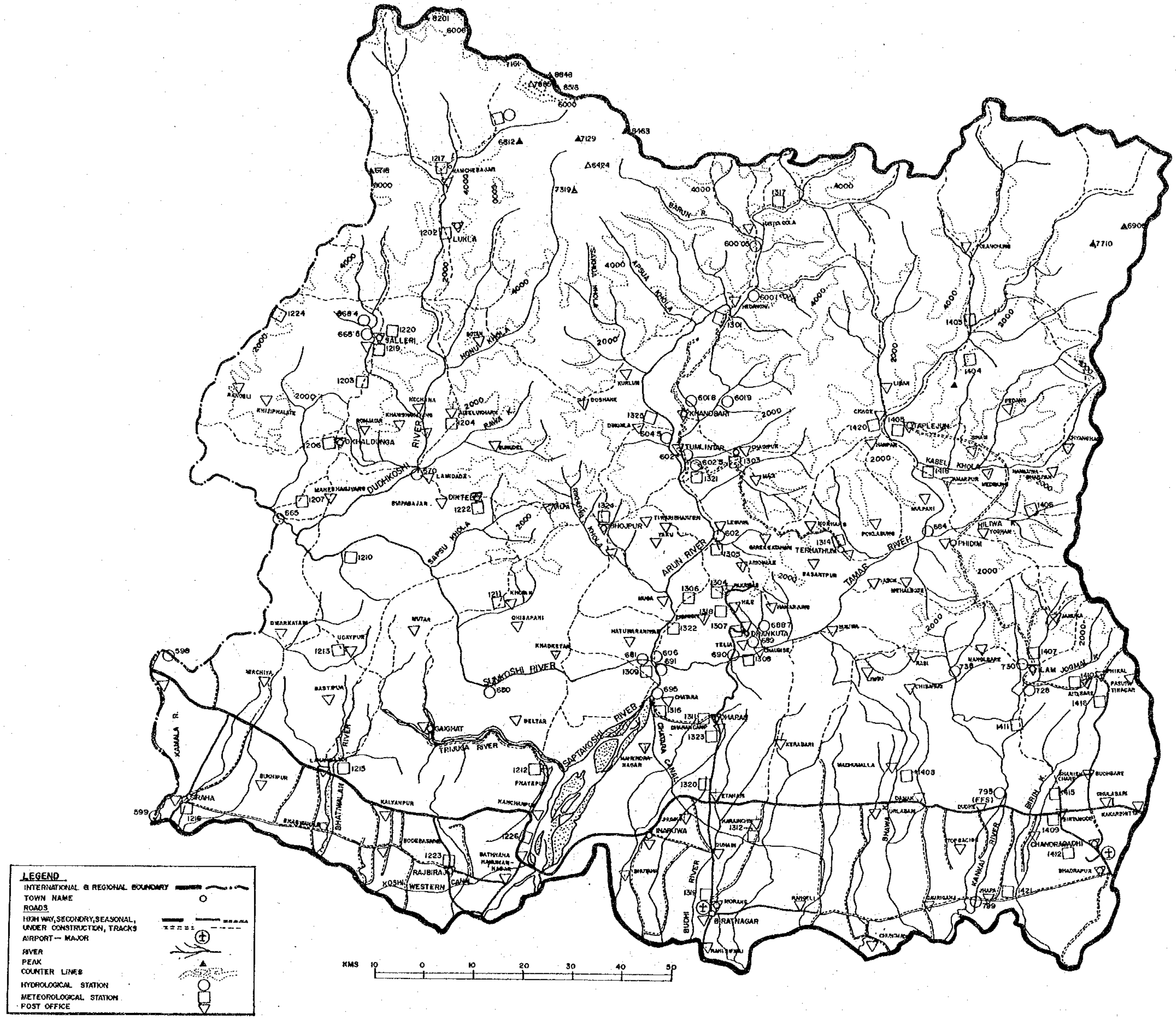


Fig. 4.9 OBSERVATION NETWORK IN EASTERN REGION

Fig. 4.10 OBSERVATION NETWORK IN CENTRAL REGION

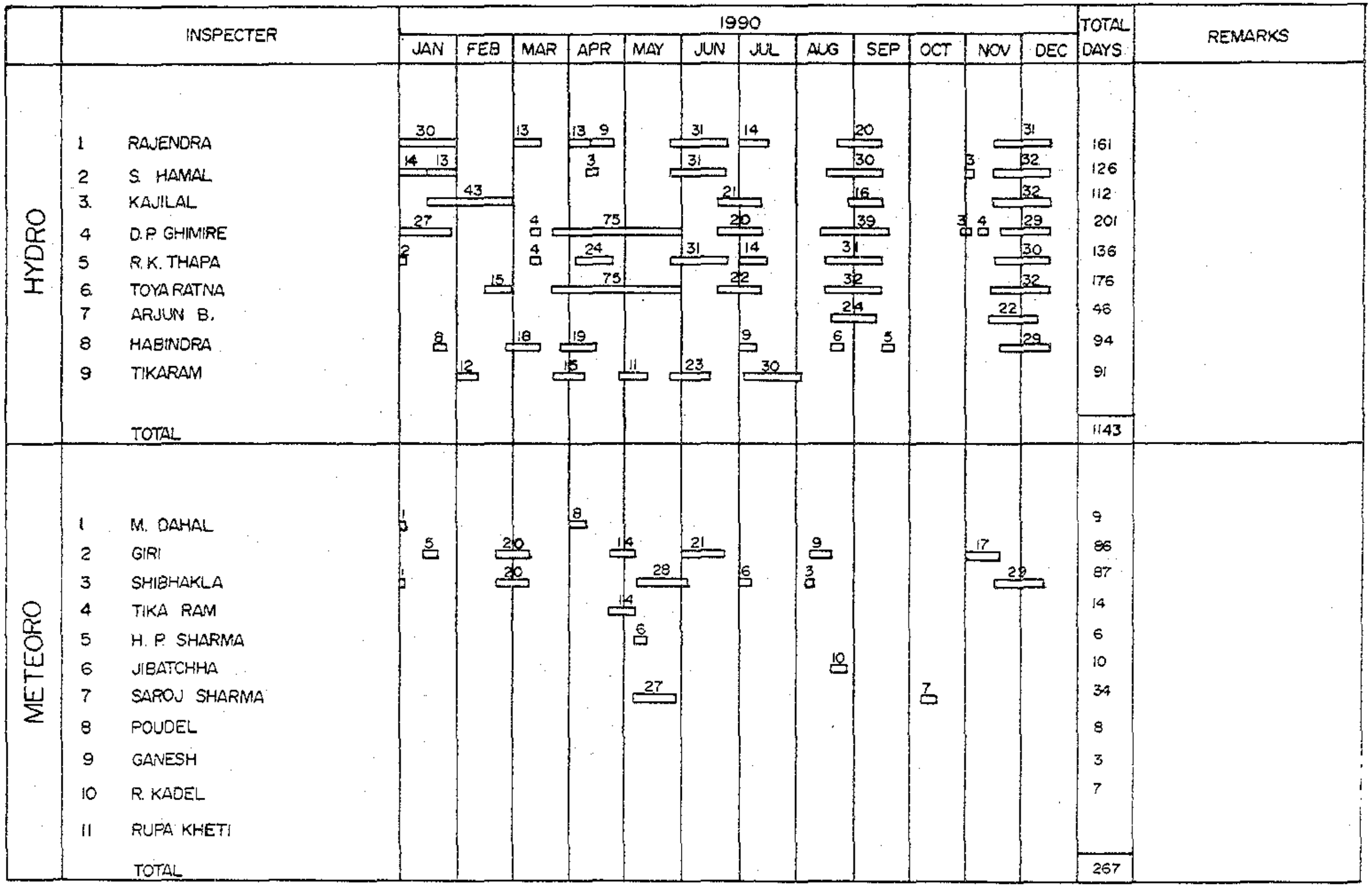


Fig. 4.11 ACTUAL TERM IN FIELD (CENTRAL REGIONAL OFFICE IN 1990)

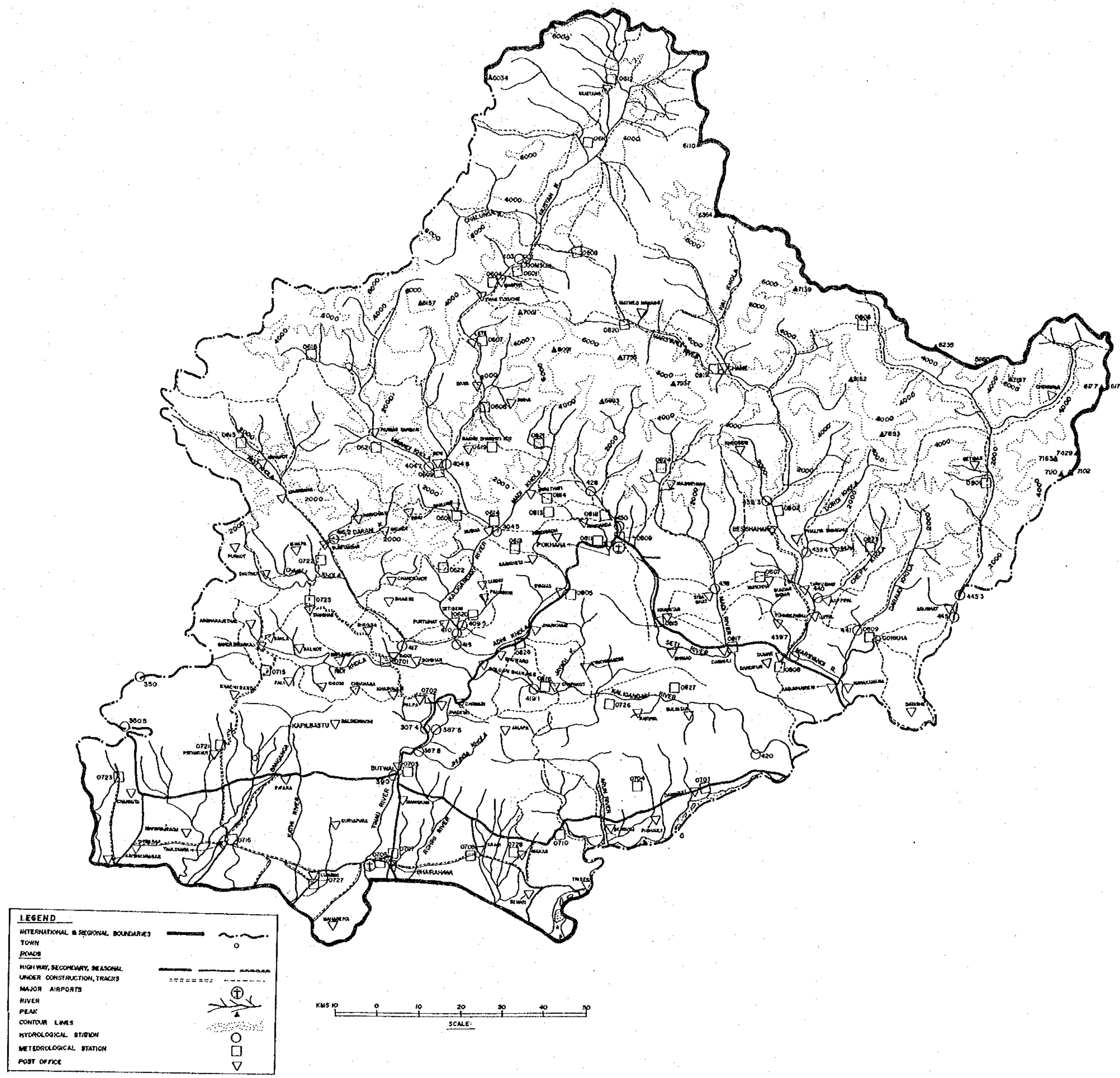


Fig. 4.12 OBSERVATION NETWORK IN WESTERN REGION

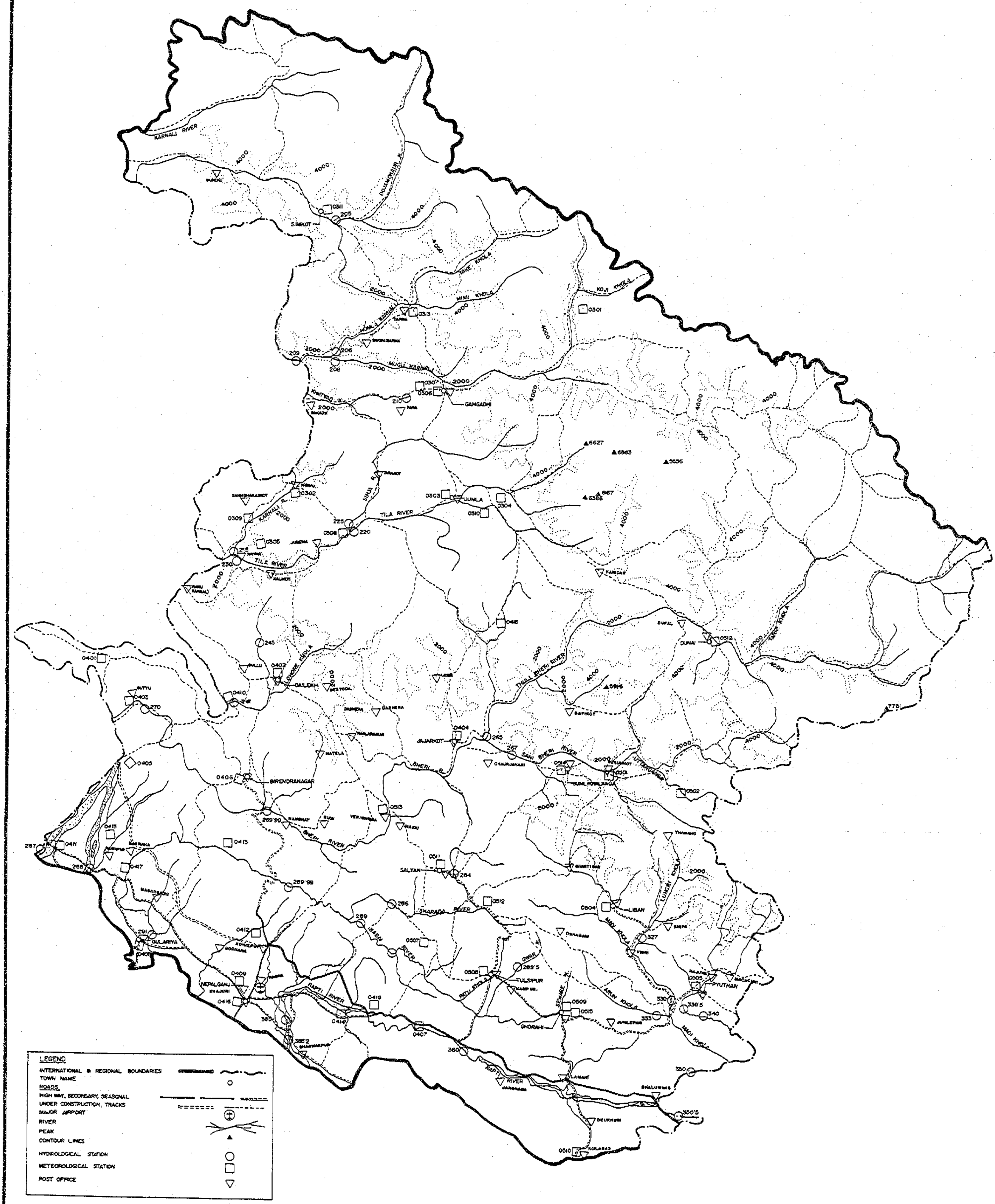


Fig. 4.13 OBSERVATION NETWORK IN MID-WESTERN REGION

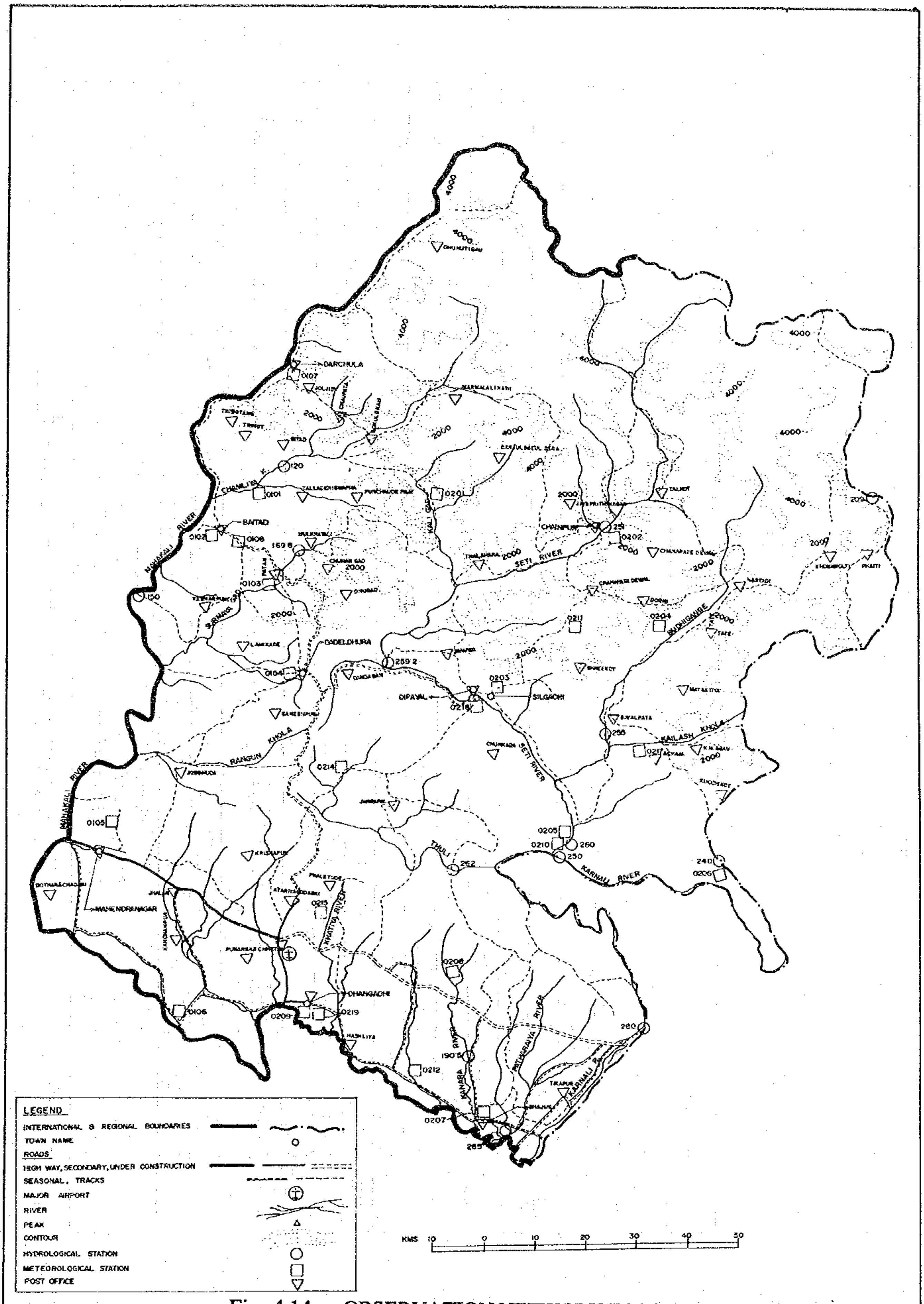
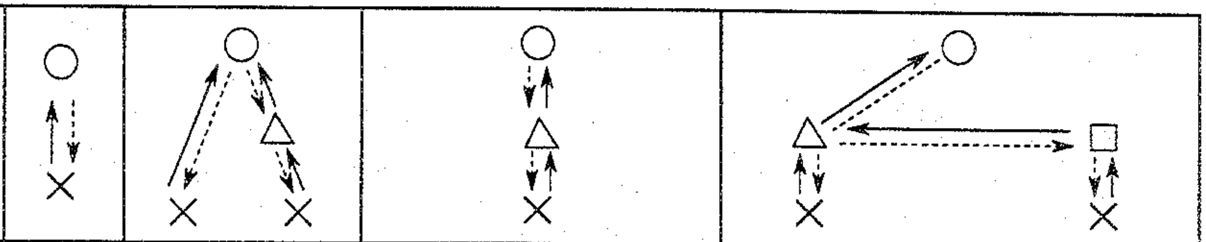


Fig. 4.14 OBSERVATION NETWORK IN FAR-WESTERN REGION

DATA FLOW											
CASE (ALTERNATIVE PLAN)		A	B-1	B-2	C-1	C-2	C-3	D-1	D-2	D-3	D-4
PROCESSING PLACE		H.Q.	H.Q.	H.Q. & R.O.	H.Q.	R.O.	H.Q. & R.O.	H.Q.	R.O.	H.Q. & R.O.	H.Q.R.O. & B.O.
CORRECT	DATA COLLECTION	4	2	2	2	2	2	1	1	1	1
	DATA PROCESSING	1	1	3	1	2	3	1	2	3	4
	QUALITY CHECKING	1	1	3	1	2	3	1	2	3	4
	GUIDANCE TO OBSERVER	4	4	3	4	2	3	4	2	3	1
	CHECKING OF INSPECTOR	4	4	3	4	2	3	4	2	3	1
FAST	DATA COLLECTION	1	2	3	2	3	3	3	4	4	4
	DISCHARGE MEASUREMENT	4	3	3	2	2	2	1	1	1	1
	PROCESSING	1	2	3	2	3	3	2	3	3	4
ECONOMICAL		1	2	2	3	3	3	4	4	4	4
COMFORT-ABLE	DATA COLLECTION	4	3	3	2	2	2	1	1	1	1
	DATA PROCESSING	1	1	2	1	3	2	1	3	2	4
	GUIDANCE TO OBSERVER	4	3	3	2	2	2	1	1	1	1
	DATA DISSEMINATION	4	4	3	4	2	3	4	2	3	1
AVERAGE OF EVALUATION		2.62	2.46	2.77	2.31	2.31	2.62	2.15	2.15	2.46	2.38
PRELIMINARY OPTIMIZATION		5	4	6	2	2	5	1	1	4	3

NOTE
○ Headquarters
△ Regional Office
× Gauging Station
□ Branch Office
← Data Flow
←---- Guidance Flow
H.O.: Central Office
R.O.: Regional Office
B.O.: Branch Office
Evaluation: 1 = Very Good
2 = Good
3 = Fair
4 = Bad

