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GOVERNMENT OF THE PEOPLE'S REPUBLIC OF
BANGLADESH

Flood Plan Coordination Organisation

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FAP-25
FLOOD MODELLING AND MANAGEMENT

Flood Hydrology Study

Annex 2

February, 1993



Krüger Consult
in association with



BCEOM

Governments of
Denmark, France,
The Netherlands and
United Kingdom

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FLOOD HYDROLOGY STUDY

MAIN REPORT

Volume 1	Main Report	
Volume 2	Annex 1	Supporting Appendices
<u>Volume 3</u>	Annex 2	Analysis of Country-Wide Protection Schemes

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1. INTRODUCTION

1.1 Content of Annex 2

The present **Annex 2** is the third volume of the **Main Report** of the Flood Hydrology Study, one of the subcomponents of component 25 of the Bangladesh Flood Action Plan (FAP 25), **Flood Modelling and Management**.

The first two volumes were issued in June 1992 and contain the main results of the Flood Hydrology Study (FHS), including a detailed assessment and analysis of existing hydrological data for the major rivers, a validation of the General Model (GM) for the period 1965-89, frequency analysis of model results with the aim of producing required design statistics and development of a methodology to be applied by the regional FAPs for establishing hydrological design criteria for the regional rivers.

The present volume contains the results of an preliminary analysis of the effects of alternative flood protection scenarios on water levels and flow distributions along the major rivers. The analysis is based on a series of runs with the FAP 25-GM, a dedicated version of the General Model, for the period 1985-89 and one long term simulation for 1965-89. The annex comprises the present introductory chapter and Chapter 2 describing the alternative country-wide protection scenarios being considered including the model setup and its limitations as well as a description of the physical structures and the way they are modelled. The model results are detailed in Chapter 3 while Chapter 4 presents the derived hydrological design criteria for one of the most likely (in the short to medium term) future protection scenario based on simulation for the period 1965-89. Finally, Chapter 5 addresses continued activities under the FHS.

Tables and figures are numbered continuously within each chapter and are placed after the text.

1.2 Preparation of Simulation Programme

The simulation programme described in Chapter 2 has been prepared on the basis of discussions with the Flood Plan Coordination Organization (FPCO), FAP 1 and the regional FAPs. It was presented in volume 1. Subsequent discussions with FPCO and members of the Panel of Experts have resulted in some minor changes of the programme.

In early August 1992 the preliminary results were discussed with FPCO. It was agreed to undertake a long term simulation (1965-89) for the so-called scenario 3 for establishing hydrological design criteria along the major rivers for one of the most likely future protection scenarios.

At the November 1992 review meeting of the FHS with FPCO and the Panel of

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Experts, the effects of various embankment setback distances along the Jamuna left bank as well as of the proposed Jamuna Bridge were discussed. Subsequently, the FHS has carried out a sensitivity analysis (for 1985-89) for these purposes the results of which are included in this final Annex 2 of the FHS.

2. ALTERNATIVE COUNTRY-WIDE PROTECTION SCENARIOS

2.1 The Simulation Programme

As stated earlier the simulation programme has been established on the basis of discussions with team leaders of FAP 1-6, findings from their reports and discussions with FPCO. Each of these FAPs has considered various options (embankments) for flood protection. The various combinations of these options are called scenarios. The total number of options identified does not allow a systematic checking of all the different combinations. A total of six scenarios has been formulated which allows to assess the impact from various stages of a phased development up to the "full protection scenario" with embankments along all the major rivers and the most important tributaries and distributaries.

The simulation programme appears from Table 2.1. Scenario 1 represents the existing situation (simulation period 1965-89) and the scenarios 2-7 various combinations of options (simulation period 1985-89). Scenario 8 is the long term simulation (1965-89) for the same physical situation as scenario 3, i.e. the existing situation plus a Jamuna Left Embankment from the offtake of the Old Brahmaputra down to the Dhaleswari offtake and thereafter along the left banks of the Dhaleswari and Kaliganga till the Dhaleswari-Kaliganga junction at Kalatia. It also includes the Jamuna Bridge (width 4608 m) at chainage 170.75 km along the Jamuna.

The sensitivity analyses for various embankment setback distances (1, 2 and 5 km) in the Jamuna left bank have been based on scenario 3 combination of options. Separate analysis for the proposed Jamuna Bridge (width 4608 m) at chainage 170.75 km in the Jamuna has been based on the existing combination of options, i.e. scenario 1.

2.2 Model Setup

The FAP 25-GM model schematization is shown on Figure 2.1, the location of model cross sections on Figure 2.2 and the cross section chainages for the major rivers in Table 2.2. Further details are provided in Appendix 8 (see volume 2 of the Main Report).

2.3 Physical Description

A description of the physical features of the various flood control options is given in the following. The description is supported by a number of figures, i.e Figures 2.3 a)-h) providing plan views of the different scenarios and Figures 2.4 a)-y) showing cross section bathymetry and assumed location of embankments.



