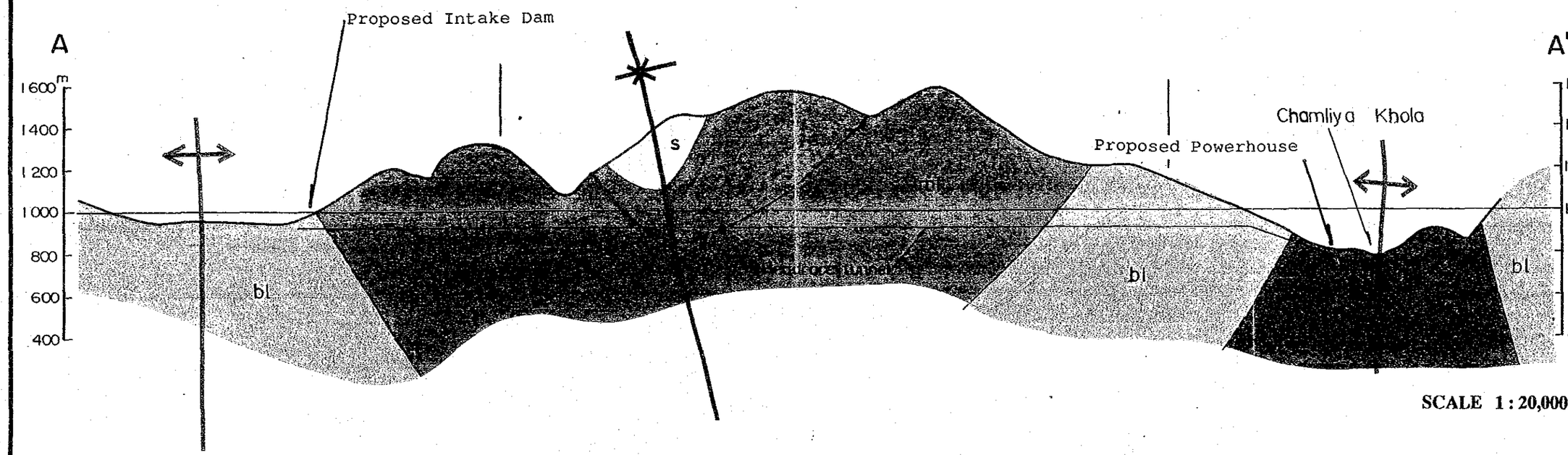
SCALE 1 : 20,000

Scheme Site

HIS MAJESTY'S GOVERNMENT OF NEPAL
WATER RESOURCES DEVELOPMENT OF
THE UPPER KARNALI RIVER AND MAHAKALI RIVER BASINS
JAPAN INTERNATIONAL COOPERATION AGENCY

Legend

- al — alluvium
- s — sandstone, conglomerate
- cs — calcareous phyllite
- ml — massive limestone, dolomite
- bl — banded limestone
- phyllite
- anticline
- syncline
- fault



SCALE 1 : 20,000

Figure 5.1.9 Geological Profile of CR-2 Scheme Site

HIS MAJESTY'S GOVERNMENT OF NEPAL
WATER RESOURCES DEVELOPMENT OF
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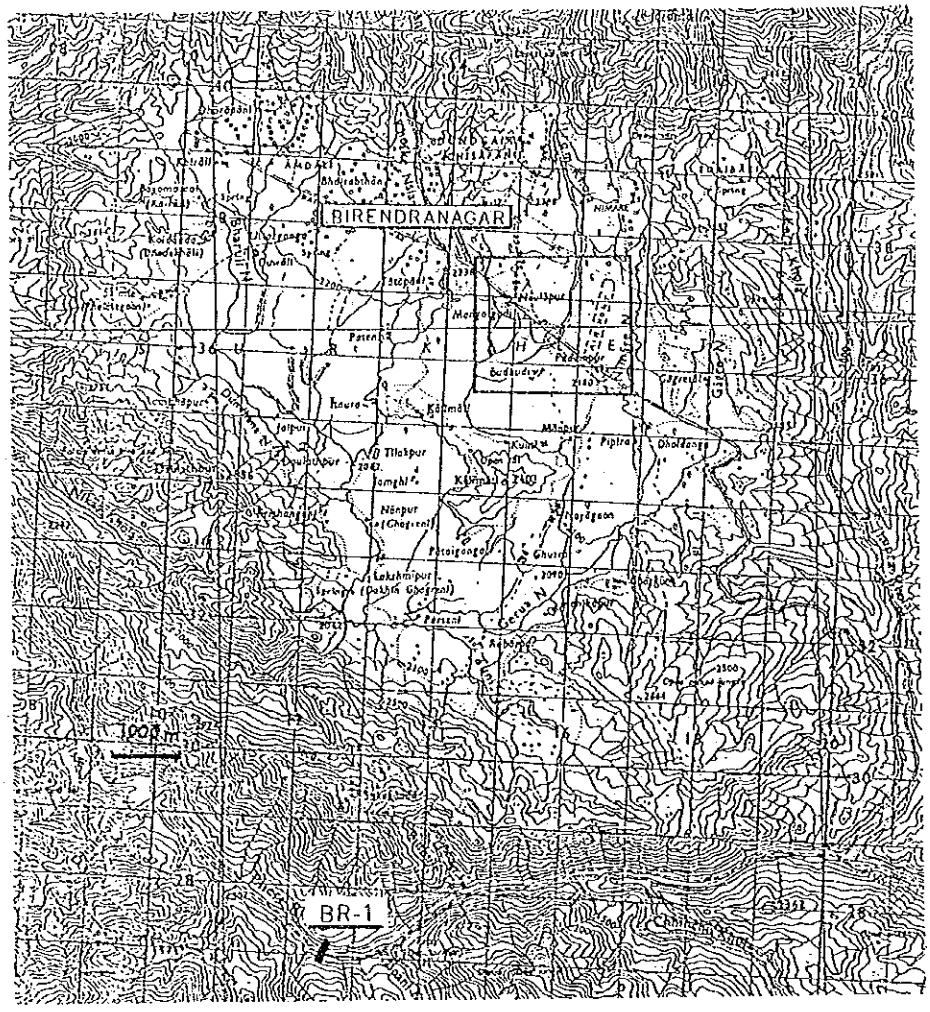

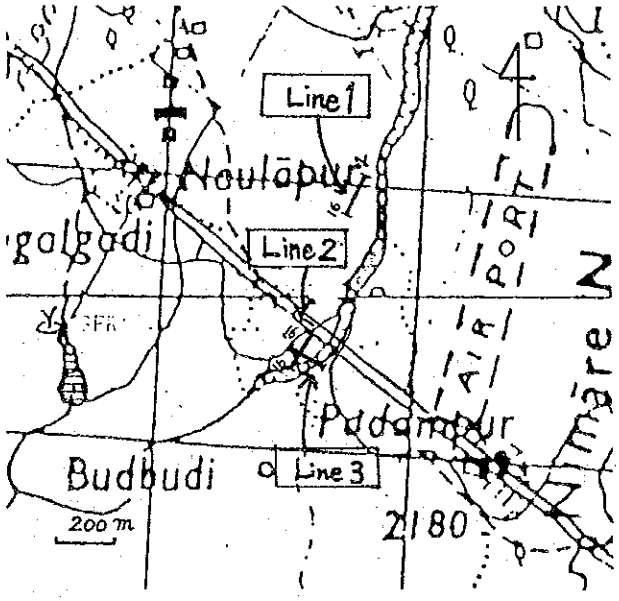

Figure 5.2.1 Index Map of Electric Survey in Surkhet Valley

HIS MAJESTY'S GOVERNMENT OF NEPAL
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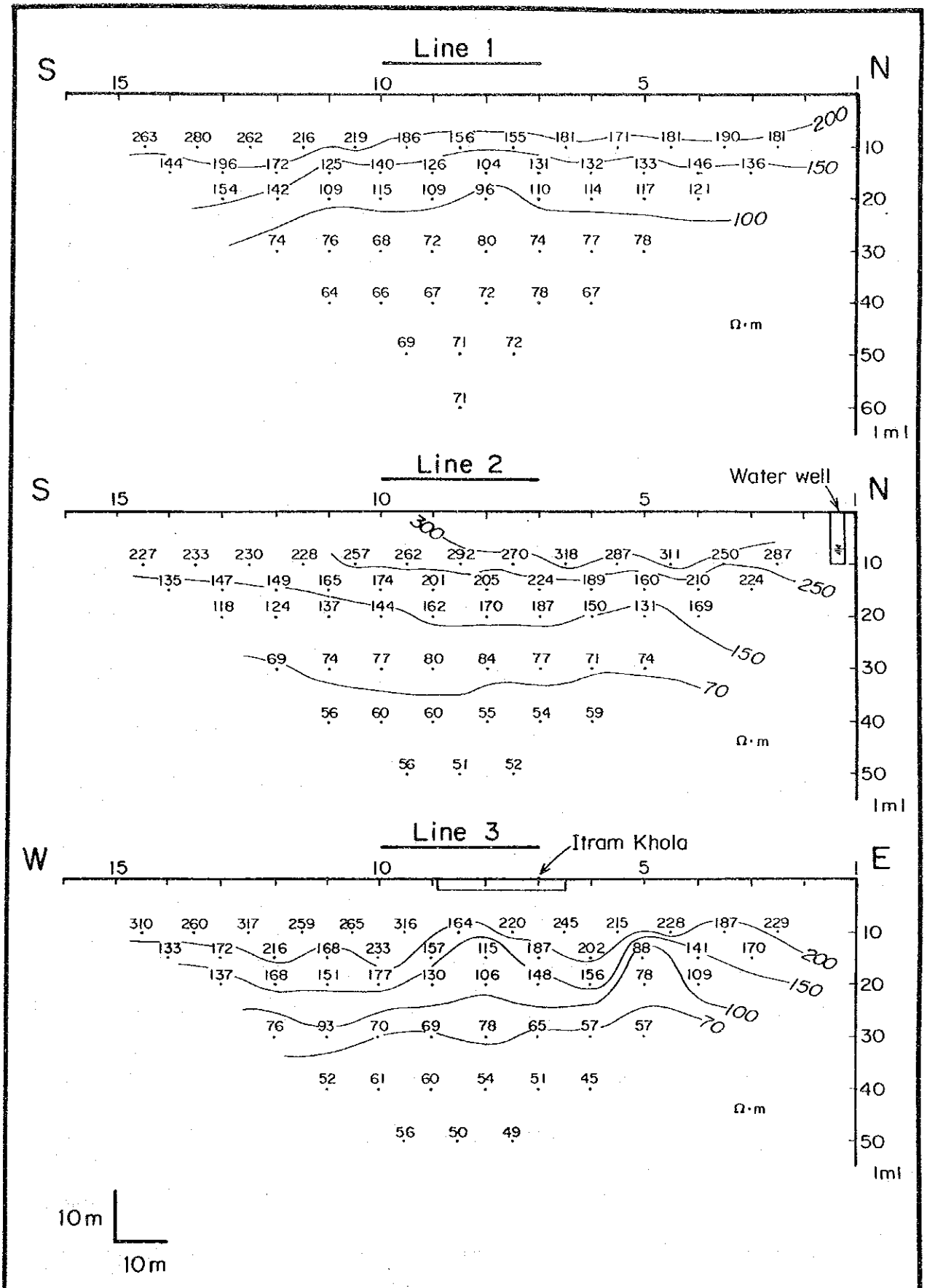

Figure 5.2.2 Resistivity Profile by Dipole-Dipole Configuration in Surkhet Valley

HIS MAJESTY'S GOVERNMENT OF NEPAL
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JAPAN INTERNATIONAL COOPERATION AGENCY

APPENDIX II

METEOROLOGY AND HYDROLOGY

APPENDIX II

METEOROLOGY AND HYDROLOGY

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1. INTRODUCTION

Meteorological and hydrological studies in this Study include the following objectives for the Karnali River and Mahakali River basins (refer to Figure 1.1.1) :

(a) to estimate mean daily runoff at the proposed scheme sites and at other locations where water balance study is required,

(b) to estimate design flood for the proposed hydropower and flood mitigation schemes, and

(c) to estimate sediment inflow to the reservoirs to be created by the proposed dams.

2. METEOROLOGY

2.1 General Climate

The climate in Nepal is generally classified into two seasons; one is a rainy season lasting for a period of June to September and the other is a dry season prevailing in winters. Ample rainfall in the rainy season is brought from the Bay of Bengal by the monsoon which whirls from south-east in the summer of northern hemisphere.

Westerly or north-westerly wind, which is dominant in winters, brings dry air from Siberia, resulting in a dry season. When wind comes from the Mediterranean, it brings winter rainfall, especially in the western part of Nepal.

The climate of Nepal is divided into five zones in terms of elevation; subtropical, warm temperate, cool temperate, alpine and Arctic zones. The Terai and the Siwaliks fall in the subtropical zone with ample rainfall in the monsoon period of June to September. The Middle Mountain is in the warm temperate zone with occasional snowfalls in winters in the highest areas. The climate of the cool temperate zone extends in the High Mountains. Snow, falling in the winter period, persists on the mountain tops throughout the winter. Alpine climate appears in the higher mountain regions with low temperature in summers and an extremely frosty condition in winters. Arctic climate is above snowline where there is perpetual frost.

2.2 Climate in the Study Area

In the Study Area, there are 23 climatological stations (refer to Figure 2.2.1) operated by DHM, observing air temperature, relative humidity and vapour pressure.

Of the climatological stations, 10 stations collect such agrometeorological data as evaporation, sunshine hours, wind velocity and soil temperature as well. Tables 2.2.1 and 2.2.2 show the type and record length of data observed at the meteorological and agrometeorological stations, respectively. Meteorological observation in the basins was commenced in early 1970s, whilst agrometeorological observation started in mid-1980s. Observation records of these stations summarize the climate of the Study Area as discussed below.

(1) Air temperature

Air temperatures are lowest in winters (January) and increase as spring advances. The highest mean air temperature of the year occurs generally in May or June as seen in Table 2.2.3. The hottest part of the Study Area lies in the Terai Belt where mean annual air temperature is 25°C, reaching over 30°C in May and June (St. 419). The coldest part of the Study Area is in the High Mountain where air temperature varies between 20°C and 4°C with an average value of 13°C (St. 310).

(2) Soil temperature

Soil temperature available at three stations shows a mean annual value of 23.6°C, ranging from 14.8°C in January to 29.9°C in June in the Study Area as given in Table 2.2.4.

(3) Relative humidity

Mean annual relative humidity in the Study Area varies in a range of 63.7% to 84.0% with an average value of 72.3% as given in Table 2.2.5. Relative humidity in seasonal variation is, on the other hand, high in July, August and September (83.6, 84.7 and 82.7%, respectively) by receiving the effect of monsoon, whilst low relative humidity is observed in March, April and May with the values of 61.9, 52.8 and 57.3%, respectively.

(4) Vapour pressure

In the Study Area, mean annual vapour pressure varies from 9.5 mb. to 25.7 mb. as shown in Table 2.2.6, whilst mean monthly vapour pressure fluctuates in a range of 10.7 mb. in January to 28.7 mb in August. The highest value of monthly vapour pressure reaches 35.6 mb. (St. 419) in the Terai.

(5) Evaporation

Table 2.2.7 shows mean monthly values of daily evaporation. The maximum daily evaporation is recorded in May and the minimum in January. Annual open-air evaporation ranges from 1,300 to 2,000 mm.

(6) Sunshine hours

In the Study Area, the records of daily sunshine hours are available at seven stations as given in Table 2.2.8, showing almost 7 hours on an annual average.

(7) Wind velocity

In the Study Area, wind velocity records are available at eight stations as shown in Table 2.2.9, giving almost 4.3 km/hour on an annual average.

2.3 Rainfall and Snowfall

2.3.1 Rainfall

There exist 71 rain gauges in the Karnali River and Mahakali River basins; 58 stations in the Karnali River basin including the Terai area and 13 stations in the Mahakali River basin including those in India as shown in Figure 2.2.1.

Rainfall data of those stations were collected on daily basis from the Department of Hydrology and Meteorology (DHM). A data base system for keeping rainfall data is established in the computer owned by DHM. Table 2.2.10 and Figure 2.2.2 give an inventory of these rain gauges with the periods of observation.

An isohyetal map of annual rainfall was drawn as giving in Figure 2.2.3 using 1963-1989 records observed at the rain gauges located in and around the Study Area. Average annual rainfall of the Study Area was estimated at 1,262 mm from the isohyetal map, which is compared with that of 1,500 mm for the whole area of Nepal.

Seasonally speaking, rainfall brought by southeast monsoon, which blows from the Bay of Bengal with moist air and is dominant over a period of June to September as mentioned earlier, accounts for more than 75% of annual rainfall, whilst remaining eight months of October to May are in a dry season.

There are five main stream gauges in the Study Area. Average annual rainfall for the catchment area draining at those gauges was computed using average annual rainfall of 52 rain gauges, which were selected from 71 gauges as representative ones in the Study Area, as follows:

Basin	Stream Gauge No.	Basin Annual Rainfall (mm)
Karnali	280	1,147
Karnali	240	855
Seti	260	1,629
Bheri	270	1,211
Mahakali	150	1,928

Table 2.2.11 summarizes the annual rainfall of the 52 selected rain gauges.

2.3.2 Snowfall

A certain percentage of total annual precipitation falls as snow in Nepal. In particular, a ratio of snowfall to rainfall in terms of annual precipitation is estimated to be high in the Himalayan region. However, few meteorological stations in Nepal measure snowfall due to the difficulty of measurements.

According to the report of Land Resource Mapping Project (Water Resources Report, 1984), the monthly and annual snowfall in Nepal was estimated on the basis of available precipitation and temperature data as shown in Table 2.2.12 (Ref. II-1).

Snowline descends to El. 3,500 m contour in winters, and ascends to El. 6,000 m contour in summers. Snow accumulated between those two contour lines melts and drains in the river as runoff, as the snowline goes up. That is to say that snow acts as a balancing reservoir in the hydrological cycle due to the delay of appearance of snow as runoff. This fact is dealt with in the subsequent Section 3.3 as the scrutiny of runoff data, and furthermore it is noted that measurements of snowfall will give more precipitation in the High Mountain areas where the 250 mm and 500 mm isohyetal lines are dominant (refer to Figure 2.2.3).

3. LOW FLOW ANALYSIS

3.1 Sub-basins in the Rivers

The Study Area is divided into the Karnali River and Mahakali River basins. The Karnali River basin is normally divided into three sub-basins, Main Karnali, Seti and Bheri, as depicted in Figure 1.1.1. The drainage areas of those sub-basins together with that of the Mahakali River are given below:

Basin Name	Drainage Area (km^2)
Karnali Basin	(43,679)
- Karnali Main	19,260
- Seti	7,460
- Bheri	12,290
Mahakali Basin	12,600

It is noted that the drainage area for the respective basins is measured at their representative stream gauge sites, i.e. 280 for the Karnali Basin, 240 for the Karnali Main, 260 for the Seti, 270 for the Bheri and 150 for the Mahakali.

3.2 Runoff Data

Stream flow data are available at 15 hydrological stations in the Study Area, the locations of which are given in Figure 3.2.1. Availability of daily discharge records at those stations is shown in Figure 3.2.2 and is summarized as below:

Name of Site	Station No.	Name of River	Available Length of Records
Nangraon	120	Chamliya	1963-1989
Pancheshwar	150	Mahakali	1989-1991
Patan	170	Surnaya Gad	1966-1984
Asara Ghat	240	Karnali	1962-1986
Benighat	250	Karnali	1963-1987
Banga near Belgaon	260	Seti	1963-1989
Khanayatal	262	Thuligad	1970-1986
Jamu	270	Bheri	1963-1987
Chisapani	280	Karnali	1962-1988
Daradhunga	286	Sarada Khola	1972-1985
Bargadha	290	Babai	1966-1985
Naya Gaon	330	Madi Khola	1965-1985
Tigra Gaon	339.5	Jhimruk Khola	1972-1985
Bagasoti Gaon	350	Rapti	1975-1985
Jalkundi	360	Rapti	1964-1985

The hydrological stations are operated and maintained by DHM. Water stages recorded at these stations are converted into discharge data by applying the rating curves developed by DHM. The development of rating curves is mainly based on discharge measurements carried out during high flow seasons. The rating curve is modified with the frequency of more than one in a year when the change is observed in the cross section at the gauge site.

In the above Table, included are the hydrological stations in the Babai and Rapti rivers; Station No. 286 and 290 in the Babai and Station No. 330, 339.5, 350 and 360 in the Rapti. Hydrological data at these stations were collected for the purpose of carrying out the water balance study of basin transfer scheme, i.e. Bheri/Babai diversion scheme which is dealt with in the Appendix IV, Hydroelectric Power Generation.

In addition to the above stations, there are four hydrological stations in the Indian territory of the Mahakali River basin, record lengths of which are as follows:

Name of Site	Name of River	Length of Record
Pancheshwar	Mahakali	1983-1989
Rameshwor	Sarju	1982-1989
Darchula	Mahakali	1982-1989
Jhulaghat	Mahakali	1982-1989

Daily runoff data were collected for the 15 stream gauges and summarized in monthly basis as given in Table 3.2.1. Mean annual runoff and its specific discharge for those stations were computed as shown below:

Mean Annual Runoff and Specific Discharge
at Hydrological Stations

Station No.	Catchment Area (km^2)	Mean Annual Runoff (m^3/sec)	Specific Discharge ($m^3/s/km^2$)
120	1,150	65.5	0.057
150	12,600	591.6	0.047
170	188	7.1	0.038
240	19,260	502.4	0.026
250	21,240	615.6	0.028
260	7,460	288.4	0.039
262	896	33.1	0.037
270	12,290	429.0	0.035
280	43,679	1,378.4	0.032
286	816	14.7	0.018
290	3,000	87.3	0.029
330	1,980	60.4	0.031
339.5	683	30.0	0.044
350	3,380	93.2	0.028
360	5,150	122.8	0.024

Mean annual runoff observed in the Mahakali River basin (Station No. 120, 150 and 170) falls in the range of 0.038 to 0.057 $m^3/sec/km^2$ in terms of specific discharge, whilst the specific discharge of mean annual runoff varies from 0.026 to 0.039 $m^3/sec/km^2$ in the Karnali River basin (Station No. 240, 250, 260, 262, 270 and 280) and from 0.018 to 0.044 $m^3/sec/km^2$ in the Babai River and Rapti River basins.