Fig. 6.1 OPTIMIZATION OF ALTERNATIVE PLAN

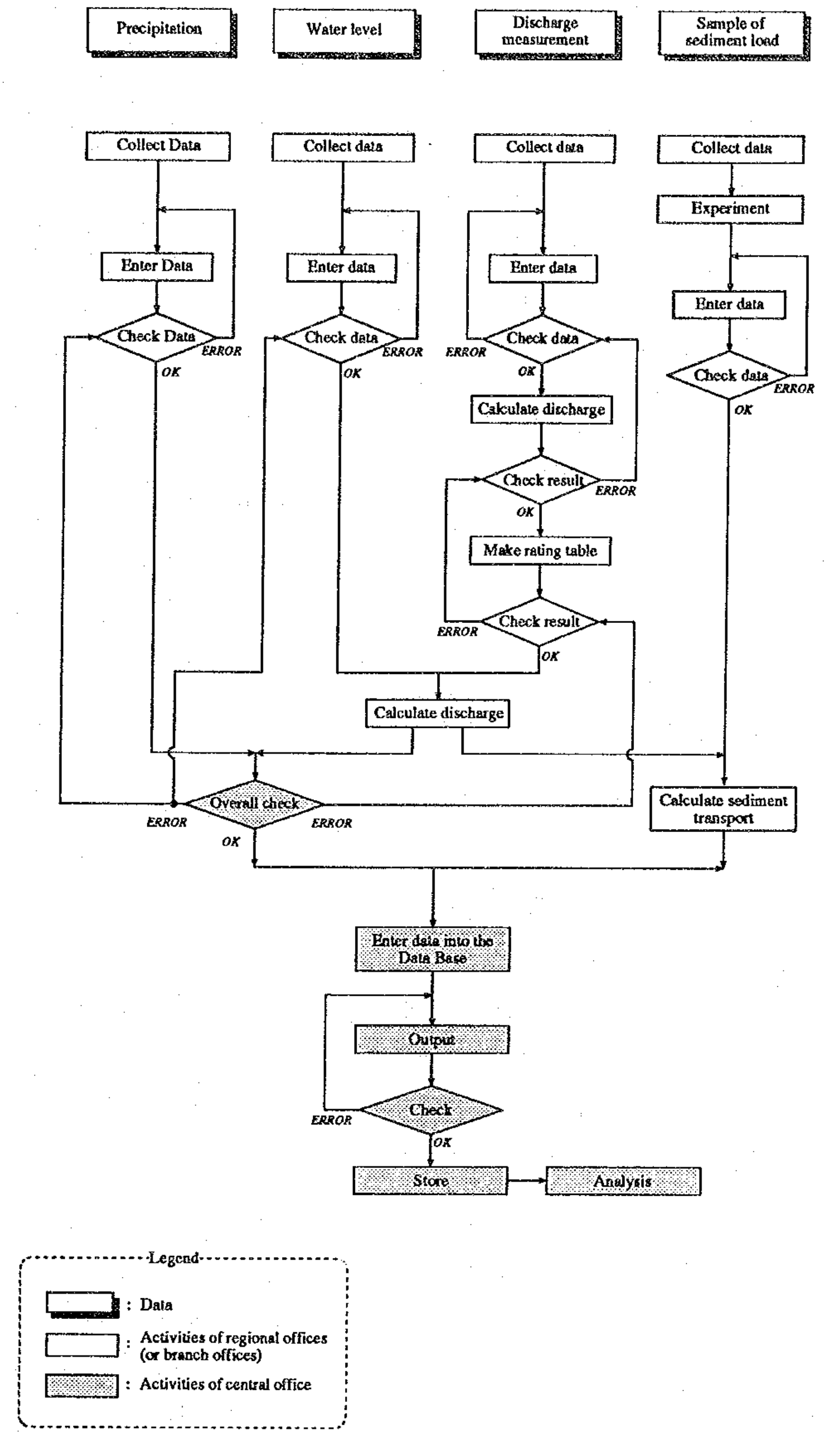


Fig. 6.2 GENERAL DATA FLOW IN THE MODEL SYSTEM

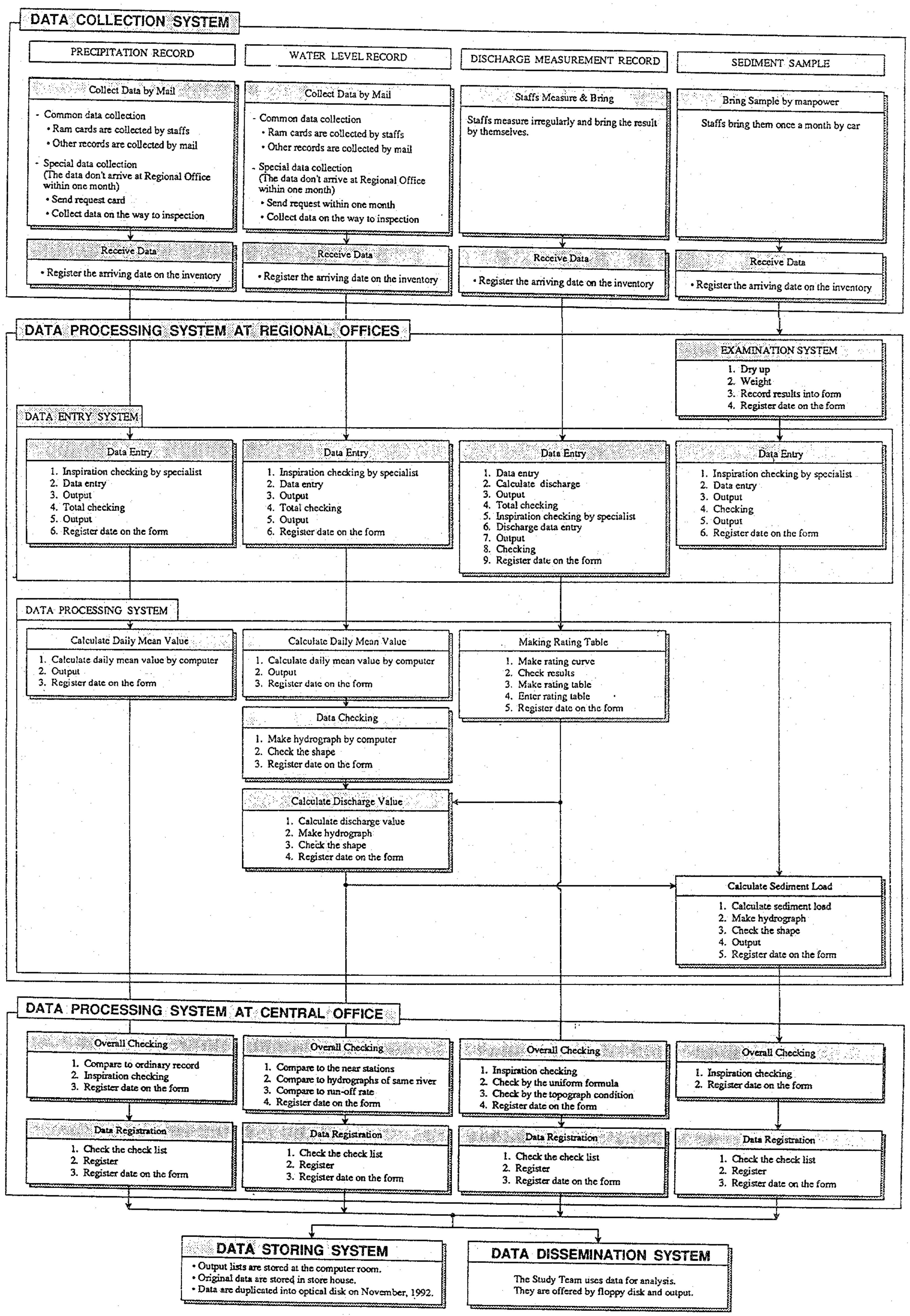


Fig. 6.3 PROCESS FLOW OF MODEL SYSTEM

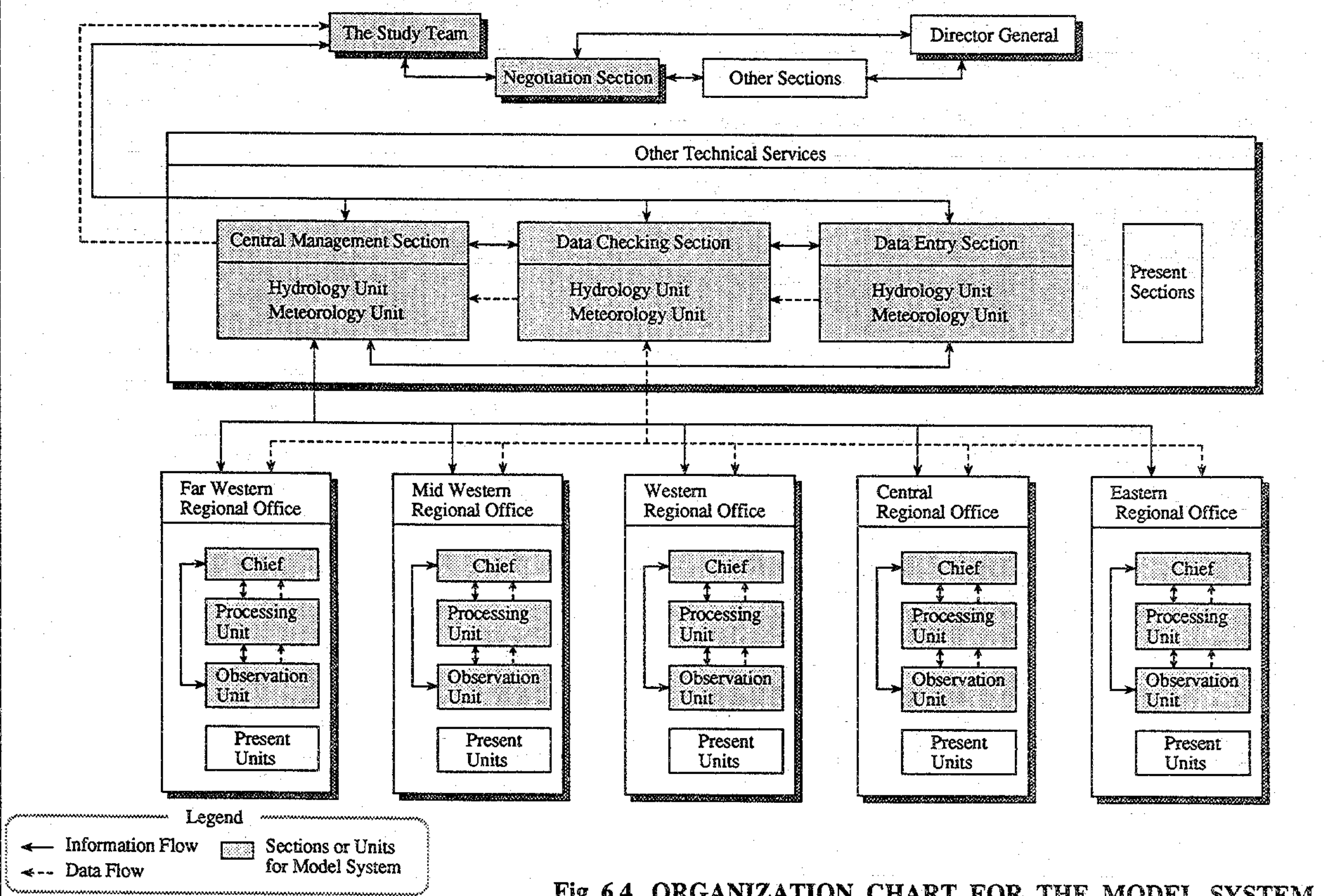
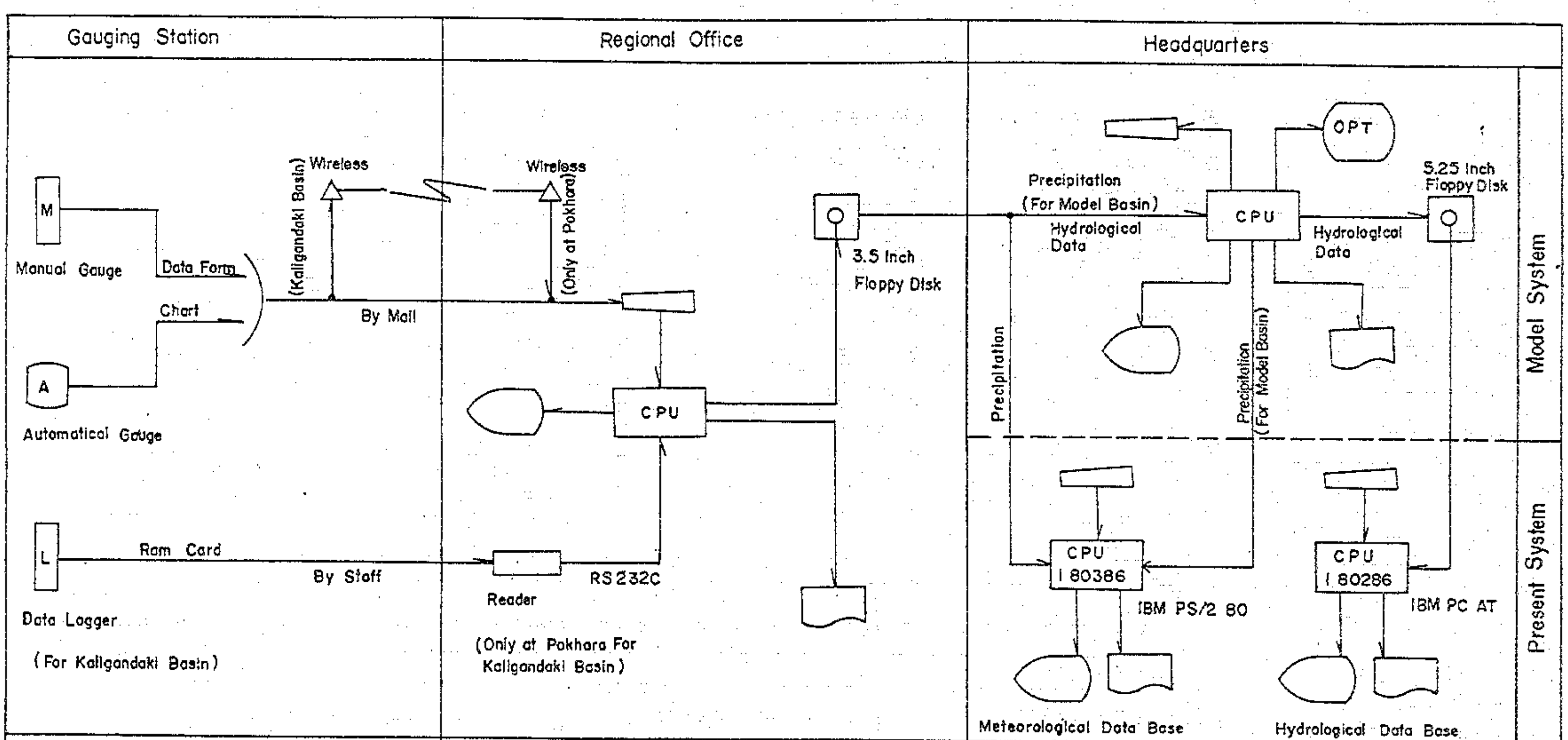


Fig. 6.4 ORGANIZATION CHART FOR THE MODEL SYSTEM



Data will be recorded into form or chart and sent to regional office mainly by mail. But the wireless and data logger will be also made experimental use of in Kali Gandaki River Basin.

The data will be processed by lap top computer at regional offices and sent to headquarters by floppy disk. At western regional office, the data logger system and wireless system will be also tried. The data recorded into ram card by data logger will be entered into the lap top computer through the ram card reader. In the wireless system, the data will be send by wireless from remote area.

New computer system will be installed to analyze data of Kali Gandaki and Jamuni Basin. The precipitation and hydrological data from these basins will be entered into the new computer system. Then it will be transferred into the present system. The other data will be entered into present data base directly. But all hydrological data will be entered through the new computer to transfer data from 3.5" floppy disk into 2.52" one. After this study, the new computer will be used for data base. Present computer will be used for analysis or data entry.

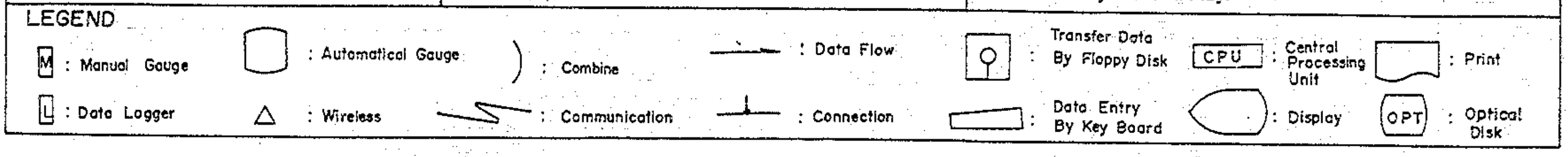
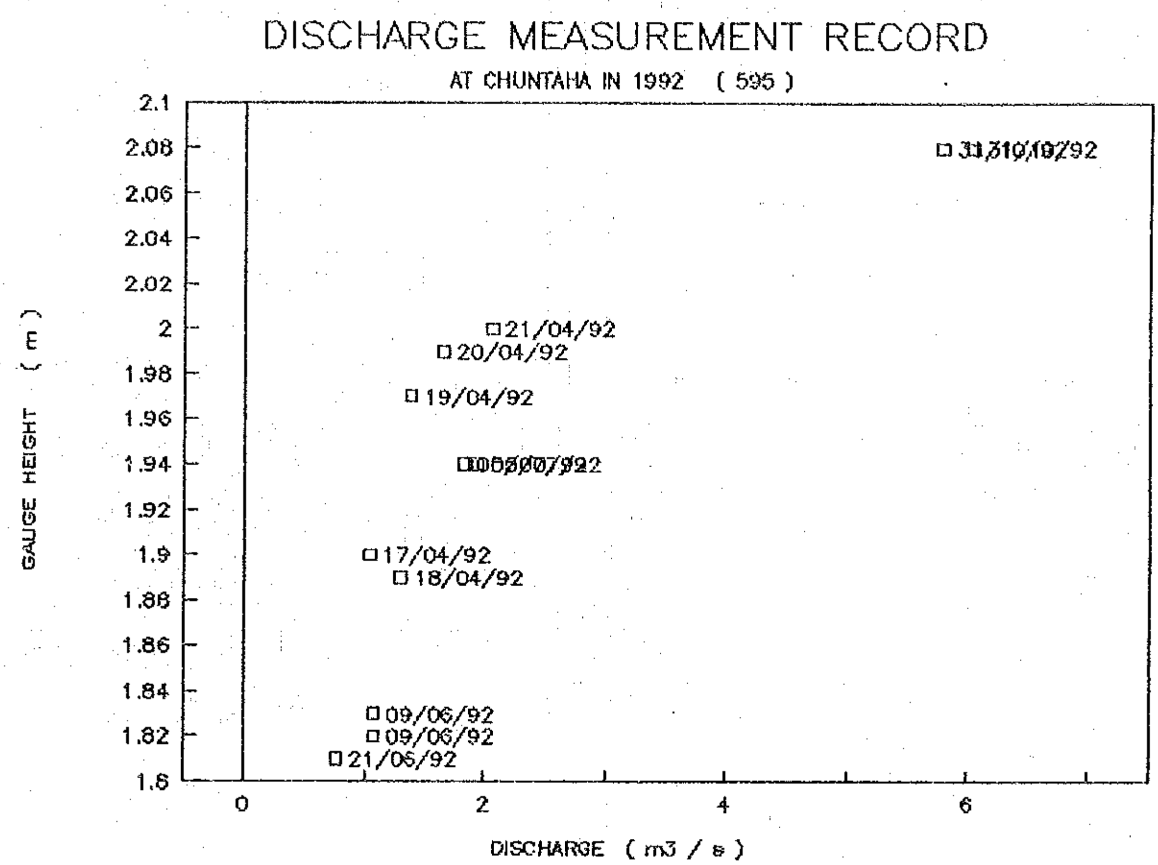
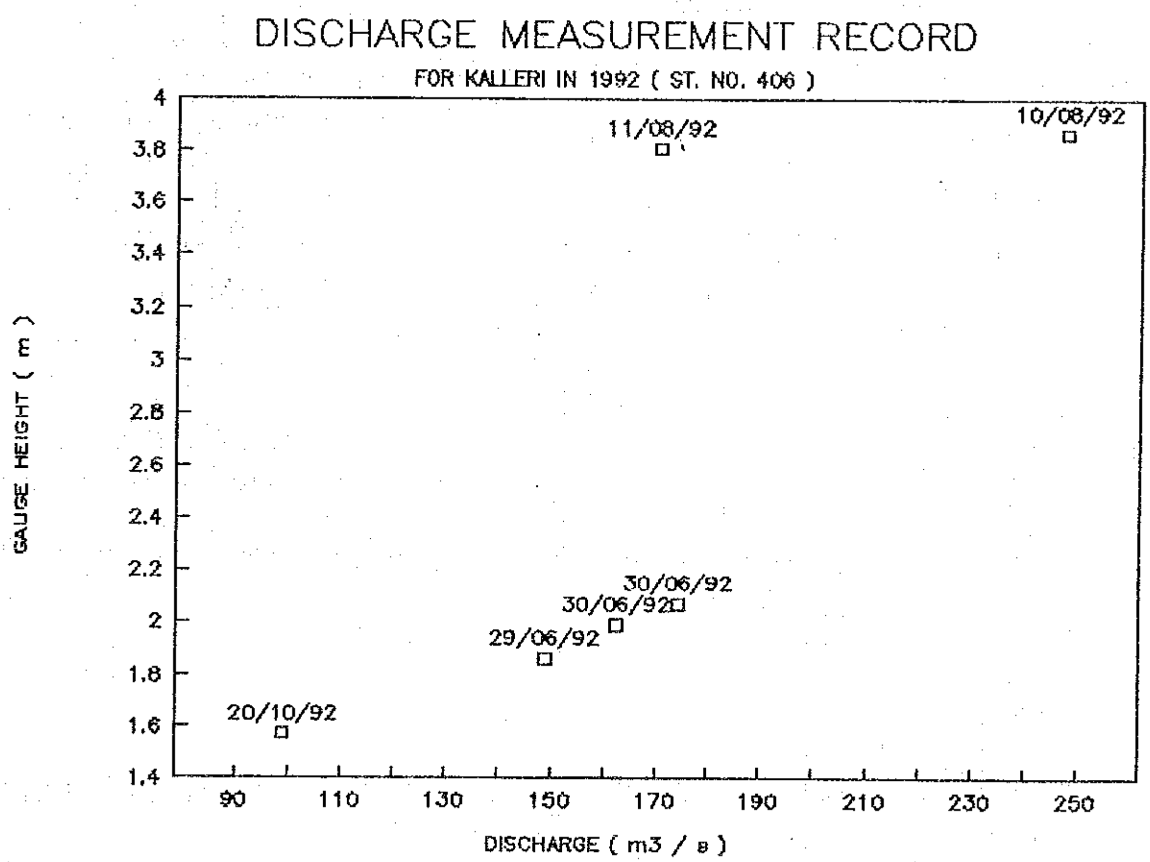