Brahmaputra Right Embankment (BRE)

In the existing situation (scenario 1) as well as for the future scenarios a watertight BRE has been assumed along its present alignment. It starts from Kaunia and ends at Hurasagar. The embankment has setback distances from nil to about 1km at various locations. Upstream of the Teesta outfall the present embankment of the Kurigram project is included. Similarly, downstream of Hurasagar the existing embankment of the Pabna IRD projects, also extending up along the Ganges left bank, is modelled.

Jamuna Left Embankment (North)

In the existing situation (scenario 1), the FAP 25-GM includes the existing Food for Work (FFW) embankments west of Chatal river. Excluding a few gaps here & there, the left bank upto Dhaleswari offtake near Porabari appears fully dyked. The alignment corresponds to the recommendations of FAP 3 and FAP 3.1. During high river stage a considerable flow enters the left bank flood plains as overbank spill or through the said gaps. In the FAP 25-GM this situation is modelled through inclusion of a distributary channel (Jamuna-FP) in the Jamuna left bank flood plain. This channel has its offtake in the Jamuna downstream of Old Brahmaputra at chainage 100.5 km and it joins the Dhaleswari approximately 20 km upstream of its confluence with the Lakhya. The channel is linked with the Jamuna through three artificial channels and with the Dhaleswari upstream of the Kaliganga bifurcation through one artificial channel.

For the future scenarios a full Jamuna Left Embankment is modelled by cutting off these artificial channels. There is no flow in the Jamuna-FP channel. The distance between embankments on the two banks varies from 10-20 km under present and future scenarios, except at Jamuna Bridge location where it is less than 5 km (Figure 2.3 c).

Jamuna Left Embankment (South) - Western Alignment;

At present, there is no continuous embankment except some piecemeal works upto Harirampur. In the existing situation (scenario 1) the FAP 25-GM morphological cross sections extend to the highest point along the left bank, which is also considered to represent the alignment for the future protection scenarios, except for a few km downstream of the Dhaleswari offtake, see Figure 2.3 f).

Ganges Left Embankment.

At present, there are embankments along the Ganges left bank from Rajshahi upto Pabna embankment. In all scenarios the existing alignment is considered as solid, see Figure 2.3 b).

There are no embankments along the Ganges from the Indo-Bangladesh border to Rajshahi. Along this stretch the FAP 25-GM uses simplified artificial cross section in the existing as well as the future scenarios.

Ganges Right Embankment.

Today, there are high grounds and FFW embankments along the Ganges right bank down to the right bank of the Padma. These existing embankments are represented in FAP 25-GM, scenario 1.

However, for the future protection scenarios 4-6 new embankments are assumed at a few locations resulting in lesser river width. These new locations are based upon the nearby sections with a view to obtaining smooth width transitions along the entire length of the river.

Padma Left Embankment.

At present, there are no continuous embankments along the Padma left bank. In the existing situation (scenario 1), the morphological cross sections extend to the highest point on the bank from Harirampur upto the confluence with the Meghna, see Figure 2.3 e). This is also the case for the future protection scenario 5.

Padma Right Embankment.

FFW embankments exist along the Padma right bank upto the offtake of the upper Arial Khan. Also, a number of spill channels exist along this stretch. During high flood large flood flows escape through the spill channels and flood plains into the Arial Khan system. In the FAP 25-GM this spill is represented by an artificial distributary channel approximately 20 km upstream of the upper Arial Khan offtake.

In the future protection scenario 5, see Figure 2.3 e), the Padma Right Embankment is considered watertight and the artificial distributary channel is cut off. The upper Arial Khan and the Arial Khan offtakes remain open. Width of the Padma is the same as in the existing situation and varies from 9 to 17 km.

Old Brahmaputra Embankments.

In the existing situation embankments exist at places along the right bank and, together with the existing railway line, prevent flood flow from entering into the North-Central region. There are no embankments along the left bank of Old Brahmaputra. Along the Lakhya embankments exist near its offtake and close to the outlet to the Dhaleswari, where the Dhaka-Narayanganj-Demra project is located along the right bank.

In the future scenarios 5 and 6, see Figure 2.3 e)-f), FAP 25-GM cuts off all flood plains along the Old Brahmaputra and the Lakhya. The distance between the embankments along the Old Brahmaputra varies between 2 km to 5 km while along the lakhya, it is approximately 2 km.

Dhaleswari Left Embankment

At present there are no embankments along the Dhaleswari left bank and the observed

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spill between the Dhaleswari left bank and the Jamuna left bank flood plains is modelled through an artificial link channel. The FAP 25-GM morphological cross sections are not extended into the flood plains and stop at the highest point in the existing as well as the future situation.

In the future scenarios 2-6 the Dhaleswari Left Embankment is thus modelled merely by cutting off the artificial spill channel.

Dhaleswari Right Embankment

In the existing situation the right bank has large flood plains and the morphological cross sections are extended into these flood plains.

In the future scenario 5, see Figure 2.3 e), the Dhaleswari Right Embankment cuts off these flood plains. The FAP 25-GM assumes a typical width of 4 to 6 km along the Dhaleswari and 2 km along the Kaligonga between the embankments.