Distribution of mean monthly discharge together with mean monthly rainfall is depicted in the form of runoff depth as given in Figure 3.2.3 and Table 3.2.2, in which a high concentration of runoff is emerged in the period of June to September owing to the combination of monsoon rainfall and snowmelt.

3.3 Data Scrutiny

Scrutiny of runoff data estimated for the 15 stream gauges in the Karnali, Mahakali, Babai and Rapti rivers as discussed above was attempted by computing the annual evapotranspiration loss and runoff coefficient, since the computation of monthly basis has no grounds due to time delay of runoff against rainfall and snowmelt in summer. Furthermore, the reliability of runoff data estimated at Stations 240, 260, 270 and 280, which are main stream gauges in the Karnali River basin, was confirmed by computing water balance among them.

3.3.1 Annual Evapotranspiration Loss

Annual rainfall of the basin draining at a stream gauge was estimated by drawing the Thiessen polygons of the 52 rain gauges selected in and around the Karnali River and Mahakali River basins as given in Figure 3.3.1. Annual evapotraspiration loss of the basin draining at the stream gauge was predicted by plotting the relationship between annual rainfall estimated above and annual runoff depth, which is computed by dividing annual accumulated runoff by catchment area, as given in Figure 3.3.2.

The intersection of a 45° angle line from the abscissa, which is drawn to represent the above relationship with the least square method with it (refer to Figure 3.3.2), shows annual evapotranspiration loss. Stations 120, 170, 240, 250, 260, 270 and 280 have annual evapotranspiration loss of less than 500 mm from the line drawn. In particular, Station 250 gives negative annual evapotranspiration loss. Small annual evapotranspiration loss is expected on relatively large runoff depth mainly due to the balancing reservoir effect of snow.

3.3.2 Coefficient of Runoff

Daily runoff data were collected for the 15 stream gauges and summarized on monthly basis. Mean annual runoff for those stations was computed based on those data as shown in Table 3.3.1. The coefficient of runoff, which is a ratio of total runoff depth to total rainfall, for the gauges was calculated based on the annual rainfall and the annual runoff depth so obtained as shown in Table 3.3.1.

The coefficients of runoff at Station 250 and 339.5 are greater than 1.0. According to the comments in the Report of Karnali Multipurpose Project (Annex D: Hydrology 1989), records of water levels at Benighat (Station 250) are likely to be affected by backwater from the Seti River during the wet season, so that the observed runoff at Benighat (Station 250) would be less reliable (Ref. II-2).

The runoff data at Tigra Gaon (Station 339.5) cannot be judged to be reliable in comparison with the runoff coefficients obtained at the nearby stations (Stations 330 and 350). The coefficient of runoff at Stations 262, 286, 290, 330, 350 and 360, which lie in the tributaries originating from the Siwaliks Zone, ranges from 0.42 to 0.63.

Stations 120, 150, 170, 260, 270 and 280 located in the tributaries originating from the mountain or high Himal zone showed a relatively high runoff coefficient. This is probably due to the fact that snowfall is not measured, although these stations include snowfall areas in the drainage area, or that cool air temperature in the region makes evapotranspiration losses small.

The coefficient of runoff obtained for Station 240 is as high as 0.96. It can be said that runoff by snowmelt as well as monsoon rainfall gives considerable contribution to total runoff. This fact is endorsed by the fact that runoff in June is greater than rainfall in that month (refer to Station 240 in Figure 3.2.3). An attempt to estimate a rough amount of snowfall was tried for assessing the runoff coefficient in more detail.

Land Resource Mapping Project, LRMP, (Water Resources Report, 1984) as discussed in the preceding Section 2.3.2, Snowfall, estimated monthly snowfall in Nepal as given in Table 2.2.12 (Ref. II-1). While collection of snowfall data was tried in the Study Area, there is no station observing snowfall. Thus, the monthly snowfall data observed at the Tijjam station (refer to Figure 3.2.1) lying at El. 3,909 m in the Indian territory of the Mahakali River basin were collected as given in Table 3.3.2 to compare with the snowfall estimated by LRMP. Comparison shows that the annual snowfall observed at Tijjam is 1.75 times larger than the one estimated by LRMP (refer to Table 3.3.3). By multiplying the ratio of 1.75 by the annual

snow accumulation estimated by LRMP, the annual snow accumulation for respective stations was estimated as follows:

Station No.	Annual Snow Accumulation ($km^3 \times 10^3$)	Annual Snow Depth (mm)
120	68.98	105
150	1,318.11	184
240	3,041.31	277
260	445.99	105
270	1,935.44	274
280	5,422.74	221

If all the snowfall can be assumed to be melted as runoff, the runoff coefficient for the above stations becomes as follows:

Station No.	Annual Precipitation		Annual	Annual	Runoff
	Rainfall (mm)	Snowfall (mm)	Runoff (mm)	Evapotranspiration Loss(mm)	Coefficient
120	2,105	105	1,784	426	0.81
150	1,928	184	1,473	639	0.70
240	855	277	818	314	0.72
260	1,629	105	1,212	522	0.70
270	1,211	274	1,093	392	0.74
280	1,147	221	995	361	0.72

The above result may group the stations into two; one is the group with a relatively small snowfall area compared with the total catchment area such as Stations 150 and 260, of which the runoff coefficient is 0.70 and annual evapotranspiration loss falls in the range of 520 mm to 640 mm.

The other has, on the contrary, a relatively large snowfall area such as Stations 120, 240, 270 and 280, of which the runoff coefficient falls in the range of 0.72 to 0.81 and annual evapotranspiration loss varies from 310 mm to 430 mm. This result may suggest that a

snowfall area acts as a reservoir which gains precipitation in both liquid and solid forms, stores a large part of this precipitation, and then releases it with little loss at a later date, so that annual evapotranspiration loss is low, about 370 mm.

It can be concluded from the study of annual evapotranspiration loss and runoff coefficient that daily runoff data estimated for 13 stream gauges except for Stations 250 and 339.5 are applicable in determining the development scale of proposed water resources development schemes.

3.3.3 Discharge from the Remaining Drainage Area

There are five major stream gauges in the Karnali River basin; Stations 240, 250, 260, 270 and 280 (refer to Figure 3.2.1). Of them, Station 250 has less reliable data due to backwater from the Seti River in the flood time.

Using monthly discharge data observed at Stations 240, 260, 270 and 280, discharge from the remaining drainage area, 4,669 km^2, was calculated based on the arithmetical computation (Q280-Q240-Q260-Q270) as part of data scrutiny as shown in Table 3.3.4.

As a result of computation, negative flow appeared mainly in dry seasons, and in particular continued for five to seven months in year 1964, 1973 and 1980. The reason why the negative flow was obtained may be accrued from the accumulation of the error of runoff data observed at four stations and the instability of the rating curves which are frequently changed after floods. The Water Resources Report of the LRMP furthermore suggested the possibilities of seepage water and underground flow which could not be comprehended at the stream gauges (Ref. II-1).

The daily discharge data measured at Stations 240, 260, 270 and 280 together with the other nine stream gauges are adopted for low flow analysis of this Study taking into consideration not only the fact that the negative flow from the remaining drainage area is relatively small compared with mean annual discharge at Station 280 (The maximum negative value is 12% of mean annual discharge of 1,378 m^3/sec), but also the result scrutinized through the relationship between rainfall and runoff.

3.4 Flow-Duration Curve and Storage-Draft Curve

3.4.1 Flow-Duration Curve

Flow duration curves for the selected 13 stream gauges except for Stations 250 and 339.5 were prepared in the series method as given in Figure 3.4.1 and Table 3.4.1.

As represented by Stations 240, the stations with snowfall areas in the basin have the characteristics that considerably large flow is sustained in the dry season due to snow melting. On the other hand, the flow in the dry season considerably decreases for the stations with a small catchment area and without snowfall areas in the basin, i.e. Stations 170 and 262.

3.4.2 Storage-Draft Curve

The preparation of storage-draft curve, which is a diagram to show the relationship between the draft rate and the active storage volume required in the reservoir to warrant the constant draft rate throughout a year, was tried by simulating monthly runoff data to the continuity equation. The curve is non-dimensionalized by annual inflow volume in ordinate and mean discharge in abscissa.

Figure 3.4.2 gives the storage-draft curves prepared for the 13 stations, showing the required active storage volumes for 25-year and 50-year drought. Less significant difference appears between two curves probably due to the fact that the summer monsoon regularly storms the Study Area, resulting in no requirement to secure the storage volume for the drought to continue over two years. The storage-draft curve for the 50-year drought will be applied in determining the development scale of the reservoir type hydropower scheme.

3.5 Low Flow Analysis for the Small Drainage Areas

The irrigation schemes in the Study Area are normally practiced by drawing required water from the rivers with a small drainage area, say less than 100 km^2, because the rivers with a large catchment area normally run in the valley bottom far below the proposed irrigation area. It is not appropriate to apply discharge data observed at such stations as 150, 240, 260, and 270 for estimating the availability of water for the irrigation schemes from the viewpoint of catchment area ratio.

An effort was made for collecting discharge data measured in the irrigation projects as given in Table 3.5.1, the location of which is shown in Figure 3.5.1. Those data are not at this

moment judged to be appropriate for estimating runoff from small drainage areas due to low reliability.

4. FLOOD ANALYSIS

4.1 Introduction

A flood analysis was made to estimate probable peak discharges and hydrographs at the selected sites for determining the scale of spillway and diversion tunnel of hydropower schemes and for planning the flood mitigation schemes. The procedure applied for the estimate of probable floods was as follows:

(a) Frequency analysis for the annual maximum instantaneous peak discharge observed at the selected stream gauges,

(b) Establishment of an equation to estimate probable peak discharge at arbitrarily selected sites,

(c) Preparation of the flood pattern or non-dimensional hydrograph based on past floods,

(d) Estimate of probable hydrographs at the arbitrarily selected sites based on the probable peak discharge and the flood pattern so obtained, and

(e) Estimate of probable maximum flood by establishing a relationship between it and the 10,000-year flood.

4.2 Frequency Analysis for Annual Maximum Instantaneous Peak Discharge

Data on annual maximum instantaneous peak discharge were collected from the stream gauges in the Karnali River and Mahakali River basins as shown in Table 4.2.1.

The frequency analysis was done for those annual maximum instantaneous peak discharges by applying the Extremal Type I distribution (Gumbel method). Probable peak discharges obtained for the respective gauges are summarized as below:

Unit : m^3/s

Station No.	Banbassa	240	260	262	270	280
Sub-basin	Mahakali	Karnali Main	Seti	Thuli Gad	Bheri	Karnali Project site
Catchment Area (km^2)	15,178	19,260	7,460	896	12,290	43,679
Return Period (Year)						
2	7,100	2,300	3,100	600	3,300	9,400
5	10,300	3,100	4,700	1,000	4,500	13,000
10	12,400	3,600	5,800	1,300	5,300	15,400
25	15,000	4,300	7,100	1,700	6,300	18,400
50	17,000	4,800	8,100	2,000	7,000	20,600
100	18,900	5,200	9,100	2,200	7,800	22,800
200	20,800	5,700	10,100	2,500	8,500	25,100
500	23,300	6,300	11,400	2,900	9,500	28,000
1,000	25,300	6,800	12,400	3,100	10,200	30,200
5,000	29,700	7,900	14,700	3,800	11,900	35,300
10,000	31,600	8,400	15,600	4,000	12,600	37,500

4.3 Probable Peak Discharge at Arbitrarily Selected Sites

It was assumed that probable peak discharge at a selected site can be expressed by the following Creager's equation:

$$Q_p = C \times A^a$$

$$a = A^{-0.05} - 1$$

where,
- C: Creager's coefficient
- A: Catchment area (km^2)
- Q_p: Specific peak discharge ($m^3/s/km^2$).

The value of C, Creager's coefficient, for respective return periods was estimated by main tributary by applying catchment area and probable peak discharges predicted at the respective gauge sites as given in the above Table. Following are the summary of the predicted C values:

Return Period Year	BANBASSA (15,178)	240 (19,260)	260 (7,460)	262 (896)	270 (12,290)	280 (43,679)
2	19	6	10	5	9	18
5	27	8	16	8	13	25
10	32	9	19	10	15	30
25	39	10	24	13	18	35
50	44	12	27	16	20	39
100	49	13	30	17	22	44
200	54	14	33	20	24	48
500	61	15	38	23	27	54
1,000	66	16	41	25	28	58
5,000	77	19	49	30	33	68
10,000	82	20	52	32	35	72

Note: The figures given with parentheses below the station name and numbers show the catchment area in square kilometer at the gauge sites.

The Creager's coefficients estimated at the above stations were used for predicting probable peak discharge at the hydropower potential scheme sites identified in the respective river basins (refer to Appendix IV, Hydroelectric Power Generation). It was assumed for the estimate of probable peak discharge that the Creager's coefficients so obtained can be applied for the sub-basin that the station lies. Table 4.3.1 shows the probable peak discharge estimated for respective hydropower potential schemes.

4.4 Estimate of Flood Pattern

It was assumed that each sub-basin in the Karnali River, i.e. Karnali Main, Seti and Bheri, and the basin of the Mahakali River have their own flood pattern. Following stream gauges were selected as the representative ones of each sub-basin in estimating the flood pattern:

River Basin	Station No.	Name of Station
Karnali Main	240	Asara Ghat
Seti	260	Banga near Belgaon
Bheri	270	Jamu
Mahakali	150	Pancheshwar

Past five floods were selected to estimate the flood pattern as follows:

Year	Period
1963	Aug. 17 - 25
1970	Jul. 18 - 25
1971	Sep. 7 - 16
1975	Jun. 19 - 27
1983	Sep. 9 - 17

The hydrographs of these five floods recorded at respective stations are shown in Figures 4.4.1, 4.4.2, 4.4.3 and 4.4.4. An emphasis was placed on selecting the hydrographs with a single flood peak on the above.

Runoff accumulation of the hydrographs recorded at each station was computed in a non-dimensional form as given in Figures 4.4.5, 4.4.6, 4.4.7, and 4.4.8. The flood pattern of each sub-basin was determined by drawing an average line of the accumulated flood hydrographs. Table 4.4.1 and Figure 4.4.9 show the non-dimensionalized flood hydrograph so determined for each sub-basin. Figure 4.4.9 depicts the proposed flood pattern of the Bheri River with a low and delayed flood peak compared with the floods in the other river basins probably due to the shape of river basin long in the east-west direction, which receives the monsoon rainstorm uniformly and releases flood discharge in the upper reaches with time delay.

4.5 Probable Flood Hydrographs

The probable flood hydrograph at the selected reservoir type scheme sites was predicted by using the flood pattern and the probable peak discharge so estimated at the scheme sites; that is, the probable flood hydrograph is composed by multiplying probable peak discharge by the ratio given in the flood pattern. Finally, the total hydrograph for each probability was estimated by adding base flow.

Base flow at the selected reservoir type scheme sites was estimated by multiplying the base flow measured at the stream gauge site by the ratios of catchment area and annual rainfall between the scheme site and the gauge site. Base flow at the stream gauge site was assumed to be the maximum value among mean monthly discharges observed in twelve months as follows:

unit : m^3/s

River Basin	Catchment Area, km^2	Station No.	Assumed Base Flow
Karnali Main	19,260	240	1,390
Seti	7,460	260	920
Bheri	12,290	270	1,440
Mahakali	12,600	150	1,750

Probable flood hydrographs estimated at the selected reservoir type scheme sites are summarized in Table 4.5.1. It is noted that the reason why the assumed base flow of Karnali Main is smaller than that of the Bheri River relies on the fact that Karnali Main lies in the lee side of monsoon.

4.6 Probable Maximum Flood

Probable maximum flood in the Study Area has been computed based on the Karnali Multipurpose Project and Pancheshwar Multipurpose Project Report. In this Study, the probable maximum flood at the selected reservoir type scheme sites was estimated by applying the ratio between probable maximum flood (PMF) and 10,000-year flood predicted in those two projects. PMF and 10,000-year flood estimated for those two projects are given as follows:

Name of Project	Catchment Area (km^2)	10,000-yr flood (m^3/s)	PMF (m^3/s)	The ratio of the PMF to the 10,000-yr flood
Karnali Multipurpose Project	43,679	37,500	63,000	1.68
Pancheshwar Multipurpose Project	12,600	29,600	39,700	1.34

The multiplier of 1.68 was applied for the reservoir type schemes in the Karnali River basin, whilst 1.34 was used for the schemes in the Mahakali River basin. The PMF so estimated for the schemes is also given in Table 4.5.1.

5. SEDIMENTATION

5.1 Introduction

A sediment analysis was made to estimate the long-term sediment loads deposited in the reservoir. In the Karnali River basin, the sediment analysis was carried out in connection with the previous feasibility studies of the Karnali Project. On the other hand, the sediment analysis in the Mahakali River basin was dealt with through the Field Investigation of the Pancheshwar Multipurpose Project.

In this Master Plan Study, all the data on sediment yield, which were observed through the Karnali and Pancheshwar Projects, were at first collected, and then the sediment analyses undertaken in those projects were reviewed including the data newly added after the completion of investigation of those projects. In addition, sampling of river bed materials was carried out by the Study Team at the selected points to grasp the characteristics of respective river basins for sediment yield.

5.2 Past Studies

A stream gauge, Station 280, was established at the Chisapani site of the Karnali River in 1962 for the feasibility study of the Karnali Multipurpose Project. Measurements of suspended load were commenced by Nippon Koei Co., Ltd. (NK) in 1963. The first estimate of sediment loads yielded from the Karnali River was made by NK in 1966 by using the data obtained in 1963 and 1964.

Snowy Mountains Hydroelectric Authority (SMHA) made a review in 1968 and revised the above-mentioned estimate upwards. When the second feasibility study for the project was carried out in 1976, Norconsult-Electrowatt made a third estimate for sediment load. The forth estimate for sediment load was made in 1989 by Himalayan Power Consultants (HPC) in the feasibility study (1987) (Ref. II-1). The review in the HPC's study pointed out the questions for the quality and reliability of available data. Then, intensive sampling of suspended loads was carried out at the Chisapani site in the 1987 monsoon season continued from July through September. Based on the sampling results, mean annual sediment load was estimated to be 298 million ton, later modified at 260 million ton by referring to the sedimentation surveys carried out at the reservoirs existing in India and Pakistan.

Mean annual totals estimated in the above four studies are summarized as follows :

Load Description	Sediment Load (10^6 ton/year)			
	Nippon Koei (1966)	SMHA (1968)	Norconsult Electrowatt (1976)	HPC (1987)
Suspended Load	93.5	137	105	259
Bed Load	0 *1	13 *2	21 *3	39 *4
Total Load	93.5	150	126	298-260

Note : *1 Assumed to be small compared with suspended load
*2 Assumed at 10% of suspended load
*3 Assumed at 20% of suspended load
*4 Assumed at 15% of suspended load.

In the Mahakali River basin, the estimate of sediment load was made by Pancheshwar Consortium as part of the Field Investigations of Pancheshwar Multipurpose Project. Samples of suspended loads were collected in the field throughout the 1990 monsoon season by the hydrometric data collection team and were analysed at the DHM laboratory in Kathmandu as follows :

	Sediment Load (10^6 ton/year)	
Load Description	Measured at Pancheshwar in 1990	Recommended
Suspended Load	50	-
Bed Load	10	-
Total Load	60	66

The recommendation for the annual sediment loads into the planned Pancheshwar reservoir was made by adding 10% allowance to the sum of suspended and bed loads.

5.3 Available Data

In the Karnali River and Mahakali River basins, there are five stations, which are measuring suspended loads. Availability of those data at each station is shown below:

Name of Station	Station No.	Name of River	Year of Observation
Chisapani	280	Karnali	1987, 1989, 1990,1991
Asara Ghat	240	Karnali	1985
Banga	260	Seti	1984
Jamu	270	Bheri	1984
Pancheshwar	150	Mahakali	1990, 1991

Of them, data sampled at Stations 240, 260 and 270 (Upper Karnali stations) are analysed by DHM, but the data at these three stations are practically useless for estimating annual sediment loads, because the sampler used is too light to measure suspended loads in flood time. Sediment analysis in this Study was made including the data collected after 1987 for Station 280 (Chisapani) and in 1991 for Station 150 (Pancheshwar).

5.4 Estimate of Sediment Load

Average daily concentration of suspended loads observed over the period of 1987 to 1991 at Station 280 (Chisapani) as given in Table 5.4.1 was plotted for average daily flow on a log-log scale paper to derive the sediment rating curve used for the estimate of long-term sediment load as shown in Figure 5.4.1. The regression line obtained by applying the least square method is given below :

$$C = 1.39 \times Q^{0.925}$$

where C : Average daily suspended load concentration, mg/l

Q : Average daily discharge, m^3/s.

Suspended loads were calculated by applying average daily flow to the above equation for the period that observed data of suspended loads are available. The comparison between observed (refer to Table 5.4.1) and calculated suspended loads is summarized as follows:

Year	Month	Calculated Load (10^3 ton)	Observed Load (10^3 ton)
1987	July	12,903	34,003
	August	18,283	38,189
	September	10,307	12,215
1989	June	1,510	2,089
	July	19,039	48,627
	August	38,677	61,676
	September	16,069	16,279
1990	August	46,463	27,277
	September	16,902	18,378
1991	June	7,275	8,846
	July	16,991	16,658
	August	40,883	27,315
	September	20,928	12,666
Total		266,230	324,219

Total calculated load is 82% of total observed load. Then, the equation was modified by changing the coefficient so that the observed and calculated loads become the same as follows:

$$C = 1.693 \times Q^{0.925}.$$

The regression line prepared by using the 1987 data is also shown in Figure 5.4.1. The new regression line yields less sediment load compared with the 1987 line.

Long-term sediment yield from the Karnali River basin was estimated at Chisapani, i.e. catchment area of 43,679 km^2, by applying the above sediment rating curve and by assuming the bed load yield at 15% of suspended loads as follows:

Suspended Load	123	million ton
Bed Load	19	million ton
Total Load	142	million ton.