Fig. 6.5 SYSTEM COMPONENT FOR THE MODEL SYSTEM

Fig. 6.6 DISCHARGE MEASUREMENT RECORD IN THE MODEL SYSTEM





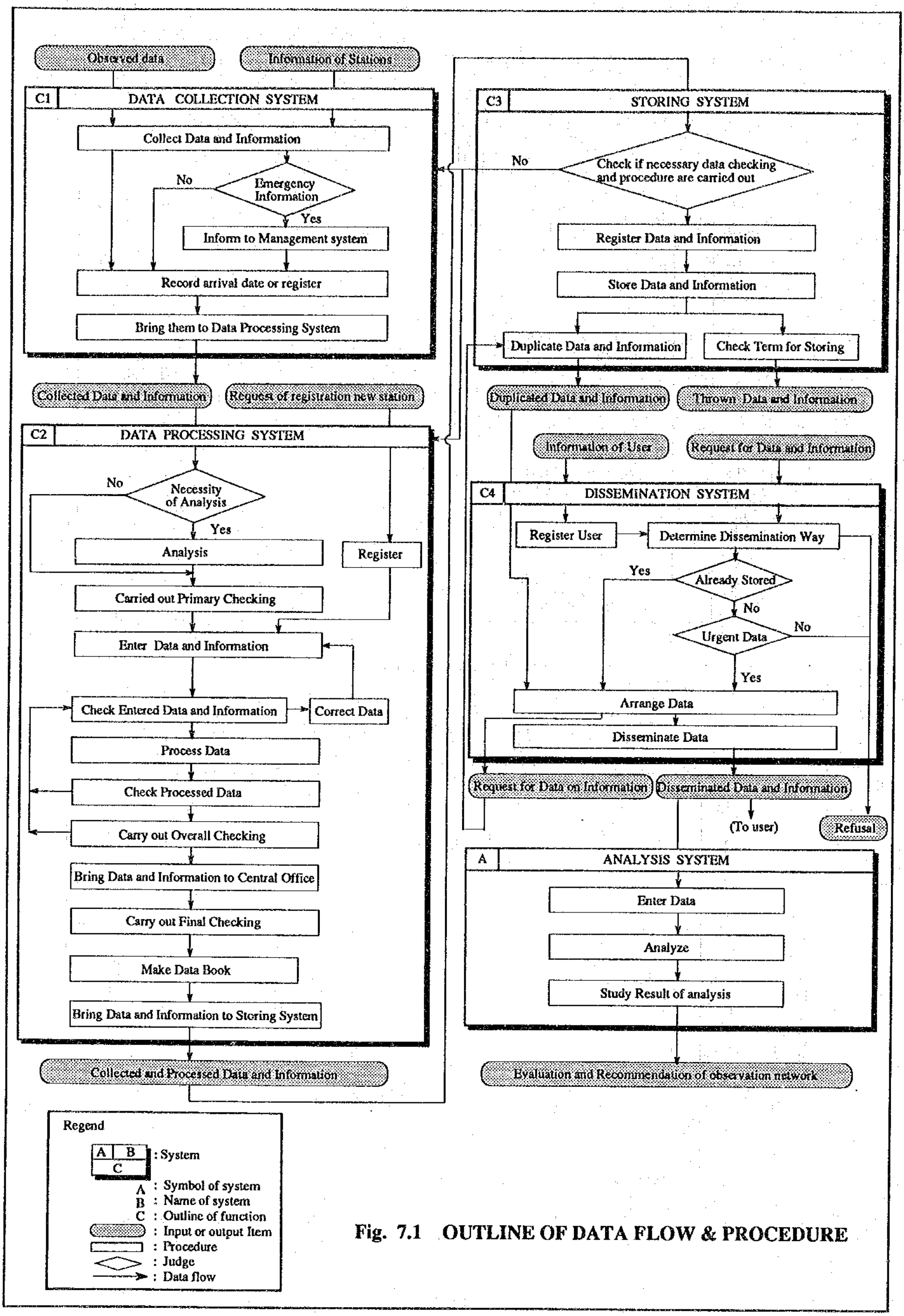


Fig. 7.1 OUTLINE OF DATA FLOW & PROCEDURE

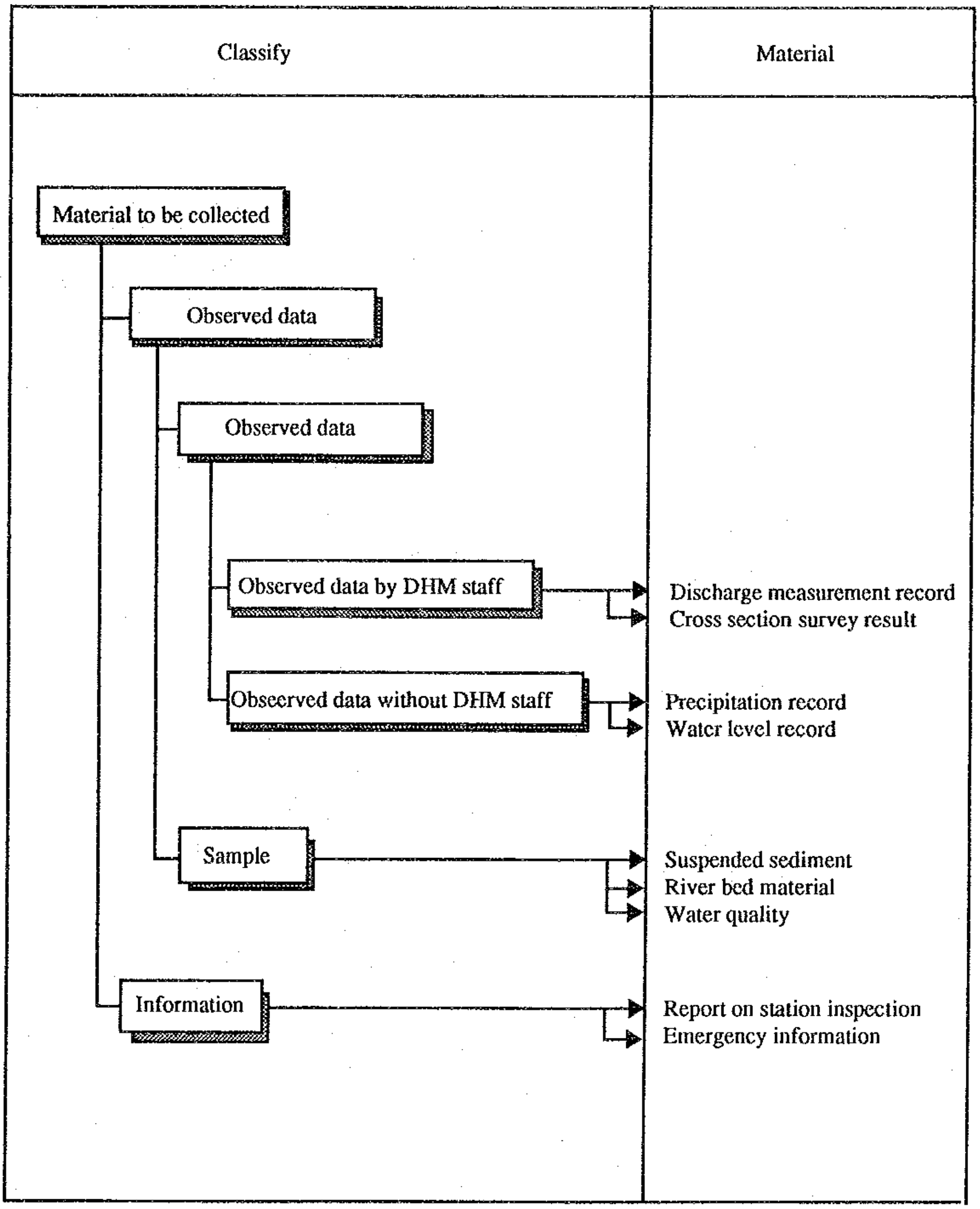


Fig. 7.2 CLASSIFICATION OF MATERIAL TO BE COLLECTED

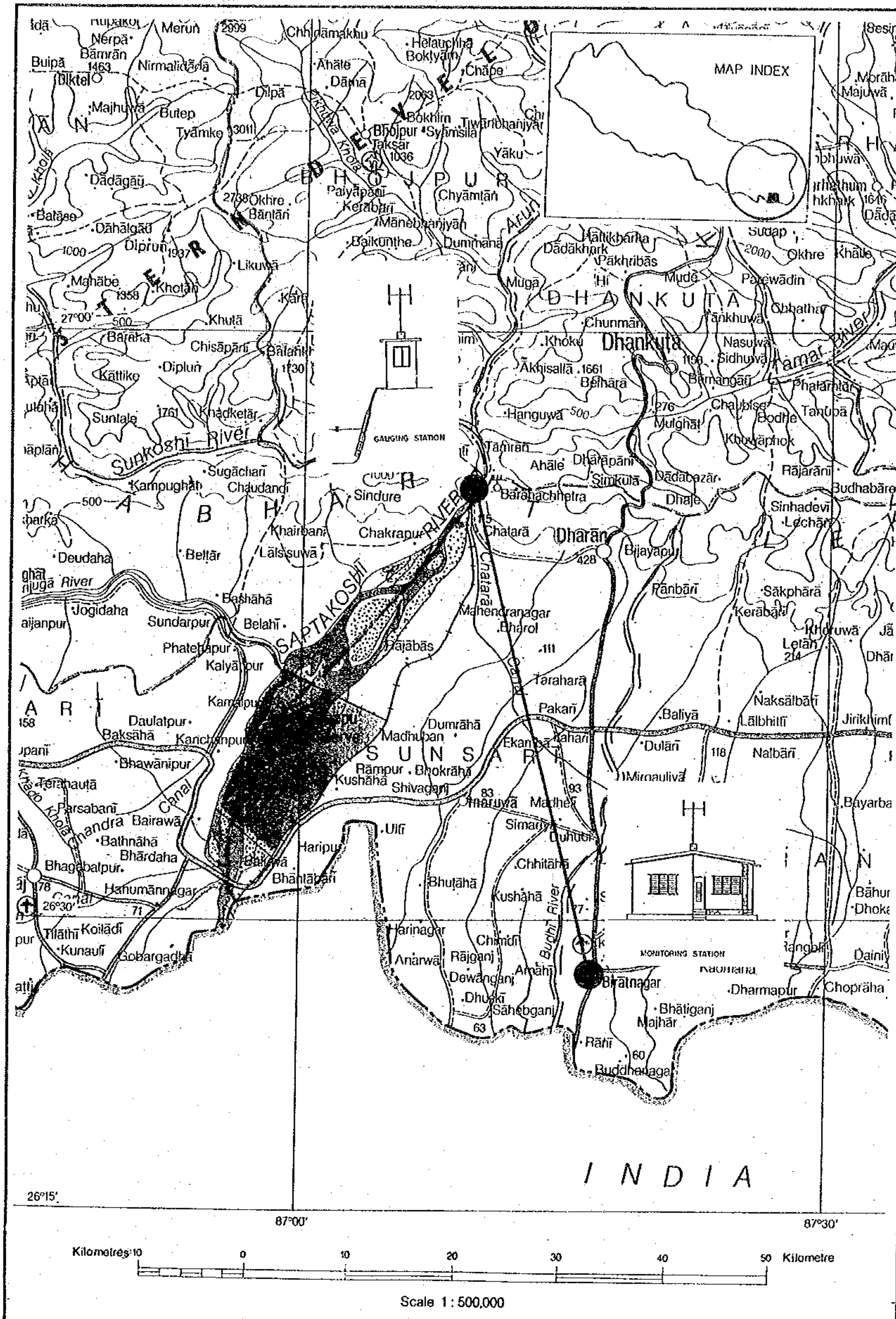


Fig. 7.3 GENERAL IDEA OF TELEMETER SYSTEM (1/3)

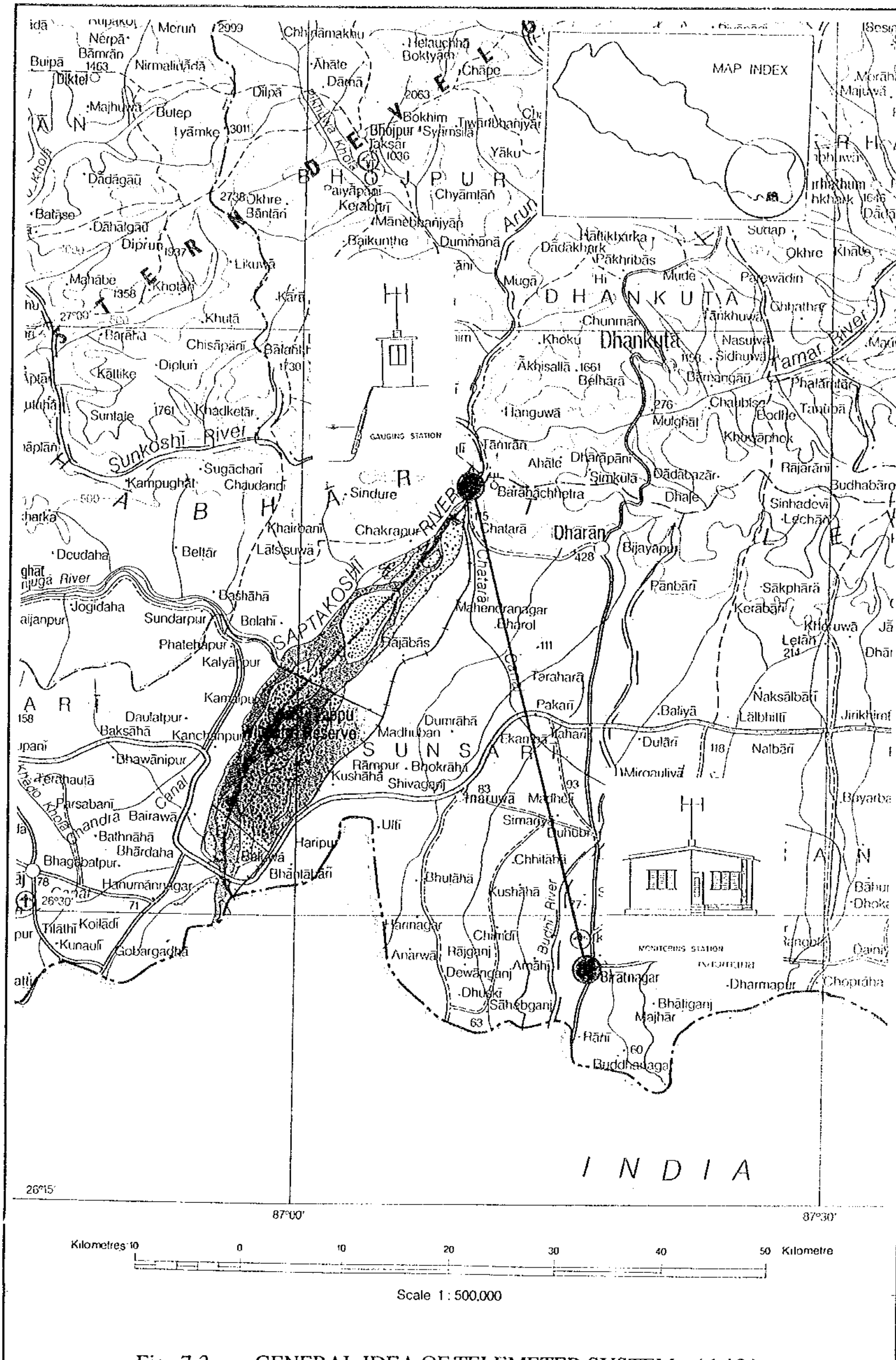


Fig. 7.3 GENERAL IDEA OF TELEMETER SYSTEM (1/3)

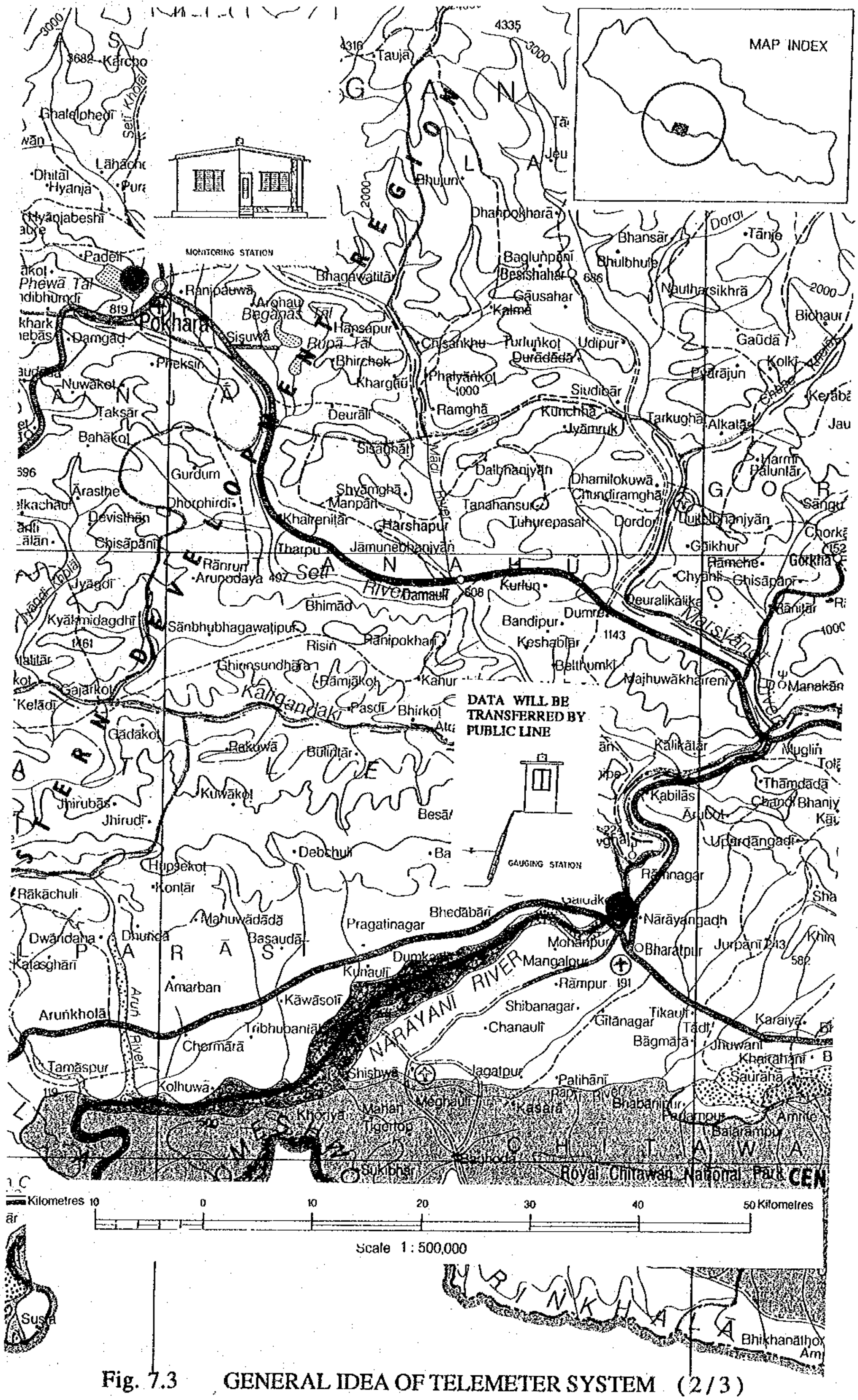


Fig. 7.3 GENERAL IDEA OF TELEMETER SYSTEM (2/3)

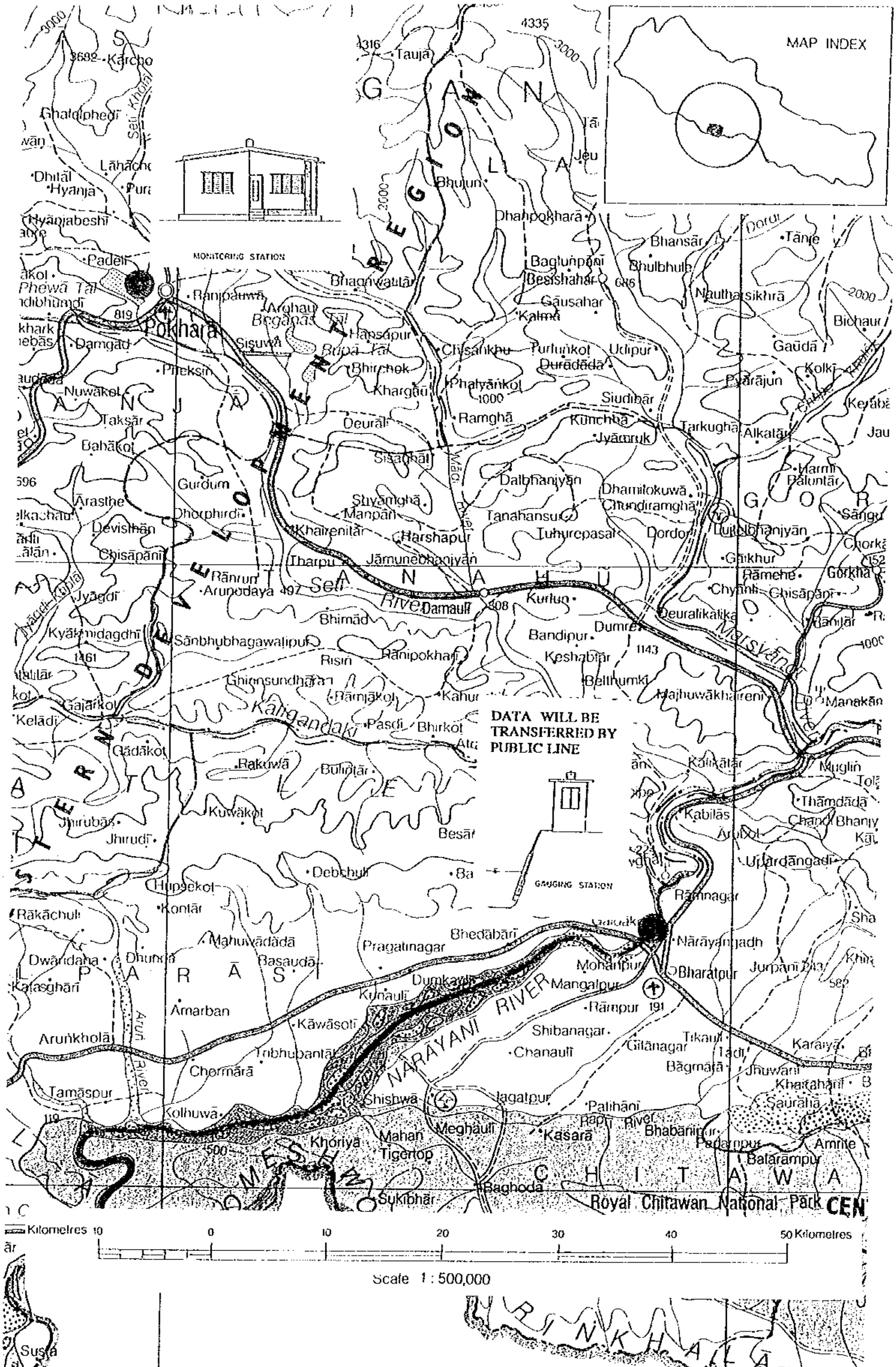


Fig. 7.3 GENERAL IDEA OF TELEMETER SYSTEM (2/3)