Upper Meghna Left Embankment

In the existing situation, there are FFW embankments at a few locations. In the future when Gumti Phase II comes up, a continuous embankment is expected along the Upper Meghna left bank.

In the FAP 25-GM the morphological cross sections extend up to the highest point in the existing as well as the future scenarios.

Upper Meghna Right Embankment

At present there are no embankments along the Upper Meghna right bank. In the FAP 25-GM the morphological cross sections are extended into the flood plains.

For the future scenario 5, an embankment has been assumed which starts from Bhairab Bazar and proceeds to the outfall of Upper Meghna, see Figure 2.3 e). The distance between the left and right embankments is typically 10 to 15 km.

Lower Meghna Left Embankment.

Today embankments exist from the Meghna-Dhonagoda to Chandpur Irrigation projects with a break above Chandpur. All scenario runs assume continuous embankment, see Figure 2.3 e).

Lower Meghna Right Embankment

Today no embankments exist along the right bank. All scenarios are identical and assume no embankments even for the future scenarios.

2.4 Limitation in Model Setup and Results.

The results described in the following chapter should be considered as indicative only and may be refined as more detailed information becomes available on actual location of future embankments and structures. Though it is believed that confidence can be placed in the absolute levels, the real strength of the analysis is in the relative comparison of various scenarios.

While some of the general model limitations have been described in volume 1 the following may be added in the case of analysis of various flood protection scenarios:

- the regional FAPs are yet to prepare the exact layout of the proposed embankments alongwith proper setback distance and their geographical reference;
- the FAP 25-GM model cross sections are actually surveyed sections, eventually extended with a width-elevation curve of the flood plain (obtained from the MPO 1 km grid). In the former case, the location of the embankment has been taken at the highest point in the model cross section (as in the existing situation). Where flood plains are included in the model the location has been decided according to an assumed width between right and left bank embankments;
- no redigitization of flood plain topography has been carried out after flood plains have been cut off by placing embankments on the flood plain;
- in absence of any definite proposals for improvement of offtakes of distributaries existing bathymetry has been assumed and no regulating structures are included in the scenarios.

It has been argued that an additional limitation of the FAP 25-GM is that it is a fixed bed model not taking into account morphological changes that may be induced by proposed flood protection schemes and the proposed Jamuna Bridge. However, it takes a relatively long time span for such changes to develop as shown by indicative morphological simulations carried out recently by SWMC and FAP 1 for the Jamuna. The design flood may nevertheless occur 'the day after tomorrow' and design water levels should, therefore, meet at least the levels derived from the fixed bed model simulations, which represent the current situation. Where induced morphological developments may lead, in the long term, to accretion, some margin must be added to design water levels, but no advantage can be taken of potential long term river bed degradation.

It is stressed that the results provided in the following chapter are increases in water levels as compared to the existing situation. The existing situation (scenario 1) includes the Brahmaputra Right Embankment along its present alignment and assumes the embankment to be fully sealed (i.e. no breaches or overtopping). The simulated increases in water levels are thus result of a combination of proposed flood protection schemes (embankments along the rivers) and the Jamuna Bridge, cf. Table 2.1.

3. MODEL RESULTS

3.1 Results of Scenarios 2-6

The results from running the FAP 25-GM for protection scenarios 2-6 for the period 1985-89 are presented in the following. The discussion is supported by a number of tables and figures including:

- Tables 3.1-3.3 presenting maximum changes in peak water levels for 1986, 1987 and 1988 floods respectively. These three years cover the range from low flood(1986) to extreme flood(1988);
- Tables 3.4a) - 3.4b) giving the distribution of maximum peak discharges and velocities during 1988 flood for the existing situation (base or scenario 1), scenario 3 and scenario 5;
- Table 3.5 providing the isolated effect of the proposed Jamuna Bridge on peak water levels for 1986, 1987 and 1988;
- Tables 3.6a) - c) presenting maximum changes in peak water levels for 1986, 1987 and 1988 floods compared to scenario 3 for different set back distances on the left bank of Jamuna;
- Figures 3.1-3.5 showing peak water level profiles for each of the five scenarios along Jamuna-Dhaleswari-Meghna, Jamuna-Padma-Meghna and Ganges-Padma-Meghna;
- Figures 3.6-3.10 showing the sub-seasonal distribution of water level differences as compared to the existing situation for each of the five scenarios for selected locations.

The Jamuna

a. Bahadurabad

Water level increases are very similar for all scenarios and less than 10 cm. For the 1988 flood the increase in peak water level will be around 10 cm. Backwater effects from the Jamuna Bridge do not extend upstream to Bahadurabad, see Table 3.5 and compare scenario 2 and 3.

b. Kazipur

At Kazipur backwater effects from the Jamuna Bridge are observed. In the case of the 1988 flood the increase in peak water level without the bridge (scenarios 2 and 4) is around 50 cm. The bridge will cause an additional rise in water level of 15 cm. The effects of the bridge reduce with low to medium floods and are from a few cms up to 10 cm. It appears from Table 3.5 that the effect of the bridge in isolation, without any new embankments in Jamuna preventing spill to Jamuna left bank flood plain, is less than 10 cm even in 1988.