Further details are given in Table 5.4.2.

Plotting of average daily concentration of suspended loads versus average daily flow observed in 1990 and 1991 at Station 150 (Pancheshwar) is given in Figure 5.4.2. The sediment concentration and load data are shown in Table 5.4.3. The regression line obtained by applying the least square method is given below:

$$C = 2.443 \times Q^{0.930}$$

The above equation was applied to daily average flow of each year and the loads calculated for two years were compared with the observed loads as summarized below:

Year	Month	Calculated Load (10^3 ton)	Observed Load (10^3 ton)
1990	January	1,730	3,864
	July	8,097	11,660
	August	13,131	16,922
	September	5,504	7,853
1991	May	201	190
	June	1,699	4,189
	July	5,578	6,973
	August	13,006	11,899
	September	4,113	2,211
	October	587	525
Total		53,646	66,289

The total calculated load is 81% of the total observed load. Then, the equation was modified by changing the coefficient so that the observed and calculated loads become the same as follows:

$$C = 3.019 \times Q^{0.930}$$

Long-term sediment yielded from the Mahakali River basin was estimated at Pancheshwar by applying the above sediment rating curve and by assuming the bed load yield at 20% of suspended loads as follows:

Suspended Load	45 million ton
Bed Load	9 million ton
Total Load	54 million ton.

Further details are given in Table 5.4.4.

The results of study on sediment yield carried out at two stations, 280 and 150, are summarized as below:

Station	Karnali River at Chisapani	Mahakali River at Pancheshwar
Drainage Area (km^2)	43,679	12,600
Suspended Load (10^6 ton/yr)	123	45
Bed Load (10^6 ton/yr)	19	9
Total Load (10^6 ton/yr)	142	54
Specific yield (ton/km^2 /yr)	3,251	4,290
Specific yield (m^3 /km^2 /yr)	2,322	3,060

The density of sediments deposited in the reservoir is assumed to be 1.4 ton/m^3 for the estimate of specific yield.

The estimate of long-term annual sediment yield including new data gave lower values than those done by the previous studies. However, it would be too hasty to give a final judgment for the long-term sediment loads. Thus, it is proposed in this Master Plan Study to apply the estimates in the previous studies, i.e. 5,953 ton/km^2/year in terms of specific yield for the Karnali River basin or 260 million ton/year for the catchment of 43,679 km^2 (corrected from 42,890 km^2 in the report) and 5,238 ton/km^2/year in term of specific yield or 66 million ton/year for the Mahakali River basin. For reference, annual sediment loads estimated in this Study are plotted on the diagram (refer to Figure 5.4.3; sources, Karnali Multipurpose Project, Report Annex E Sedimentation, 1989) to show the relationship between mean annual discharge and annual sediment load, in which sediment data actually deposited in the existing reservoirs are included (refer to Table 5.4.5; sources, Karnali Multipurpose Project, Report Annex E Sedimentation, 1989). The sediment yield from the Karnali and Mahakali River basins lies in the rather high yield zone (Ref. II-1).

5.5 Sampling Tests of River Bed Materials

5.5.1 Past Sampling

Sampling tests of river bed materials were carried out by HPC in 1987 in the Karnali River and the Bheri River. The locations where these sampling tests were undertaken are shown in Figure 5.5.1.

Following shows the summary of the sampling tests carried out for river bed materials by HPC (Ref. II-1):

Name of Rivers	River Bed Material	Median Size (mm)
Karnali River	Surface	180
	Subsurface	100
Bheri River	Surface	140
	Subsurface	40

Source : Karnali Multipurpose Project Annex E Sedimentation (December 1989)

5.5.2 Sampling Method

In this Master Plan Study, additional sampling tests were carried out in April 14 to 16, 1992 for the river bed materials in the Karnali River, the Seti River, the Bheri River and the Mahakali River. The locations where these sampling tests were undertaken are also shown in Figure 5.5.1.

As a sampling method, the line transact method was adopted for surface sampling, whilst the measuring weight method was used for sub-surface sampling.

Surface sampling

Following the line transact method, one stone was selected by every one meter on the tape stretched for 50 m, and then an accumulation curve of frequency was prepared for the median values of length measured in three directions for the 50 selected stones.

Sub-surface sampling

The sampling location of sub-surface material was selected in the submergible place during flood, at which river bed materials are prone to move by its tractive force. As the measuring weight method to collect samples, following process was adopted. The surface material was stripped away by the thickness equal to the largest surface stone for an area of about one meter by one meter. After stripping away, the sub-surface sand, gravel and cobbles of 30 cm in depth and about 35 kg in weight were collected and spread on the sheet. Samples were segregated by passing the sediment gauge plates. The segregated stones were weighed with a simple spring scale. An accumulation curve was prepared by summing up the weight of sub-surface materials segregated by the sediment gauge plates.

5.5.3 Grain Size of River Bed Materials

The distribution (accumulation) curves of the surface and sub-surface bed materials are presented in Figures 5.5.2 and 5.5.3. Table 5.5.1 shows the results of grain size analysis for bed materials. Following shows the summary of the sampling tests carried out for river bed materials by JICA Study Team:

Name of Rivers	River Bed Material	Median Size (mm)
Karnali River (KR1A)	Surface	105
	Subsurface	75
Bheri River (BR1)	Surface	80
	Subsurface	20
Seti River	Surface	90
	Subsurface	20
Mahakali River	Surface	95
	Subsurface	35

The median size of surface materials sampled at four sites ranged from 80 to 105 mm, compared with the size measured by HPC, 140 and 180 mm. On the other hand, the median size of sub-surface was small in the range of 20 to 35 mm except 75 mm sampled at the KR1A site. It can be said that distinct difference appears in the median size between surface and sub-surface materials.

List of References

Ref. II-1 Kenting Earth Sciences Limited/Gov. of Canada (1986) Land Resources Mapping Project

Ref. II-2 Himalayan Power Consultants/MWR (1989) Karnali Multipurpose Project Feasibility Study Report

TABLES

Table 3.2.1 RESULTS OF GEOLOGICAL FIELD INVESTIGATION CARRIED OUT IN PHASE II (1/5)

Scheme	Description of Location and Geology	Geological Conditions
TR-3	Helicopter landing is impossible. Rocktype is schist and phyllite (Nawakot group). The site is located 30 km north of existing and planned road between Surkhet and Dailekh. Construction materials: Concrete aggregates are available from gravel bed of terrace deposits.	Fair
TR-4	Helicopter landing is possible. The site is located 10 km upstream of Jumla, and about 150 km north of Dailekh-Surkhet road now under construction. Rock type is well foliated schist. Geological structure shows N 75 E / 30 N. Construction materials: concrete aggregates are available from gravel bed of terrace deposits. The site is located in the uppermost among those in the Tila River basin.	Fair
MKR-2	Helicopter landing is possible. The site is located 3 km east and upstream from Gamgadhi, the district headquarters of Mugu. Rock type consists of gneiss with quartz vein (Himal group). Concrete aggregates are available from terrace deposits.	Good
MKR-3	Helicopter landing is impossible. The site is located about 35 km east of Gamgadhi. Two-day walk is necessary along foot path from Gamgadhi to the site. Rock type is gneissose granite according to the geologic map. Construction materials cannot be expected from the gravel bed. A quarry site is thus necessary. The site is located in the uppermost of the Mugu Karnali River basin.	Good
HKR-2	Helicopter landing is impossible. Motorable access road does not exist. A foot track exists from Simikot airport for about 25 km in the northwest direction. Rock type consists of Himalayan gneiss according to the geological map. Construction materials: concrete aggregate is not available. A quarry site is thus necessary. Remarks: Darma fault, which is an active fault trending in NW-SE direction, is running near the site.	Good
HKR-3	Helicopter landing is possible. Together with the HKR-2 site, access by motorable road is very hard. The site is located about 5 km south from the Simikot airport by foot track. Rock type is Himalayan gneiss intercalated with schistose gneiss. Geological structure shows N 60 W / 60 N. Construction materials: Concrete aggregate is available from terrace deposits. Remarks: Darma fault line appears to pass at the east side of the site.	Good
HKR-4	Helicopter landing is possible. The site is located about 3 km southwest from the Simikot airport. Access by motor vehicle is not possible. Rock type is Himalayan gneiss with granite. Geologic structure shows N 80 E / 20 - 25 W. Concrete aggregate is available from gravel bed of terrace deposits. Remarks: The site is located in the uppermost of the Humla Karnali River basin.	Good

Table 2.2.2 INVENTORY OF AGROMETEOROLOGICAL STATIONS

Station Number	Station Name	Elev. (El. m)	Date			
			Evaporation (mm)	Sunshine (hrs.)	Wind (Km/hr.)	Soil Temp (°c)
0104	DADELDHURA	1,837	-	1985-1986	-	-
0105	MAHENDRA NAGAR	176	-	1985-1986	1985-1986	1985-1986
0218	DIPAYAL (DOTI)	617	-	1985-1986	1985-1986	-
0303	JUMLA	2,300	1985-1986	-	1985-1986	-
0401	PUSMA CAMP	950	1985-1986	-	1985-1986	-
0405	CHISAPANI (KARNALI)	225	1985-1986	-	1985-1986	-
0406	SURKHET (BIRENDRA NAGAR)	720	-	1985-1986	1985-1986	1985
0409	KHAJURA (NEPALGANJ)	190	1985-1986	1985-1986	1985-1986	1985-1986
0419	SIKTA	195	-	1985	1985-1986	-
0508	TULSIPUR	725	-	1986	-	-

Table 2.2.3 MEAN MONTHLY AIR TEMPERATURE

Unit : °C

St. no.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean
103	10.1	12.1	16.6	20.2	22.1	24.1	23.8	23.8	22.5	19.3	15.0	11.4	18.7
104	8.0	9.2	12.8	17.6	20.0	21.0	20.1	19.9	18.6	16.1	12.7	9.9	15.6
105	14.2	16.1	20.9	26.3	29.9	30.4	28.9	29.1	27.9	24.9	20.3	15.9	23.9
202	10.1	12.2	16.2	19.9	22.7	24.6	24.4	24.3	22.5	18.8	14.7	11.1	18.5
203	11.8	13.8	18.3	22.8	25.0	25.7	25.0	24.8	23.9	21.3	17.3	13.3	20.4
207	14.9	16.3	21.3	26.9	30.2	30.5	29.3	28.9	27.8	24.9	20.6	16.0	24.4
209	13.9	15.9	21.6	26.2	29.3	30.2	29.3	29.1	28.1	25.0	19.6	15.2	24.7
215	16.3	17.9	23.4	28.9	30.7	31.5	29.1	28.9	27.6	25.6	21.5	17.3	24.7
218	13.0	14.9	19.8	24.2	27.0	29.2	28.8	28.8	27.0	23.2	18.6	14.5	22.4
303	3.8	5.3	8.9	12.4	15.6	19.0	19.7	19.7	17.5	12.7	8.2	5.2	12.7
310	4.1	6.5	9.5	12.6	15.8	20.2	20.0	20.0	18.3	12.7	8.8	4.3	13.4
401	12.7	14.7	19.6	24.3	25.8	25.7	24.2	23.9	23.3	21.2	17.5	13.8	20.6
402	10.1	11.5	16.2	20.9	23.0	23.9	22.8	22.6	21.3	18.6	14.7	11.2	18.1
405	15.5	17.8	23.2	28.5	30.6	30.3	28.3	28.3	27.2	25.2	20.8	16.4	24.5
406	11.9	14.3	19.3	24.4	26.9	27.5	26.6	26.6	25.1	21.8	16.9	12.9	21.2
409	14.3	16.5	21.3	27.4	30.1	30.6	29.3	29.2	27.9	25.2	20.3	16.0	24.1
416	15.6	27.9	23.2	28.6	30.9	31.3	29.5	29.7	28.1	26.1	21.6	16.9	25.0
417	14.8	17.0	22.0	26.8	29.3	30.4	29.1	29.1	28.5	25.1	20.5	15.9	24.7
419	14.5	16.4	21.6	27.4	30.7	30.7	29.3	29.7	28.0	24.6	19.9	15.8	24.3
508	13.8	15.9	20.8	25.4	27.6	27.6	26.5	26.7	25.2	22.6	18.8	15.0	22.2
511	10.8	12.6	17.5	21.4	22.7	23.1	21.7	21.7	20.8	18.8	14.9	12.3	18.3
513	12.4	14.9	19.8	24.1	26.1	27.5	27.0	26.9	25.3	22.3	17.7	13.3	21.7
514	10.7	12.4	17.6	20.5	23.0	24.6	23.9	24.0	22.6	19.3	15.3	11.9	18.1
Average	12.1	14.4	18.8	23.4	25.9	26.9	25.9	25.9	24.6	21.5	17.2	13.3	21.0

Table 3.2.1 RESULTS OF GEOLOGICAL FIELD INVESTIGATION CARRIED OUT IN PHASE II (4/5)

Scheme	Description of Location and Geology	Geological Conditions
SR-6	Helicopter landing is not possible. A motorable access road exists up to Dipayal, and extension of this road to Sopheboga is currently under construction, passing 10 km north of the site. Rock type is schist and phyllite of meta sedimentary rocks.	Fair to Good
SR-3	Helicopter landing is not possible. A motorable access road is now under construction between Khodpe and Chainpur along the right bank of the Seti River. Rock type is schist and phyllite of meta sedimentary rocks.	Fair to Good
SR-1A (West Seti)	Helicopter landing is possible. The existing motorable road, which passes downstream of the dam site, is available to reach the power house lying between Bhatkoda and Dipayal. A 10 km long walk is necessary to reach the diversion site. Rock type is massive, hard gneissose schist with green schist. Geological structure is N 75 W / 80 to 90 S. Construction materials: Concrete aggregates are available from the river bed.	Good
THR-1	Helicopter landing is not possible. A motorable road now under construction will run upstream of the intake site. The road is completed only for a distance of less than 5 km from Budar toward Silgadi. Rock consists of Siwalik formation, sandstone with shale, conglomerate and mudstone, having N 60 to 70 E/20 to 30 N geological structure. Construction material: Concrete aggregates will be obtained from river bed or river terrace deposits, and impervious core materials are available from weathered surface deposits. Remarks: The helicopter survey in Phase II identified a landslide on the slope located at the left bank near the intake site. Main Boundary Thrust active fault is located upstream of the diversion site.	Poor
KR-4	Helicopter landing is not possible. The site is located at the upper reaches of the Karnali River, far from any existing motorable road. Rock type consists of schist and phyllite of meta sedimentary rocks.	Fair to Good
HKR-1	Helicopter landing is not possible. Accessibility is very poor as in the case of the KR-4 site. Rock type is schist and phyllite of meta sedimentary rocks.	Fair to Good
TR-2	Helicopter landing is not possible. A motorable road currently under construction will be extended up to Dailekh, 30 km south of the site. Rock type consists of schist and phyllite of meta sedimentary rocks.	Fair to Good
BR-4	Helicopter landing is not possible. A motorable access road is currently under construction between Chhinyu and Jajarkot along the Bheri River. This road connects the existing road at a midway point between Nepalganj and Birendranagar. Rock type is schist and phyllite of meta sedimentary rocks.	Fair to Good

Table 2.2.5 MEAN MONTHLY RELATIVE HUMIDITY

UNIT : %

St. no.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean
103	71.3	66.9	63.4	58.8	64.5	71.4	83.5	85.2	81.3	72.9	66.5	69.1	71.3
104	61.6	62.0	55.5	48.9	55.1	73.3	90.3	92.2	86.2	71.1	63.8	54.6	68.0
105	80.6	75.8	71.4	61.5	64.4	72.8	84.6	84.9	83.4	80.0	73.0	76.1	75.5
202	65.5	64.7	63.6	53.1	59.5	61.4	78.2	80.4	75.7	67.2	66.0	65.3	66.7
203	82.6	78.2	70.8	63.7	67.3	76.9	87.2	90.0	86.0	77.4	73.6	75.8	77.2
207	82.7	80.2	74.6	64.0	62.4	76.4	88.4	89.0	87.7	82.4	79.9	80.8	79.0
209	83.4	79.3	67.9	51.9	58.4	69.2	82.0	82.6	80.0	77.0	80.5	84.0	75.4
215	79.9	74.7	58.4	48.6	44.8	61.2	79.3	82.3	83.5	79.1	77.3	80.2	71.0
218	85.0	79.7	66.5	52.7	56.8	63.2	76.2	79.8	78.9	75.5	80.1	86.7	73.4
303	63.5	61.8	55.9	54.7	55.9	63.9	77.7	78.9	75.1	63.2	55.3	58.8	63.7
310	80.5	77.0	61.3	61.8	63.3	67.5	83.8	81.5	76.3	65.8	52.5	65.0	69.8
401	79.7	73.6	60.4	49.1	59.0	74.6	88.0	88.8	87.1	80.2	77.4	78.5	74.7
402	65.0	63.3	52.2	44.9	52.1	67.5	83.8	84.4	81.6	71.6	65.4	61.1	66.4
405	85.4	80.8	70.8	60.9	63.6	74.2	87.4	88.6	88.1	85.4	85.1	85.6	79.7
406	80.8	73.0	53.9	38.0	42.7	63.7	82.5	84.8	83.1	77.4	78.5	83.3	70.1
409	80.7	74.3	58.8	46.7	50.8	64.7	81.0	82.4	83.5	79.3	75.7	80.5	71.5
416	79.9	70.7	55.3	47.5	48.2	64.4	82.1	83.1	82.1	78.6	76.4	80.5	69.8
417	83.1	80.9	67.2	59.2	64.6	72.4	85.4	85.1	82.9	81.7	82.5	79.2	77.5
419	88.8	80.9	66.8	47.6	49.8	63.8	81.1	83.6	83.0	83.4	84.4	88.9	74.8
508	74.7	63.8	46.9	38.9	48.7	66.1	82.3	82.9	82.7	76.2	74.5	75.8	67.4
511	63.8	60.3	45.9	39.2	50.9	68.4	84.8	85.1	84.7	73.9	65.6	61.3	65.3
513	76.9	65.9	61.1	49.1	55.2	68.1	83.2	82.9	79.6	73.6	72.0	75.4	70.4
514	81.5	84.3	75.0	72.8	79.0	84.0	90.2	90.8	90.5	85.9	86.0	83.3	84.0
Average	77.3	72.7	61.9	52.8	57.3	69.1	83.6	84.7	82.7	76.5	73.6	75.2	72.3

Table 2.2.6 MEAN MONTHLY VAPOUR PRESSURE

Unit : mb.

St. no.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Mean
103	8.2	8.7	10.2	12.1	16.4	20.5	24.0	24.7	22.4	16.7	11.3	9.3	15.5
104	5.8	6.3	7.9	9.1	12.9	17.8	20.9	21.1	18.6	13.2	8.9	6.1	12.4
105	13.2	13.8	17.4	16.7	22.4	29.8	32.7	33.5	30.8	23.8	16.3	12.9	21.3
202	7.6	7.7	11.4	12.4	14.3	19.1	23.4	23.9	20.2	14.3	9.8	7.6	14.3
203	8.7	9.0	12.2	14.2	18.2	22.4	25.0	25.4	22.0	16.9	12.2	9.2	16.3
207	12.8	14.3	18.1	20.4	22.9	29.9	33.0	34.3	31.1	24.5	17.3	13.6	22.7
209	12.9	13.7	16.6	17.6	25.0	27.9	32.7	33.4	30.4	24.9	19.1	14.9	22.4
215	12.8	13.5	16.2	18.8	22.3	28.6	32.2	32.8	30.1	24.6	17.5	14.2	22.0
218	11.3	12.2	14.3	15.5	20.5	25.9	29.8	30.7	27.4	21.0	15.6	12.5	19.7
303	4.1	4.2	5.5	7.6	10.1	14.0	17.3	17.4	14.9	9.8	5.3	4.2	9.5
310	6.4	7.0	7.0	8.4	10.1	13.9	17.4	17.7	15.0	10.2	6.4	5.8	10.6
401	10.6	11.4	12.7	13.3	18.7	24.0	27.3	27.7	25.4	20.1	14.7	11.8	18.1
402	7.8	8.4	10.0	10.4	14.0	17.6	20.3	20.8	19.8	15.9	11.0	8.5	13.7
405	13.5	15.5	19.6	22.0	26.9	31.6	33.2	33.6	31.3	26.0	18.8	14.7	23.9
406	10.5	11.0	11.7	11.9	16.8	23.2	28.1	28.8	26.0	20.5	15.0	12.0	17.9
409	12.4	13.5	16.9	16.7	22.3	29.5	32.9	33.9	31.7	27.0	19.0	14.9	22.6
416	13.0	13.3	14.5	17.4	22.3	28.8	32.9	33.8	31.1	25.2	18.3	14.6	22.1
417	13.3	15.4	16.5	16.9	23.9	31.0	33.2	35.2	32.8	27.1	21.0	15.9	25.7
419	14.2	15.3	18.0	18.9	24.4	29.5	33.9	35.6	32.5	27.2	19.8	16.0	23.8
508	11.8	12.5	11.3	14.8	16.9	24.0	28.5	28.9	26.4	21.1	17.0	13.6	19.0
511	11.8	12.5	11.3	14.8	16.9	24.0	28.5	28.9	26.4	21.1	17.0	13.6	14.7
513	11.8	12.5	11.3	14.8	16.9	24.0	28.5	28.9	26.4	21.1	17.0	13.6	17.6
514	11.8	12.5	11.3	14.8	16.9	24.0	28.5	28.9	26.4	21.1	17.0	13.6	19.5
Average	10.7	11.5	13.1	14.8	18.8	24.4	28.0	28.7	26.0	20.6	15.0	11.9	18.5

Table 2.2.7 MEAN MONTHLY EVAPORATION

Unit : mm/day

St. no.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean
303	2.0	3.3	5.2	5.3	5.6	4.3	4.2	3.5	4.4	3.2	4.2	3.0	4.0
401	1.8	2.6	4.8	6.5	6.5	5.7	3.5	3.8	3.2	2.8	1.8	2.0	3.7
405	2.4	3.6	6.9	9.9	9.6	8.2	5.3	5.0	4.1	4.3	2.8	2.3	5.4
409	1.9	2.7	4.6	6.4	8.9	7.2	6.1	5.2	4.5	4.0	2.4	2.5	4.7
Average	2.0	3.0	5.4	7.0	7.6	6.3	4.8	4.4	4.0	3.5	2.8	2.4	4.4