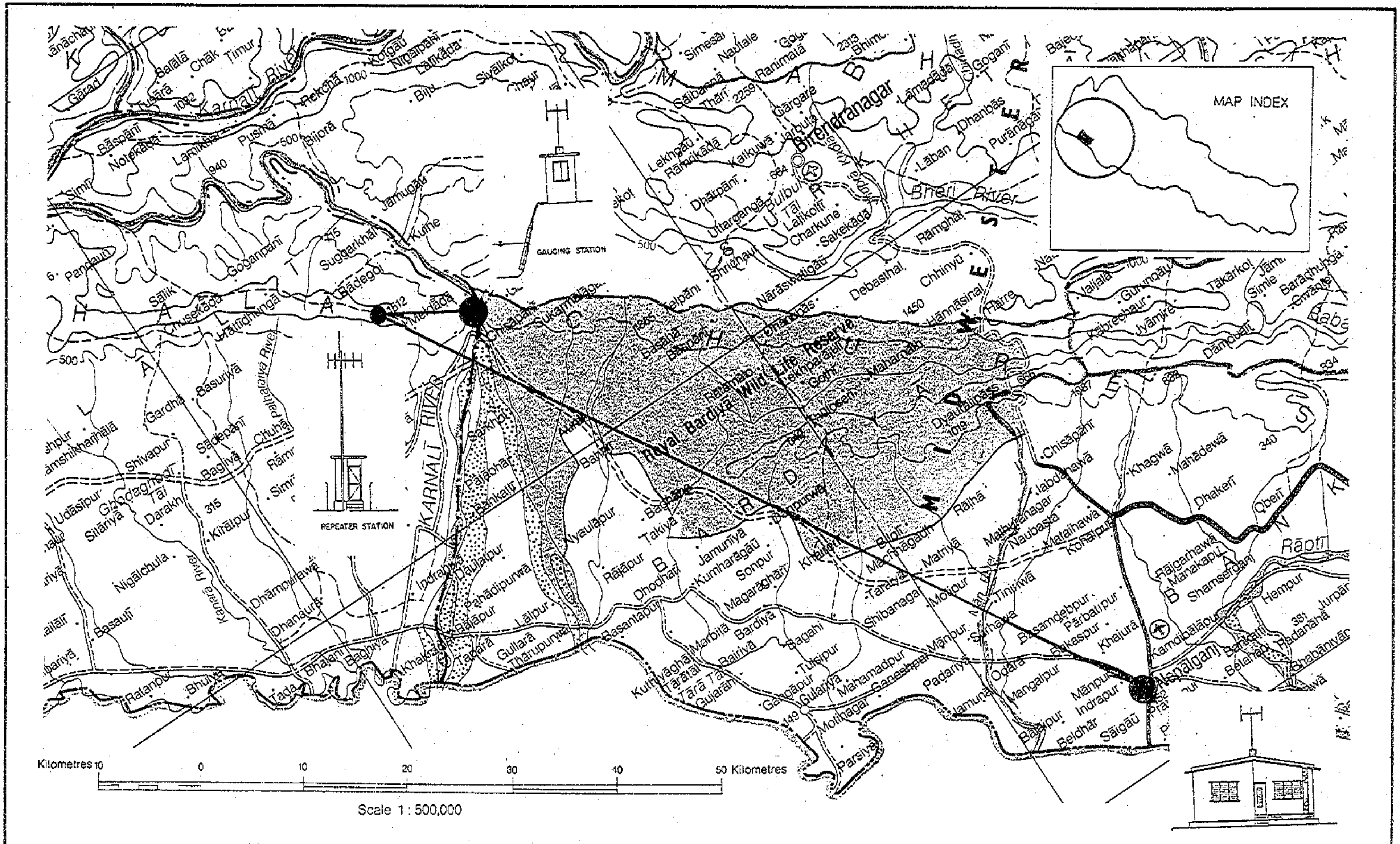


Fig. 7.3 GENERAL IDEA OF TELEMETER SYSTEM (3/3)

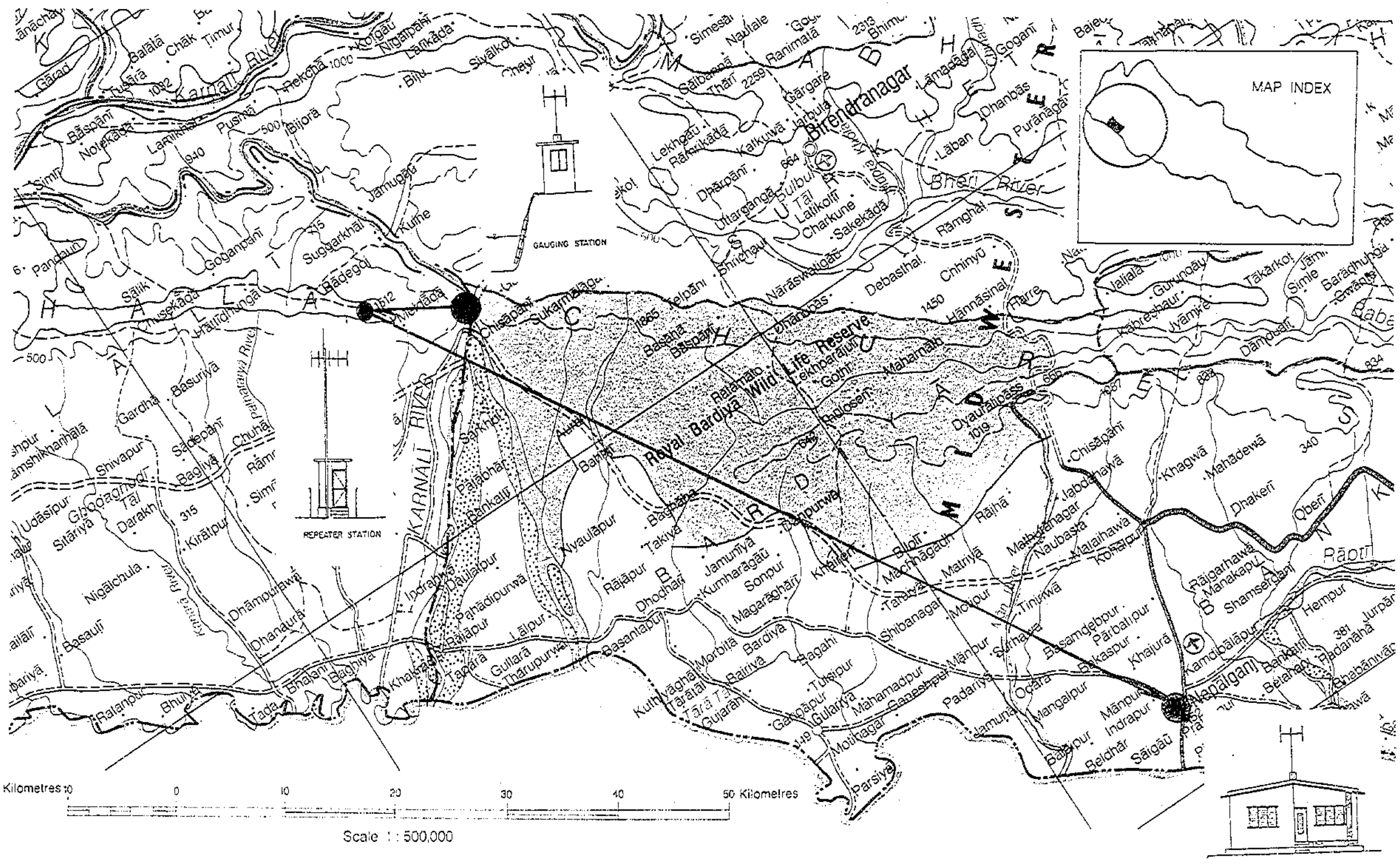


Fig. 7.3 GENERAL IDEA OF TELEMETER SYSTEM (3/3)