c. Serajganj

Simulated water level increases in the Jamuna reach a maximum at Serajganj though they show a similar pattern as at Kazipur. Without the bridge, water level increases are generally less than 20 cm though it reaches a maximum of 55 cm for the 1988 flood. With the bridge in place increases are typically 20-30 cm but reach around 85 cm in 1988. The effect of the bridge in isolation, see Table 3.5 is less and would not exceed 21 cm.

d. Porabari

Porabari is downstream of the Jamuna Bridge and there are no effects from the bridge. For the 1988 flood the change in peak water level is around 55 cm for scenarios 2-4. The Jamuna Left Embankment (South) and especially the Dhaleswari Right Embankment are both felt at Porabari (scenarios 5-6) causing an additional rise for the 1988 flood of 15 cm with both embankments in place and of 5cm without the Dhaleswari Right Embankment.

e. Mathura

At Mathura, the increase in peak water level for the 1988 flood is approximately 40 cm for all scenarios except scenario 5 where the increase is a further 10 cm because of the combined effect of the Padma Left Embankment and the increased flow in the Jamuna due to the Dhaleswari confinement.

The Ganges

Generally, the effects along the Ganges are much less than in the Jamuna, mainly because the Ganges to a large extent is already embanked. For all scenarios water level increases are typically less than 10 cm. However, in the downstream part (Mahendrapur) the combination of increased backwater effects from the Jamuna and a Ganges Right embankment will cause an increase in 1988 flood levels of little more than 15 cm, each of the two factors being of equal importance.

The Padma

For scenarios 2-4 and 6 water level increases in the Padma are typically in the order of 5-15 cm but reach approximately 20 cm for the 1988 flood. Embanking the Padma (scenario 5) will cause an additional water level increase of 10-15 cm, increasing in the downstream direction.

The Meghna

For all scenarios water levels in the upper Meghna decrease though less than 10 cm. The only exception is for scenario 5 during the 1988 flood, where peak water levels are increased with a few centimeters. The observed decrease in water levels is mainly caused by the Jamuna Left Embankment (N), which prevents the spilling of the Jamuna into the North Central region and the subsequent drainage from here to the Dhaleswari and the upper Meghna. The decreases in water levels are identical for scenarios 2-4.

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The water level decreases are less in scenarios 5-6 due to the combined effects of the upper Meghna Right Embankment and increased backwater effects from Padma as a result of the Padma Right Embankment.

At Chandpur, limited effects of Jamuna Left Embankment (N) are observed (scenarios 2-4) with water level differences being less than ± 10 cm. The negative values are observed especially during the recession of the floods in September and October and are a result of a slight phase shift in the hydrograph caused by the redistribution of flows between the Jamuna itself and its left bank flood plain. The Padma Right Embankment and the upper Meghna Right Embankment (scenarios 5 and 6) increase peak water levels at Chandpur from 5 cm to 17 and 10 cm respectively for the 1988 flood. Also for these scenarios water level decreases are observed due to phase shifts as explained above.

The Dhaleswari/Kaliganga

Of all the comparison stations the maximum impacts are observed in the Dhaleswari/Kaliganga system. Water level increases exceed 50 cm, especially in July-August. The peak water level difference is observed for the 1988 flood and is 115-120 cm for all scenarios except scenario 5. This increase in water levels and discharges in Dhaleswari is caused by the increased water levels in Jamuna resulting from the reduced spill to the Jamuna left bank flood plains.

In the case of scenario 5 the offtake discharge of Dhaleswari is reduced to the level of the existing situation and the observed water level increases, slightly less than for the other scenarios, are due to the Dhaleswari Right Embankment. However, it is observed that the peak discharge at the Dhaleswari outfall in Meghna is higher than for the other protection scenarios because the attenuating effect of the flood plains is lost due to the embankments.

The Old Brahmaputra

Scenarios 2-4 have only very limited effects on water levels in the Old Brahmaputra with increases generally less than 5 cm.

Embanking the river (scenario 5 and 6) has no effect on the offtake discharge from Jamuna and only very limited effects on water levels in the upstream part of the river. However, in the downstream reaches where flood plains are dominating in the existing situation, the construction of embankments will increase water levels with more than 50 cm. For the 1988 flood the peak water level will increase by almost 80 cm.

The Lakhya

In the Lakhya at Demra, water level decreases are observed for scenarios 2-4. Generally, decreases are less than 10 cm but for the 1988 flood the peak water level is reduced by almost 20 cm. This decrease in water levels is due to reduced backwater effects from Meghna where water levels also decrease, as explained above.

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Scenarios 5 and 6, which include embanking the Lakhya, seem to affect water levels at Demra in a complex way with water level differences compared to the existing situation of more than ± 20 cm. The decreases are typically observed during flood recession in September-October, while the increases are found in July-August. For the 1988 flood peak water level increases would be around 60 cm for both scenarios.

The Atrai

For all scenarios water levels increase in the downstream part of lower Atrai due to increased backwater effects. Typically, increases are 10-20 cm but may exceed this especially in July-August. The peak water level increase observed under the 1988 flood is very similar for scenarios 2-4 and 6 and reaches around 45 cm. For the full protection scenario 5 the increase is more than 50 cm.