Table 2.2.8 MEAN DAILY SUNSHINE HOURS

Unit : hours/day

St. no.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean
104	6.6	8.0	7.6	8.4	7.7	6.8	2.6	3.5	4.1	6.9	8.2	5.9	6.3
105	6.5	7.5	7.3	7.9	8.6	6.0	2.5	5.3	7.2	7.1	6.4	6.5	7.1
218	5.9	7.4	7.4	7.6	8.0	6.6	4.3	4.9	5.1	6.2	7.2	5.4	6.3
406	6.9	9.0	9.4	9.5	10.0	8.1	3.2	5.3	5.3	7.9	8.7	6.8	7.5
409	6.7	8.7	9.1	9.4	10.5	7.7	5.2	6.4	6.1	7.5	8.9	6.7	7.7
419	5.4	7.1	7.7	9.0	9.7	7.4	-	-	-	-	-	-	7.7
508	8.0	8.5	9.6	8.5	8.9	6.7	3.3	5.3	5.1	7.7	6.9	7.1	7.1
Average	6.6	8.0	8.3	8.6	9.0	7.0	3.5	5.1	5.5	7.2	7.7	6.4	7.1

Table 2.2.9 MEAN MONTHLY WIND VELOCITY

Unit : km/hour

St. no.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean
105	1.4	1.9	2.6	3.1	2.8	2.5	-	-	-	-	-	-	2.4
218	1.4	1.8	2.9	3.8	5.0	3.6	3.0	2.0	1.9	2.2	1.9	1.3	2.6
303	4.5	7.0	7.5	7.1	7.9	11.2	7.2	6.3	6.8	5.6	6.4	4.9	6.9
401	4.5	4.8	7.6	8.4	9.3	5.0	2.2	1.8	2.7	4.2	3.9	4.6	5.3
405	9.3	8.4	9.8	10.3	9.9	6.7	4.0	3.8	3.5	6.2	7.8	9.0	7.7
406	3.8	4.8	6.0	6.5	6.1	5.4	3.7	3.3	3.2	3.3	3.1	3.0	4.3
409	2.0	3.2	4.0	5.4	5.8	5.8	5.1	3.1	3.1	2.3	1.8	1.9	3.2
419	1.3	1.9	2.7	3.8	5.2	2.9	1.1	0.6	1.0	0.9	0.6	0.9	1.9
Average	3.5	4.2	5.4	6.0	6.5	5.4	3.7	3.0	3.2	3.5	3.6	3.6	4.3

Table 2.2.10 INVENTORY OF RAINFALL GAUGING STATIONS (1/2)

Station Number	Station Name	Zone	Recorded Period	Nos. of Recorded Years
101	Kakerpakha	Mahakali	1957-1989	33
102	Baitadi	Mahakali	1973-1982	10
103	Patan (West)	Mahakali	1957-1989	33
104	Dadeldhura	Mahakali	1957-1989	33
105	Mahendra Nagar	Mahakali	1971-1989	19
106	Belauri Shantipur	Mahakali	1971-1989	19
107	Darchula	Mahakali	1974-1989	16
108	Satbanjh	Mahakali	1976-1989	14
201	Pipalkot	Seti	1957-1989	33
202	Chainpur (West)	Seti	1957-1989	33
203	Silgadhi Doti	Seti	1957-1989	33
204	Bajura	Seti	1976-1989	14
205	Katai	Seti	1958-1989	32
206	Asara Ghat	Seti	1971-1989	19
207	Tikapur	Seti	1976-1989	14
208	Sandepani	Seti	1963-1989	28
209	Dhangadhi	Seti	1957-1989	33
210	Bangga Camp	Seti	1963-1989	27
211	Khaptad	Seti	1976-1989	14
212	Sitapur	Seti	1971-1989	19
214	Kola Gaun	Seti	1975-1989	15
215	Godavari (West)	Seti	1976-1989	14
217	Nangalsen	Seti	1976-1989	14
218	Dipayal (Doti)	Seti	1983-1989	7
301	Mugu	Karnali	1959-1989	31
302	Thibru	Karnali	1957-1989	33
303	Jumla	Karnali	1957-1989	33
304	Guthi Chaur	Karnali	1976-1989	14
305	Sheri Ghat	Karnali	1966-1989	24
306	Gam Shree Nagar	Karnali	1971-1989	19
307	Rara	Karnali	1971-1989	19
308	Nagma	Karnali	1971-1989	19
309	Bijayapur (Raskot)	Karnali	1957-1989	34
310	Dipal Gaun	Karnali	1974-1989	26
311	Simikot	Karnali	1978-1989	12
312	Dunai	Karnali	1958-1989	32
313	Darma	Karnali	1980-1982	3
401	Pusma Camp	Bheri	1963-1989	27
402	Dailekh	Bheri	1957-1989	33
403	Jamu (Tikuwa Kuna)	Bheri	1963-1989	27
404	Jajarkot	Bheri	1957-1989	33
405	Chisapani (Karnali)	Bheri	1963-1989	27
406	surkhet (Birendra Nagar)	Bheri	1957-1989	33
407	Kusum	Bheri	1957-1989	33
408	Gulariya	Bheri	1957-1989	33
409	Khajura (Nepalganj)	Bheri	1968-1989	22
410	Bale Budha	Bheri	1966-1989	24
411	Rajapur	Bheri	1978-1989	12
412	Naubasta	Bheri	1971-1989	19
413	Shyand Shree	Bheri	1971-1989	19
414	Baijapur	Bheri	1971-1989	19
415	Bargadaha	Bheri	1968-1989	22
416	Nepalganj (Reg. Off.)	Bheri	1974-1989	16
417	Rani Jaruwa Nursery	Bheri	1976-1989	14
418	Maina Gaun (D. Bas)	Bheri	1975-1989	15
419	Sikta	Bheri	1978-1989	12
501	Rukmkot	Rapti	1957-1989	33

Table 2.2.10 INVENTORY OF RAINFALL GAUGING STATIONS (2/2)

Station Number	Station Name	Zone	Recorded Period	Nos. of Recorded Years
502	Shera Gaun	Rapti	1958-1989	32
504	Libang Gaun	Rapti	1973-1989	17
505	Bijuwar Tar	Rapti	1973-1989	17
507	Naya Basti (Dang)	Rapti	1971-1989	19
508	Tulsipur	Rapti	1971-1989	19
509	Ghorahi (Masina)	Rapti	1971-1989	19
511	Salyan Bazar	Rapti	1957-1989	33
512	Luwamjula Bazar	Rapti	1972-1989	18
513	Chaur Jahari Tar	Rapti	1976-1989	14
514	Musikot (Rukumkot)	Rapti	1976-1989	14
- STATIONS in Indian Territory -				
	Pancheshwor	India	1983-1988	6
	Baijnath	India	1983-1988	6
	Berinag	India	1983-1988	6
	Khetikhan	India	1983-1988	6
	Narayani Ashram	India	1983-1984	2

Table 2.2.11 ANNUAL RAINFALL FROM 1963 TO 1989 AT 52 SELECTED STATIONS (1/6)

Unit: mm

Year	101	103	104	105	106	201	202	203	204
1963	1,954.2	1,480.2	1,524.5	1,886.0	1,847.0	2,348.6	2,021.3	1,070.1	1,680.0
1964	1,546.6	1,537.2	1,459.3	1,533.0	1,525.0	2,503.8	2,079.3	1,286.2	1,816.0
1965	1,372.8	1,004.0	1,201.9	1,346.0	1,330.0	1,844.9	1,511.0	893.0	1,308.0
1966	1,255.5	1,240.9	1,252.0	1,255.0	1,255.0	2,430.2	1,084.6	784.3	1,023.0
1967	1,492.4	1,312.2	1,445.0	1,485.0	1,481.0	2,560.4	1,126.7	1,176.1	1,190.0
1968	1,415.0	1,161.3	1,348.0	1,404.0	1,398.0	2,454.3	1,310.2	1,184.4	1,357.0
1969	1,736.2	1,339.2	1,632.0	1,720.0	1,710.0	2,309.5	1,401.0	1,112.1	1,330.0
1970	1,433.8	1,242.2	1,384.0	1,426.0	1,421.0	2,034.6	1,343.9	860.8	1,199.0
1971	2,379.8	1,892.0	1,703.4	1,654.0	1,844.0	2,071.0	1,406.8	2,104.8	1,672.0
1972	1,418.6	1,072.0	789.4	1,221.3	1,680.6	1,415.9	1,224.4	1,194.9	1,220.0
1973	1,963.8	1,643.6	1,527.9	1,422.7	1,953.5	1,957.7	1,565.2	1,488.1	1,551.0
1974	1,595.7	1,022.9	1,076.0	1,256.7	1,258.8	1,267.9	952.2	858.9	930.0
1975	2,039.6	1,602.2	1,590.7	1,603.1	1,860.7	1,844.2	1,581.3	1,884.0	1,314.0
1976	1,693.9	1,284.0	1,218.0	1,651.1	1,452.2	1,766.2	1,113.8	1,122.8	1,445.0
1977	1,487.0	1,198.7	1,224.2	1,595.0	1,704.9	1,770.9	1,422.1	1,128.0	982.0
1978	1,954.7	1,383.9	1,765.0	1,699.0	1,559.5	2,746.4	1,415.6	1,395.1	2,721.4
1979	1,376.5	989.6	1,230.2	1,416.0	1,208.9	2,063.8	1,129.8	962.6	1,842.6
1980	1,725.1	1,680.0	1,484.8	1,241.0	1,430.2	2,102.8	1,595.5	1,250.2	2,443.4
1981	1,483.3	1,276.4	1,338.3	1,435.0	1,444.4	2,298.9	1,645.1	1,342.4	2,420.3
1982	1,848.4	1,449.7	1,547.5	1,730.0	1,736.0	2,159.6	1,661.5	1,352.9	2,681.0
1983	2,342.8	1,857.6	2,072.0	2,008.0	2,209.0	2,708.5	2,005.0	1,949.1	2,791.5
1984	1,378.9	1,437.0	1,345.0	2,062.2	1,574.0	2,563.9	1,495.7	1,262.8	2,228.4
1985	1,567.4	1,624.0	1,764.3	334.8	1,660.0	2,430.1	1,675.0	1,445.3	2,179.0
1986	1,884.2	1,492.8	1,613.2	1,860.1	1,986.2	2,280.1	1,662.1	1,609.9	1,135.4
1987	1,530.0	947.2	998.2	-	1,375.6	2,205.0	1,349.3	1,182.1	1,458.4
1988	1,814.8	1,527.1	1,448.9	-	1,323.8	2,359.8	1,609.5	1,253.6	2,532.4
1989	1,922.6	1,193.3	956.1	-	1,255.7	2,477.5	1,547.1	1,525.0	2,289.3
Average	1,689.4	1,366.3	1,405.2	1,510.2	1,573.5	2,184.3	1,479.1	1,284.4	1,731.1

Table 2.2.11 ANNUAL RAINFALL FROM 1963 TO 1989 AT 52 SELECTED STATIONS (2/6)

Unit: mm

Year	205	207	208	209	214	217	301	302	303
1963	2,109.8	1,801.0	2,170.0	1,643.3	1,670.0	1,125.0	747.2	1,141.0	805.7
1964	2,185.8	1,815.0	2,299.7	1,647.6	1,493.0	1,418.0	1,630.0	364.3	595.4
1965	1,954.6	1,244.0	1,627.0	947.3	1,268.0	1,002.0	1,593.1	374.5	490.5
1966	1,512.9	1,146.0	1,384.2	997.3	1,172.0	896.0	758.1	625.0	508.9
1967	1,927.1	1,460.0	1,650.5	1,319.8	1,428.0	1,246.0	410.4	338.8	722.6
1968	2,889.7	1,772.0	1,782.9	1,915.9	1,368.0	1,351.0	585.2	420.8	498.5
1969	2,198.3	1,615.0	1,478.0	1,776.8	1,579.0	1,205.0	686.3	536.5	925.5
1970	2,330.3	1,591.0	1,702.1	1,577.4	1,328.0	972.0	778.9	441.1	563.3
1971	2,571.8	1,941.0	2,261.1	1,309.0	2,100.0	2,047.0	1,000.0	825.9	806.0
1972	1,296.0	1,351.0	1,380.3	1,367.0	1,200.0	1,207.0	676.0	388.0	780.0
1973	1,763.7	1,428.0	1,621.0	1,482.4	1,748.0	1,521.0	1,020.0	641.0	874.0
1974	1,253.0	1,249.0	1,781.9	1,430.0	1,289.0	891.0	782.0	692.2	800.0
1975	1,757.1	2,193.0	2,000.8	1,920.6	1,845.0	1,858.0	489.5	870.4	1,000.0
1976	1,104.5	1,108.4	1,573.7	1,300.6	1,829.8	988.8	369.2	533.6	707.0
1977	607.3	1,904.0	1,164.0	1,150.4	1,735.0	1,223.9	741.8	743.4	956.2
1978	1,683.2	1,897.8	2,110.8	1,576.6	1,769.1	1,474.0	887.0	689.0	1,035.7
1979	1,647.7	1,285.8	1,716.9	1,563.0	1,499.2	1,208.9	460.5	602.2	658.3
1980	1,941.4	1,609.0	1,764.6	1,682.0	1,924.2	1,476.5	322.0	894.6	1,030.6
1981	1,017.4	1,904.0	2,148.0	1,920.0	1,293.0	1,233.0	240.4	732.7	1,002.0
1982	1,353.0	1,724.6	2,193.3	1,714.0	1,473.0	1,363.0	655.1	664.6	1,051.1
1983	1,869.4	2,286.4	2,579.0	2,308.7	1,764.0	2,142.9	928.0	961.7	896.0
1984	1,366.3	2,124.2	1,950.2	2,374.6	2,206.5	1,249.7	699.0	376.6	628.2
1985	1,892.9	1,878.4	2,353.5	1,777.3	1,985.4	2,013.6	784.0	650.7	876.6
1986	1,337.6	1,407.3	1,853.7	1,442.6	2,136.1	1,543.0	-	661.8	856.2
1987	1,638.9	1,251.0	1,565.0	1,394.7	1,710.3	1,156.1	516.5	361.4	696.6
1988	1,858.6	1,837.7	2,236.1	1,711.1	2,096.2	1,460.8	-	456.5	885.0
1989	1,636.0	1,922.9	1,620.8	1,823.9	1,613.7	1,345.0	-	506.5	703.8
Average	1,729.8	1,657.3	1,850.7	1,595.3	1,649.0	1,356.2	737.5	610.9	790.9

Table 2.2.11 ANNUAL RAINFALL FROM 1963 TO 1989 AT 52 SELECTED STATIONS (3/6)

Unit: mm

Year	305	307	308	311	312	313	401	402	403
1963	1,553.0	1,175.0	1,217.0	1,283.0	1,409.2	1,231.0	2,010.0	1,772.3	1,739.0
1964	1,617.0	600.0	811.0	848.0	606.7	720.0	1,735.6	1,450.5	1,484.7
1965	1,328.0	545.0	701.0	702.0	347.8	622.0	1,653.6	1,301.8	1,131.6
1966	1,413.0	707.0	788.0	774.0	508.6	741.0	1,175.9	1,362.2	1,386.6
1967	1,374.4	544.0	748.0	683.0	536.1	616.0	1,406.0	1,357.0	1,068.0
1968	1,591.0	624.0	812.0	775.0	541.8	698.0	1,979.8	1,845.3	1,131.8
1969	1,402.6	723.0	885.0	844.0	594.2	780.0	1,480.3	1,665.0	2,190.5
1970	1,606.6	670.0	883.0	779.0	477.0	724.0	1,801.9	1,790.8	1,601.7
1971	2,172.0	983.3	799.0	1,190.0	609.0	1,126.0	2,342.0	2,482.4	2,299.5
1972	1,600.1	473.4	777.0	862.0	526.0	813.0	1,341.9	1,587.8	1,701.7
1973	2,188.5	694.8	952.8	1,139.0	588.0	1,085.0	2,275.6	2,154.0	1,935.6
1974	1,683.2	683.0	395.5	872.0	429.1	864.0	1,035.7	1,222.0	1,220.8
1975	2,281.2	1,090.2	729.0	1,191.0	622.2	1,148.0	2,302.9	2,166.7	2,100.7
1976	1,776.7	952.6	757.3	1,031.0	180.5	884.0	1,320.7	1,444.6	1,182.0
1977	1,429.7	1,157.0	573.4	1,026.0	790.0	1,042.0	1,699.0	1,679.0	1,303.2
1978	1,570.0	1,158.0	803.7	932.0	401.0	1,239.0	1,864.4	1,893.9	2,111.6
1979	423.7	915.6	635.6	783.0	495.0	854.0	1,018.1	1,288.4	1,106.0
1980	1,272.0	998.0	911.7	1,732.0	541.5	1,537.7	1,574.0	1,618.3	2,122.0
1981	1,588.7	970.0	869.8	1,607.0	438.7	1,319.7	1,477.4	1,816.2	2,233.9
1982	1,254.2	922.0	949.6	203.0	704.1	1,287.6	1,317.2	1,894.5	1,696.8
1983	906.2	887.0	1,008.9	1,457.0	711.0	986.0	2,289.9	1,997.7	1,709.2
1984	668.3	681.0	540.3	1,144.0	750.0	761.0	1,311.0	1,897.7	1,418.5
1985	394.9	725.0	701.0	912.6	787.0	800.0	2,115.0	2,069.0	2,293.2
1986	1,286.5	-	752.4	582.8	501.7	1,483.4	1,482.6	1,944.0	1,585.4
1987	1,389.4	915.0	763.7	498.1	448.7	1,091.7	1,096.8	1,548.2	1,108.3
1988	1,572.6	1,059.3	-	-	-	1,407.5	1,629.9	1,930.2	1,939.6
1989	1,441.0	-	501.3	-	-	1,132.5	1,684.8	1,432.5	-
Average	1,436.5	834.1	779.5	954.0	581.8	999.8	1,645.3	1,726.4	1,646.2

Table 2.2.11 ANNUAL RAINFALL FROM 1963 TO 1989 AT 52 SELECTED STATIONS (4/6)

Unit: mm

Year	405	406	407	408	412	413	414	415	418
1963	2,010.7	2,696.0	1,182.2	1,250.9	2,015.0	2,303.0	2,098.0	1,496.0	2,283.0
1964	2,414.2	3,771.6	1,407.4	1,063.1	2,465.0	2,993.0	2,622.0	1,393.0	1,906.0
1965	1,962.4	2,384.5	1,119.0	782.2	1,619.0	1,934.0	1,712.0	1,007.0	1,281.0
1966	2,078.4	2,171.0	1,241.6	828.3	1,520.0	1,780.0	1,598.0	977.0	1,396.0
1967	1,979.7	1,303.0	1,683.2	1,226.2	1,291.0	1,315.0	1,294.0	1,339.0	1,730.0
1968	2,363.2	1,919.8	3,181.1	1,636.9	1,483.0	1,425.0	1,518.0	408.0	2,318.0
1969	2,156.9	1,620.0	1,471.0	1,470.6	1,297.0	1,232.0	1,321.0	434.4	2,058.0
1970	2,099.4	1,489.9	1,387.9	1,396.5	1,185.0	1,105.0	1,225.0	312.9	3,272.0
1971	2,769.6	2,013.4	2,493.8	1,961.5	1,502.0	2,341.0	904.0	553.1	2,178.0
1972	2,166.1	1,363.5	2,489.4	1,394.0	1,002.0	1,674.3	1,312.0	1,391.0	1,658.0
1973	2,199.9	1,662.0	1,501.3	1,545.4	1,511.0	2,141.1	1,512.2	549.6	3,448.0
1974	1,874.6	536.0	1,164.0	850.8	1,150.1	1,154.6	533.8	364.6	1,333.0
1975	3,831.2	1,672.5	1,306.8	1,843.9	1,167.3	2,215.9	1,285.5	680.6	387.0
1976	1,648.8	1,129.4	-	1,171.2	1,218.6	1,861.0	1,100.0	341.9	743.0
1977	2,325.5	1,168.3	460.2	1,374.1	872.2	1,080.0	500.6	325.9	1,775.0
1978	2,174.6	1,880.3	815.1	1,573.0	1,688.0	2,285.0	1,119.2	1,651.0	1,557.0
1979	1,728.2	1,471.3	533.7	920.9	1,362.5	1,167.7	1,018.1	1,203.0	373.4
1980	1,917.9	1,418.2	1,341.9	1,191.1	1,317.1	1,585.8	1,039.9	1,565.6	236.6
1981	2,541.7	1,995.7	-	2,185.3	1,961.9	1,986.0	1,796.0	1,965.0	1,964.0
1982	1,877.9	1,496.0	993.6	1,229.7	1,377.8	1,461.0	1,367.0	1,387.0	1,881.0
1983	2,023.7	1,754.8	1,105.3	1,925.2	1,395.4	1,995.0	1,261.2	1,849.8	2,395.6
1984	2,482.7	1,614.4	1,277.8	1,620.4	1,791.9	2,160.2	1,515.0	1,899.4	2,958.7
1985	2,067.0	1,828.0	1,305.4	1,648.2	1,828.1	1,978.4	1,391.4	1,954.0	2,319.0
1986	2,055.1	1,930.4	982.2	1,174.1	1,523.0	1,503.8	712.4	1,489.4	2,256.2
1987	-	1,247.6	922.9	1,067.0	1,147.6	1,856.7	1,117.5	1,151.2	1,597.5
1988	2,366.2	1,914.3	1,418.6	1,504.1	-	2,374.1	1,530.1	1,791.1	2,408.9
1989	2,543.5	1,539.4	1,644.7	1,472.4	1,540.4	2,728.0	1,177.9	1,795.8	2,144.8
Average	2,217.7	1,740.4	1,377.2	1,381.7	1,470.5	1,838.4	1,317.8	1,158.4	1,846.6

Table 2.2.11 ANNUAL RAINFALL FROM 1963 TO 1989 AT 52 SELECTED STATIONS (5/6)