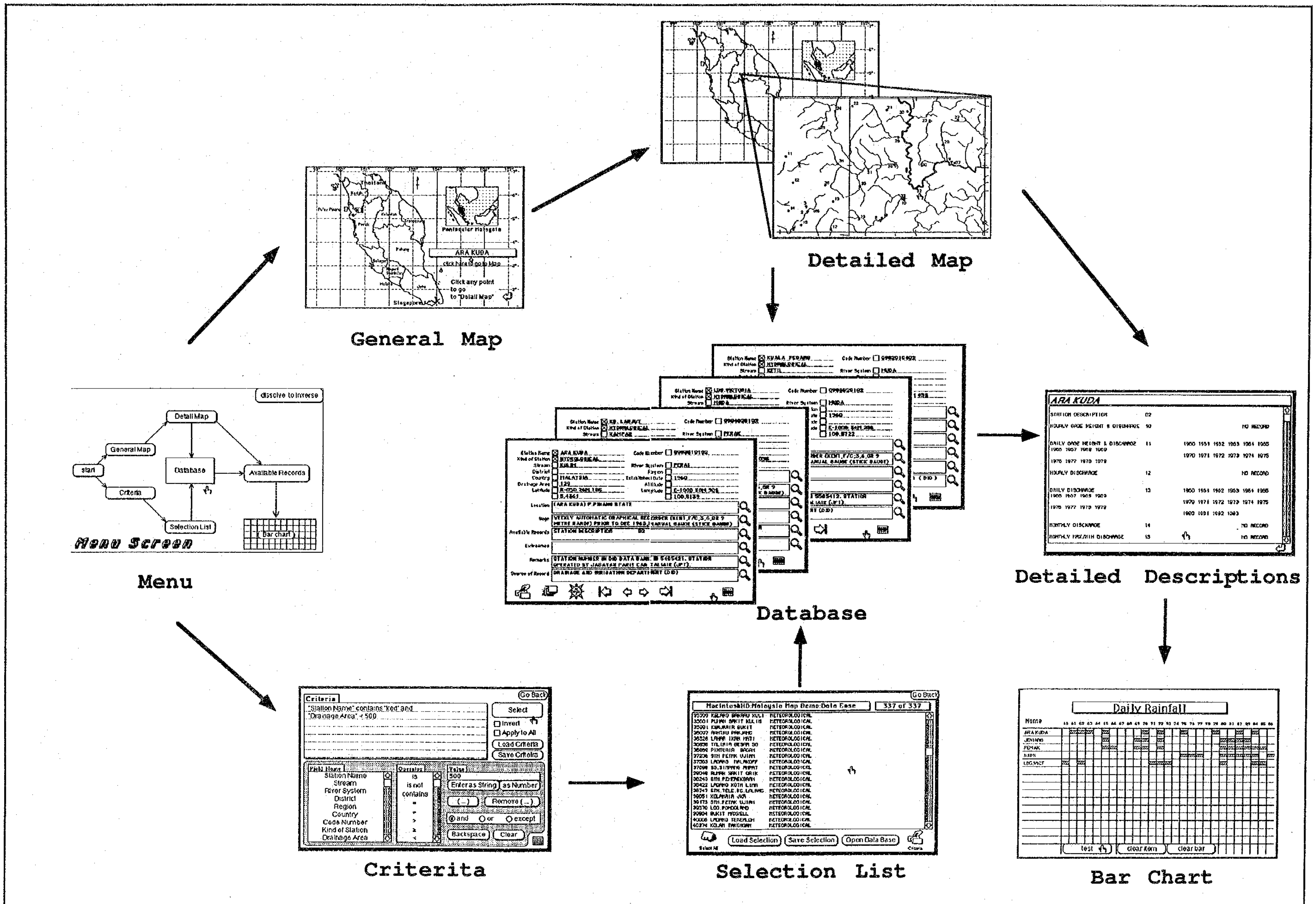


FIG. 7.4 GENERAL IDEA FOR SEARCH SYSTEM

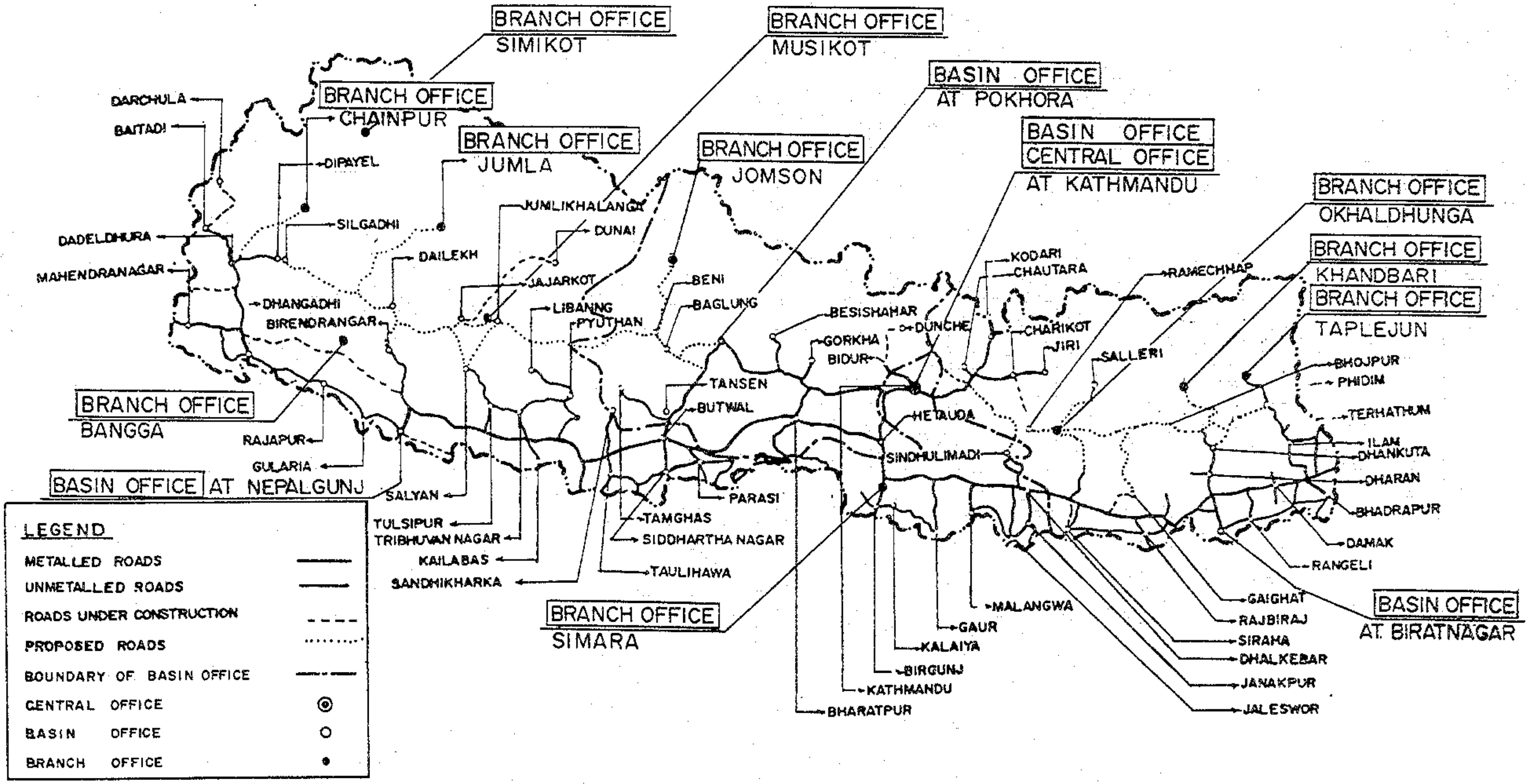


Fig. 7.5 SITE OF OFFICES IN THE LONG TERM PROGRAMME

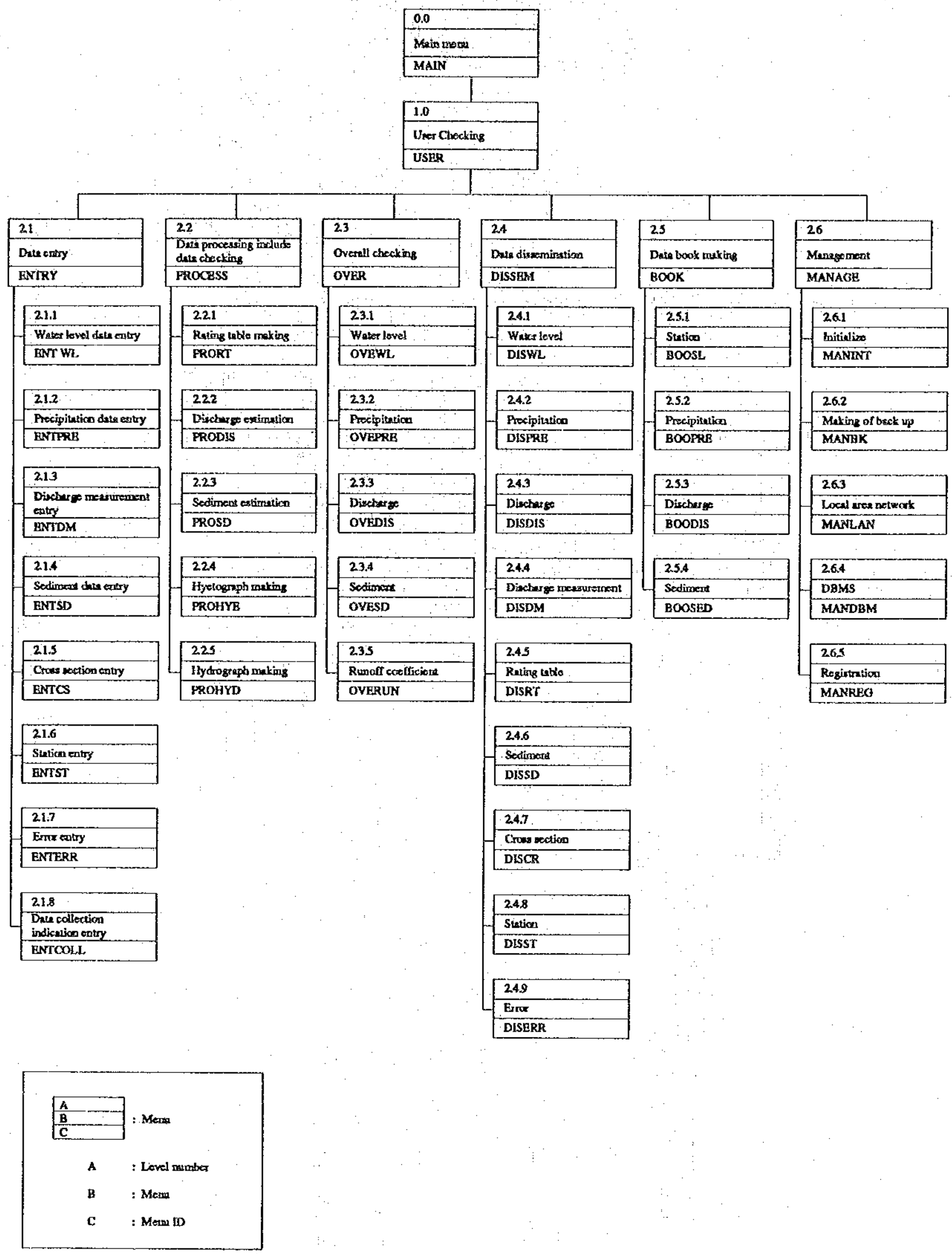


Fig. 8.1 BASIC MENU STRUCTURE

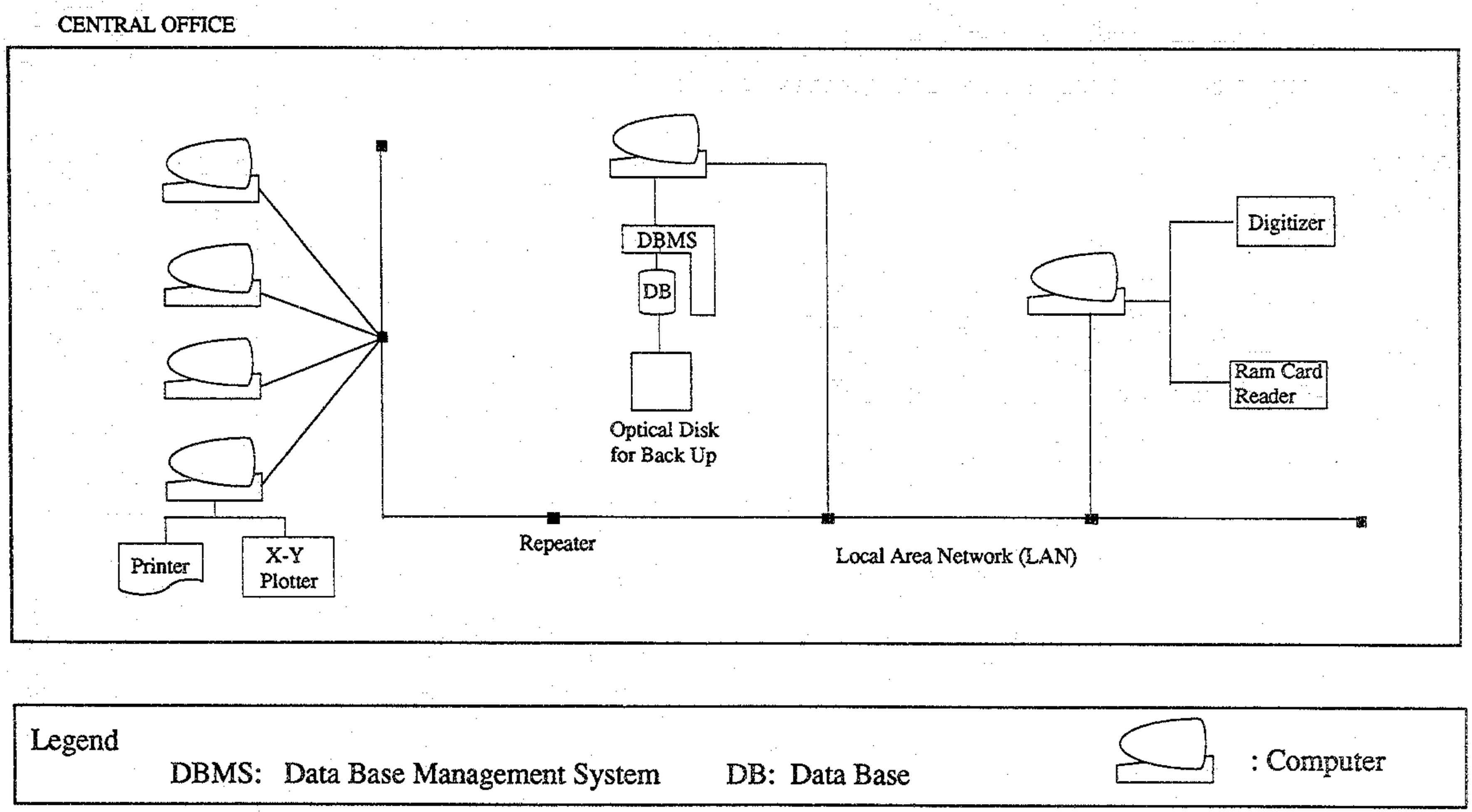


Fig. 9.1 COMPUTER SYSTEM FOR PROGRAMMING

Fig. 9.2 IMPLEMENTATION SCHEDULE FOR THE IMMEDIATE PROGRAMME

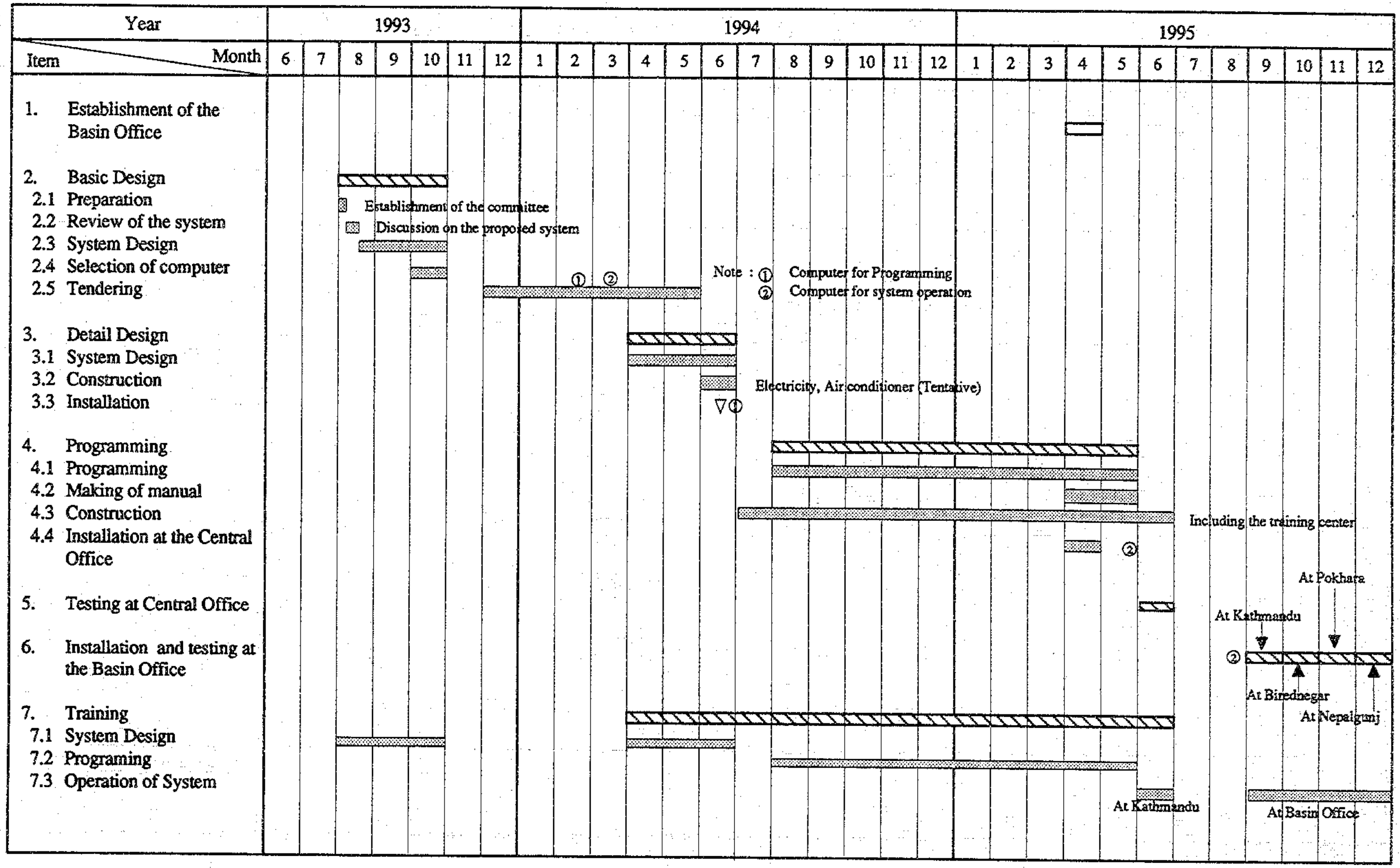
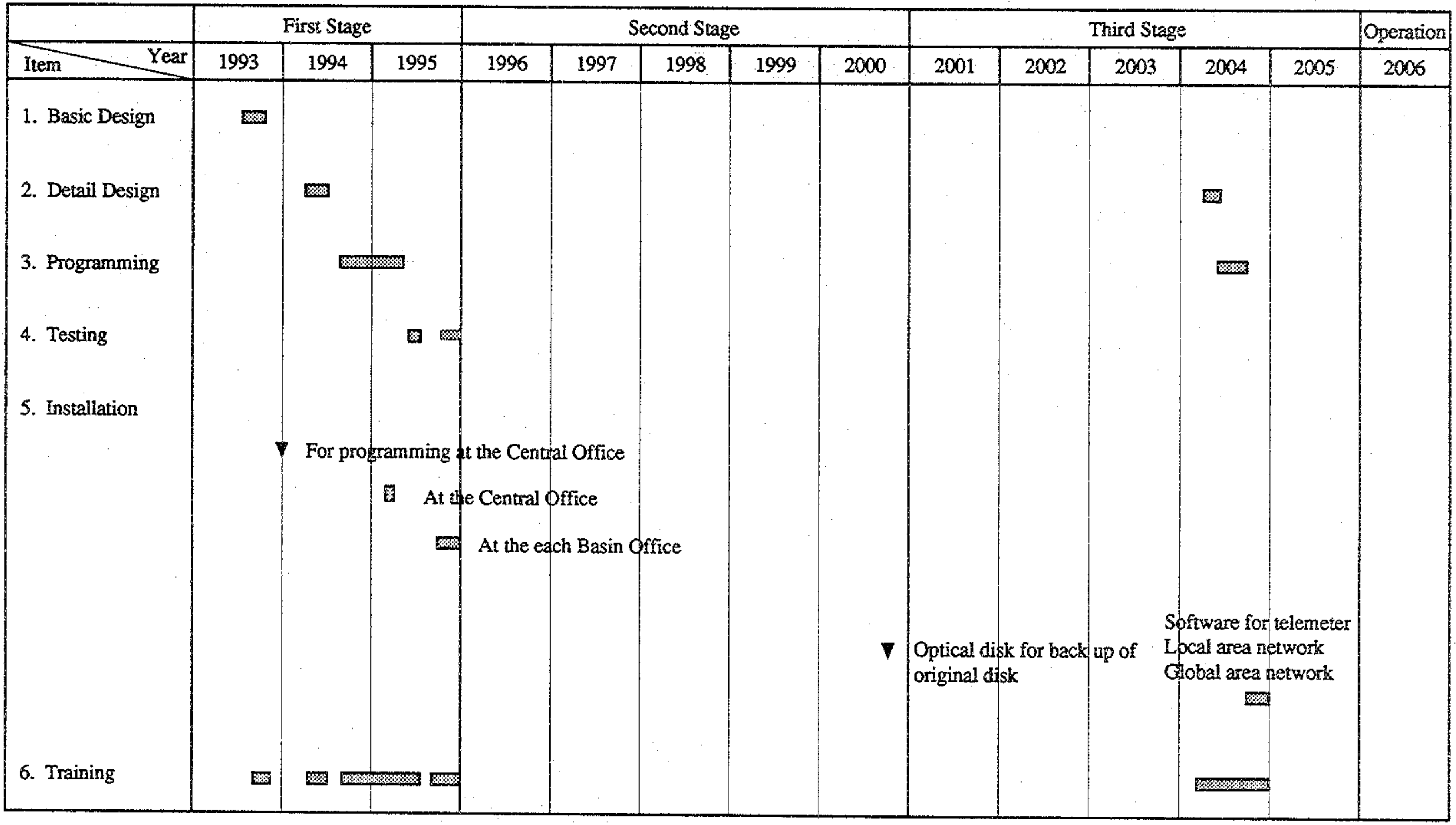


Fig. 9.3 IMPLEMENTATION SCHEDULE FOR THE LONG TERM PROGRAMME



ANNEX G

STRUCTURAL DESIGN AND CONSTRUCTION

NATIONWIDE HYDRO-METEOROLOGICAL DATA MANAGEMENT PROJECT

ANNEX G STRUCTURAL DESIGN AND CONSTRUCTION

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1. MODEL SYSTEM

1.1 Site Selection Points and Selection of Gauge Type

1.1.1 Site Selection Points

The selection for the site of the raingauge station, the water level gauge station and the discharge measurement facility was performed in consideration of the following points.

(1) Raingauge

- Finding educated person in a village as an observer
- If he has his own land to settle the station around his residence? (for care of the station easily)
- If his own land is suitable for the observation station? (no obstruction to affect rain fall around the station)

(2) Water Level Gauge and Discharge Measurement Facility

- Near village
- Good access
- Good location for the cable way and construction of the water level gauge
- Straight part of the river alignment
- Good point for the discharge measurement (smooth flow, small velocity, no river bed evolution)
- No possibility of land sliding

1.1.2 Selection of Gauge Type

The gauge type of each station was selected as follows and the reasons for selection were shown in Fig. 1.1.1 and Fig. 1.1.2.

(1) Water Level Gauge:

- Chyuntaha station .... Float type (with adjustable steel pipe)
- Setibeni station .... Pressure type

- Kalleri station .... Pressure type
- Tatopani station .... Pressure type

(2) Discharge Measurement Facility

- Cable way in the double winch system (Bank operation)

(3) Rain Gauge Station

- Installation of both automatic recorder raingauge and manual raingauge on the stage made of the stone masonry

1.2 Design Concept for Civil Works

The civil works on the Model System are composed of the followings:

(1) Construction of the steel pipe well with the concrete abutment and the observation house for the float type water level gauge at Chyuntaha.

(2) Installation of the pressure type water level gauge at Tatopani, Kalleri and Setibeni.

(3) Construction of the cable way tower with the observation house at Chyuntaha, Tatopani and Kalleri.

(4) Installation of the ordinary and recording raingauge at 14 locations.

(5) Installation of the staff gauge at 6 locations.

These civil works have to be designed and constructed in consideration of problems of the civil works on the existing observation stations. The following problems are reported by the DHM:

(1) Water Level Gauge

1) Float type

- Disablement of observation of the water level because of blockade of the intake pipe and the well by the sediment stays inside the well.
- Disablement of observation of the lowest water level because of the water located lower than the lowest intake pipe, which is caused by the declination of the river bed.
- The observation well to be destroyed by the big flood.

2) Pressure type

- (Still under examination of availability)

(2) Cable Way

- Danger of observation of the velocity by using the single winch with the manned carriage, specially in the flood time.
- No observation house to keep equipments and spare parts for observation of the velocity.

(3) Raingauge

- Disablement of observation of accurate rainfall because of obstacles which interrupt the natural rainfall, for example crops, trees and structures around the installed raingauge in the open field.

Designing the civil works on the Model System, the following points are to be taken into consideration according to the above problems:

(1) Water Level Gauge

1) Float type

- The pipe type to be employed instead of the well type which is generally used in Nepal to avoid sediment staying inside the well.
- The adjustable pipe system, which is composed of individual pipes (its length of 50 cm) to be connected by bolts, to cover a range of ±1.5 m of the river bed evolution.
- The bottom block of the pipe, which is used as the intake, to be tapered off to the diameter of 10 cm to moderate the fluctuation of the water level inside the pipe, which is caused by the fluctuation of the water surface of the river.
- Deeper embedment of the foundation not to overturn due to the declination of the river bed.
- Construction of the wet cobble masonry revetment on both sides of the foundation to protect the foundation.
- The water level gauge to be located in a little way back from the flow of the river to observe the water level on condition of still water.

2) Pressure type

- Installation of the detachable protective pipe in case of adjustment of the sensor depth due to the river bed evolution.
- The bottom of the protective pipe to be opened to avoid sediment staying inside the pipe.
- Using the steel pipe in the lower part to protect the sensor from specially rolling boulders in the flood time and using the vinyl pipe in the upper part, which is easily installed along the surface of the river bank because of the easiness of bending by heat, to protect the connecting cable from floating objects in the flood time.

(2) Cable Way

- Employment of the double winch system, which is operated to observe the velocity with the instrument carriage from the bank without man going with the manned carriage, for safety and for simplification of the structure of the cableway tower using the smaller safety factor in the design.
- Construction of the observation house to get the work space for the observation and to keep observation equipments and spare parts.

(3) Raingauge

- Installation of the raingauge near private house basically for security and easy observing point of view.
- Construction of the stage for installation of the raingauge in the mountain area to keep certain space around the raingauge in order not to be interrupted for the natural rainfall by crops and trees, which grow highly around the raingauge in the narrow terrace field which is located in the steep mountain slope.

The points mentioned above shall also be taken into consideration in the future design by the DHM.

1.3 Installation Method of Gauge and Instrument

Installation Manual which shows the outline of installation method of individual instrument and facility are to be prepared for training of DHM staff. Detail information on installation should be referred to manufacture's instruction.

(1) Raingauge

Rainfall gauges at Chyuntaha and Kolbni station are installed on the ground and others are installed on the stage made of the stone masonry which is 1.5 m high above the ground. A height of both a recording raingauge and an ordinary raingauge is 1 m high.

The raingauge is fixed on the concrete foundation tightly and its surface should be horizontal.

A tipping bucket-type gauge is to be connected with a data logger.

(2) Water Level Gauge

1) Pressure-type Gauge

The pressure-type gauge consists of a pressure sensor and a recording device (pen recorder/data logger). A sensor is installed in a protective pipe in a direction to down stream so as to avoid the influence of dynamic water pressure.

A sensor should be fixed in a pipe at least 50 cm below the prospective lowest water level. A pressure gauge at Kalleri is to be connected with a data logger.

2) Float-type gauge

Outer steel pipes consist of some pieces so as to be vertically movable and adjustable to river bed evolution. Steel pipes should be connected exactly and tightly.

(3) Discharge Measurement Facility

Double-drum winch cable way applied for the bank operation is to be installed at Tatopani, Kalleri and Chyuntaha.

The cable way consists of a track and two cable, suspension conduction cable, double-drum winch and bearing poles. One drum for the tow cable controls horizontal movement of a carrier on the track cable and other drum for the suspension conduction cable lowers or raises the current meter.

Procedure of cableway installation is as follows:

1) Election of bearing posts
2) Fix the angle bracket and pulley block to the winch post
3) Fix the angle bracket and guide pulley to the opposite post

4) Spread a track cable and tension it to the desired cable sag

5) Fix the double drum winch to the winch post

6) Using auxiliary cable, hauling the towing cable across the river from the bank of the winch post, then run the towing cable back to the winch post and arrange it on the pulley block and wind it around the cable drum

7) Place the carrier and the cable support pulley on the track cable and attach lower half of tow cable to the carrier

8) Arrange suspension conduction cable over the guide pulley and fasten it to suspended current meter

9) Operation test

This cable way equips manual float drop device and vertical angle measurement protractor.

1.4 Tendering for Civil Works

1.4.1 General

This tender applies for not only the civil construction of raingauge stations, water level gauge stations and cable ways including survey works, but also the installation of gauges and instruments in Kali Gandaki river basin and Jamuni river basin in Model System of the Project. The tendering works are consisted of making tender documents, tendering call and open and contract mainly. The detailed tendering is mentioned in the subsequent section.

1.4.2 Scope of Tendering

The civil works are divided into 3 Lots because the area of the tendering is so large for the tenderers and each Lot is shown in DWG. No -01 of As Built Drawings. This tender covers the following items:

Lot I: Civil works in Jamuni river basin

1) 2 raingauge including manufacturing the ordinary raingauge
   - Kolbhi station
   - Chyuntaha station

2) 1 water level gauge
   - Chyuntaha station

3) 1 cable way including manufacturing the metal work
   - Chyuntaha station

4) 1 staff gauge
   - Chyuntaha station

5) 2 levelling survey for the raingauge
   - Kolbhi station
   - Chyuntaha station

6) 1 river cross sectional survey
   - Chyuntaha station

Lot II: Civil works in northern part of Kali Gandaki river basin

1) 7 raingauge including manufacturing the ordinary raingauge
   - Yaragau station
   - Samargau station
   - Dhagarjong station
   - Bega station
   - Beghara station
   - Muna station
   - Kuhun station

2) 1 water level gauge
   - Tatopani station

3) 1 cable way including manufacturing the metal work
   - Tatopani station

4) 1 staff gauge
   - Tatopani station

5) 7 levelling survey for the raingauge
   - Yaragau station

- Samargau station
- Dhagarjong station
- Bega station
- Beghara station
- Muna station
- Kuhun station

6) 1 river cross sectional survey
   - Tatopani station

Lot III: Civil works in southern part of Kali Gandaki river basin

1) 5 raingauge including manufacturing the ordinary raingauge
   - Pamdur station
   - Sallyan station
   - Sirkon station
   - Tisedi station
   - Doban station

2) 2 water level gauge
   - Kalleri station
   - Setibeni station

3) 1 cable way including manufacturing the metal work
   - Kalleri station

4) 4 staff gauge
   - Kalleri station (1 gauge)
   - Setibeni station (3 gauges)

5) 5 levelling survey for the raingauge
   - Pamdur station
   - Sallyan station
   - Sirkon station
   - Tisedi station
   - Doban station

6) 4 river cross sectional survey
- Kalleri station (1 gauge)
- Setibeni station (3 gauges)

1.4.3 Tendering Schedule

The tendering was carried out as the following procedure.

1) Prequalification (the beginning of Nov. 1991 - Nov. 19, 1991)

- 11 Contractors, which belong to the Contractor's Association of Nepal, applied and 9 contractors were selected by the evaluation.

2) Tender call and submission of tender by the contractor (Nov. 20, 1991 - Dec. 3, 1991)

- 9 contractors submitted the tender documents

3) Opening of tender and evaluation (Dec. 3, 1991)

- 3 contractors were selected by the evaluation.

These contractors are listed below.
Lot I : Prera Nirman Sewa Pvt. Ltd.
Lot II : Engineering Construction and Services
Lot III : Rabina Construction Pvt. Ltd.

4) Contract of civil works

- The agreement for the civil works was signed between the JICA team and the Contractor on each Lot. (Dec. 8, 1991)

1.4.4 Tender Documents

The tender documents were prepared for Lot I, Lot II and Lot III respectively and they consisted of the following sections.

1. INSTRUCTION TO TENDERERS
2. FORM OF TENDER
3. GENERAL CONDITIONS

4. BILL OF QUANTITIES

5. SPECIFICATIONS

6. FORM OF AGREEMENT

7. DRAWINGS

1.4.5 Bill of Quantities of Successful Tenderers

The Bill of Quantities of the successful tenderers are shown in Appendix-1.

1.5 Civil Construction and Installation Works

The Model System was established in the two selected model basins, the Kali Gandaki river basin in the western development region and the Jamuni river basin in the central development region. Twelve (12) new raingauges and three (3) new recording water level gauges were installed in the Kali Gandaki river model basin. In the Jamuni river basin, two (2) new raingauges and one (1) new recording water level gauge were provided.

Civil construction works for installation of the above gauges were carried out by dividing the works into the following three lots.

Lot I : Civil construction works in the Jamuni river basin
Lot II : Civil construction works in the northern part of the Kali Gandaki river basin
Lot III : Civil construction works in the southern part of the Kali Gandaki river basin

The civil construction works in the Lot I covered civil works of station for and installation of:

- two (2) raingauges at Kolbhi and Chyuntaha,
- one (1) recording water level gauge with staff gauges at Chyuntaha,
- one (1) cable way facility at Chyuntaha,
- including levelling survey at the above raingauge sites and river cross sectional survey at Chyuntaha.

The civil construction works in the Lot II comprised civil works of station for and installation of:

- seven (7) raingauges at Yaragau, Samargau, Dhagarjong, Bega, Beghara, Muna and Kuhun,

- one (1) recording water level gauge with staff gauges at Tatopani,
- one (1) cable way facility at Tatopani,
- including levelling survey at the above raingauge sites and river cross sectional survey at Tatopani.

The civil construction works in the Lot III consisted of civil works of station for and installation of:

- five (5) raingauges at Pamdur, Sallyan, Sirkon, Tisedi and Doban,
- two (2) recording water level gauges with staff gauges at Kalleri and Setibeni,
- one (1) cable way facility at Kalleri,
- including levelling survey at the above raingauge sites and river cross sectional survey at the above water level gauge sites.

Design of the above civil works and preparation of the tender documents were performed in the early stage of the First Home Works in October and November, 1991. The tender for the civil construction works was called on November 20, 1991 in Kathmandu and nine (9) contractors who submitted the tender documents were evaluated on December 3, 1991. The successful tenderers, who were approved by the JICA after evaluation, are listed below.

Lot I : Prera Nirman Sewa Pvt. Ltd.
Lot II : Engineering Construction and Services
Lot III : Rabina Construction Pvt. Ltd.

The contract agreement for each Lot was signed between the Study Team and the selected contractor on December 8, 1991. The Contract price of each Lot is shown below.

Lot I : NRs. 2,363,810
Lot II : NRs. 3,804,555
Lot III : NRs. 2,704,524

During the civil construction works, the main changes of design were made as follows.

- In Chyuntaha water level gauge station, the observation house for the cable way was shifted by around 5m toward bank side to found on the stable ground.
- In Modibeni water level gauge station, the cable way was shifted by around 30 m toward upstream to measure discharge under stable flow condition.

Subsequently to the civil construction works, raingauges, water level gauges and cable way facilities were installed as designed.

The Construction Schedule is shown in Fig. 1.5.1 and the As Built Drawings are shown in Appendix-2.

1.6 Structural Design

The structural design is basically performed according to the design specifications by the Japan Road Association and the Japan Society of Civil Engineers.