The Gorai and Arial Khan

The limited effect under any scenario on water levels in the upstream part of Ganges is clearly reflected in the Gorai, where maximum water level increases are less than 5 cm.

In the Arial Khan, water level increases are observed corresponding to the increases in the Padma from where it takes off. Only in scenario 5 a drop is observed caused by a 15% reduction in discharges as a result of construction of the Padma Right Embankment, simulated by cutting of the artificial spill channel upstream of the upper Arial Khan offtake.

Inundation of Charlands

In the existing situation, charlands in the major rivers are known to be inundated every year, even under normal flood. The inundation may be partly or total, for shorter or longer durations.

The qualitative effect on charland inundations for water level increases caused by various flood protection scenarios is an increased duration of inundation with larger charland areas being inundated.

3.2 Effects of Different Setback Distances of the Jamuna Left Embankment.

The results of the sensitivity analysis of different embankment setback distances in the left bank of Jamuna for 1986, 1987 and 1988 are shown in Tables 3.6a) - c). The tables show peak water levels in the Jamuna for the base case (i.e. the existing situation - scenario 1), for scenario 3, and for scenario 3 with further 1, 2 and 5 km setback of the Jamuna left embankments.

The effects of different setback distances are not felt downstream of Porabari. Peak water levels decrease with increasing setback distances, the decrease being more pronounced for high floods (1988). Maximum effects are observed in a 30 km stretch

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around and mainly upstream of Kazipur. With a setback distance of 5 km, the effects on peak water levels in this area were around 5 cm for the 1986 flood, around 15 cm in 1987 and 20-25 cm in 1988.

3.3 Effects of Sea Level Rise (Scenario 7)

The possible effects of a future sea level rise are illustrated in scenario 7, which corresponds to the existing situation (scenario 1) the only difference being that downstream water level boundaries have been increased by 35 cm. The results appear from:

- Tables 3.1-3.3 presenting maximum changes in peak water levels for 1986, 1987 and 1988 floods for increase of downstream boundary under scenario 7 alongwith other scenarios;
- Figures 3.11 a)-c) showing longitudinal minimum water level profiles along Jamuna-Dhaleswari-Meghna, Jamuna-Padma-Meghna and Ganges-Padma-Meghna respectively for March 1988.

The results show that in the monsoon season there are no effects from sea level rise in the Jamuna and the Ganges. In the downstream part of Padma and in the upper Meghna peak water levels rise by up to 10 cm the effect increasing with decreasing flood levels. In the lower Meghna increases in peak water level exceed 10 cm. Some effects are also observed in the Arial Khan and in the Lakhya, the latter due to backwater effects from Meghna.

Not surprisingly, the effects of sea level rise are more pronounced during the dry season. In the Jamuna, the sea level rise is felt up to Porabari (a few cm) and at Mathura the increase in water level is around 10 cm. In the Ganges, the effects are observed 10-15 km upstream of Mahendrapur and at Mahendrapur the increase is almost 20cm. In the Padma and the upper Meghna water level increases are 20-30 cm and in the lower Meghna the rise is identical to the sea level rise.

3.4 25-year Run for Scenario 3

With a view to establishing hydrological design criteria for one of the most likely future protection schemes, the scenario 3 was run for the entire 25-year period. The results are shown on:

- Figures 3.12 a)-b) - water level hydrographs compared to existing situation at Bahadurabad, Serajganj, Baruria, Bhairab Bazar and Chandpur;
- Figures 3.13 a)-b) - distribution of water level increases compared to existing situation at selected stations;
- Tables 3.7 - statistical analysis of water level differences between existing

situation and scenario 3 (25 years);

Table 3.8 - statistical analysis of discharge differences between existing situation and scenario 3 (25 years).

The Tables 3.7-3.8 confirm the representativeness of the short period 1985-89 for the period 1965-89 both with respect to its range of floods as well as the mean relative changes on a seasonal and subseasonal basis.

3.5 Comparison with Other Studies

A number of other studies has been carried out in which the effects of alternative flood protection options on water levels and river morphology have been assessed. The more recent studies include FAP 1 and the China-Bangladesh Study(CBS), see Ref.1. The results from FAP 1 are not yet published.

With respect to the CBS, the results are not directly comparable with the results from the FHS as some of the assumptions and tools being applied differ in the two cases. Some reservations on the approach used in the CBS include:

- the model has not been verified for the 1988 peak floods but only for the lower floods during the period June-August;
- the model does not take into account the Jamuna left bank spill which occur in the existing situation;
- the indicated increase in peak water levels for each of the three schemes considered has been derived from a comparison with observed water levels in the existing situation instead of the simulated values;
- doubts on the model chainages being applied considering the revisions proposed by FAP 1.

The basic schemes considered by the CBS is a Jamuna Left Embankment extending from Patharar Char in the north to Aricha in the south with average widths between the embankments of 12-14 km. Of the scenarios analysed in the FHS this corresponds more or less to scenario 2 and for the Padma scenario 5.