Unit: mm

Year	502	504	505	507	509	510	512	513	514
1963	1,604.0	-	-	-	-	-	1,529.0	2,345.0	3,895.0
1964	1,381.4	-	-	-	-	-	2,678.0	3,091.0	2,818.0
1965	1,171.3	-	-	-	-	-	1,704.0	1,988.0	1,571.0
1966	1,302.4	-	-	-	-	-	957.0	1,831.0	1,794.0
1967	981.5	-	-	-	-	-	1,010.0	1,303.0	2,125.0
1968	1,275.6	-	-	-	-	-	1,155.0	1,621.0	3,040.0
1969	1,386.1	-	-	-	-	-	1,735.0	1,393.0	2,414.0
1970	1,444.5	-	-	-	-	-	1,814.0	1,270.0	6,207.0
1971	1,387.0	-	-	1,415.4	1,866.7	-	1,532.0	1,939.0	3,824.0
1972	2,994.0	-	-	830.5	1,161.0	1,215.5	833.4	1,335.0	2,587.0
1973	1,258.0	-	-	1,701.0	2,112.4	1,824.0	1,671.9	1,756.0	5,588.0
1974	1,293.6	1,515.3	897.9	-	1,420.2	1,215.9	1,024.5	932.0	1,339.4
1975	1,345.8	1,704.2	1,479.6	1,311.8	2,440.2	1,808.8	1,611.5	1,630.0	1,899.2
1976	1,334.4	-	836.8	1,085.7	2,672.4	1,362.6	832.1	1,203.9	1,668.0
1977	1,352.0	-	912.2	1,193.2	1,489.6	1,664.6	1,044.0	1,397.6	1,331.5
1978	1,697.4	1,925.9	1,531.1	1,515.8	1,317.6	-	1,432.8	1,518.8	1,489.0
1979	1,357.8	2,035.5	1,348.2	1,533.2	1,538.4	1,567.5	1,250.5	1,215.0	1,422.0
1980	1,580.0	1,852.7	1,415.3	2,042.2	1,952.8	2,140.2	1,411.5	1,375.0	2,538.2
1981	1,943.3	1,344.1	1,561.4	1,640.4	2,204.4	997.6	1,421.7	1,201.5	1,759.8
1982	1,476.4	1,817.3	1,244.6	2,125.0	1,895.1	-	1,344.1	1,452.0	1,560.0
1983	1,375.8	-	-	1,593.5	-	-	1,373.6	1,593.3	2,296.8
1984	1,445.9	-	-	2,254.3	-	-	1,187.7	1,144.7	2,269.7
1985	1,823.4	-	-	2,275.2	-	-	1,349.9	1,522.1	2,947.9
1986	1,304.2	2,283.5	1,306.0	1,924.4	2,447.5	1,424.7	1,066.1	1,364.2	2,425.6
1987	1,533.5	1,444.3	1,242.7	1,676.2	2,145.1	1,635.4	1,023.7	1,131.6	1,989.0
1988	1,672.1	1,769.3	1,417.7	1,736.3	1,804.2	2,477.2	1,262.1	1,406.4	-
1989	1,482.7	1,762.3	1,453.8	1,850.9	2,192.2	1,932.9	1,157.8	920.8	-
Average	1,489.0	1,768.6	1,280.6	1,650.3	1,916.2	1,635.9	1,348.6	1,514.1	2,512.0

Table 2.2.11 ANNUAL RAINFALL FROM 1963 TO 1989 AT 52 SELECTED STATIONS (6/6)

Unit: mm

Year	Baijnnath	Berinag	Khetikhan	Narayani Ashram	Panchesh war	Tejam	Tijjam
1963	-	-	-	-	-	-	-
1964	-	-	-	-	-	-	-
1965	-	-	-	-	-	-	-
1966	-	-	-	-	-	-	-
1967	-	-	-	-	-	-	-
1968	-	-	-	-	-	-	-
1969	-	-	-	-	-	-	-
1970	-	-	-	-	-	-	-
1971	-	-	-	-	-	-	-
1972	-	-	-	-	-	-	-
1973	-	-	-	-	-	-	-
1974	-	-	-	-	-	-	-
1975	-	-	-	-	-	-	-
1976	-	-	-	-	-	-	-
1977	-	-	-	-	-	-	-
1978	-	-	-	-	-	-	-
1979	-	-	-	-	-	-	-
1980	-	-	-	-	-	-	-
1981	-	-	-	-	-	-	-
1982	-	-	-	-	-	-	-
1983	1,361.8	1,814.5	1,369.5	2,344.5	1,338.4	4,294.3	-
1984	-	2,214.4	-	1,424.6	1,131.1	-	-
1985	1,602.8	3,161.0	-	2,124.0	-	-	-
1986	1,397.7	-	2,020.9	1,913.5	1,573.2	2,798.9	1,793.6
1987	1,023.9	1,553.4	1,045.6	2,120.2	807.8	2,916.7	1,286.7
1988	1,393.7	2,110.6	1,305.8	2,863.6	1,283.1	3,243.2	2,079.6
1989	-	-	-	-	-	-	-
Average	1,356.0	2,170.8	1,435.5	2,131.7	1,226.7	3,313.3	1,720.0

Table 2.2.12 MONTHLY AND ANNUAL SNOWFALL IN NEPAL

Month	Mean Snowfall (mm)	Snowline Elevation (El.m)	Area (km2)	Snow Accumulation (km3 x 10^-3)
Four months of pre-monsoon season				
February	22	3,590	35,250	775.5
March	61	3,990	31,020	1,892.2
April	69	4,425	26,790	1,848.5
May	80	4,780	21,150	1,692.0
Four months of monsoon season				
June	182	5,390	14,805	2,694.5
July	281	6,035	11,280	3,169.7
August	260	6,000	11,280	2,938.7
September	173	5,770	14,100	2,439.3
Four months of post-monsoon season				
October	75	4,785	21,250	1,586.3
November	14	4,125	28,905	404.7
December	11	3,785	33,840	372.2
January	33	3,460	38,775	1,279.6
Annual Total				21,093.2

Source : Land Resource Mapping Project, Water Resources Report (1984)

Table 3.2.1 MONTHLY NATURAL RUNOFF AT HYDROLOGICAL STATIONS
STATIONS NO. 120 (NANGRAON) (1/15)

Unit: m3/s

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	AVERAGE
1963	15.8	12.9	19.4	20.2	29.6	68.0	186.7	339.5	207.0	59.4	32.6	22.6	85.1
1964	17.1	14.7	14.1	18.9	23.0	44.7	215.6	247.9	215.8	66.4	28.8	19.5	77.7
1965	15.1	16.8	20.3	24.7	21.6	49.3	127.4	146.8	89.6	33.9	24.0	15.8	49.1
1966	11.4	11.7	10.1	10.6	21.6	49.5	130.0	225.2	103.1	36.5	21.5	16.4	54.4
1967	13.2	10.1	9.8	13.4	16.0	38.9	183.1	261.8	145.8	48.7	26.7	20.8	66.3
1968	17.3	16.6	21.6	21.3	28.9	80.1	187.4	240.1	128.7	52.8	29.0	20.0	70.8
1969	18.8	16.4	17.3	20.0	30.8	47.4	124.0	220.4	214.8	71.4	32.8	19.9	69.9
1970	16.3	14.5	13.6	17.2	23.4	81.9	243.0	235.7	112.9	56.7	27.4	19.6	72.5
1971	16.1	15.7	17.0	25.2	25.7	180.7	218.8	292.6	228.5	72.3	38.1	24.3	96.7
1972	17.5	18.4	17.5	17.7	29.6	37.6	163.5	153.1	191.6	50.8	29.6	20.2	62.5
1973	18.0	17.6	23.6	29.5	41.4	121.1	182.2	238.6	181.1	105.2	37.1	25.0	85.5
1974	19.9	18.2	15.6	19.6	21.1	34.3	110.2	199.2	109.1	48.0	25.2	18.9	53.6
1975	17.6	16.8	18.0	23.2	31.3	123.9	204.4	235.3	200.9	67.1	33.4	23.3	83.4
1976	16.9	16.0	14.7	18.8	29.7	46.8	103.1	197.0	140.2	41.3	22.7	15.7	55.5
1977	13.2	11.6	9.2	12.1	25.4	46.8	170.3	193.5	130.3	50.0	27.5	19.0	59.5
1978	15.0	15.2	25.4	27.6	43.4	85.5	188.6	271.7	160.0	57.6	29.2	20.5	78.9
1979	14.0	15.0	14.5	21.7	41.2	58.4	148.2	184.5	68.2	34.2	18.5	14.3	53.1
1980	11.8	10.1	15.0	19.2	28.2	62.3	198.3	226.4	153.7	53.7	27.9	19.1	69.3
1981	16.3	14.9	14.8	23.3	35.5	58.8	192.4	215.4	101.6	65.9	34.2	22.4	66.8
1982	17.9	17.5	37.3	34.6	41.0	68.5	146.6	262.3	123.8	43.5	24.4	16.9	70.0
1983	14.7	11.8	11.4	25.9	42.1	60.8	130.6	219.1	265.3	79.9	39.6	27.7	77.7
1984	24.7	24.7	21.2	21.1	32.9	79.6	150.6	113.5	121.2	38.5	23.5	18.8	56.0
1985	17.1	14.3	12.3	15.7	21.1	31.4	106.5	121.7	115.1	110.5	33.7	21.5	52.1
1986	20.4	17.2	16.4	19.8	31.3	61.0	171.6	139.8	99.4	47.4	28.5	24.2	56.8
1987	19.3	17.9	17.3	19.3	26.9	40.0	79.0	123.5	87.3	36.8	23.9	19.6	42.8
1988	16.9	15.1	20.2	22.7	30.0	36.8	159.1	189.2	81.8	38.4	24.3	21.0	55.1
1989	19.8	18.4	18.7	19.5	25.4	34.6	76.8	169.0	82.6	38.8	26.1	21.9	46.2
AVERAGE	16.7	15.6	17.3	20.8	29.6	64.0	159.2	209.7	142.9	55.8	28.5	20.3	65.5

Table 3.2.1 MONTHLY NATURAL RUNOFF AT HYDROLOGICAL STATIONS
STATIONS NO. 150 (PANCHESHWAR) (2/15)

Unit: m3/s

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	AVERAGE
1984	137.9	142.4	139.0	160.1	396.3	976.8	1435.9	1193.4	1114.6	385.0	210.2	212.0	543.4
1985	150.4	120.0	120.7	158.0	283.5	446.2	1112.3	1704.3	993.8	902.7	391.0	240.5	554.9
1986	184.1	138.6	128.1	199.2	349.3	769.9	1924.0	1535.2	793.7	380.8	268.6	208.2	576.4
1987	158.8	149.2	144.0	176.3	306.7	553.5	1101.9	1749.8	1364.4	374.2	224.3	157.9	540.1
1988	134.8	123.7	144.8	238.0	453.1	690.9	2393.0	2598.7	1163.1	551.5	294.2	203.7	754.2
1990	159.3	143.1	193.8	248.7	404.6	595.4	1459.5	1747.8	1102.0	437.2	249.5	190.9	580.3
AVERAGE	154.2	136.2	145.0	196.7	365.6	672.1	1571.1	1754.9	1088.6	505.2	273.0	202.2	591.6

Table 3.2.1 MONTHLY NATURAL RUNOFF AT HYDROLOGICAL STATIONS
STATIONS NO. 170 (PATAN) (3/15)

Unit: m3/s

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	AVERAGE
1966	1.1	1.0	0.9	0.6	0.7	28.4	32.0	39.6	11.2	2.4	1.7	1.4	10.2
1967	1.1	0.9	0.9	0.8	0.4	0.9	6.6	19.1	11.2	3.0	1.7	1.5	4.0
1968	1.3	1.2	1.1	0.9	0.6	7.4	12.9	20.9	8.2	3.3	1.8	1.4	5.1
1969	1.3	1.0	0.8	0.5	0.4	1.4	8.3	19.6	27.3	6.1	2.5	1.9	5.9
1970	1.6	1.2	1.0	0.7	0.6	2.5	22.8	18.4	8.7	3.3	1.4	1.1	5.3
1971	1.1	1.2	1.4	1.3	2.2	39.5	39.6	48.7	26.7	4.8	2.5	1.6	14.3
1972	1.1	1.2	0.9	0.9	0.8	0.9	8.4	12.7	22.1	4.3	3.9	1.3	4.9
1973	1.7	1.2	1.2	0.9	1.2	18.0	14.7	18.1	15.0	19.4	4.9	2.5	8.3
1974	1.3	0.9	0.6	0.5	0.4	0.7	8.0	28.4	12.2	5.6	1.8	1.4	5.2
1975	1.4	1.6	0.8	0.6	0.7	9.4	21.8	24.4	23.7	4.9	1.9	1.4	7.8
1976	1.1	1.0	1.0	1.0	1.7	1.5	8.7	28.7	15.1	11.7	7.8	4.5	7.0
1977	0.9	0.8	0.7	0.7	0.9	3.0	12.4	14.7	14.6	2.0	1.1	0.8	4.4
1978	0.7	0.7	2.7	1.5	0.5	5.2	34.9	53.3	21.4	5.5	2.9	2.1	11.1
1979	1.6	2.1	1.8	1.1	1.2	2.2	20.7	27.6	5.2	1.9	1.3	1.3	5.7
1980	0.9	0.9	0.9	0.6	0.4	3.9	34.8	54.0	25.2	4.8	1.6	1.2	10.9
1981	1.0	0.9	0.8	0.6	1.3	4.2	16.0	24.0	4.2	3.0	1.9	1.7	5.0
1982	1.5	1.3	2.0	1.3	1.4	3.2	12.1	38.9	13.0	3.1	1.8	1.2	6.8
1983	1.2	1.1	1.0	1.9	1.3	2.2	7.9	29.4	32.2	5.3	1.6	1.0	7.2
1984	0.6	0.9	0.5	0.4	0.6	7.2	21.0	20.4	17.0	2.5	1.1	0.7	6.1
AVERAGE	1.2	1.1	1.1	0.9	0.9	7.5	18.1	28.5	16.5	5.1	2.4	1.6	7.1

Table 3.2.1 MONTHLY NATURAL RUNOFF AT HYDROLOGICAL STATIONS
STATIONS NO. 240 (ASARA GHAT) (4/15)

Unit: m3/s

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	AVERAGE
1963	143.3	123.2	150.0	217.8	397.2	765.1	1290.2	1823.0	1107.8	425.7	271.0	184.5	578.5
1964	185.2	164.6	168.3	228.6	274.5	546.0	1281.6	1391.3	1076.6	422.1	244.1	178.5	516.2
1965	140.6	128.4	137.1	203.1	279.4	612.9	801.6	734.3	503.8	218.1	135.9	97.3	334.1
1966	86.4	82.5	82.6	99.3	225.0	513.8	902.6	1480.9	655.1	264.4	164.5	120.7	392.7
1967	108.3	93.3	92.9	124.0	197.1	428.7	1005.4	1670.6	940.2	344.1	206.6	147.8	449.7
1968	122.6	120.2	150.8	190.1	324.0	747.3	1211.5	1455.5	636.7	309.4	189.7	134.6	469.1
1969	127.5	112.1	129.0	184.5	468.9	850.0	1191.6	1517.4	1089.5	494.9	258.5	163.3	552.0
1970	127.9	111.8	114.5	203.6	315.5	641.5	1168.0	1360.0	848.4	437.9	246.2	164.2	481.2
1971	119.5	98.1	114.6	197.0	236.7	1105.4	1382.6	1615.8	1064.4	506.0	291.7	192.5	580.0
1972	144.6	132.4	143.6	172.4	445.4	570.3	1039.6	1103.4	915.2	396.7	264.8	181.1	461.6
1973	150.6	140.4	184.9	334.7	618.5	1141.9	1184.8	1433.9	1206.6	935.0	318.4	186.3	656.1
1974	138.0	116.5	106.8	182.0	252.5	441.8	879.0	1517.4	729.9	354.1	185.6	125.2	421.9
1975	97.6	90.7	112.6	245.0	488.9	1088.2	1536.8	1636.8	1310.2	566.4	276.0	163.5	637.8
1976	119.6	101.0	94.8	167.4	387.0	658.4	956.9	1174.0	942.4	329.3	208.3	151.5	443.1
1977	122.8	112.5	105.3	129.5	256.5	548.5	1473.2	1478.1	905.2	375.4	222.5	162.1	494.5
1978	130.7	116.2	148.6	243.3	628.2	856.1	1127.1	1590.6	1001.9	414.9	236.7	175.6	559.1
1979	134.7	122.2	138.9	250.5	444.2	765.1	1243.5	1050.4	481.7	255.0	170.4	133.3	435.2
1980	112.0	98.2	126.6	219.7	439.8	789.7	1559.4	1646.8	984.7	437.8	238.4	174.1	572.9
1981	141.7	128.5	133.1	219.9	400.6	634.6	1334.0	1449.0	807.0	484.0	249.1	169.7	516.1
1982	134.3	123.2	169.0	280.4	447.8	998.9	1349.7	1462.9	936.8	343.2	210.2	151.2	553.5
1983	123.5	105.0	106.7	169.7	423.5	640.7	1074.5	1260.3	1304.3	642.3	304.1	203.8	532.5
1984	156.3	135.2	156.5	180.3	509.1	777.4	990.0	945.6	847.0	300.7	188.7	140.5	445.9
1985	122.8	103.0	104.5	146.9	260.9	436.0	1009.7	1225.2	952.3	758.4	307.9	199.6	472.0
AVEARGE	130.0	115.6	129.2	199.5	379.2	719.9	1173.6	1392.3	923.8	435.5	234.3	160.9	502.4

Table 3.2.1 MONTHLY NATURAL RUNOFF AT HYDROLOGICAL STATIONS
STATION NO. 250 (BENIGHAT) (5/15)

Unit: m3/s

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	AVERAGE
1963	153.7	130.3	161.5	224.9	392.7	861.4	1558.5	2253.9	1417.5	470.2	282.5	205.8	680.3
1964	162.5	139.3	140.6	204.3	262.7	537.8	1571.9	1700.3	1328.0	482.2	262.5	193.9	585.8
1965	155.9	143.5	154.4	225.7	303.5	625.4	956.7	994.4	674.4	297.9	200.0	140.8	407.9
1966	113.0	109.2	108.2	142.8	290.7	558.1	1100.1	1842.9	782.1	318.1	203.1	153.7	480.5
1967	121.0	105.0	102.9	135.7	206.5	463.5	1232.8	2085.8	1145.2	405.6	237.4	179.4	539.0
1968	149.8	139.8	161.7	196.0	352.7	812.9	1434.6	1852.6	896.4	421.5	240.4	176.6	573.5
1969	100.7	82.0	78.9	101.7	184.8	301.6	1044.1	1660.3	1531.0	447.9	186.4	128.2	490.2
1970	163.2	144.6	139.5	212.5	325.6	713.7	1728.3	1716.5	968.4	507.5	284.4	204.0	596.5
1971	163.9	149.1	163.5	243.9	280.1	1368.6	1799.0	2235.8	1533.4	554.3	315.2	213.3	755.4
1972	166.4	156.2	163.7	194.0	440.3	589.9	1307.4	1258.7	1292.8	464.7	266.6	185.8	543.2
1973	159.8	139.0	191.2	355.9	624.6	1260.3	1418.4	1851.9	1564.2	1171.1	408.5	245.1	786.5
1974	180.5	153.2	141.4	235.7	304.4	496.5	1169.4	1890.3	946.5	467.0	242.1	169.3	536.7
1975	138.8	128.8	147.5	285.9	530.2	1216.1	1984.2	2229.7	1810.7	670.6	329.8	212.2	811.5
1976	154.8	141.9	129.9	199.5	406.7	658.9	1139.2	1652.6	1240.6	412.0	230.9	157.1	546.5
1977	124.9	109.5	98.7	125.7	267.6	588.6	1791.0	1943.5	1187.3	480.7	275.3	188.6	603.1
1978	148.9	132.6	176.3	273.6	672.8	986.7	1580.6	2192.6	1304.6	543.7	301.4	216.8	715.6
1979	160.9	144.6	158.1	285.5	536.3	836.4	1430.3	1419.6	606.3	311.0	189.9	143.9	522.1
1980	114.5	96.2	126.9	230.5	491.8	849.1	1915.2	2094.8	1264.5	544.7	307.9	218.7	693.0
1981	179.9	156.3	164.2	265.6	477.2	717.6	1724.2	1970.6	1033.1	653.1	343.5	228.5	664.4
1982	179.6	161.5	236.4	364.3	535.5	1023.1	1580.0	2036.1	1201.6	473.9	274.5	185.8	691.7
1983	150.0	123.7	120.8	206.0	503.7	727.2	1280.6	1694.5	2137.3	880.5	404.1	229.3	707.8
1984	166.4	155.4	169.3	183.7	525.6	942.0	1449.6	1362.3	1283.2	456.6	303.4	242.7	606.2
1985	219.9	196.1	192.9	237.7	358.5	550.0	1335.5	1636.8	1311.4	1175.9	522.7	375.8	680.3
1986	310.5	266.4	257.6	274.5	352.1	481.3	1904.2	1645.2	998.7	559.4	355.6	285.3	645.2
1987	239.9	215.1	210.3	268.0	422.5	769.8	1135.7	1245.5	902.0	411.5	273.5	218.2	528.3
AVERAGE	163.2	144.8	155.9	226.9	402.0	757.5	1462.9	1778.7	1214.5	543.3	289.7	204.0	615.6

Table 3.2.1 MONTHLY NATURAL RUNOFF AT HYDROLOGICAL STATIONS
STATIONS NO. 260 (BANGA NEAR BELGAON) (6/15)