1.6.1 Cable way

(1) Calculation of the Tension for the Track Cable

The tension (T) in the cable suspended between supports is given by the following formula.

$$T = \frac{WS^2}{8\,D} + \frac{PS}{4\,D} \quad \text{(Reference to ISO 4375)}$$

where

T : Horizontal tension in cable (kg)
W : Weight of track cable (kg/m) (W = 1.25 kg/m)
S : Horizontal span (m)

Chyuntaha station	S = 102 m
Kalleri station	S = 140 m
Tatopani station	S = 87 m

D : Ultimate sag (m)

D = 0.02 x L (Reference to ISO 4375)

Chyuntaha station	D = 2.04 m
Kalleri station	D = 2.80 m
Tatopani station	D = 1.74 m

P : Concentrated moving load (kg) (P = 170 kg)

∴ Chyuntaha station $$T = \frac{1.25 \times 102^2}{8 \times 2.04} + \frac{170 \times 102}{4 \times 2.04} = 2{,}922 \text{ kg}$$

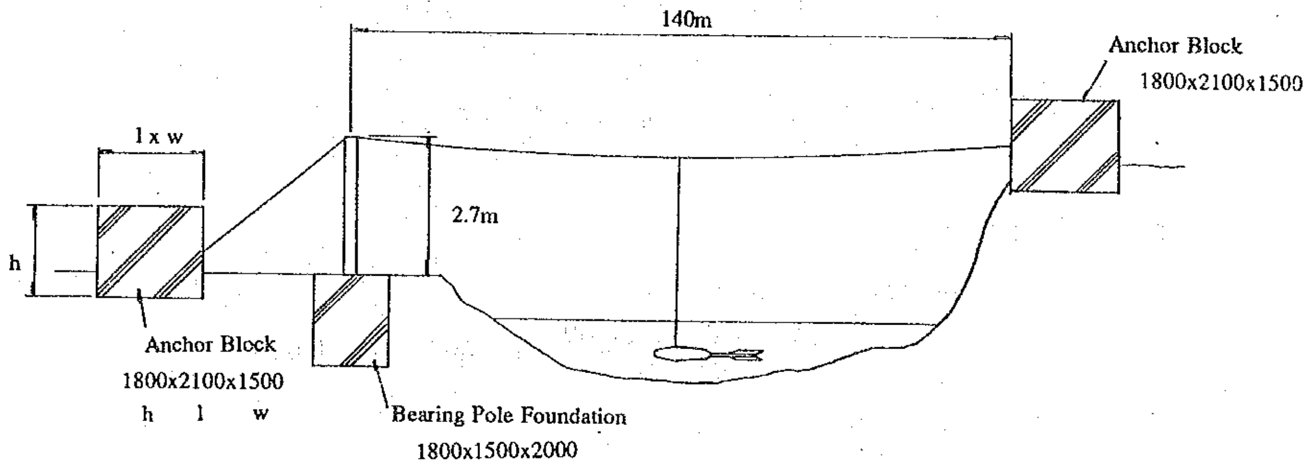
Kalleri station $$T = \frac{1.25 \times 140^2}{8 \times 2.80} + \frac{170 \times 140}{4 \times 2.80} = 3{,}219 \text{ kg}$$

Tatopani station $$T = \frac{1.25 \times 87^2}{8 \times 1.74} + \frac{170 \times 87}{4 \times 1.74} = 2{,}805 \text{ kg}$$

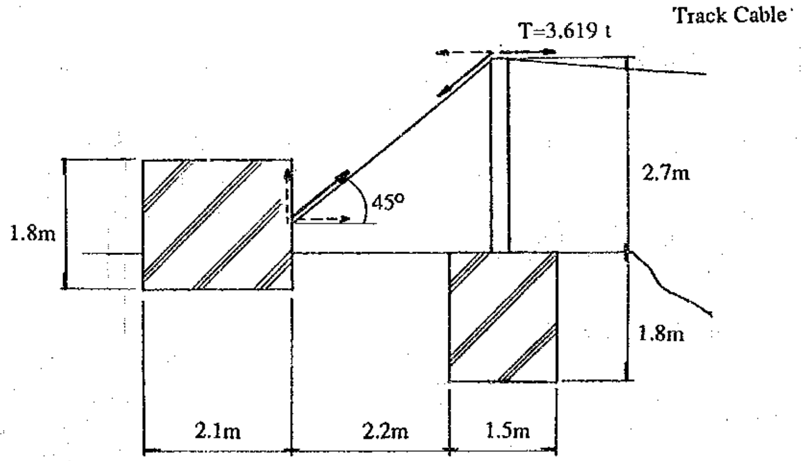
The cable shall have a strength sufficient for above the tensions and the track cable shall be tensioned to the desired cable sag (D = 0.02 x L) according to above the tensions.

(2) Stability Analysis (Kalleri station)

1) Design Condition



2) Cable Way Direction (Anchor Block)



Tension of track cable	: T_1	= 3,219 kg
Tension of towing cable	: T_2	= 400 kg
	T	= 3,619 kg

a) Lifting V = 1.5 m x 2.1 m x 1.8 m x 2.35 t/m^3 = 13.3 t > T = 3.619 t

b) Sliding H = 13.3 t x 0.577 = 7.67 t

7.67 t ÷ 3.619 t = 2.1 > F = 1.5

Friction coefficient $\tan \phi = \tan 30° = 0.577$

c) Overturning

B : Width

e : Eccentricity

V = 13.3 t

$$Mc = 13.3 \times \frac{2.1}{2} - 3.619 \times \frac{1.8}{2} = 10.7 \text{ t·m}$$

$$\therefore \quad e = \frac{B}{2} - \frac{Mc}{V} = \frac{2.1}{2} - \frac{10.7}{13.3} = 0.25 \text{ m} < \frac{B}{6} = \frac{2.1}{6} = 0.35 \text{ m}$$

d) Bearing capacity

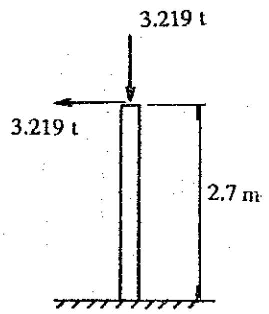
Bearing pole foundation

$$q = \frac{3.619 + 0.4 + 12.69}{1.5 \times 2.0} = 5.6 \text{ t/m}^2 < q_a = 20 \text{ t/m}^2$$

Anchor block

$$q = \frac{13.3}{1.5 \times 2.1} = 4.2 \text{ t/m}^2 < q_a = 20 \text{ t/m}^2$$

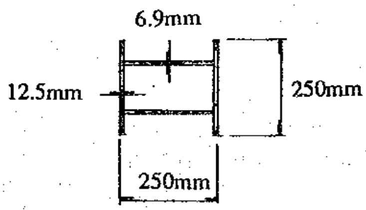
e) Stress of bearing pole



$$\begin{cases} M = 3.219 \times 2.7 = 8.69 \text{ t·m} \\ N = 3.219 \text{ t} \end{cases}$$

$$I = (12.5 \times 1.25 \times 11.875^2 \times 2 + \frac{0.69 \times 22.5^3}{12}) \times 2$$

$$= 10{,}123 \text{ cm}^4$$



$$Z = \frac{I}{y} = \frac{10{,}123}{12.5} = 809.8 \text{ cm}^3$$

$$A = 1.25 \times 25 \times 2 + 0.69 \times 22.5 \times 2$$

$$= 93.55 \text{ cm}^2$$

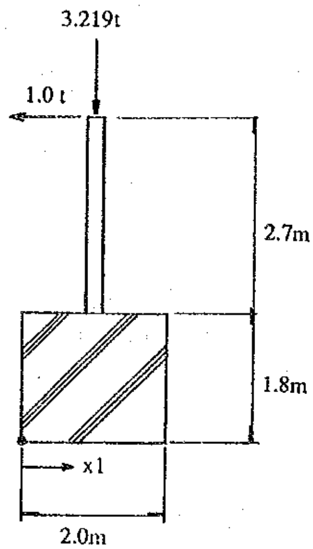
$$\sigma = \frac{N}{A} \pm \frac{M}{Z} = \frac{3.219 \times 10^3}{93.55} \pm \frac{8.69 \times 10^5}{809.8} = 34.4 \pm 1073.1$$

$$= \begin{matrix} 1108 \text{ kg/cm}^2 \\ -1039 \text{ kg/cm}^2 \end{matrix} < \sigma_a = 1400 \text{ kg/cm}^2 \text{ (SM41)}$$

3) Right Angle Direction (Bearing Pole Foundation)

- Water flow pressure

$$P = k \cdot v^2 \cdot A \text{ (t)}$$
$$= 0.02 \times 7.0^2 \times (\pi \times 0.05^2) + 0.04 \times 7.0^2 \times (0.005 \times 6.0)$$
$$= 0.07 \text{ t}$$



- Wind load

$$w = (0.015 \text{ m} \times 150 \text{ m} + 0.008 \text{ m} \times 300 \text{ m} + 0.005 \text{ m} \times 170 \text{ m} + 0.2 \text{ m}^2) \times 0.15 \text{ t/m}^2$$
$$= 0.855 \text{ t}$$

$$\Sigma H = 0.07 + 0.855 = 0.925 \doteqdot 1.0 \text{ t}$$

a) Overturning

$$Mc = (3.619 + 0.4 + 12.69) \times \frac{2.0}{2} - 1.0 \times 4.5$$
$$= 12.2 \text{ t·m}$$
$$\chi_1 = \frac{12.2}{16.709} = 0.73 \text{ m}$$
$$\therefore \quad e = \frac{B}{2} - 0.73 = 1.0 - 0.73 = 0.27 \text{ m} < \frac{B}{6} = \frac{2.0}{6} = 0.33 \text{ m}$$

b) Stress of bearing pole

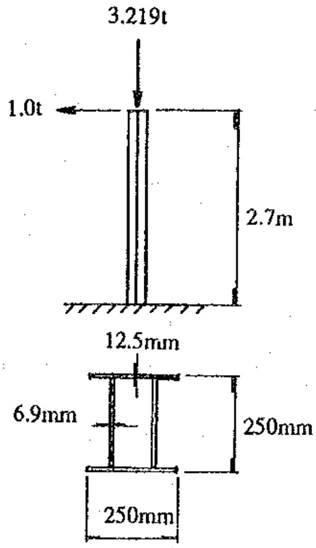
$$\begin{cases} M = 1.0 \times 2.7 = 2.7 \text{ t·m} \\ N = 4.906 \text{ t} \end{cases}$$

$$I = \frac{1.25 \times 25.0^3}{12} \times 2 + 22.5 \times 0.69 \times 6.25^2 \times 2 = 4.468 \text{ cm}^4$$

$$Z = \frac{I}{y} = \frac{4,468}{12.5} = 357.4 \text{ cm}^3$$

$$A = 1.25 \times 25.0 \times 2 + 0.69 \times 22.5 \times 2$$
$$= 93.55 \text{ cm}^2$$

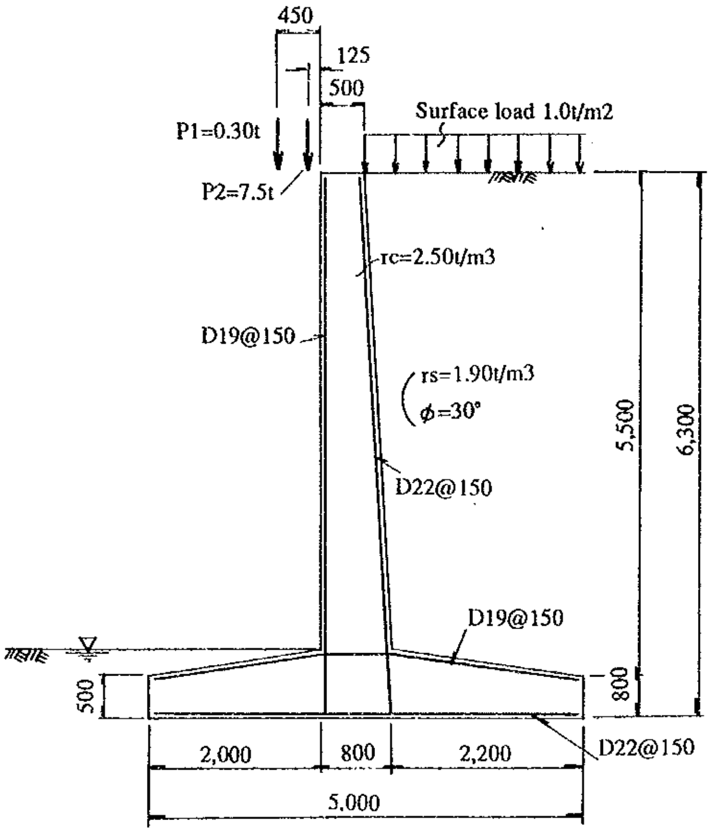
$$\sigma = \frac{N}{A} \pm \frac{M}{Z} = \frac{3.219 \times 10^3}{93.55} \pm \frac{2.7 \times 10^5}{357.4}$$
$$= 34.4 \pm 755.5$$
$$= \begin{matrix} 790 \text{ kg/cm}^2 \\ -721 \text{ kg/cm}^2 \end{matrix} < \sigma_a = 1400 \text{ kg/cm}^2 \text{ (SM41)}$$



1.6.2 Water Level Gauge (Chyuntaha Station)

(1) Design Condition

The over all dimensions of cantilever retaining wall are shown as follows.



1) Concrete

- Grade of concrete f_{ck} = 210 kg/cm^2
- Allowable stress
  - Compression σ_{ca} = 80 kg/cm^2
  - Shear τ_{a1} = 4.25 kg/cm^2

2) Reinforcement bar (SD295A)

- Allowable stress in tension σ_{sa} = 1,800 kg/cm^2 (General)

  σ_{sa} = 1,600 kg/cm^2 (In water)

3) Earth

- Allowable bearing capacity q_a = 20 t/m^2
- Friction coefficient between concrete and soil F = tanøB = 0.6

4) Seismic coefficient Kh = 0.12, Kv = 0

The following calculations shall be performed for one meter run of wall.

(2) Stability Analysis

1) Calculation of Coulomb's Earth Pressure

a) Normal condition

i) Coefficient of earth pressure

ϕ :	Internal friction angle	30.000 (°)
δ :	Angle of wall friction between the back and backfill material	
		$\delta = \beta = 0.000$ (°)
β :	Surface slope of back fill with the horizontal	0.000 (°)
θ :	Inclination of the back with the vertical	0.000 (°)

$$Ka = \frac{\cos^2(\phi-\theta)}{\cos^2\theta \times \cos(\theta+\delta) \times \left[1+\sqrt{\frac{(\sin(\phi+\delta) \times \sin(\phi-\beta))}{(\cos(\theta+\delta) \times \cos(\theta-\beta))}}\right]^2}$$

$= 0.333$

ii) Earth pressure

Ka :	Coefficient of earth pressure	0.333
δ :	Angle of wall friction between the back and backfill material	0.000 (°)
θ :	Inclination of the back with vertical	0.000 (°)
H :	Height of earth pressure	6.300 (m)
Hw :	Height of water level	0.800 (m)
h1 :	H - Hw	5.500 (m)
γo :	Unit weight of earth	
γ :	Unit weight of earth in wet condition	1.900 (t/m^3)
γw :	Unit weight of earth in submerged condition	0.900 (t/m^3)
C :	Cohesion of earth	0.000 (t/m^2)
Q :	Surface load	1.000 (t/m^2)

$p = Ka \times \gamma o \times H - 2 \times C \times \sqrt{Ka} + Ka \times Q$

$p1 = 0.333\ (t/m^2)$

$p2 = 3.817\ (t/m^2)$

$p3 = 4.057\ (t/m^2)$

Resultant of earth pressure

$P1 = (p1 + p2) \times h1/2 = 11.413\ (t/m)$

$P2 = (p2+p3) \times Hw/2 = 3.149\ (t/m)$

$P = P1 + P2 = 14.562\ (t/m)$

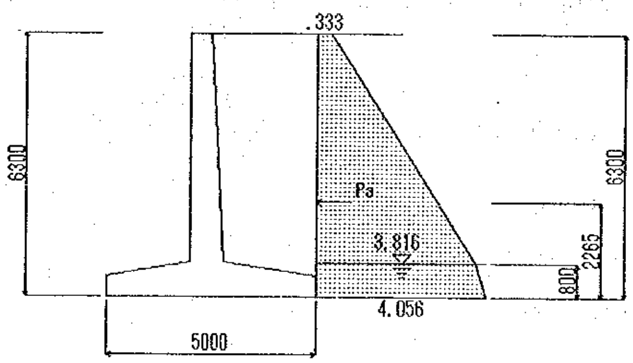
Horizontal $Ph = 14.562\ (t/m)$

Vertical $Pv = 0.000\ (t/m)$

Location of working

$y = 2.265\ (m)$

$x = 0.000\ (m)$



b) Seismic condition

i) Coefficient of earth pressure

$\phi = 30.000\ (°)$

$\tan\delta = \sin\phi \times \sin(\theta o + \Delta - \beta)/(1 - \sin\phi \times \cos(\theta o + \Delta - \beta))$

where $\sin\Delta = \sin(\beta + \theta o)/\sin(\phi)$

$\therefore\ \delta = 18.319\ (°)$

$\beta = 0.000\ (°)$ $\theta = 0.000\ (°)$

$$Kea = \frac{\cos^2(\phi-\theta o-\theta)}{\cos\theta o \times \cos^2\theta \times \cos(\theta+\theta o+\delta) \times (1+\sqrt{Xa})^2}$$

where $$Xa = \frac{\sin(\phi+\delta) \times \sin(\phi-\beta-\theta o)}{\cos(\theta+\theta o+\delta) \times \cos(\theta-\beta)}$$

θo = arctan (Kh) = arctan 0.12 = 6.84°

∴ Kea = 0.382

ii) Earth pressure

Kea	:	Coefficient of earth pressure	0.382
δ	:	Angle of wall friction between the back and backfill material	18.32 (°)
θ	:	Inclination of the back with vertical	0.00 (°)
H	:	Height of earth pressure	6.300 (m)
Hw	:	Height of water level	0.800 (m)
h1	:	H - Hw	5.500 (m)
γo	:	Unit weight of earth	
γ	:	Unit weight of earth in wet condition	1.900 (t/m^3)
γw	:	Unit weight of earth in submerged condition	0.900 (t/m^3)
C	:	Cohesion of earth	0.000 (t/m^2)
Q'	:	Surface load	0.000 (t/m^2)

pe = Kea x γo x H - 2 x C x $\sqrt{Kea}$ + Kea x Q'

pe1 = 0.000 (t/m^2)

pe2 = 3.990 (t/m^2)

pe3 = 4.265 (t/m^2)

Resultant of earth pressure

Pe1 = (pe1 + pe2) x h1/2 = 10.972 (t/m)

Pe2 = (pe2 + pe3) x Hw/2 = 3.302 (t/m)

Pe = Pe1 + Pe 2 = 14.274 (t/m)

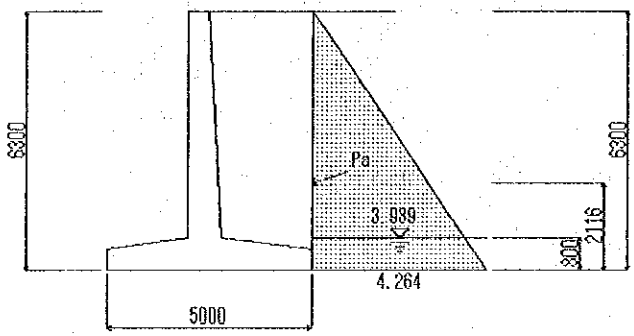
Horizontal Peh = 13.550 (t/m)

Vertical Pev = 4.486 (t/m)

Location of working

y = 2.116 (m)

x = 0.000 (m)



2) Self Weight and Earth Pressure

a) Self weight of body

No.	V (t)	H (t)	x (m)	y (m)	Mx (t·m)	My (t·m)
1	6.250	0.750	2.500	0.250	15.625	0.188
2	0.750	0.090	1.333	0.600	1.000	0.054
3	0.600	0.072	2.400	0.650	1.440	0.047
4	0.825	0.099	3.533	0.600	2.915	0.059
6	6.875	0.825	2.250	3.550	15.469	2.929
7	2.063	0.248	2.600	2.633	5.363	0.652
Total	17.363	2.084			41.811	3.928

V = Xi x Yi x GAMC H = V x KH1
Mx = V x x My = H x y

b) Weight of backfill

No.	V (t)	H (t)	x (m)	y (m)	Mx (t·m)	My (t·m)
1	0.627	0.075	4.267	0.700	2.675	0.053
2	1.568	0.188	2.700	4.467	4.232	0.840
3	22.990	2.759	3.900	3.550	89.661	9.794
Total	25.185	3.022			96.569	10.687

V = Xi x Yi x GAM1 H = V x KH1
Mx = V x x My = H x y

c) Weight of front earth

No.	V (t)	H (t)	x (m)	y (m)	Mx (t·m)	My (t·m)
1	0.570	0.000	0.667	0.770	0.380	0.000
Total	0.570	0.000			0.380	0.000

V = Xi x Yi x GAM2 H = V x KH2
Mx = V x x My = H x y

d) Earth pressure

	V (t)	H (t)	x (m)	y (m)	Mx (t·m)	My (t·m)
Normal Condition	0.000	14.562	5.000	2.265	0.00	32.980
Seismic Condition	4.486	13.550	5.000	2.116	22.431	28.669

e) Buoyancy

	V (t)	H (t)	x (m)	y (m)	Mx (t·m)	My (t·m)
Normal Condition						
Body	-3.370		2.490		-8.392	
Backfill	-0.330		4.267		-1.408	
Front earth	-0.300		0.667		-0.200	
Total	-4.000		2.500		-10.000	
Seismic Condition						
Body	-3.370		2.490		-8.392	
Backfill	-0.330		4.267		-1.408	
Front earth	-0.300		0.667		-0.200	
Total	-4.000		2.500		-10.000	

f) Others

	V (t)	H (t)	x (m)	y (m)	Mx (t·m)	My (t·m)
Normal Condition	7.800	0.000	1.863	6.300	14.528	0.000
Seismic Condition	7.800	0.936	1.863	6.300	14.528	5.897

3) External Force at Point "0"

a) Normal condition

	V (t)	H (t)	Mx (t·m)	My (t·m)
Body	17.363		41.811	
Backfill	25.185		96.569	
Front earth	0.570		0.380	
Earth pressure	0.000	14.562	0.000	32.980
Others	7.800	0.000	14.528	0.000
Buoyancy	-4.000		-10.000	
Total	46.917	14.562	143.287	32.980

$Mo = \Sigma Mx - \Sigma My = 110.307$ (t·m)

b) Seismic condition

	V (t)	H (t)	Mx (t·m)	My (t·m)
Body	17.363	2.084	41.811	3.928
Backfill	25.185	3.022	96.569	10.687
Front earth	0.570	0.000	0.380	0.000
Earth pressure	4.486	13.550	22.431	28.669
Others	7.800	0.936	14.528	5.897
Buoyancy	-4.000		-10.000	
Total	51.403	19.592	165.719	49.180

Mo = ΣMx - ΣMy = 116.538 (t·m)

4) External Force at Center of Base

	V (t)	H (t)	e (m)	Mc (t·m)
Normal condition	46.917	14.562	0.149	6.986
Seismic condition	51.403	19.592	0.233	11.970

e = B0/2 - Mo/V : Mc = V x e

BO : Width of body

e : Eccentricity

5) Stability Analysis of Spread Foundation

a) Stability against overturning

	V (t)	Mc (t·m)	e (m)
Normal Condition	46.917	6.986	0.149 < 0.833
Seismic Condition	51.403	11.970	0.233 < 1.667

e = Mc/V

e : Eccentricity

Normal condition B/6 ≥ e

Seismic condition B/3 ≥ e

b) Stability against sliding

	D (m)	V (t)	H (t)	Hu (t)	Fs
Normal Condition	5.000	46.917	14.562	28.150	1.933 > 1.5
Seismic Condition	5.000	51.403	19.592	30.842	1.574 > 1.2

C = 0.00 (t/m^2) tan (δ) = 0.60

Hu = C x D + V x tan(δ)

Fs = Hu/H

D : Working width

Hu : Shear resistance of foundation

Fs : Safe factor of sliding

C : Cohesion between base slab and earth

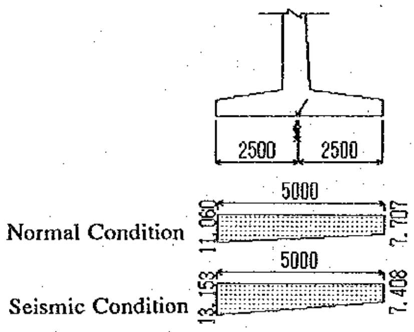
d : Friction angle between base slab and earth

c) Stability against bearing capacity of foundation

		Normal Condition	Seismic Condition
B	(m)	5.000	5.000
L	(m)	1.000	1.000
V	(t)	46.917	51.403
H	(t)	14.562	19.592
Mc	(t·m)	6.986	11.970
e	(m)	0.149	0.233
X	(m)	5.000	5.000
Q_{max}	(t/m^2)	11.060	13.153
Q_{min}	(t/m^2)	7.707	7.408
Allowable stress		20.000	30.000

Q = V/(B x L) + 6 x Mc/(L x B x B) (Trapezoidal distribution)

Q = 2 x V/(L x X): X = 3 x (B/2 - Mc/V) (Triangle distribution)



d) Summary of stability analysis for spread foundation

	Overturning e (m)	Sliding Fs	Bearing Capacity (t/m^2)		
			Q_{max}	Q_{min}	Working Width
Normal Condition	0.149	1.933	11.060	7.707	5.000
Seismic Condition	0.233	1.574	13.153	7.408	5.000

Allowable value

	Overturning Eccentricity (m)	Sliding Safe Factor	Bearing Capacity (t/m^2)
Normal Condition	0.833	1.500	20.000
Seismic Condition	1.667	1.200	30.000

(3) Design of Stem

The design shall be focussed on the bottom section of the stem.