Comparing the results of the CBS and the FHS on that basis and considering the reservations above there seems to be, in general terms, a fairly good agreement in the Jamuna while the CBS study in the Ganges and the Padma shows some unexplainable large increases in peak water levels, i.e. 60-90 cm as compared to 5-35 cm in the FHS.

4. HYDROLOGICAL DESIGN CRITERIA

4.1 General

In volume 1 of the Main Report peak design water levels, peak and mean seasonal design discharges have been recommended for key stations along the major rivers for the existing situation. The analysis was based on the results from the so-called run 6 with the FAP 25-GM and using the probability distribution function proposed in volume 1.

The implementation of future flood protection options along the major rivers would affect peak water levels in the rivers as demonstrated above and hence also affect design water levels. Which design water levels to be applied would depend on the actual combination of flood protection options, considering also the time schedule for a phased implementation in relation to the design life of the individual options.

Considering the above factors it is the responsibility of the FPCO to decide on the design levels to be applied by the FAP consultants. As the Flood Action Plan progresses such design levels may even change when more accurate model data (e.g. bench mark levels for water level gauges) and exact knowledge of actual flood control options become available.

4.2 Peak Design Water Levels

The design water levels and discharges in the major rivers presented in the following relate to the particular combination of flood control options represented by scenario 3, i.e the existing situation assuming a watertight Brahmaputra Right Embankment and including:

- the Jamuna Bridge with an opening of 4608 m;
- the Jamuna Left Embankment west of Chatal between the Old Brahmaputra and Dhaleswari offtakes;
- the Dhaleswari-Kaliganga Left Embankment from the offtake to Kalatia.

The peak design water levels assuming flood protection scenario 3 appear from Table 4.1. Compared to the design water levels for the existing situation (scenario 1), see volume 1, considerable increases are observed for the 100-year return period, especially in the Jamuna and Padma and also to be expected in the Dhaleswari-Kaliganga system.

In the Jamuna, the 100-year design water levels on the Kazipur-Porabari stretch go up with 60-90 cm. At Bahadurabad design water levels increase with the order of 5 cm for return periods up to 50 years, while a slight decrease is observed for the 100-year return period. This shows some of the limitations in fitting probability distributions to a limited sample.

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In the Padma the increase in 100-year design water levels amount to approximately 35 cm and at Chandpur 10 cm.

Design water levels in the regional rivers should be established using the regional models, but the results indicate that in the case of scenario 3 100-year design water levels in the Dhaleswari-Kaliganga would rise with 1.2 m or more.

The results from the other scenarios indicate that in the "full protection scenario", i.e. scenario 5, the 100-year design levels may go up another 10-20 cm in the Jamuna, the Padma and lower Meghna.

4.3 Peak and Mean Seasonal Design Discharges

Peak and mean seasonal design discharges are shown in Table 4.2. Compared to the existing situation, see volume 1, the main difference is observed at Baruria where design values rise by about 22% for 100 year return period due to the redistribution of flow caused by prevention of the Jamuna left bank spill.

4.4 Safety Margins

In volume 1 of the Main Report the concept of safety margins on peak design water levels has been introduced to take into account the effects of random morphological processes, model errors and shortness of hydrological records. The values recommended should also be applied in the case of the future protection scenarios. This means that for the 100-, 50-, 20- and 10-year return periods a value of 40, 35, 25 and 20 cm respectively should be added to the figures in Table 4.1.

5. CONTINUATION OF THE FLOOD HYDROLOGY STUDY

5.1 Updating of Hydrological Design Criteria

As mentioned above, the hydrological design criteria may be revised during the course of the Flood Action Plan as more exact information becomes available on the actual flood control options and their likely combination. Also model input data and performance may be improved, e.g. when bench mark data from FAP 18 becomes available.

It is proposed that the next updating of hydrological design criteria along the major rivers be undertaken in early 1993 following the SWMC updating of the GM. This updating could be carried out within the existing scope of FAP 25. Subsequent updates may be carried out by the SWMC.

5.2 Supply of Results to Other FAPs

Results from the Flood Hydrology Study are available to other FAPs. The data in question are water level and discharge time series at selected points in the model as specified by the various FAPs, see Appendix 10 of volume 2.

As mentioned in volume 1, section 7.9, these results may be used either to derive design criteria along the major rivers or used as boundary conditions for long term simulations with the regional models.

In the former case, the safety margins proposed by the FHS should be added to the derived design water levels. It is recommended to use the scenario 3 data assuming that this scenario represents a likely combination of schemes in the medium term. However, the final decision on this rests with FPCO.

In the latter case, it is recommended to use scenario 1 data both for the "future without" and "future with" project analysis on a regional level to avoid that the real benefits of a proposed scheme(A) within the region are being distorted by changed hydrological conditions due to a proposed scheme(B) outside the region (externality cost of scheme B). Additional sensitivity analysis may be undertaken for the final, preferred development scheme with boundary water levels from scenario 2-7 as required. As above, the final decision on this rests with FPCO.