Unit: m3/s

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	AVERAGE
1963	70.2	57.4	86.4	89.7	131.4	302.3	829.7	1508.6	920.0	264.1	144.8	100.4	378.1
1964	76.3	65.4	62.5	84.0	102.2	198.4	958.3	1101.7	959.2	295.3	127.8	86.8	345.4
1965	67.0	74.5	90.2	109.8	96.0	219.0	566.0	652.3	398.4	150.7	106.8	70.3	218.0
1966	50.8	51.6	45.0	47.2	95.8	220.2	577.7	1001.0	458.3	162.3	95.8	72.8	241.8
1967	59.0	44.9	43.6	59.5	71.3	172.9	813.9	1163.5	647.9	216.5	118.7	92.3	294.5
1968	76.6	73.7	95.9	94.8	128.2	356.0	832.9	1067.1	571.9	234.7	129.0	89.0	314.7
1969	83.8	73.2	76.9	89.1	136.6	210.5	551.2	979.4	954.8	317.5	145.8	88.6	310.4
1970	72.7	64.3	60.3	76.5	104.2	364.0	1079.9	1047.5	501.7	251.7	121.9	87.3	322.0
1971	71.6	69.6	75.8	112.1	114.4	803.2	972.4	1300.5	1015.4	321.3	169.5	107.9	429.7
1972	78.2	81.9	78.1	78.9	131.4	166.9	726.5	680.4	851.3	225.9	131.5	89.9	278.0
1973	80.3	78.6	104.9	131.1	183.9	538.2	809.6	1060.4	805.0	467.3	164.8	111.1	380.1
1974	88.5	81.1	69.2	87.1	93.7	152.4	489.7	885.1	485.0	213.2	112.0	84.0	238.3
1975	78.3	74.9	80.2	103.2	139.2	550.5	908.5	1045.8	892.8	298.2	148.3	103.6	370.4
1976	75.5	71.2	65.5	83.7	131.9	207.7	458.1	875.3	622.9	183.7	101.0	69.8	246.9
1977	58.7	51.7	40.8	53.7	112.7	208.2	756.7	859.9	579.2	222.2	122.2	84.5	264.5
1978	66.6	67.5	112.9	122.6	192.9	380.1	838.4	1207.3	710.9	255.9	129.9	91.2	350.4
1979	62.1	66.6	64.2	96.5	183.2	259.4	658.6	819.9	303.2	151.7	82.3	63.6	236.2
1980	52.4	45.0	66.6	85.4	125.5	277.0	881.3	1006.1	682.9	238.5	123.8	84.8	308.1
1981	72.2	66.0	66.0	103.6	157.6	261.3	855.0	957.3	451.6	292.9	152.1	99.7	297.1
1982	79.5	77.9	165.5	153.6	182.0	304.4	651.5	1165.7	550.3	193.4	108.5	75.1	311.2
1983	65.3	52.6	50.7	115.1	187.0	270.0	580.3	973.8	1178.9	355.0	176.2	123.1	345.4
1984	109.9	110.0	94.3	93.7	146.0	353.8	669.1	504.4	538.5	170.9	104.3	83.5	249.1
1985	76.1	63.6	54.7	69.9	93.6	139.7	473.1	540.7	511.5	491.2	149.6	95.7	231.5
1986	86.7	75.8	72.7	84.6	125.2	237.0	689.7	546.0	387.2	183.2	115.1	100.1	226.7
1987	83.0	78.0	76.1	83.0	109.8	156.5	306.9	479.4	335.0	145.0	99.1	83.9	170.4
1988	74.7	68.2	86.1	94.9	120.9	141.8	632.4	763.5	312.6	150.4	103.2	83.9	221.2
1989	74.7	80.6	83.0	86.7	111.3	149.7	370.6	742.5	384.6	176.2	116.7	97.8	207.5
AVERAGE	73.7	69.1	76.6	92.2	129.9	281.5	701.4	923.5	630.0	245.5	126.0	89.6	288.4

Table 3.2.1 MONTHLY NATURAL RUNOFF AT HYDROLOGICAL STATIONS
STATIONS NO. 262 (KHANAYATAL) (7/15)

Unit: m3/s

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	AVERAGE
1970	2.0	1.7	1.5	1.0	1.2	27.7	89.7	101.6	54.5	39.3	24.7	20.9	30.8
1971	19.3	19.9	22.0	26.6	27.1	89.5	134.2	146.1	93.9	30.4	19.1	14.4	53.8
1972	12.7	13.8	10.7	10.7	7.6	7.9	48.7	54.2	247.3	14.7	8.0	6.2	36.7
1973	5.8	5.4	5.2	4.6	4.6	27.8	39.5	77.4	68.9	29.8	4.8	2.7	23.1
1974	2.2	2.2	1.7	1.4	1.1	16.5	57.0	83.6	32.8	11.3	7.8	6.9	18.9
1975	7.2	7.2	6.3	4.8	4.2	85.1	118.6	107.0	84.5	18.5	4.8	3.0	37.8
1976	2.3	2.3	1.8	1.5	2.7	4.7	72.3	168.2	72.4	11.8	4.3	3.1	29.3
1977	2.8	2.5	2.2	2.8	10.2	13.8	133.5	122.8	72.0	18.0	7.9	5.5	33.2
1978	4.4	7.0	11.5	4.0	2.9	28.2	63.9	97.6	65.4	13.0	5.8	4.4	25.8
1979	3.7	8.1	3.3	2.5	17.4	10.1	46.2	98.1	12.7	4.2	2.7	2.6	17.8
1980	2.2	2.0	2.6	1.7	1.7	7.7	70.5	83.7	72.9	15.6	6.1	4.2	22.8
1981	5.0	3.8	3.8	3.3	3.9	20.7	143.0	104.5	44.1	29.5	17.5	11.0	32.9
1982	12.7	10.7	16.5	9.1	9.1	13.8	56.5	72.8	38.0	7.3	4.3	3.3	21.3
1983	5.2	3.0	2.6	10.2	7.9	16.0	46.5	96.0	160.0	81.1	42.3	32.7	42.1
1984	28.1	31.1	26.2	25.7	25.1	105.8	136.9	76.7	81.0	51.0	26.5	22.4	53.1
1985	19.3	14.8	10.0	9.9	9.7	21.8	118.7	109.2	79.1	57.0	19.4	7.8	40.0
1986	4.2	3.4	1.8	1.2	3.8	31.3	110.1	137.6	93.0	59.2	34.0	28.0	42.7
AVERAGE	8.2	8.2	7.6	7.1	8.2	31.1	87.4	102.2	80.7	28.9	14.1	10.5	33.1

Table 3.2.1 MONTHLY NATURAL RUNOFF AT HYDROLOGICAL STATIONS
STATIONS NO. 270 (JAMU) (8/15)

Unit: m3/s

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	AVERAGE
1963	114.1	91.9	102.1	122.4	200.2	404.3	1410.3	2161.6	1206.5	369.7	192.3	137.6	547.1
1964	104.6	88.3	82.1	98.4	124.7	289.4	1066.6	1405.8	1407.7	479.6	197.9	141.0	459.8
1965	112.1	92.0	88.4	126.5	141.3	263.8	605.9	928.5	646.4	236.1	150.6	107.0	293.1
1966	80.8	76.3	71.6	79.2	128.3	296.9	818.5	1560.0	797.0	230.3	140.4	105.9	368.2
1967	80.6	66.2	65.9	80.8	96.6	266.5	854.4	1420.2	865.1	279.3	158.3	117.1	365.2
1969	100.7	82.0	78.9	101.7	184.8	301.6	1044.1	1660.3	1531.0	447.9	186.4	128.2	490.2
1970	100.7	84.2	78.3	88.5	99.8	590.3	1552.7	1469.7	964.7	365.0	182.7	117.1	477.9
1971	95.7	73.1	88.9	124.6	180.5	857.4	1328.0	1499.1	1097.9	296.3	201.2	132.1	500.6
1972	100.6	101.9	93.1	103.6	156.7	251.8	937.9	1098.5	1083.5	295.6	175.6	120.3	378.5
1973	116.4	103.4	115.2	143.0	187.8	728.3	1047.9	1534.2	1507.9	1396.8	360.0	163.5	620.5
1974	126.5	103.7	86.0	101.0	116.9	215.7	1086.9	1698.7	1153.0	342.4	166.6	118.7	446.2
1975	97.5	90.1	87.3	118.2	186.1	541.6	1372.3	1587.6	1324.2	413.2	204.5	136.0	516.3
1976	101.8	91.5	84.0	97.3	135.5	220.7	798.8	1232.4	1047.6	257.8	107.7	77.2	356.4
1977	67.4	60.9	53.9	62.9	85.2	199.0	1086.6	1462.5	806.6	223.0	133.5	95.6	364.6
1978	81.1	86.5	86.1	115.2	168.7	620.2	1178.7	1684.3	1158.3	371.1	155.8	115.3	488.1
1979	94.1	94.1	82.3	101.7	338.7	242.5	804.0	1050.1	397.9	171.9	119.4	100.1	302.3
1980	83.9	72.7	79.9	96.9	146.3	265.7	1701.4	1706.0	899.7	263.7	146.8	111.3	469.0
1981	96.2	81.9	80.6	108.1	128.3	226.3	1427.3	1493.9	702.8	300.2	145.0	104.3	411.8
1982	98.8	90.0	103.7	131.2	179.2	455.5	860.4	2060.0	1005.9	289.3	141.7	107.0	463.5
1983	98.6	81.3	73.9	83.1	157.8	261.2	426.2	1071.9	1843.1	408.4	169.0	96.2	398.1
1984	78.8	72.0	68.4	66.5	108.2	325.4	1105.6	1047.2	1190.0	298.6	165.1	119.8	389.2
1985	100.3	80.9	73.1	88.0	108.6	204.8	1051.2	1337.2	1182.5	808.3	313.0	173.4	463.4
1986	132.3	108.0	95.3	117.8	141.2	428.2	1216.6	1379.5	704.6	398.5	206.2	141.0	425.7
1987	106.7	93.5	84.6	103.2	164.2	235.8	562.6	926.7	722.1	286.1	164.5	119.6	299.1
AVERAGE	98.8	86.1	83.5	102.5	152.7	362.2	1056.0	1436.5	1051.9	384.5	178.5	120.2	429.0

Table 3.2.1 MONTHLY NATURAL RUNOFF AT HYDROLOGICAL STATIONS
STATIONS NO. 280 (CHISAPANI) (9/15)

Unit: m3/s

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	AVERAGE
1962	487.1	461.2	497.6	554.9	739.6	1757.0	2982.8	5794.2	4116.0	1473.0	689.4	458.9	1676.3
1963	341.3	282.6	349.2	439.5	723.6	1543.5	3655.0	5685.2	3519.8	1094.1	627.5	442.8	1569.5
1964	338.9	277.9	257.3	375.0	458.5	980.7	3551.6	4056.8	3545.3	1211.7	619.8	447.0	1351.7
1965	350.8	324.1	343.9	473.4	563.5	1095.9	2074.2	2577.4	1685.8	717.3	469.2	329.1	921.8
1966	268.3	260.1	247.2	277.8	518.3	1080.2	2443.8	4504.2	2007.8	739.9	456.1	336.2	1103.4
1967	265.0	225.4	216.5	271.2	374.8	819.5	2761.3	4661.3	2672.1	958.6	543.8	404.5	1190.2
1968	355.6	316.0	354.3	388.7	653.8	1612.9	3555.2	4433.2	2162.8	1050.7	576.3	406.7	1331.9
1969	351.3	300.9	308.8	391.9	788.0	1331.0	2794.6	4249.4	3752.0	1359.8	675.0	452.6	1403.7
1970	365.3	315.2	301.8	408.5	567.5	1428.1	3887.7	4205.8	2392.3	1241.5	659.6	464.1	1363.1
1971	371.8	334.0	369.4	528.9	605.2	2877.3	4243.9	5201.6	3573.0	1393.3	809.0	552.0	1747.5
1972	423.3	418.0	401.8	410.0	814.5	1045.6	2853.2	3061.6	2957.2	995.7	591.0	396.2	1203.2
1973	344.9	317.0	385.5	577.6	950.6	2344.0	3012.2	4439.7	3678.6	2917.1	880.2	522.7	1707.0
1974	395.6	333.5	307.0	408.0	493.3	878.0	2511.1	4420.7	2271.7	1078.7	574.0	402.2	1181.3
1975	347.1	333.7	342.9	542.4	872.4	2921.0	4219.5	4849.8	4119.1	1533.2	714.0	485.6	1781.9
1976	360.2	328.1	306.0	400.6	704.1	1127.5	2330.6	3811.0	2881.4	916.6	525.6	362.8	1177.4
1977	292.2	270.4	239.6	276.2	498.9	969.7	3889.7	4614.1	2751.2	1041.0	597.8	411.6	1331.6
1978	332.0	319.0	419.6	536.0	1115.1	1870.0	3931.7	5660.3	3089.4	1133.3	612.0	442.8	1633.5
1979	326.3	341.6	308.5	462.6	915.1	1300.9	3079.2	3449.1	1231.1	630.6	374.4	288.3	1067.3
1980	236.9	191.8	243.8	369.6	683.7	1400.7	4363.9	5120.1	2993.7	1037.6	549.1	369.9	1475.3
1981	300.3	256.0	284.3	413.4	736.6	1162.9	4018.9	4796.6	2521.8	1393.0	689.8	438.7	1429.6
1982	343.1	315.8	499.2	632.5	921.0	1939.8	3276.3	4976.0	3129.8	982.5	561.9	373.5	1504.9
1983	305.0	249.8	233.9	440.1	839.4	1166.5	2461.5	3699.4	5517.7	3125.8	797.3	479.2	1616.7
1984	377.1	357.1	334.8	340.4	755.0	1654.6	3126.5	2845.5	2744.9	799.4	469.0	352.0	1185.1
1985	296.9	253.5	242.0	296.8	450.0	755.3	2935.6	3992.6	3206.7	2658.4	942.6	562.4	1392.9
1986	429.9	348.5	317.3	451.5	621.5	2445.7	3727.4	3864.2	2285.0	1130.3	626.2	475.3	1401.5
1987	361.5	322.6	304.0	368.1	630.0	1202.7	2339.0	2929.7	2187.7	837.4	526.2	401.5	1039.6
1988	335.1	302.4	377.1	509.0	781.1	1038.0	4167.1	5458.1	2113.3	930.3	557.6	434.5	1430.1
AVERAGE	344.5	309.5	325.7	427.6	695.4	1472.2	3266.4	4346.6	2929.9	1273.4	619.0	425.7	1378.4

Table 3.2.1 MONTHLY NATURAL RUNOFF AT HYDROLOGICAL STATIONS
STATIONS NO. 286 (DARADHUNGA) (10/15)

Unit: m3/s

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	AVERAGE
1972	4.8	4.6	3.6	2.5	1.4	3.0	18.6	21.8	28.8	13.5	7.4	5.0	9.6
1973	6.1	5.0	5.0	2.6	2.6	26.9	29.7	53.0	44.2	56.4	15.7	8.7	21.4
1974	6.9	5.2	3.7	2.9	2.0	2.4	18.1	38.3	23.8	11.7	6.1	4.2	10.5
1975	4.6	4.6	3.6	2.4	1.8	22.1	64.5	68.7	45.3	16.4	9.9	5.5	20.9
1976	3.8	3.3	2.4	2.5	2.3	2.0	8.0	22.6	21.6	8.2	5.0	3.6	7.1
1977	3.2	2.7	2.2	2.4	2.7	8.4	27.7	35.6	24.9	11.3	6.3	4.8	11.1
1978	4.6	4.2	4.5	3.4	3.2	14.6	47.2	69.4	32.1	13.1	5.8	4.2	17.3
1979	3.4	3.8	2.6	2.6	15.1	2.7	37.7	54.6	14.2	5.8	3.9	3.4	12.6
1980	3.0	2.1	2.2	1.6	6.0	5.0	39.7	80.7	46.0	14.4	7.3	5.1	17.9
1981	4.6	4.0	3.5	3.0	3.0	4.0	37.2	48.8	81.8	32.7	15.3	8.9	20.6
1982	7.8	7.3	8.6	6.1	6.2	6.8	15.8	47.7	66.7	7.9	4.4	3.0	15.7
1983	2.6	2.2	1.7	1.7	2.2	1.2	4.6	12.7	52.7	59.3	9.7	5.2	13.0
1984	5.4	3.2	2.3	2.2	1.7	5.3	58.7	21.7	69.4	12.5	6.7	4.4	16.1
1985	3.8	2.7	2.6	2.7	2.5	3.0	19.7	36.6	33.6	27.9	7.6	5.0	12.3
AVERAGE	4.6	3.9	3.5	2.8	3.8	7.7	30.5	43.7	41.8	20.8	7.9	5.1	14.7

Table 3.2.1 MONTHLY NATURAL RUNOFF AT HYDROLOGICAL STATIONS
STATIONS NO. 290 (BARGADHA) (11/15)

Unit: m3/s

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	AVERAGE
1967	13.7	10.8	7.9	6.0	5.4	13.0	191.5	100.0	151.0	48.1	21.6	18.1	49.3
1968	17.7	12.9	8.2	7.2	6.1	58.5	107.0	191.4	142.8	62.7	24.4	17.5	55.0
1969	15.0	11.9	9.8	8.5	12.7	21.1	88.6	413.0	156.9	60.9	26.7	11.9	70.4
1970	10.4	9.6	7.4	5.2	5.4	68.9	391.9	169.9	138.8	118.0	33.8	23.5	82.7
1971	18.6	15.1	18.2	37.0	63.8	106.3	138.5	265.9	181.5	106.3	53.6	29.9	86.7
1972	21.7	25.5	14.5	8.9	7.9	23.4	127.7	91.9	460.8	75.7	32.8	21.1	75.8
1973	32.6	22.8	17.5	9.2	11.2	164.1	238.3	245.4	249.9	192.4	40.3	24.1	104.5
1974	18.3	14.9	11.6	9.7	8.6	39.3	147.8	294.0	124.2	39.8	27.7	17.8	63.3
1977	13.7	11.6	8.0	7.4	16.2	38.6	276.0	449.1	122.4	56.0	25.3	18.9	88.0
1978	16.3	19.0	13.2	8.7	9.0	118.0	659.4	352.1	246.1	113.8	55.1	23.2	137.4
1979	17.8	17.5	11.2	6.7	31.7	20.2	339.3	222.2	137.9	36.8	17.7	23.7	74.3
1980	20.2	13.7	11.9	9.5	11.7	35.6	89.0	126.9	361.9	56.6	28.3	17.7	65.2
1981	14.6	12.7	10.3	10.8	15.4	77.9	210.9	332.0	489.8	113.7	57.4	25.8	114.6
1982	21.0	20.8	37.2	12.1	18.7	37.0	50.4	206.2	298.0	49.1	30.6	19.6	66.8
1983	17.0	14.0	9.4	8.8	14.7	11.2	69.3	129.9	532.2	318.7	53.8	32.7	101.1
1984	36.1	20.3	13.6	10.1	10.7	74.2	636.4	257.4	505.1	61.1	40.0	32.1	142.2
1985	24.3	18.7	16.2	14.2	25.0	89.8	212.3	436.1	286.5	218.3	52.1	37.6	120.2
1986	20.9	18.5	13.5	11.0	19.6	62.4	159.1	312.1	114.9	80.7	32.2	29.7	73.5
AVERAGE	19.4	16.1	13.3	10.6	16.3	58.9	229.6	255.3	261.2	100.5	36.3	23.6	87.3

Table 3.2.1 MONTHLY NATURAL RUNOFF AT HYDROLOGICAL STATIONS
STATIONS NO. 330 (NAYA GAON) (12/15)

Unit: m3/s

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	AVERAGE
1965	19.4	15.8	13.1	11.1	7.1	29.0	89.1	161.9	101.4	43.8	26.2	18.0	44.9
1966	14.3	13.0	10.4	8.0	15.7	29.2	87.9	180.2	87.8	35.1	20.9	15.7	43.5
1967	12.8	10.2	10.3	9.6	7.5	31.0	82.0	126.9	125.7	64.2	40.7	31.9	46.3
1968	27.2	18.8	11.2	9.1	8.1	36.8	137.3	205.2	118.4	92.5	42.2	29.3	61.8
1969	19.0	14.1	12.6	10.3	10.9	16.9	67.2	236.0	238.8	88.5	26.8	17.8	63.5
1970	13.9	11.9	8.1	5.4	8.2	78.8	168.6	243.6	161.8	81.6	39.4	25.4	71.0
1971	17.8	13.4	11.3	15.9	14.9	89.5	162.5	267.0	155.1	79.6	45.2	30.4	75.7
1972	24.4	22.1	18.4	15.3	12.5	24.2	85.1	84.6	109.0	48.1	22.4	13.3	40.1
1973	16.8	13.6	12.7	6.2	10.7	73.6	200.1	270.0	302.4	210.9	34.8	27.3	98.9
1976	14.9	14.9	12.4	12.0	11.9	18.8	69.8	129.6	139.4	57.8	26.7	17.5	44.0
1978	18.7	17.2	16.5	15.2	14.8	87.3	273.1	222.6	88.2	57.8	22.3	17.1	71.5
1979	16.2	16.6	12.9	12.0	14.5	22.1	93.1	155.7	56.7	34.5	23.8	20.7	40.2
1980	17.9	16.0	15.0	12.5	14.4	45.8	171.8	270.0	231.2	61.0	29.8	20.7	76.0
1981	17.5	13.8	12.5	11.0	12.3	29.9	123.1	200.9	205.3	74.4	34.9	20.6	63.3
1982	16.0	14.2	15.3	11.1	11.2	18.5	62.1	272.2	295.4	74.1	35.0	22.5	70.9
1983	17.6	14.6	11.7	10.5	13.6	10.7	45.2	143.3	269.9	133.9	44.9	26.0	62.0
1984	20.0	15.2	12.5	11.4	9.7	34.8	184.9	209.3	244.3	44.1	24.7	18.3	69.4
1985	14.6	12.4	10.7	10.2	13.3	17.7	79.9	129.2	108.4	77.6	33.6	22.4	44.4
AVERAGR	17.7	14.9	12.6	10.9	11.7	38.6	121.3	194.9	168.9	75.5	31.9	21.9	60.4

Table 3.2.1 MONTHLY NATURAL RUNOFF AT HYDROLOGICAL STATIONS STATIONS NO. 339.5 (TIGRAGAON) (13/15)