1) Calculation of Coulomb's Earth Pressure

Coefficient and force of earth pressure

	Kv	Kh	Pv	Ph	x	y	h
Normal Condition	0.126	0.295	4.307	10.086	0.29	1.98	5.50
Seismic Condition	0.127	0.387	3.639	11.120	0.30	1.83	5.50

	β	δ	θ	εo
Normal Condition	0.0°	20.0°	3.1°	
Seismic Condition	0.0°	15.0°	3.1°	6.8°

where

Kh	:	Coefficient of earth pressure (Horizontal)	
Kv	:	Coefficient of earth pressure (Vertical)	
Ph	:	Force of earth pressure (Horizontal)	(t/m)
Pv	:	Force of earth pressure (Vertical)	(t/m)
y	:	Location of working (Horizontal)	(m)
x	:	Location of working (Vertical)	(m)
h	:	Height of earth pressure	(m)
δ	:	Angle of wall friction between the bank and backfill material	(°)
β	:	Surface slope of backfill with the horizontal	(°)
θ	:	Inclination of the bank with the vertical	(°)
εo	:	Seismic resultant angle	(°)

2) Self Weight and Earth Pressure

a) Self weight of body

	V (t)	H (t)	x (m)	y (m)	Mx (t·m)	My (t·m)
6	6.875	0.825	-0.150	2.750	-1.031	2.269
7	2.063	0.248	0.200	1.833	0.413	0.454
Total	8.938	1.073			-0.619	2.723

b) Earth pressure

	V (t)	H (t)	x (m)	y (m)	Mx (t·m)	My (t·m)
Normal Condition	4.307	10.086	0.292	1.981	1.257	19.977
Seismic Condition	3.639	11.120	0.300	1.833	1.092	20.386

c) Others

	V (t)	H (t)	x (m)	y (m)	Mx (t·m)	My (t·m)
Normal Condition	7.800	0.000	-0.538	5.500	-4.193	0.000
Seismic Condition	7.800	0.936	-0.538	5.500	-4.193	5.148

3) External Force at Bottom Section

a) Normal condition

	V (t)	H (t)	Mx (t·m)	My (t·m)
Body	8.938		-0.619	
Earth Pressure	4.307	10.086	1.257	19.977
Others	7.800	0.000	-4.193	0.000
Total	21.044	10.086	-3.554	19.977

$$Mo = \Sigma My - \Sigma Mx = 23.530 \text{ (t·m)}$$

b) Seismic condition

	V (t)	H (t)	Mx (t·m)	My (t·m)
Body	8.938	1.073	-0.619	2.723
Earth Pressure	3.639	11.120	1.092	20.386
Others	7.80	0.936	-4.193	5.148
Total	20.377	13.128	-3.720	28.256

$$Mo = \Sigma My - \Sigma Mx = 31.976 \text{ (t·m)}$$

c) Summary of external force at bottom section

	V (t)	H (t)	Mx (t·m)	My (t·m)
Normal Condition	21.044	10.086	1.118	23.530
Seismic Condition	20.377	13.128	1.569	31.976

4) Stress Calculation of Stem

Case		Normal Condition	Seismic Condition
M	(t·m)	23.53	31.98
N	(t)	21.04	20.38
S	(t)	10.09	13.13
b	(cm)	100.0	100.0
h	(cm)	80.0	80.0
d	(cm)	72.0	72.0
d'	(cm)	8.0	8.0
Tension Side			
Steel bar dia.	(mm)	D 22	D 22
Pitch	(mm)	150	150
Asreq	(cm^2)	15.90	15.91
As	(cm^2)	25.81	25.81
Compression Side			
Steel bar dia.	(mm)	D 19	D 19
Pitch	(mm)	150	150
Asreq'	(cm^2)	11.77	11.77
As'	(cm^2)	19.10	19.10
σc	(kg/cm^2)	34.0	45.8
σs	(kg/cm^2)	1,017.2	1,524.4
τ	(kg/cm^2)	1.4	1.8
σca	(kg/cm^2)	80	120
σsa	(kg/cm^2)	1,600	2,700
τa	(kg/cm^2)	4.3	6.4

5) Check of Shear Stress

Case		Normal Condition	Seismic Condition
M	(t·m)	23.53	31.98
S	(t)	10.09	13.13
b	(cm)	100.0	100.0
d	(cm)	72.0	72.0
τ	(kg/cm^2)	1.4	1.8
τa	(kg/cm^2)	4.3	6.4

(4) Design of Toe Slab

The design shall be focussed on the end section of the toe slab.

1) Self Weight and Earth Pressure

a) Self weight of body

	V (t)	x (m)	Mx (t·m)
1	2.500	1.000	2.500
2	0.750	0.667	0.500
Total	3.250		3.000

b) Weight of front earth

	V (t)	H (t)	x (m)	y (m)	Mx (t·m)	My (t·m)
1	0.570	0.000	1.333	0.300	0.760	0.000
Total	0.570	0.000			0.760	0.000

c) Bearing capacity

	Q1 (t/m)	Q2 (t/m)	B (m)	x (m)	Mx (t·m)	V (t)
Normal Condition	-11.060	-9.719	2.000	1.022	-21.226	-20.779
Seismic Condition	-13.153	-10.855	2.000	1.032	-24.774	-24.008

Q1 : Bearing capacity at end

Q2 : Bearing capacity in front

B : Width of loading

d) Buoyancy

	V (t)	x (m)	Mx (t·m)
Normal Condition			
Body	-1.300	0.923	-1.200
Front earth	-0.300	1.333	-0.400
Total	-1.600	1.000	-1.600
Seismic Condition			
Body	-1.300	0.923	-1.200
Front earth	-0.300	1.333	-0.400
Total	-1.600	1.000	-1.600

2) External Force at End Section

a) Normal condition

	V (t)	H (t)	Mx (t·m)	My (t·m)
Body	3.250		3.000	
Front Earth	0.570		0.760	
Bearing Capacity	-20.779		-21.226	
Buoyancy	-1.600		-1.600	
Total	-18.559		-19.066	

Mo = ΣMx + ΣMy = -19.066 (t·m)

b) Seismic condition

	V (t)	H (t)	Mx (t·m)	My (t·m)
Body	3.250		3.000	
Front Earth	0.570	0.000	0.760	0.000
Bearing Capacity	-24.008		-24.774	
Buoyancy	-1.600		-1.600	
Total	-21.788	0.000	-22.614	0.000

Mo = ΣMx + ΣMy = -22.614 (t·m)

3) Summary of External Force

	V (t)	H (t)	e (m)	Mo (t·m)
Normal Condition	-18.559	0.000	0.000	-19.066
Seismic Condition	-21.788	0.000	0.000	-22.614

4) Stress Calculation of Toe Slab

Case		Normal Condition	Seismic Condition
M	(t·m)	19.07	22.61
N	(t)	0.00	0.00
S	(t)	18.56	21.79
b	(cm)	100.0	100.0
h	(cm)	80.0	80.0
d	(cm)	72.0	72.0
Tension Side			
Steel bar dia.	(mm)	D 22	D 22
Pitch	(mm)	150	150
Asreq	(cm^2)	18.08	18.08
As	(cm^2)	25.81	25.81
σc	(kg/cm^2)	29.1	34.5
σs	(kg/cm^2)	1,131.1	1,341.6
τ	(kg/cm^2)	2.6	3.0
σca	(kg/cm^2)	80	120
σsa	(kg/cm^2)	1,600	2,700
τa	(kg/cm^2)	4.3	6.4

5) Check of Shear Stress

Case	Normal Condition	Seismic Condition
M (t·m)	19.07	22.61
S (t)	18.56	21.79
Sh (t)	14.59	17.08
b (cm)	100.0	100.0
d (cm)	72.0	72.0
β	0.150	0.150
τ (kg/cm^2)	2.0	2.4
τa (kg/cm^2)	4.3	6.4

Note ; $\beta = \tan\theta$, $\tau a = \alpha \tau a$

2. IMMEDIATE PROGRAMME

2.1 Design Concept

The design of civil works for the Immediate Programme shall be mainly performed in consideration of the practical experience of the Model System.

The key points for the design of civil works and the selection of the site for each gauge station are as follows respectively.

2.1.1 Raingauge

Both the recording raingauge and the ordinary raingauge shall be installed at each new station. The new stations for raingauges are listed below.

Plain area (5);		Mountain area (5);	
0218	Dipayal	0312	Dunai
0416	Nepal Ganj	0725	Tamaghas
1002	Aru Ghat D. Bazar	1107	Sindhuli Gandhi
1212	Phatepun	1103	Jiri
1421	Gaida	1301	Num

The key points for the design of civil works are as follows.

- Installation shouldn't be made on the roof in the plain area specially because of too strong wind.
- Installation in a school has to be avoided so as not to be damaged by the pupil.
- The fence should be provided around the gauge to keep it in security.

Some of the existing ordinary raingauge stations are reported to be repaired and need new foundations.

2.1.2 Staff Gauge

Each basic station shall be provided three (3) sections of staff gauges to observe the water level. The number of additional sections for the staff gauge at each basic station is as follows.

Station No.	Location	River	Number of additional section
280	Cisapani	Karnali	(2)
289.95	Chepang	Babai	(2)
350	Jalkundi	West Rapti	(2)
390	Butwal	Tinau	(3)
450	Narayanghat	Gandaki	(2)
589	Pondhera dovan	Bagmati	(2)
598	Chisapani	Kamala	(3)
695	Chatara Kotsu	Saptakoshi	(2)
795	Mainachuli	Kankai	(2)
		Total	(20)

The site to be installed the staff gauge shall be selected as follows.

- To be able to easily observe the water level from the bank
- Not to be directly hit by the floating tree and the rolling stone in flood
- To access easily to the station
- Installing the staff gauge on the surface of the rock, staff gauge should be fastened tightly by using anchor bolts in the rock.
- The distance between two staff gauges is approximately 100 m.

2.1.3 Water Level Gauge

The existing water level gauge at each basic station shall be treated as follows.

Station No.	Location	River	Existing condition	Treatment
150	Pancheshwar	Mahakari	- Well operated	—
280	Cisapani	Kamali	- Well operated	—
289.95	Chepang	Babai	- Lowest water level is 2 - 3 cm below lowest intake pipe	- Installation of additional intake pipe
350	Jalkundi	West Rapti	- No observation during dry season because of river bed evolution and sedimentation	- New installation of pressure type gauge
390	Butwal	Tinau	- No existing gauge	- New installation of pressure type gauge
450	Narayanghat	Gandaki	- Sedimentation - Structurally no problem	- Clearing of sedimentation
589	Pondhera dovan	Bagmati	- Sedimentation - Structurally no problem	- Clearing of sedimentation
598	Chisapani	Kamala	- Too wide river - Changeable water route in dry season	- New installation of pressure type gauge
695	Chatara Kotsu	Saptakoshi	- Sedimentation - Structurally no problem	- Clearing of sedimentation
795	Mainachuli	Kankai	- Sedimentation - Structurally no problem	- Clearing of sedimentation

The pressure type gauge shall be installed at the location in a little way back from the main flow of the river so as not to be flashed away and damaged in flood.

2.1.4 Cable Way

Basically the cable way at the basic station shall be improved to the double winch system (bank operation system) from the single winch system (manual system). The existing cable way at each basic station shall be treated as follows.

Station No.	Location	River	Existing condition	Treatment
150	Pancheshwar	Mahakari	Double winch	—
280	Cisapani	Karnali	Double winch	—
289.95	Chepang	Babai	Single winch R...... Tower L...... Tower	- Using existing both towers - Installation of double winch - Construction of observation house and bearing pole
350	Jalkundi	West Rapti	Single winch R...... Tower L...... Anchor block	- Using exiting right bank tower - Installation of double winch - Construction of observation house and bearing pole
390	Butwal	Tinau	Need for new section of cable way	- New double winch cable way
450	Narayanghat	Gandaki	Single winch R...... Tower L...... Tower	- Using existing both towers, - Installation of double winch - Construction of observation house and bearing pole
589	Pondhera dovan	Bagmati	Single winch R...... Anchor block L...... Anchor block	- New double winch cable way
598	Chisapani	Kamala	No existing cable way	- Observation from bridge
695	Chatara Kotsu	Saptakoshi	Single winch R...... Tower L...... Anchor block	- Using existing right bank tower - Installation of double winch - Construction of observation house and bearing pole
795	Mainachuli	Kankai	Single winch R...... Anchor block L...... Anchor block	- New double winch cable way

Legend; R.....Right bank
L.....Left bank

2.1.5 Building of Basic Station

The office building of basic station shall be newly constructed in Nepalese type (DHM type) at the following basic stations.

Station No.	Location	River
289.95	Chepang	Babai
350	Jalkundi	West Rapti
390	Butwal	Tinau
598	Chisapani	Kamala
695	Chatara Kotsu	Saptakoshi

2.1.6 Current Meter Calibration Facility

The calibration facility shall be constructed to be able to calibrate up to 10 m/s, which is the prospected maximum velocity in Nepalese rivers. The dimension of the open tank is shown below.

1) Length : 160 m

- 100 m	for Test section
- 25 m	for Acceleration
- 25 m	for Deceleration
- 5 m + 5 m	for Rating carriage parking space

2) Depth : 2.3 m

3) Width : 2.0 m

The open tank shall be designed in consideration of the following matters.

1) Material : Water proof reinforced concrete structure

2) Contraction joint : Every 15.0 m with water stop

3) Foundation : Concrete foundation layer t = 50 cm
(to avoid unequal settlement on axial direction so that the rating carriage runs smoothly)

4) Drain system : Pump up at the drain pit / 2‰ water gradient at bottom

5) Water supply : Using ordinary water supply

2.1.7 Training Center

The location of the training center is prospectively inside the ring road in Kathmandu and the land for the center is considered 5,000 m^2 approximately.

Main facilities of the training center are composed of as follows.

1) Training Center Building
2) Current Meter Calibration Facility (Calibration Open Tank)
3) Parking Area
4) Multipurpose Space

The Training Center building consists of:

- Training Room	(2)	
- Expert Room	(1)	
- Equipment Room	(1)	
- Computer Room	(1)	
- Library	(1)	
- Calibration Room	(1)	
- Administration Office	(1)	
- Guard-man Room	(1)	
- Kettle Room	(1)	
- Lavatory	(1)	
- Storage	(1)	Note: ( ) shows number of room.

The design concept of the Training Center is considered as follows.

1) Focus on the long open tank and making image of whole flow toward its axial direction.

2) The open tank enters deeply into the big-open patio of the center building, where takes inside sufficient sunlight through wide-open windows above the doorways.

3) Calibration Room is given the whole view of the open tank through the wide-open window.

4) Training Rooms is situated best location to have the wide-spread view of the whole part of the multipurpose space including the open tank through the wide-open window.

5) Equipment Room is next to the Training Rooms for easy access and to bring equipments into the Taining Rooms.

6) To put Training Rooms, Expert Room and Administration Office, which have more important functions, in the sunny side facing the south.

7) Making wider roof to collect rain into the open tank for water saving.

2.2 Cost Estimate

2.2.1 Base of Price

The estimation of the construction cost for civil works is performed as follows.

1) The construction cost of civil works for Immediate Programme is estimated basically referring to the prices of "THE MODEL SYSTEM (1991)".

2) Training Center building is estimated basically referring to the prices of "THE PROJECT FOR CONSTRUCTION OF BUS TERMINAL IN KATHMANDU (1991)" and "KULEKHANI DISASTER PREVENTION PROJECT (1990)".

3) The data for cost estimation to have been collected during the field investigation is used to estimate other prices and confirm the prices above mentioned.

The prices to be estimated for civil works of the Immediate Programme are shown below.

- Engineering Service (1 man/month)	1,150,000 NRs
- Supervision (1 man/month)	1,150,000
- Raingauge (Mountain area)	130,000
Raingauge (Plain area)	70,000
- Staff gauge	18,000
- Maintenance (clearing) of existing water level station	10,000
- Pressure type water level gauge	121,000
- Repairing existing water level station	70,000
- Improvement of existing single winch cable way	560,000
- Double winch cable way	970,000
- Basic station	370,000
- Current meter calibration facility (Open tank)	6,664,000
- Training Center	83,100,000
- Land acquisition (Inside the ring road) (m^2)	4,915

2.2.2 Construction Cost

The construction cost for the Immediate Programme is shown in Table 2.2.1.

2.3 Construction Schedule

The construction schedule for the Immediate Programme is shown in Fig. 2.3.1.

2.4 Drawings

The drawings for the Immediate Programme are shown in Appendix-3.

3. SECOND AND THIRD STAGE OF LONG TERM PROGRAMME

3.1 Design Concept

The design for civil works for the second and third stage in the Long Term Programme is basically performed the same policy as the design for the Immediate Programme but if some improvement matters about the design are pointed out during the observation and operation in the Immediate Programme, those shall be reflected to the subsequent design.

Observation gauges and facilities to be prospectively installed for the second and third stage are listed below and applicable conditions for those are given respectively.

3.1.1 Raingauge

Refer to the Immediate Programme.

3.1.2 Staff Gauge

Refer to the Immediate Programme.

3.1.3 Water Level Gauge

(1) Float type well gauge (Adjustable pipe type for low bank)

Application to river like
- River in the plain like Jamuni River
- River route is very close to the bank.
- Bank height within 4.0 - 5.0 m
- Occurrence of river bed evolution
- Water included plenty of suspended load

Revetment around the gauge shall be constructed straight along the existing bank in consideration of the Study on the Model System.

(2) Float type well gauge (Adjustable pipe type for high bank)

Application to river like
- River route is very close to the bank.
- Bank height around 10.0 m
- Smooth river flow
- No floating tree and rolling stone in flood

- Occurrence of river bed evolution
- Water included plenty of suspended load

(3) Present Nepalese type (Well with intake pipe)

Application to river like
- River route is near the bank.
- Small river bed evolution
- Little suspended load
- Calm river in the plain

(4) Pressure type water level gauge

Refer to the Immediate Programme.

Application to
- Location doesn't apply to above three types.
- Site is impossible to construct the abutment or well.
- Site is in high cost to construct the abutment or well.

3.1.4 Cable Way

(1) Double winch system

Refer to the Immediate Programme.

Application to
- High velocity in flood
- Wide river
- Rivers in the mountain area
- Location has more important function.

(2) Single winch system (Present Nepalese type)

Application to
- Low velocity
- Narrow river
- Rivers in the plain area
- Location has less important function.

3.1.5 Water Level Telemetering System

The concept of facilities is shown in the drawing.

3.2 Cost Estimate

The estimation of the construction cost for civil works of the second and third stage shall be basically performed using the same prices of gauges and facilities as the Immediate Programme, which are given in Section 2.2.1, but the prices which are not in the Immediate Programme are provisionally estimated referring to the prices of the Immediate Programme.

The type, number and price of gauge or facility, which are provisionally used for the cost estimate, are shown in each stage respectively in Table 3.2.1.

The construction cost for those stages is shown in Table 6 -15 in the MAIN REPORT.

3.3 Construction Schedule

The construction schedule for the second and third stage is shown in Fig. 6-11 in the MAIN REPORT.

3.4 Drawings

The drawings of observation gauges and facilities for the Long Term Programme are shown in Appendix-4 except for those of the Immediate Programme.