6. REFERENCES

1. China-Bangladesh Joiny Expert Team:
Study Report on Flood Control and River Training Project on the Brahmaputra River in Bangladesh. Vol.2: General Plan and Design of Embankment Along the Brahmaputra River. March, 1991.

TABLES



Table 2.1 : Simulation Programme for Stage 3 of the Flood Hydrology Study

FAPs	OPTIONS	SCENARIOS							
		1	2	3	4	5	6	7	8
FAP1	Brahmaputra RE, present alignment	x	x	x	x	x	x	x	x
FAP2	Ganges LE		x	x	x	x	x		x
FAP3 & FAP3.1	Jamuna LE(N), West of Chatal		x	x	x	x	x		x
	Jamuna LE(S), Western alignment *1					x	x		
	Dhaleswari LE, to Kalatia *2		x	x	x	x	x		x
	Dhaleswari LE, D/S Kalatia *2					x	x		
	Padma LE *1					x			
	Dhaleswari RE					x			
	Old Brahmaputra, RE + LE & Lakhya					x	x		
FAP4	Ganges RE				x	x	x		
	Padma RE					x			
FAP5	Lower Meghna LE	x	x	x	x	x	x	x	x
FAP5B	Lower Meghna RE *2								
FAP6	Upper Meghna LE					x	x		
	Upper Meghna RE					x			
MISC.	Jamuna Bridge at Ch. 170.75 *3			x		x	x		x
	Sea Level Rise (+35 cm)							x	

Legend : R=Right, L=Left, E=Embankment

Notes : Scenario 1 : 1965-89, Scenario 2-7 : 1985-89

Scenario 8 : 1965-89 for one of the scenarios 2-7 (Scenario 3)

*1 Changes made in rationalising one x-sction.

*2 No change from Base run i,e Existing condition

*3 One x-section is reduced to 4608 meter

Table 2.2 : Chainages of Cross Sections in the General Model

RIVERS	CHAINAGE	STATIONS	RIVERS	CHAINAGE	STATIONS
JAMUNA	25		JAMUNA	230.75	
JAMUNA	31.35		JAMUNA	235.4	
JAMUNA	37.1	Chilmari	GANGES	0	
JAMUNA	44.25		GANGES	6.5	
JAMUNA	49.95		GANGES	13	
JAMUNA	55.65		GANGES	19.5	
JAMUNA	63.3		GANGES	26	
JAMUNA	71.2		GANGES	32.5	Hardinge Br.
JAMUNA	76.45		GANGES	39	
JAMUNA	81.7		GANGES	45.5	
JAMUNA	84.7	Bahadurabad	GANGES	49.5	
JAMUNA	92.6		GANGES	52	
JAMUNA	100.5		GANGES	58.5	
JAMUNA	108.9		GANGES	65	
JAMUNA	117.75		GANGES	71.5	Sengram
JAMUNA	126.5		GANGES	78	
JAMUNA	134.3		GANGES	84.5	
JAMUNA	139	Kazipur	GANGES	91	
JAMUNA	142.45		GANGES	97.5	Mahendrapur
JAMUNA	145.4		GANGES	104	
JAMUNA	149.5		GANGES	110.5	
JAMUNA	156.6		GANGES	117	
JAMUNA	162.35	Serajganj	PADMA	0	
JAMUNA	170.75	Jamuna Bridge	PADMA	7.5	
JAMUNA	177.7		PADMA	14.75	Baruria
JAMUNA	180.6		PADMA	22	
JAMUNA	188.2	Porabari	PADMA	29	
JAMUNA	193.55		PADMA	36	
JAMUNA	195.75		PADMA	43	
JAMUNA	201.3		PADMA	51.5	
JAMUNA	205.15		PADMA	60	Mawa
JAMUNA	213.2		PADMA	70	
JAMUNA	213.4		PADMA	80	
JAMUNA	220	Mathura	PADMA	86.5	
JAMUNA	223.2		PADMA	93.25	
JAMUNA	229.4		PADMA	100	