Unit: m3/s

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	AVERAGE
1972	5.3	4.8	3.9	3.5	2.4	5.0	55.5	36.4	31.2	14.6	8.8	6.1	14.9
1973	6.0	5.0	5.0	3.1	3.8	43.3	69.2	135.7	133.4	133.4	24.2	11.9	48.0
1974	8.0	5.6	4.9	4.2	2.9	10.6	55.2	93.5	54.5	26.9	12.5	7.8	24.0
1975	7.3	8.7	8.3	6.4	5.9	28.7	111.2	110.9	100.4	53.0	21.7	13.7	39.9
1976	10.6	9.3	7.9	7.2	7.5	13.2	93.2	81.8	64.0	26.1	12.0	7.5	28.5
1977	5.8	4.6	3.7	3.2	3.6	8.3	48.9	95.7	56.4	24.6	13.2	9.0	23.2
1978	8.0	6.8	6.7	6.0	7.2	43.4	114.6	92.2	77.1	32.9	11.9	6.7	34.6
1979	4.7	4.6	3.3	2.6	2.1	14.0	68.1	104.6	30.1	15.3	9.3	8.1	22.4
1980	6.1	5.2	4.9	2.7	3.0	10.5	58.7	96.1	107.3	18.6	8.3	5.3	27.3
1981	5.0	3.5	3.4	2.7	2.4	8.4	91.0	78.7	85.9	25.7	10.5	6.0	27.1
1982	5.2	4.5	4.4	3.5	3.3	9.6	48.4	106.4	82.9	21.7	12.1	8.0	25.9
1983	6.7	5.5	4.8	3.5	10.0	6.2	28.3	79.5	182.0	45.1	15.5	9.0	32.9
1984	7.1	5.5	4.6	3.1	2.8	18.5	133.3	82.3	91.0	20.1	9.3	6.6	32.2
1985	5.9	4.2	3.9	2.7	2.9	16.8	88.3	77.3	87.4	40.0	14.8	9.4	29.6
1988	6.6	5.7	5.4	4.3	4.7	12.3	116.6	162.5	95.5	29.6	17.7	13.5	39.8
AVERAGE	6.5	5.6	5.0	3.9	4.3	16.6	78.7	95.6	85.3	35.2	13.4	8.6	30.0

Table 3.2.1 MONTHLY NATURAL RUNOFF AT HYDROLOGICAL STATIONS STATIONS NO. 350 (BAGASOTI GAON) (14/15)

Unit: m3/s

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	AVERAGE
1976	29.5	25.0	19.6	19.3	20.7	51.3	200.0	258.1	219.3	107.1	61.9	44.3	88.4
1977	36.4	29.6	23.5	20.8	26.9	40.2	161.7	282.9	149.0	72.7	46.9	34.6	77.5
1978	28.5	24.5	23.7	23.7	21.6	132.2	287.9	308.5	203.1	110.1	53.3	35.7	104.8
1979	25.9	25.2	17.3	14.5	19.4	56.2	176.8	254.4	130.3	82.9	52.7	46.9	75.6
1980	34.8	28.3	24.7	15.8	24.7	71.1	183.3	258.8	327.3	105.7	62.0	41.9	98.4
1981	36.0	25.5	23.9	18.2	22.5	47.6	196.0	240.4	379.4	129.4	64.6	39.4	102.0
1982	30.9	26.7	24.9	16.8	18.0	36.9	137.6	275.7	276.3	94.4	55.2	35.9	86.0
1983	28.8	23.2	18.7	15.5	34.9	32.7	90.2	226.4	423.5	195.0	75.8	47.9	101.1
1984	37.0	27.0	20.1	17.3	14.2	83.5	281.9	241.0	324.5	100.1	50.7	34.8	102.9
1985	29.4	21.4	18.1	20.3	25.4	51.3	207.2	248.7	252.6	169.7	62.6	36.5	95.7
AVERAGE	31.7	25.6	21.4	18.2	22.8	60.3	192.3	259.5	268.5	116.7	58.6	39.8	93.2

Table 3.2.1 MONTHLY NATURAL RUNOFF AT HYDROLOGICAL STATIONS
STATIONS NO. 360 (JALKUNDI) (15/15)

Unit: m3/s

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	AVERAGE
1964	24.8	18.3	15.3	14.7	18.9	46.1	259.0	354.5	346.2	156.8	123.3	33.2	118.0
1965	44.1	30.6	32.3	13.5	4.6	57.3	175.1	295.7	154.7	77.4	39.5	27.0	79.7
1966	22.8	19.2	15.0	9.8	5.6	66.1	183.1	315.6	148.2	51.1	29.2	23.8	74.6
1967	19.6	14.5	14.2	14.1	6.5	55.4	205.8	260.5	262.6	90.8	40.4	30.0	84.8
1968	26.7	22.5	17.8	10.9	3.7	105.9	259.5	418.1	195.4	172.5	55.6	35.6	111.0
1969	28.5	21.4	18.7	12.5	9.2	46.2	137.3	399.5	367.6	138.8	60.7	37.0	106.8
1970	31.3	24.5	15.0	8.6	9.7	167.2	384.5	327.6	244.9	164.5	54.2	32.9	122.6
1971	26.0	20.7	19.6	46.9	41.4	169.2	320.0	363.6	244.5	141.9	76.2	40.1	126.3
1972	28.2	27.0	19.9	12.2	5.0	36.1	209.9	149.8	214.8	84.7	43.6	27.8	71.8
1973	41.3	28.1	28.1	13.5	18.1	265.4	323.6	475.1	455.7	432.0	111.4	47.3	187.2
1974	31.6	24.7	19.4	14.1	7.5	23.3	289.5	450.8	204.7	112.3	47.9	31.2	105.5
1975	26.9	22.1	17.4	11.6	5.8	98.8	467.4	533.5	469.1	238.8	63.8	40.3	167.1
1976	28.3	22.9	16.3	13.1	18.4	46.8	277.4	348.8	345.1	99.3	42.0	27.4	107.6
1977	22.2	17.7	13.8	10.2	12.9	77.1	227.3	549.9	236.7	75.3	35.1	26.6	109.4
1978	22.2	20.2	19.3	13.8	8.1	186.9	649.9	494.5	318.3	151.8	50.3	31.9	164.9
1979	23.6	23.9	16.3	13.3	20.0	97.2	356.1	471.9	122.1	70.0	30.6	31.9	107.3
1980	22.1	17.3	14.6	8.0	9.7	179.9	337.5	446.6	624.8	104.4	43.5	27.8	153.1
1981	24.3	18.4	15.6	15.5	17.0	25.6	300.7	428.6	772.7	148.8	54.4	29.0	154.3
1982	37.0	30.4	27.2	13.7	53.0	41.1	210.2	389.5	410.7	77.9	39.8	26.2	113.4
1983	21.3	18.9	13.8	11.3	34.4	18.1	106.1	271.4	657.3	306.8	79.2	40.7	131.6
1984	36.2	24.8	16.3	12.8	5.9	148.2	533.9	370.3	577.1	110.7	48.5	31.7	160.0
1985	24.6	17.5	13.7	9.8	17.4	86.5	341.4	411.4	436.8	236.6	88.4	54.4	145.4
AVERAGE	27.9	22.1	18.2	13.8	15.1	92.9	298.0	387.6	355.0	147.4	57.2	33.4	122.8

Table 3.2.2 MEAN MONTHLY RAINFALL AND RUNOFF DEPTH
STATION NO.120(NANGRAON) : BASIN AREA 1,150 km2 (1/15)

Unit: mm

Station no.	Duration	(%)	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
101	1956-1989	18	39.6	38.7	56.7	46.4	76.6	256.7	443.1	407.3	217.7	67.3	8.3	18.8	1676.9
201	1956-1989	59	59.4	49.3	61.4	65.5	109.2	313.2	566.0	549.2	308.2	73.1	12.3	29.0	2195.7
Narayani Ashram	1982-1989	23	31.3	97.3	110.9	92.4	142.7	207.3	557.9	532.9	284.6	93.7	3.7	53.5	2208.3
Basin precipitation by Thiessen(mm)			49.4	58.4	71.9	68.2	111.0	278.6	542.0	519.9	286.5	76.8	9.6	32.8	2105.2
Mean runoff at Station 120(m3/s)			16.7	15.6	17.3	20.8	29.6	64.0	159.2	209.7	142.9	55.8	28.5	20.3	780.4
Mean runoff depth (mm)			38.9	32.8	40.3	46.9	68.9	144.3	370.8	488.4	322.1	130.0	64.2	47.3	1783.4
Runoff/precipitation ratio			0.79	0.56	0.56	0.69	0.62	0.52	0.68	0.94	1.12	1.69	6.70	1.44	0.85

Table 3.2.2 MEAN MONTHLY RAINFALL AND RUNOFF DEPTH
STATION NO.150(PANCHESHWAR) : BASIN AREA 12,600km2 (2/15)

Unit: mm

Station no.	Duration	(%)	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
101	1956-1989	9	39.6	38.7	56.7	46.4	76.6	256.7	443.1	407.3	217.7	67.3	8.3	18.8	1676.9
201	1956-1989	7	59.4	49.3	61.4	65.5	109.2	313.2	566.0	549.2	308.2	73.1	12.3	29.0	2195.7
311	1978-1989	2	33.5	31.6	45.9	37.0	57.3	58.4	155.0	145.4	70.8	34.3	8.6	16.9	694.7
Pancheshwar	1982-1989	6	28.9	69.3	29.1	63.8	119.4	121.1	276.3	186.6	144.7	93.2	4.6	47.3	1184.3
Khetikhan	1982-1989	4	22.9	41.8	53.0	74.1	111.9	124.8	300.5	164.4	178.6	81.1	2.3	32.9	1188.3
Berinag	1983-1989	12	33.0	52.4	60.2	81.0	115.5	275.4	478.9	503.0	450.0	117.1	5.3	41.4	2213.3
Baijnath	1982-1989	7	27.0	27.0	49.1	67.1	80.4	131.2	313.7	341.2	160.5	78.8	6.5	44.9	1327.6
Tejam	1982-1989	14	41.9	56.7	49.8	57.8	151.5	250.5	634.8	838.5	470.9	74.9	6.4	42.1	2675.7
Tijjam	1985-1989	23	29.7	46.7	119.0	76.2	161.2	76.5	491.6	372.4	187.9	136.6	9.2	53.6	1760.4
Narayan Ashram	1982-1989	16	31.3	97.3	110.9	92.4	142.7	207.3	557.9	532.9	284.6	93.7	3.7	53.5	2208.3
Basin precipitation by Thiessen(mm)			34.6	55.8	76.9	71.1	127.9	186.5	481.8	468.3	278.3	97.2	6.8	43.1	1928.4
Mean runoff at Station 150(m3/s)			154.2	136.2	145.0	196.7	365.6	672.1	1571.1	1754.9	1088.6	505.2	273.0	202.2	7064.8
Mean runoff depth (mm)			32.8	26.2	30.8	40.5	77.7	138.3	334.0	373.0	223.9	107.4	56.2	43.0	1473.5
Runoff/precipitation ratio			0.95	0.47	0.40	0.57	0.61	0.74	0.69	0.80	0.80	1.11	8.23	1.00	0.76

Table 3.2.2 MEAN MONTHLY RAINFALL AND RUNOFF DEPTH
STATION NO.170(PATAN NEAR BAITADI) : BASIN AREA : 188 km2 (3/15)

Unit: mm

Station no.	Duration	(%)	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
103	1956-1989	95	40.5	36.5	48.7	43.3	100.6	209.1	356.3	311.0	172.4	44.5	10.2	20.8	1393.8
201	1956-1989	5	59.4	49.3	61.4	65.5	109.2	313.2	566.0	549.2	308.2	73.1	12.3	29.0	2195.7
Basin precipitation by Thiessen(mm)			41.5	37.1	49.3	44.4	101.1	214.3	366.8	322.9	179.2	45.9	10.3	21.2	1433.9
Mean runoff at Station 170(m3/s)			1.2	1.1	1.1	0.9	0.9	7.5	18.1	28.5	16.5	5.1	2.4	1.6	84.9
Mean runoff depth (mm)			17.1	14.2	15.7	12.4	12.8	103.4	257.9	406.0	227.5	72.7	33.1	22.8	1186.8
Runoff/precipitation ratio			0.41	0.38	0.32	0.28	0.13	0.48	0.70	1.26	1.27	1.58	3.20	1.08	0.83

Table 3.2.2 MEAN MONTHLY RAINFALL AND RUNOFF DEPTH
STATION NO.240(ASARA GHAT) : BASIN AREA : 19,260 km2 (4/15)

Unit: mm

Station no.	Duration	(%)	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
206	1956-1989	1	46.3	43.2	38.1	35.0	95.0	176.3	324.1	250.3	147.8	48.1	11.0	23.1	1238.4
301	1958-1989	17	58.7	42.1	66.2	43.0	44.4	60.6	144.1	144.5	80.0	44.7	9.3	26.0	763.8
302	1957-1989	6	44.8	34.2	46.2	33.5	42.6	56.9	96.7	99.3	67.2	32.2	5.2	20.4	579.2
303	1957-1989	7	27.7	39.1	53.7	39.1	48.0	69.0	189.7	169.8	88.4	33.3	5.7	15.1	778.4
305	1966-1989	3	56.7	45.6	38.7	52.3	116.1	218.5	375.5	313.4	154.2	51.9	5.8	18.5	1447.3
307	1971-1989	6	20.5	40.8	41.8	36.9	72.4	102.3	218.0	220.2	107.1	28.2	6.4	26.2	920.8
308	1971-1989	4	38.6	50.5	57.9	50.6	60.9	71.6	134.5	123.2	90.6	47.7	8.5	16.5	751.0
311	1978-1989	39	23.2	41.2	66.0	30.0	69.8	46.6	184.3	154.4	118.1	43.6	13.0	21.4	811.5
312	1958-1989	7	33.5	31.6	45.9	37.0	57.3	58.4	155.0	145.4	70.8	34.3	8.6	16.9	694.7
313	1979-1989	8	27.5	37.8	77.1	54.4	70.6	82.1	369.6	299.9	134.8	41.2	23.2	29.2	1247.3
418	1975-1989	2	26.4	38.1	40.8	48.5	86.1	186.5	364.7	343.1	230.2	72.0	9.0	28.0	1473.3
Basin precipitation by Thiessen(mm)			33.7	40.2	60.1	37.8	63.3	68.4	196.1	173.7	106.4	41.6	11.0	22.1	854.6
Mean runoff at Station 240(m3/s)			130.0	115.6	129.2	199.5	379.2	719.9	1173.6	1392.3	923.8	435.5	234.3	160.9	5993.8
Mean runoff depth (mm)			18.1	14.5	18.0	26.8	52.7	96.9	163.2	193.6	124.3	60.6	31.5	22.4	817.8
Runoff/precipitation ratio			0.54	0.36	0.30	0.71	0.83	1.42	0.83	1.11	1.17	1.46	2.86	1.01	0.96

Table 3.2.2 **MEAN MONTHLY RAINFALL AND RUNOFF DEPTH**
STATION NO.250(BENIGHAT) : BASIN AREA 21,240 km2 (5/15)

Unit: mm

Station no.	Duration	(%)	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
206	1956-1989	3	46.3	43.2	38.1	35.0	95.0	176.3	324.1	250.3	147.8	48.1	11.0	23.1	1238.4
301	1958-1989	16	58.7	42.1	66.2	43.0	44.4	60.6	144.1	144.5	80.0	44.7	9.3	26.0	763.8
302	1957-1989	7	44.8	34.2	46.2	33.5	42.6	56.9	96.7	99.3	67.2	32.2	5.2	20.4	579.2
303	1957-1989	8	27.7	39.1	53.7	39.1	48.0	69.0	189.7	169.8	88.4	33.3	5.7	15.1	778.4
305	1966-1989	3	56.7	45.6	38.7	52.3	116.1	218.5	375.5	313.4	154.2	51.9	5.8	18.5	1447.3
307	1971-1989	5	20.5	40.8	41.8	36.9	72.4	102.3	218.0	220.2	107.1	28.2	6.4	26.2	920.8
308	1971-1989	4	38.6	50.5	57.9	50.6	60.9	71.6	134.5	123.2	90.6	47.7	8.5	16.5	751.0
311	1978-1989	36	23.2	41.2	66.0	30.0	69.8	46.6	184.3	154.4	118.1	43.6	13.0	21.4	811.5
312	1958-1989	7	33.5	31.6	45.9	37.0	57.3	58.4	155.0	145.4	70.8	34.3	8.6	16.9	694.7
313	1979-1989	8	27.5	37.8	77.1	54.4	70.6	82.1	369.6	299.9	134.8	41.2	23.2	29.2	1247.3
401	1963-1989	1	38.4	33.9	34.8	25.5	67.4	276.6	459.5	381.0	238.5	38.6	5.8	22.2	1621.9
406	1957-1989	1	35.4	33.6	29.0	34.8	68.7	265.8	564.7	531.5	278.3	61.7	5.5	17.5	1926.5
418	1975-1989	1	26.4	38.1	40.8	48.5	86.1	186.5	364.7	343.1	230.2	72.0	9.0	28.0	1473.3
Basin precipitation by Thiessen(mm)			34.3	40.1	59.0	37.7	63.3	73.7	202.9	178.8	108.4	41.5	10.8	21.9	872.5
Mean runoff at Station 250(m3/s)			163.2	144.8	155.9	226.9	402.0	757.5	1462.9	1778.7	1214.5	543.3	289.7	204.0	7343.4
Mean runoff depth (mm)			20.6	16.5	19.7	27.7	50.7	92.4	184.5	224.3	148.2	68.5	35.4	25.7	908.6
Runoff/precipitation ratio			0.60	0.41	0.33	0.73	0.80	1.25	0.91	1.25	1.37	1.65	3.26	1.17	1.04

Table 3.2.2 MEAN MONTHLY RAINFALL AND RUNOFF DEPTH
STATION NO.260(BANGA NEAR BELGAON) : BASIN AREA 7,460 km2 (6/15)

Unit: mm

Station no.	Duration	(%)	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
103	1956-1989	1	40.5	36.5	48.7	43.3	100.6	209.1	356.3	311.0	172.4	44.5	10.2	20.8	1393.8
104	1956-1989	5	49.5	54.2	61.0	50.9	70.9	176.6	351.1	312.4	174.4	70.8	7.3	28.9	1408.0
201	1956-1989	15	59.4	49.3	61.4	65.5	109.2	313.2	566.0	549.2	308.2	73.1	12.3	29.0	2195.7
202	1956-1989	31	57.2	55.3	63.5	47.3	55.4	171.3	355.6	375.6	210.5	61.5	7.1	30.0	1490.3
203	1956-1989	15	52.1	40.8	50.5	38.4	77.0	208.3	290.1	250.8	173.4	67.3	6.8	26.0	1281.6
204	1976-1989	14	52.1	62.8	81.2	63.5	125.6	287.7	581.5	505.4	233.7	38.1	8.5	39.4	2079.3
205	1958-1989	4	50.4	39.1	45.9	41.9	87.2	307.3	464.2	423.6	242.0	57.0	5.3	20.4	1784.1
217	1976-1989	10	43.7	53.4	45.6	52.3	124.1	167.7	351.8	320.0	160.8	64.0	7.9	43.8	1435.2
305	1966-1989	1	56.7	45.6	38.7	52.3	116.1	218.5	375.5	313.4	154.2	51.9	5.8	18.5	1447.3
311	1978-1989	3	23.2	41.2	66.0	30.0	69.8	46.6	184.3	154.4	118.1	43.6	13.0	21.4	811.5
401	1963-1989	1	38.4	33.9	34.8	25.5	67.4	276.6	459.5	381.0	238.5	38.6	5.8	22.2	1621.9
Basin precipitation by Thiessen(mm)			52.6	51.5	60.5	50.7	87.1	217.9	408.8	386.5	213.9	60.3	8.2	30.9	1628.9
Mean runoff at Station 260(m3/s)			73.7	69.1	76.6	92.2	129.9	281.5	701.4	923.5	630.0	245.5	126.0	89.6	3439.0
Mean runoff depth (mm)			26.5	22.4	27.5	32.0	46.6	97.8	251.8	331.6	218.9	88.1	43.8	32.2	1211.5
Runoff/precipitation ratio			0.50	0.44	0.45	0.63	0.54	0.45	0.62	0.86	1.02	1.46	5.31	1.04	0.74

Table 3.2.2 MEAN MONTHLY RAINFALL AND RUNOFF DEPTH
STATION NO.262(KHANAYATAL) : BASIN AREA 896 Km2 (7/15)

Unit: mm

Station no.	Duration	(%)	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
205	1958-1989	28	50.4	39.1	45.9	41.9	87.2	307.3	464.2	423.6	242.0	57.0	5.3	20.4	1784.1
208	1956-1989	5	26.3	15.7	21.1	20.8	46.3	269.4	566.7	519.4	310.5	49.5	3.1	17.7	1866.6
214	1975-1989	67	40.4	47.2	50.9	37.7	114.0	293.0	486.1	458.7	248.8	52.9	7.3	31.8	1868.9
Basin precipitation by Thiessen(mm)			42.5	43.4	48.0	38.1	103.1	295.8	484.0	451.9	250.0	53.8	6.5	27.9	1845.0
Mean runoff at Station 262(m3/s)			8.2	8.2	7.6	7.1	8.2	31.1	87.4	102.2	80.7	28.9	14.1	10.5	394.2
Mean runoff depth (mm)			24.5	22.1	22.7	20.5	24.5	90.0	261.3	305.5	233.5	86.4	40.8	31.4	1156.2
Runoff/precipitation ratio			0.58	0.51	0.47	0.54	0.24	0.30	0.54	0.68	0.93	1.60	6.26	1.13	0.63

Table 3.2.2 MEAN MONTHLY RAINFALL AND RUNOFF DEPTH
STATION NO.270(JAMU) : BASIN AREA 12,290 km2 (8/15)