TABLES

Table 2.2.1 CONSTRUCTION COST FOR IMMEDIATE PROGRAMME

1,000 NRs

	1993		1994		1995	
	F/C	L/C	F/C	L/C	F/C	L/C
1) Engineering Service (10 M/M)	11,500	—	—	—	—	—
2) Supervision (33 M/M)	1,150	—	20,690	—	16,090	—
3) Raingauge						
Repair of Existing	—	—	—	660	—	660
New Station in Mountain (5)	—	—	—	390	—	260
New Station in Plain (5)	—	—	—	210	—	140
4) Water Level Observation						
Installation of Staff Gauge (20)	—	—	—	126	—	234
Maintenance of Existing Station (4)	—	—	—	13	—	27
Installation of Pressure Type (3)	—	—	—	121	—	242
Repair of Existing Station (1)	—	—	—	—	—	70
5) Discharge Measurement						
Improvement of Single Winch Cable Way (2)	—	—	—	1,120	—	—
Installation of Double Winch Cable Way (5)	—	—	—	4,850	—	—
6) Basic Station (5)	—	—	—	1,110	—	740
7) Current Meter Calibration Facility	—	—	—	3,998	—	2,665
8) Training Center	—	—	20,477	8,776	20,477	8,776
Land Acquisition (5,000 m^2)	—	—	—	24,575	—	—
Total	12,650		41,167	45,949	36,567	13,814
Grand Total						150,147

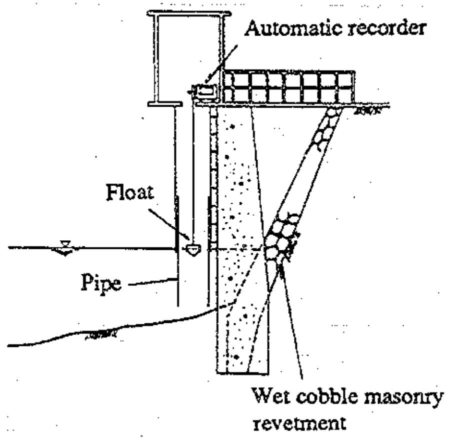
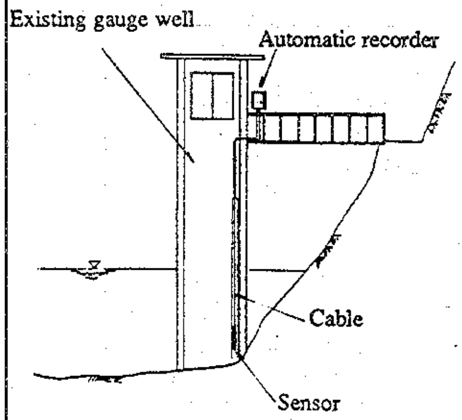
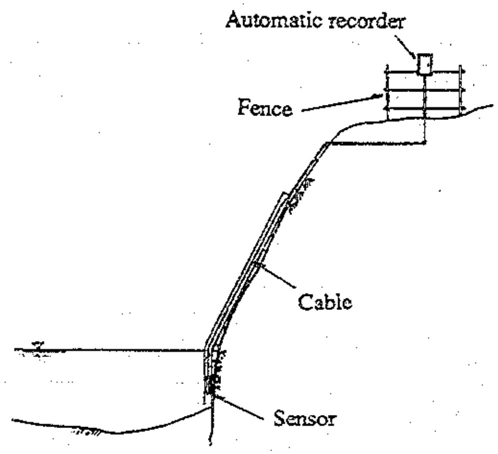
Notes: 1) ( ) shows the number of gauges.
2) The land acquisition cost for the basic station is excluded.
3) The cost for the training center includes items below.
- Supervision
- Electrical work (11 kV, 3 km)
- Water supply
- Telephone system
- Exterior works (Fence, Land grading, Plantation)

Table 3.2.1 NUMBER AND PRICE OF GAUGE AND FACILITY

WORK	Number of Gauge and Facility		Price (NRs)	Remarks
	Second Stage	Third Stage		
1) Raingauge				
- Ordinary				
Repair of existing	65	43	10,000	incl. gauge
New installation	102	102	10,000	incl. gauge
- Recording				
Mountain area	10	4	130,000	incl. ordinary gauge
Plain area	5	3	70,000	incl. ordinary gauge
2) Water Level Gauge				
- Staff Gauge				
Primary station				
New installation	12	–	18,000	incl. staff plate
Additional section for existing	68	–	18,000	incl.. staff plate
Secondary station				
New installation	–	17	18,000	incl. staff plate
- Peak Water Level Gauge				
New installation	–	62	30,000	incl. steel pipe and staff plate
- Float Type (Pipe)				
New installation	11	–	1,135,000	excl. float and recorder
- Float Type (Well)				
Repair of existing	5	–	378,000	
- Pressure Type				
New installation	7	–	121,000	excl. sensor and recorder
3) Cable Way				
- Double Winch				
New installation	27	–	970,000	excl. double winch, carrier, wire, accessaries
- Single Winch				
New installation	1	25	663,000	incl. winch, tower, wire, cable car
Repair of existing	–	15	221,000	incl. winch, tower, wire, cable car
4) Telemetering System				
- Transmitter house	–	3	150,000	
- Relay house	–	1	187,000	

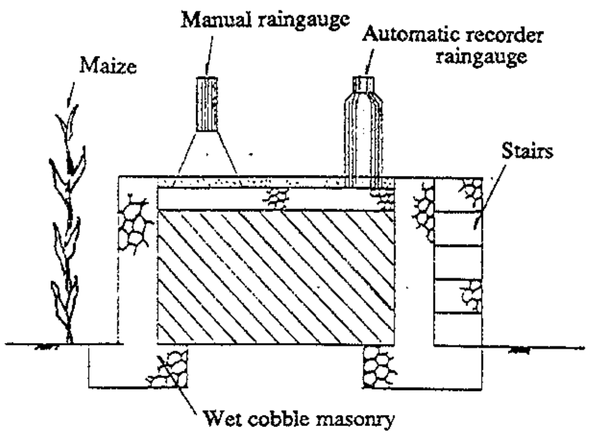
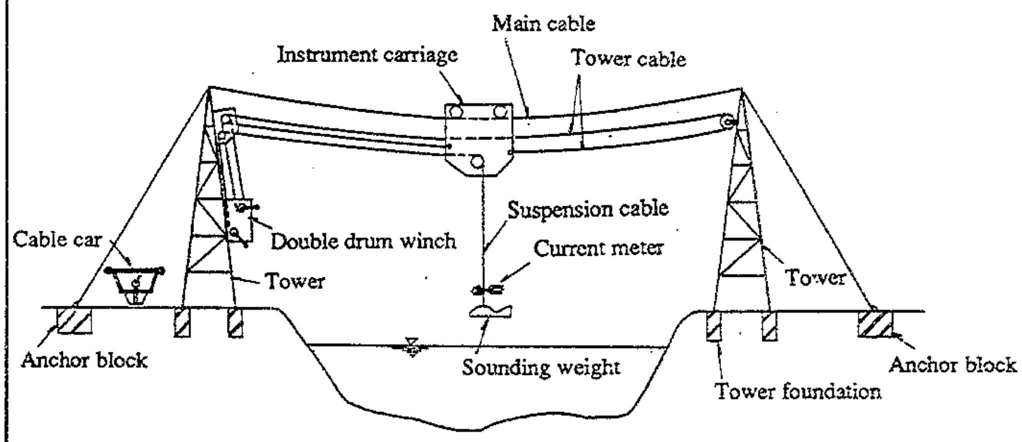
FIGURES

Fig. 1.1.1 SELECTION OF WATER LEVEL GAUGE STATION

Basin Name		Thali River Basin	Kali Gandaki River Basin	
Station Name		Chyuntaha	Setibeni (Existing)	Kalleri / Tatopani
Structure				
Evaluation	Float-type (well)	- Scouring of river bed makes intake-pipe above L.W.L. - Sediment inside gauge well causes intake-pipe to block because of much suspended load in water. ×	—	- Scouring of river bed makes intake-pipe above L.W.L. - Sediment inside gauge well causes intake-pipe to block because of much suspended sediment in water. - Float-type needs long intake-pipe to the center of flow, which causes intake-pipe to block easily by sediment. - Construction of gauge well in cliff and easily erosive bank is very difficult. ×
	Float-type (pipe)	- Employment of adjustable double pipe system mentioned above drawing makes scouring and sedimentation problems solve. - Life time of Float-type is longer than Pressure-type. ◎	—	- Construction of gauge well in cliff and easily erosive bank is very difficult. △
	Pressure-type	- Also, Pressure-type will be suitable for this station. ○	- Utilization of existing gauge well to install Pressure-type is most effective and economical. ◎	- Pressure-type is easy to adjust depth cf sensor due to scouring of river bed. - Pressure-type is not affected by suspended sediment much. - Installation of Pressure-type is much easier than Float-type. ◎

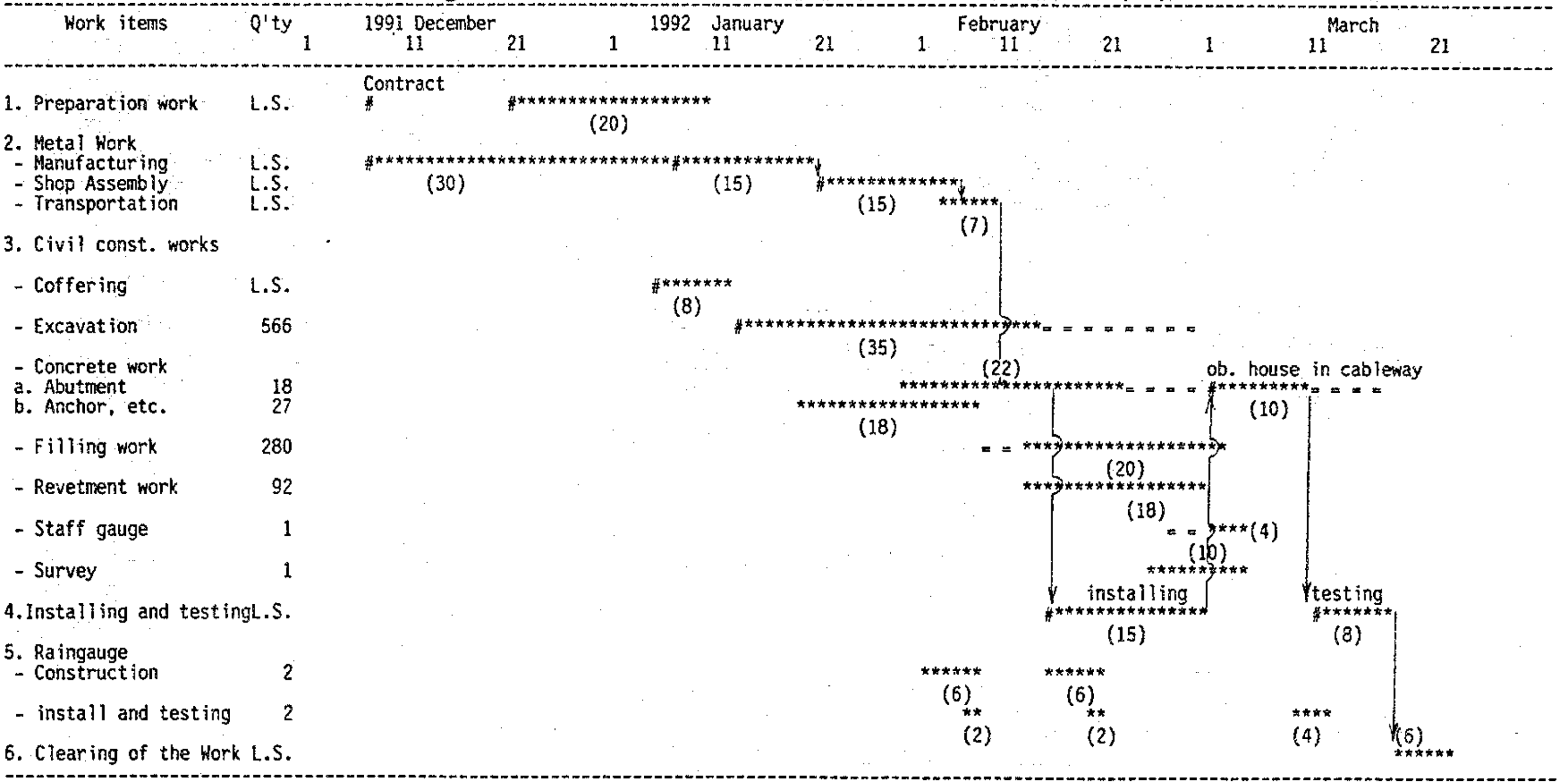
LEGEND: ◎ Selected gauge type

Fig. 1.1.2 SELECTION OF RAIN GAUGE STATION AND DISCHARGE MEASUREMENT FACILITY

	RAIN GAUGE STATION	DISCHARGE MEASUREMENT FACILITY
STRUCTURE		
NOTE;	(1) Installation of Ordinary and Recording raingauge due to Japanese Standard of River and Sabou. (2) Construction of Stage to make Rain Gauge higher to avoid affecting rain fall by maize.	(1) Installation of double drum winch for bank operation system. - It is secure during measurement in flood. - Heavy sounding weight due to big velocity can not be operated by hand. (2) Cable car also to be prepared for manual operation.

Lot I

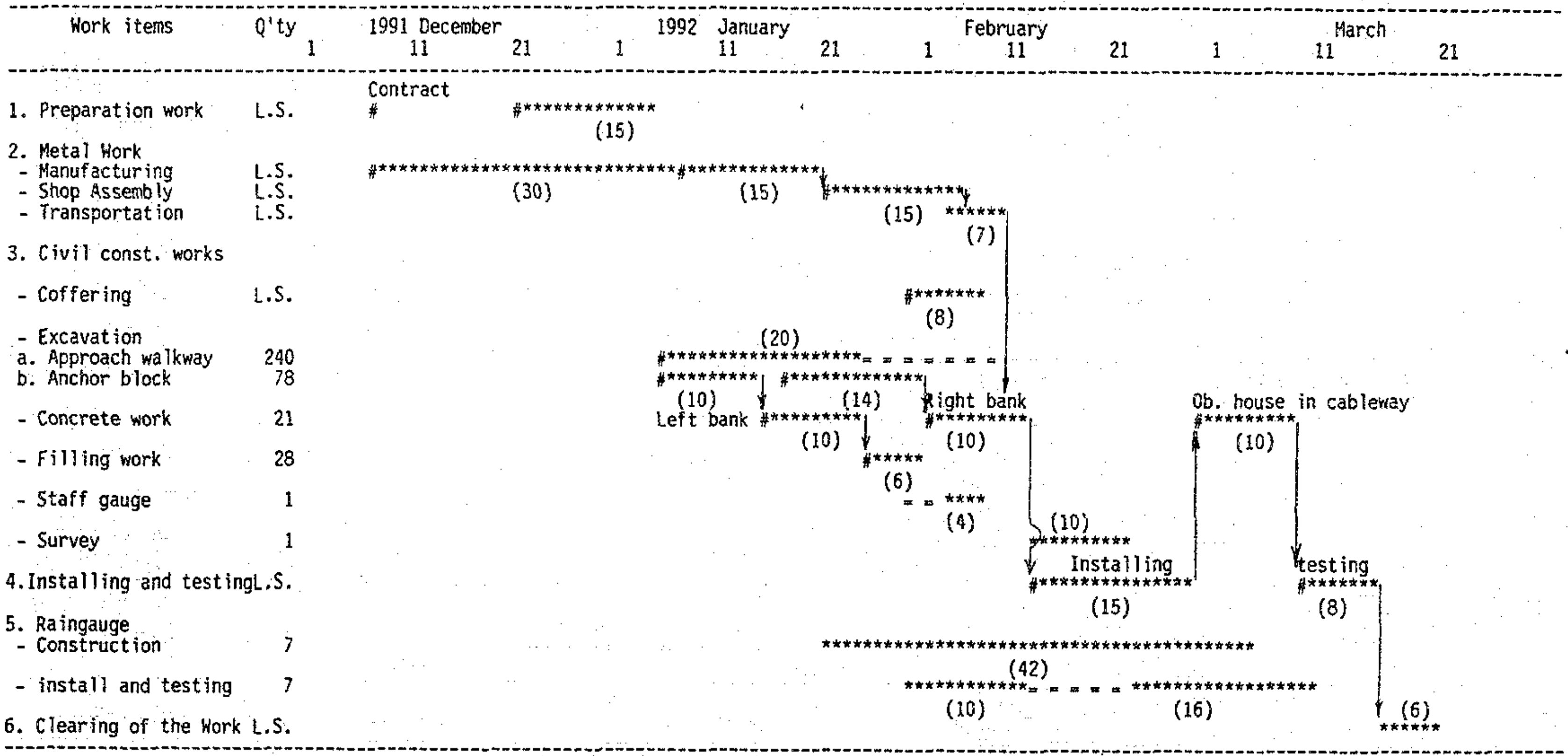
Fig. 1.5.1 CONSTRUCTION SCHEDULE FOR MODEL SYSTEM (1/3)



Notes *: Working =: not continuous working
#: Mile stone (): a number of scheduled working day

Lot II

Fig. 1.5.1 CONSTRUCTION SCHEDULE FOR MODEL SYSTEM (2/3)



Notes *: Working =: not continuous working
#: Mile stone (): a number of scheduled working day

Lot III

Fig. 1.5.1 CONSTRUCTION SCHEDULE FOR MODEL SYSTEM (3/3)

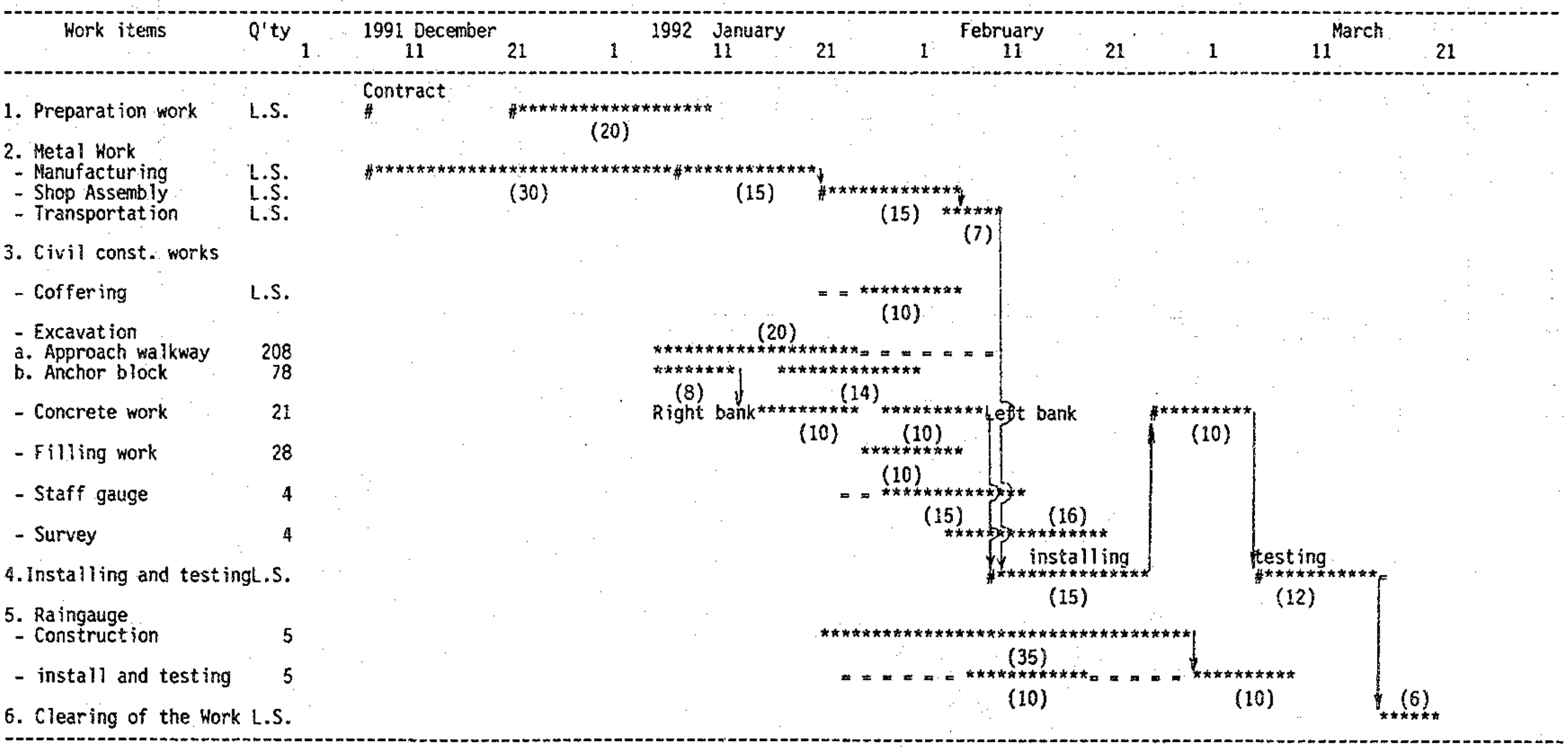
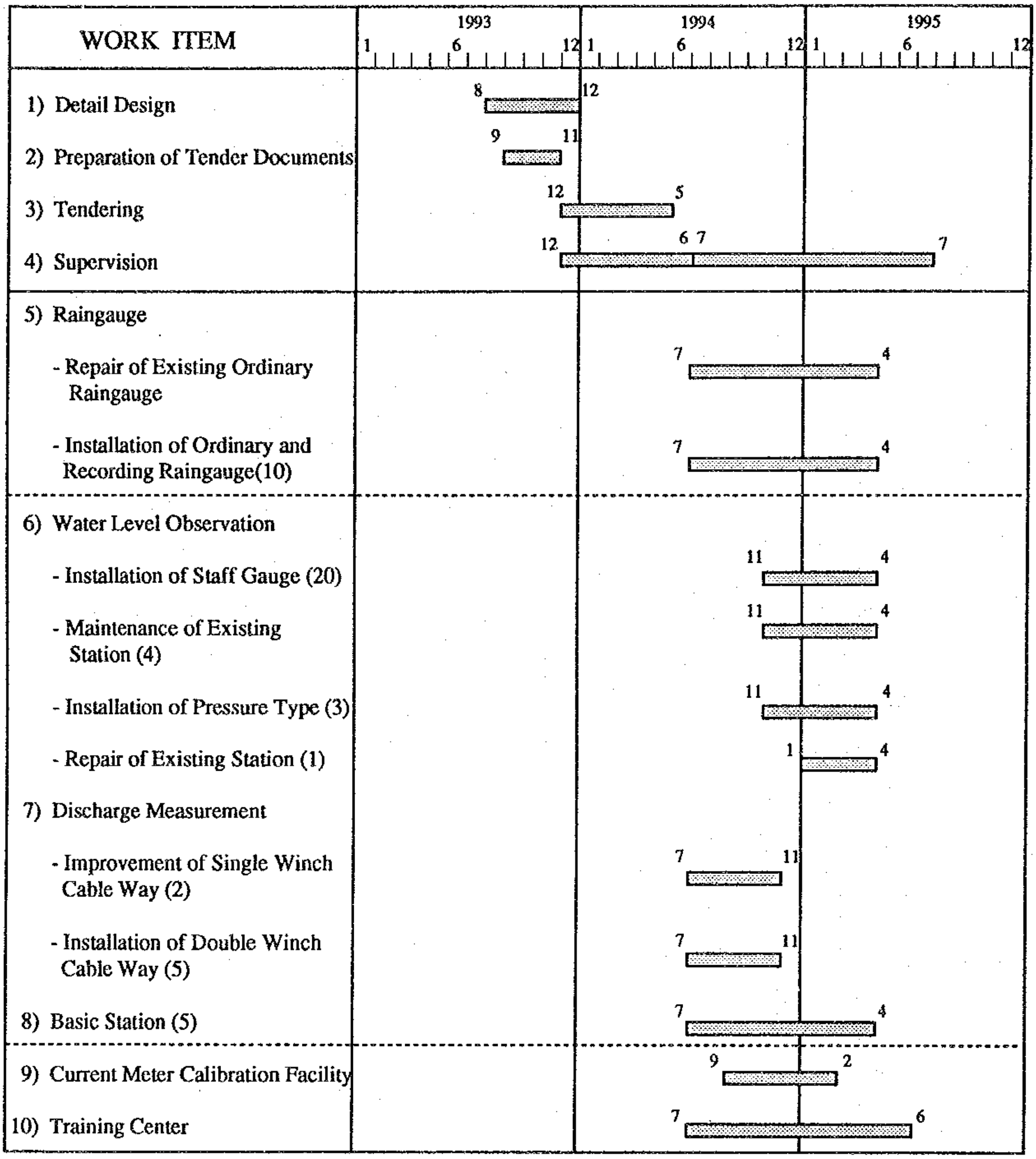


Fig. 2.3.1 CONSTRUCTION SCHEDULE FOR IMMEDIATE PROGRAMME



Note; ( ) shows the number of gauges.