Unit: mm

Station no.	Duration	(%)	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
301	1958-1989	1	58.7	42.1	66.2	43.0	44.4	60.6	144.1	144.5	80.0	44.7	9.3	26.0	763.8
303	1957-1989	1	27.7	39.1	53.7	39.1	48.0	69.0	189.7	169.8	88.4	33.3	5.7	15.1	778.4
312	1958-1989	39	33.5	31.6	45.9	37.0	57.3	58.4	155.0	145.4	70.8	34.3	8.6	16.9	694.7
402	1957-1989	1	37.7	29.1	41.3	40.0	79.2	223.6	486.9	485.2	214.2	53.8	10.6	18.0	1719.4
403	1963-1989	2	34.4	35.6	27.4	27.7	84.4	260.9	451.4	396.9	231.6	38.1	4.9	15.5	1608.9
406	1957-1989	5	35.4	33.6	29.0	34.8	68.7	265.8	564.7	531.5	278.3	61.7	5.5	17.5	1926.5
413	1971-1989	2	31.8	24.0	9.9	18.6	74.4	310.6	659.4	476.3	300.2	59.4	6.1	13.2	1983.7
418	1975-1989	15	26.4	38.1	40.8	48.5	86.1	186.5	364.7	343.1	230.2	72.0	9.0	28.0	1473.3
502	1957-1989	12	33.4	33.5	50.1	54.4	79.6	202.3	372.1	344.7	169.9	49.5	9.7	16.4	1415.5
513	1975-1989	12	23.1	14.8	20.2	30.3	77.1	177.0	345.7	327.2	168.2	61.5	8.2	21.4	1274.7
514	1973-1989	10	19.0	17.5	24.8	42.3	111.8	257.3	587.8	505.3	295.7	67.0	6.2	22.1	1956.7
Basin precipitation by Thiessen(mm)			30.0	29.5	38.7	40.0	73.6	150.3	318.7	291.3	160.7	50.5	8.2	19.6	1211.2
Mean runoff at Station 270(m3/s)			98.8	86.1	83.5	102.5	152.7	362.2	1056.0	1436.5	1051.9	384.6	178.5	120.2	5113.5
Mean runoff depth (mm)			21.5	16.9	18.2	21.6	33.3	76.4	230.1	313.1	221.8	83.8	37.6	26.2	1093.4
Runoff/precipitation ratio			0.72	0.57	0.47	0.54	0.45	0.51	0.72	1.07	1.38	1.66	4.58	1.34	0.90

Table 3.2.2 **MEAN MONTHLY RAINFALL AND RUNOFF DEPTH**
STATION NO.280(CHISAPANI) : BASIN AREA 42,890 km2 (9/15)

Unit: mm

Station no.	Duration	(%)	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
206	1956-1989	1	46.3	43.2	38.1	35.0	95.0	176.3	324.1	250.3	147.8	48.1	11.0	23.1	1238.4
217	1976-1989	2	43.7	53.4	45.6	52.3	124.1	167.7	351.8	320.0	160.8	64.0	7.9	43.8	1435.2
305	1966-1989	2	56.7	45.6	38.7	52.3	116.1	218.5	375.5	313.4	154.2	51.9	5.8	18.5	1447.3
302	1957-1989	3	44.8	34.2	46.2	33.5	42.6	56.9	96.7	99.3	67.2	32.2	5.2	20.4	579.2
308	1971-1989	2	38.6	50.5	57.9	50.6	60.9	71.6	134.5	123.2	90.6	47.7	8.5	16.5	751.0
418	1975-1989	5	26.4	38.1	40.8	48.5	86.1	186.5	364.7	343.1	230.2	72.0	9.0	28.0	1473.3
303	1957-1989	4	27.7	39.1	53.7	39.1	48.0	69.0	189.7	169.8	88.4	33.3	5.7	15.1	778.4
307	1971-1989	3	20.5	40.8	41.8	36.9	72.4	102.3	218.0	220.2	107.1	28.2	6.4	26.2	920.8
301	1958-1989	8	58.7	42.1	66.2	43.0	44.4	60.6	144.1	144.5	80.0	44.7	9.3	26.0	763.8
311	1978-1989	18	23.2	41.2	66.0	30.0	69.8	46.6	184.3	154.4	118.1	43.6	13.0	21.4	811.5
313	1979-1989	4	27.5	37.8	77.1	54.4	70.6	82.1	369.6	299.9	134.8	41.2	23.2	29.2	1247.3
312	1958-1989	15	33.5	31.6	45.9	37.0	57.3	58.4	155.0	145.4	70.8	34.3	8.6	16.9	694.7
402	1957-1989	3	37.7	29.1	41.3	40.0	79.2	223.6	486.9	485.2	214.2	53.8	10.6	18.0	1719.4
406	1957-1989	2	35.4	33.6	29.0	34.8	68.7	265.8	564.7	531.5	278.3	61.7	5.5	17.5	1926.5
403	1963-1989	1	34.4	35.6	27.4	27.7	84.4	260.9	451.4	396.9	231.6	38.1	4.9	15.5	1608.9
401	1963-1989	1	38.4	33.9	34.8	25.5	67.4	276.6	459.5	381.0	238.5	38.6	5.8	22.2	1621.9
202	1956-1989	5	57.2	55.3	63.5	47.3	55.4	171.3	355.6	375.6	210.5	61.5	7.1	30.0	1490.3
201	1956-1989	2	59.4	49.3	61.4	65.5	109.2	313.2	566.0	549.2	308.2	73.1	12.3	29.0	2195.7
204	1976-1989	2	52.1	62.8	81.2	63.5	125.6	287.7	581.5	505.4	233.7	38.1	8.5	39.4	2079.3
203	1956-1989	2	52.1	40.8	50.5	38.4	77.0	208.3	290.1	250.8	173.4	67.3	6.8	26.0	1281.6
104	1956-1989	1	49.5	54.2	61.0	50.9	70.9	176.6	351.1	312.4	174.4	70.8	7.3	28.9	1408.0
205	1958-1989	2	50.4	39.1	45.9	41.9	87.2	307.3	464.2	423.6	242.0	57.0	5.3	20.4	1784.1
214	1975-1989	1	40.4	47.2	50.9	37.7	114.0	293.0	486.1	458.7	248.8	52.9	7.3	31.8	1868.9
502	1957-1989	3	33.4	33.5	50.1	54.4	79.6	202.3	372.1	344.7	169.9	49.5	9.7	16.4	1415.5
514	1973-1989	3	19.0	17.5	24.8	42.3	111.8	257.3	587.8	505.3	295.7	67.0	6.2	22.1	1956.7
513	1975-1989	4	23.1	14.8	20.2	30.3	77.1	177.0	345.7	327.2	168.2	61.5	8.2	21.4	1274.7
405	1963-1989	1	35.0	24.9	25.9	21.8	62.9	290.7	690.6	620.2	356.2	49.9	8.9	18.8	2205.8
Basin precipitation by Thiessen(mm)			36.1	38.4	52.0	40.3	71.5	129.8	287.2	263.2	148.4	47.8	9.5	22.7	1146.9
Mean runoff at Station 280(m3/s)			344.5	309.5	325.7	427.6	695.4	1472.2	3266.4	4346.6	2929.9	1273.4	619.0	425.7	16435.9
Mean runoff depth (mm)			21.5	17.5	20.3	25.8	43.4	89.0	204.0	271.4	177.1	79.5	37.4	26.6	1007.1
Runoff/precipitation ratio			0.60	0.45	0.39	0.64	0.61	0.69	0.71	1.03	1.19	1.66	3.94	1.17	0.88

Table 3.2.2 MEAN MONTHLY RAINFALL AND RUNOFF DEPTH
STATION NO.286(DARADHUNGA) : BASIN AREA 816 km2 (10/15)

Unit: mm

Station no.	Duration	(%)	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
507	1971-1989	21	24.4	19.4	14.0	18.8	72.5	220.2	455.4	397.8	277.2	51.0	12.9	16.9	1580.5
512	1971-1989	70	33.3	26.3	37.3	26.1	73.5	200.2	342.6	231.6	178.5	53.6	9.5	24.3	1237.0
513	1975-1989	5	23.1	14.8	20.2	30.3	77.1	177.0	345.7	327.2	168.2	61.5	8.2	21.4	1274.7
514	1973-1989	4	19.0	17.5	24.8	42.3	111.8	257.3	587.8	505.3	295.7	67.0	6.2	22.1	1956.7
Basin precipitation by Thiessen(mm)			30.3	23.9	31.1	25.4	75.0	205.6	376.2	282.3	203.4	54.0	10.0	22.5	1339.8
Mean runoff at Station 286(m3/s)			4.6	3.9	3.5	2.8	3.8	7.7	30.5	43.7	41.8	20.8	7.9	5.1	176.1
Mean runoff depth (mm)			15.1	11.6	11.5	8.9	12.5	24.5	100.1	143.4	132.8	68.3	25.1	16.7	567.1
Runoff/precipitation ratio			0.50	0.48	0.37	0.35	0.17	0.12	0.27	0.51	0.65	1.26	2.50	0.74	0.42

Table 3.2.2 MEAN MONTHLY RAINFALL AND RUNOFF DEPTH
STATION NO.290(BARRGADHA) : BASIN AREA 3,000 km2 (11/15)

Unit: mm

Station no.	Duration	(%)	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
407	1957-1989	7	31.3	18.6	20.4	19.8	43.4	210.7	416.0	358.4	232.4	68.5	3.7	10.4	1433.5
412	1971-1989	8	25.3	11.0	10.5	18.6	42.9	219.7	482.9	340.1	198.3	59.6	2.9	9.5	1421.5
413	1971-1989	8	31.8	24.0	9.9	18.6	74.4	310.6	659.4	476.3	300.2	59.4	6.1	13.2	1983.7
415	1967-1989	5	19.0	10.4	8.3	13.2	46.3	144.5	313.1	241.8	161.6	40.0	1.8	13.5	1013.6
507	1971-1989	22	24.4	19.4	14.0	18.8	72.5	220.2	455.4	397.8	277.2	51.0	12.9	16.9	1580.5
509	1971-1989	22	23.8	21.6	18.2	25.9	90.1	276.4	532.0	483.9	334.7	87.9	10.5	11.1	1916.2
512	1971-1989	26	33.3	26.3	37.3	26.1	73.5	200.2	342.6	231.6	178.5	53.6	9.5	24.3	1237.0
513	1975-1989	2	23.1	14.8	20.2	30.3	77.1	177.0	345.7	327.2	168.2	61.5	8.2	21.4	1274.7
Basin precipitation by Thiessen(mm)			27.4	20.8	20.7	22.3	71.2	229.3	449.4	363.2	248.6	62.1	8.9	16.1	1539.8
Mean runoff at Station 290(m3/s)			19.4	16.1	13.3	10.6	16.3	58.9	229.6	255.3	261.2	100.5	36.3	23.6	1041.1
Mean runoff depth (mm)			17.3	13.0	11.9	9.2	14.6	50.9	205.0	227.9	225.7	89.7	31.4	21.1	912.0
Runoff/precipitation ratio			0.63	0.62	0.57	0.41	0.20	0.22	0.46	0.63	0.91	1.45	3.54	1.31	0.59

Table 3.2.2 MEAN MONTHLY RAINFALL AND RUNOFF DEPTH
STATION NO.330(NAYAGAON) : BASIN AREA 1,980 km2 (12/15)

Unit: mm

Station no.	Duration	(%)	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
502	1957-1989	10	33.4	33.5	50.1	54.4	79.6	202.3	372.1	344.7	169.9	49.5	9.7	16.4	1415.5
504	1973-1989	55	30.9	40.6	47.2	36.9	123.8	304.3	475.3	405.2	276.8	60.5	9.8	16.4	1827.7
505	1973-1989	14	26.4	22.4	29.0	34.7	83.5	237.0	352.6	282.7	175.7	46.2	11.0	13.8	1315.1
512	1971-1989	9	33.3	26.3	37.3	26.1	73.5	200.2	342.6	231.6	178.5	53.6	9.5	24.3	1237.0
514	1973-1989	12	19.0	17.5	24.8	42.3	111.8	257.3	587.8	505.3	295.7	67.0	6.2	22.1	1956.7
Basin precipitation by Thiessen(mm)			29.3	33.3	41.4	38.0	107.7	269.7	449.4	378.4	245.4	57.6	9.5	17.4	1677.0
Mean runoff at Station 330(m3/s)			17.7	14.9	12.6	10.9	11.7	38.6	121.3	194.9	168.9	75.5	31.9	21.9	720.8
Mean runoff depth (mm)			23.9	18.2	17.0	14.3	15.8	50.5	164.1	263.6	221.1	102.1	41.8	29.6	956.7
Runoff/precipitation ratio			0.82	0.55	0.41	0.38	0.15	0.19	0.37	0.70	0.90	1.77	4.40	1.70	0.57

Table 3.2.2 MEAN MONTHLY RAINFALL AND RUNOFF DEPTH
STATION NO.339.5(TIGRA GAON) : BASIN AREA 683 km2 (13/15)

Unit: mm

Station no.	Duration	(%)	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
505	1973-1989	100	26.4	22.4	29.0	34.7	83.5	237.0	352.6	282.7	175.7	46.2	11.0	13.8	1315.1
Basin precipitation by Thiessen(mm)			26.4	22.4	29.0	34.7	83.5	237.0	352.6	282.7	175.7	46.2	11.0	13.8	1315.1
Mean runoff at Station 339.5(m3/s)			6.5	5.6	5.0	3.9	4.3	16.6	78.7	95.6	85.3	35.2	13.4	8.6	358.7
Mean runoff depth (mm)			25.5	19.8	19.6	14.8	16.9	63.0	308.6	374.9	323.7	138.0	50.9	33.7	1380.2
Runoff/precipitation ratio			0.96	0.88	0.68	0.43	0.20	0.27	0.88	1.33	1.84	2.99	4.64	2.44	1.05

Table 3.2.2 MEAN MONTHLY RAINFALL AND RUNOFF DEPTH
STATION NO.350(BAGASOTI GAON) : BASIN AREA 3,380 km2 (14/15)

Unit: mm

Station no.	Duration	(%)	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
502	1957-1989	5	33.4	33.5	50.1	54.4	79.6	202.3	372.1	344.7	169.9	49.5	9.7	16.4	1415.5
504	1973-1989	31	30.9	40.6	47.2	36.9	123.8	304.3	475.3	405.2	276.8	60.5	9.8	16.4	1827.7
505	1973-1989	49	26.4	22.4	29.0	34.7	83.5	237.0	352.6	282.7	175.7	46.2	11.0	13.8	1315.1
509	1971-1989	4	23.8	21.6	18.2	25.9	90.1	276.4	532.0	483.9	334.7	87.9	10.5	11.1	1916.2
512	1971-1989	5	33.3	26.3	37.3	26.1	73.5	200.2	342.6	231.6	178.5	53.6	9.5	24.3	1237.0
514	1973-1989	6	19.0	17.5	24.8	42.3	111.8	257.3	587.8	505.3	295.7	67.0	6.2	22.1	1956.7
Basin precipitation by Thiessen(mm)			28.0	28.5	35.4	36.0	97.2	257.1	412.4	342.6	220.4	54.1	10.2	15.7	1537.6
Mean runoff at Station 350(m3/s)			31.7	25.6	21.4	18.2	22.8	60.3	192.3	259.5	268.5	116.7	58.6	39.8	1115.4
Mean runoff depth (mm)			25.1	18.3	17.0	14.0	18.1	46.2	152.4	205.6	205.9	92.5	44.9	31.5	867.2
Runoff/precipitation ratio			0.90	0.64	0.48	0.39	0.19	0.18	0.37	0.60	0.93	1.71	4.42	2.01	0.56

Table 3.2.2 MEAN MONTHLY RAINFALL AND RUNOFF DEPTH
STATION NO.360(JALKUNDI) : BASIN AREA 5,150 km2 (15/15)

Unit: mm

Station no.	Duration	(%)	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
407	1957-1989	2	31.3	18.6	20.4	19.8	43.4	210.7	416.0	358.4	232.4	68.5	3.7	10.4	1433.5
502	1957-1989	4	33.4	33.5	50.1	54.4	79.6	202.3	372.1	344.7	169.9	49.5	9.7	16.4	1415.5
504	1973-1989	22	30.9	40.6	47.2	36.9	123.8	304.3	475.3	405.2	276.8	60.5	9.8	16.4	1827.7
505	1973-1989	40	26.4	22.4	29.0	34.7	83.5	237.0	352.6	282.7	175.7	46.2	11.0	13.8	1315.1
509	1971-1989	11	23.8	21.6	18.2	25.9	90.1	276.4	532.0	483.9	334.7	87.9	10.5	11.1	1916.2
510	1971-1989	13	14.1	28.8	21.8	24.5	48.6	232.1	539.6	383.6	290.2	52.2	6.3	12.8	1654.6
512	1971-1989	3	33.3	26.3	37.3	26.1	73.5	200.2	342.6	231.6	178.5	53.6	9.5	24.3	1237.0
514	1973-1989	5	19.0	17.5	24.8	42.3	111.8	257.3	587.8	505.3	295.7	67.0	6.2	22.1	1956.7
Basin precipitation by Thiessen(mm)			25.7	27.4	31.6	33.5	88.7	253.5	437.1	358.5	237.3	56.6	9.6	14.7	1574.2
Mean runoff at Station 360(m3/s)			27.9	22.1	18.2	13.8	15.1	92.9	298.0	387.6	355.0	147.4	57.2	33.4	1468.6
Mean runoff depth (mm)			14.5	10.4	9.5	6.9	7.9	46.8	155.0	201.6	178.7	76.7	28.8	17.4	749.4
Runoff/precipitation ratio			0.56	0.38	0.30	0.21	0.09	0.18	0.35	0.56	0.75	1.36	3.01	1.18	0.48

Table 3.3.1 COEFFICIENT OF RUNOFF AT THE HYDROLOGICAL STATIONS

Station No.	Catchment Area (Km2)	Mean Annual Runoff (m3/sec)	Specific Discharg (m3/sec)	Rainfall (mm)	Runoff Depth (mm)	Runoff coefficient
120	1,150	65.5	0.057	2,105.2	1,783.4	0.85
150	12,600	591.6	0.047	1,928.4	1,473.5	0.76
170	188	7.1	0.038	1,433.9	1,186.8	0.83
240	19,200	502.4	0.026	854.6	817.8	0.96
250	21,240	615.6	0.028	872.5	908.6	1.04
260	7,460	288.4	0.039	1,628.9	1,211.5	0.74
262	896	33.1	0.037	1,845.0	1,156.2	0.63
270	12,290	428.9	0.035	1,211.2	1,093.4	0.90
280	42,890	1,378.4	0.032	1,146.9	1,007.1	0.88
286	816	14.7	0.018	1,339.8	567.1	0.42
290	3,000	87.3	0.029	1,539.8	912.0	0.59
330	1,980	60.4	0.031	1,677.0	956.7	0.57
340	683	30.0	0.044	1,315.1	1,380.2	1.05
350	3,380	93.2	0.028	1,537.6	867.2	0.56
360	5,150	122.8	0.024	1,574.2	749.4	0.48

Table 3.3.2 MONTHLY SNOWFALL DATA OBSERVED AT THE TIJJAM STATION IN INDIA

Unit : mm

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1983	380.0	40.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.0	432.0
1984	68.2	397.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	465.8
1985	0.0	8.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	213.0	221.0
1986	0.0	14.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.4
1987	0.0	92.0	22.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	114.6
1988	0.0	129.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	112.4	241.6

Table 3.3.3 COMPARISON OF SNOWFALL OBSERVED AT TIJJAM AND ESTIMATED BY LRMP

Unit : mm

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Observed snowfall at Tijjam	74.7	113.5	3.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	56.2	248.2
Calculated snawfall by LRMPs' value	33.0	22.0	62.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.0	11.0	142.0

Table 3.3.4 DISCHARGE FROM THE REMAINING DRAINAGE AREA

Unit : m3/s

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	AVE
1963	13.7	10.1	10.7	9.6	-5.2	71.8	124.8	192	285.5	34.6	19.4	20.3	65.6
1964	-27.2	-40.4	-55.6	-36	-42.9	-53.1	245.1	158	101.8	14.7	50	40.7	29.6
1965	31.1	29.2	28.2	34	46.8	0.2	100.7	262.3	137.2	112.4	75.9	54.5	76.0
1966	50.3	49.7	48	52.1	69.2	49.3	145	462.3	97.4	82.9	55.4	36.8	99.9
1967	17.1	21	14.1	6.9	9.8	-48.6	87.6	407	218.9	118.7	60.2	47.3	80.0
1969	39.3	33.6	24	16.6	-2.3	-31.1	7.7	92.3	176.7	99.5	84.3	72.5	51.1
1970	64	54.9	48.7	39.9	48	-167.7	87.1	328.6	77.5	186.9	108.8	95.5	81.0
1971	85	93.2	90.1	95.2	73.6	111.3	560.9	786.2	395.3	269.7	146.6	119.5	235.6
1972	99.9	101.8	87	55.1	81	56.6	149.2	179.3	107.2	77.5	19.1	4.9	84.9
1973	-2.4	-5.4	-19.5	-31.2	-39.6	-64.4	-30.1	411.2	159.1	118	37	61.8	49.5
1974	42.6	32.2	45	37.9	30.2	68.1	55.5	319.5	-96.2	169	109.8	74.3	74.0
1975	73.7	78	62.8	76	58.2	740.7	401.9	579.6	591.9	255.4	85.2	82.5	257.2
1976	63.3	64.4	61.7	52.2	49.7	40.7	116.8	529.3	268.5	145.8	108.6	64.3	130.4
1977	43.3	45.3	39.6	30.1	44.5	14	573.2	813.6	460.2	220.4	119.6	69.4	206.1
1978	53.6	48.8	72	54.9	125.3	13.6	787.5	1178.1	218.3	91.4	89.6	60.7	232.8
1979	35.4	58.7	23.1	13.9	-51	33.9	373.1	528.7	48.3	52	2.3	-8.7	92.5
1980	-11.4	-24.1	-29.3	-32.4	-27.9	68.3	221.8	761.2	426.4	97.6	40.1	-0.3	124.2
1981	-9.8	-20.4	4.6	-18.2	50.1	40.7	402.6	896.4	560.4	315.9	143.6	65	202.6
1982	30.5	24.7	61	67.3	112	181	414.7	287.4	636.8	156.6	101.5	40.2	176.1
1983	17.6	10.9	2.6	72.2	71.1	-5.4	380.5	393.4	1191.4	1720.1	148	56.1	338.2
1984	32.1	39.9	15.6	-0.1	-8.3	198	361.8	348.3	169.4	29.2	10.9	8.2	100.4
1985	-2.3	6	9.7	-8	-13.1	-25.2	401.6	889.5	560.4	600.5	172.1	93.7	223.7