Table 2.2(Contd.) : Chainages of Cross Sections in the General Model

RIVERS	CHAINAGE	STATIONS	RIVERS	CHAINAGE	STATIONS
LOWER MEGH	0		OLD B.PUTRA	96	
LOWER MEGH	10		OLD B.PUTRA	108	Nilukhirchar
LOWER MEGH	19.167	Chandpur	OLD B.PUTRA	120	
LOWER MEGH	28.333		OLD B.PUTRA	132	
LOWER MEGH	37.5		OLD B.PUTRA	144	
LOWER MEGH	46.667		OLD B.PUTRA	156	
LOWER MEGH	55.833		OLD B.PUTRA	162	Toke
LOWER MEGH	65		OLD B.PUTRA	168	
LOWER MEGH	75		OLD B.PUTRA	174	
LOWER MEGH	85		OLD B.PUTRA	180	
UPPER MEGH	0		OLD B.PUTRA	186	
UPPER MEGH	10		OLD B.PUTRA	192	
UPPER MEGH	20	Bhairab Bazar	OLD B.PUTRA	198	
UPPER MEGH	26		OLD B.PUTRA	204	
UPPER MEGH	32		OLD B.PUTRA	212	
UPPER MEGH	38		LAKHYA	0	
UPPER MEGH	44		LAKHYA	10	
UPPER MEGH	50		LAKHYA	20	
UPPER MEGH	56		LAKHYA	25	
UPPER MEGH	62		LAKHYA	30	
UPPER MEGH	68	Badyer Bazar	LAKHYA	40	
UPPER MEGH	74		LAKHYA	50	
UPPER MEGH	80	Meghna FG	LAKHYA	60	
UPPER MEGH	87.5		LAKHYA	70	Demra
UPPER MEGH	95		LAKHYA	80	
UPPER MEGH	102.5		LAKHYA	90	
UPPER MEGH	110		KALIGANGA	0	
OLD B.PUTRA	0		KALIGANGA	8	
OLD B.PUTRA	6		KALIGANGA	14	
OLD B.PUTRA	12		KALIGANGA	20	Taraghat
OLD B.PUTRA	18		KALIGANGA	26	
OLD B.PUTRA	24		KALIGANGA	32.5	
OLD B.PUTRA	36	Jamalpur	KALIGANGA	39	
OLD B.PUTRA	48		KALIGANGA	47	
OLD B.PUTRA	60		KALIGANGA	52.5	
OLD B.PUTRA	72		KALIGANGA	60	
OLD B.PUTRA	84				

Table 3.1 : Change in Peak Water Levels (1986) for the Different Scenarios

RIVER	STATION	SCENARIOS					
		2	3	4	5	6	7
JAMUNA	Bahadurabad	05	05	05	05	05	00
	Kazipur	16	18	16	18	18	00
	Serajganj	20	28	20	28	29	00
	Porabari	18	18	18	20	19	00
	Mathura	11	11	11	12	10	00
GANGES	Hardinge Bridge	00	00	04	04	04	00
	Sengram	00	00	08	08	08	00
	Mahendrapur	00	00	18	18	18	00
PADMA	Baruria	07	07	07	11	07	00
	Mawa	04	04	04	10	04	04
MEGHNA	Bhairab Bazar	-02	-02	-02	01	-01	04
	Badyer Bazar	-03	-03	-03	02	-01	07
	Meghna FG	-05	-05	-05	02	-03	09
	Chandpur	-01	-01	-01	05	00	16
KALIGANGA	Taraghat	70	70	70	72	70	00
OLD B.PUTRA	Jamalpur	02	02	02	-02	-02	00
	Nilukhirchar	01	01	01	02	02	00
	Toke	00	00	00	87	87	01
LAKHYA	Demra	-06	-06	-06	41	40	08
ATRAI	Baghabari	17	17	17	18	17	00
ARIAL KHAN	Madaripur	09	09	09	-15	10	07
GORAI	Gorai RB	00	00	02	02	02	00

Table 3.2 : Change in Peak Water Levels (1987) for the Different Scenarios

RIVER	STATION	SCENARIOS					
		2	3	4	5	6	7
JAMUNA	Bahadurabad	05	05	05	05	05	00
	Kazipur	35	44	35	45	45	00
	Seraiganj	38	58	38	60	59	00
	Porabari	39	39	39	47	43	00
	Mathura	24	24	24	27	23	00
GANGES	Hardinge Bridge	00	00	06	06	06	00
	Sengram	00	00	08	08	08	00
	Mahendrapur	01	01	17	17	17	00
PADMA	Baruria	14	14	14	19	14	01
	Mawa	08	08	08	17	08	01
MEGHNA	Bhairab Bazar	-03	-03	-03	09	04	03
	Badyer Bazar	-07	-07	-07	-02	-06	03
	Meghna FG	-11	-11	-11	-07	-10	03
	Chandpur	-02	-02	-02	02	-02	06
KALIGANGA	Taraghat	87	87	87	81	89	00
OLD B.PUTRA	Jamalpur	02	02	02	-04	-04	00
	Nilukhirchar	02	02	02	13	13	00
	Toke	01	01	01	79	79	00
LAKHYA	Demra	-14	-14	-14	46	41	03
ATRAI	Baghabari	29	29	29	34	29	00
ARIAL KHAN	Madaripur	10	10	10	-19	11	03
GORAI	Gorai RB	00	00	03	03	03	00

Table 3.3 : Change in Peak Water Levels (1988) for the Different Scenarios

RIVER	STATION	SCENARIOS					
		2	3	4	5	6	7
JAMUNA	Bahadurabad	08	09	08	09	09	00
	Kazipur	50	64	50	67	65	00
	Serajganj	55	83	55	87	84	00
	Porabari	54	54	54	69	59	00
	Mathura	39	39	39	49	39	00
GANGES	Hardinge Bridge	00	00	07	06	07	00
	Sengram	03	03	07	08	07	00
	Mahendrapur	07	07	16	18	16	00
PADMA	Baruria	23	23	23	33	23	00
	Mawa	17	17	17	34	20	01
MEGHNA	Bhairab Bazar	-06	-06	-06	-02	-05	01
	Badyer Bazar	-08	-08	-08	03	-02	02
	Meghna FG	-09	-09	-09	02	-01	03
	Chandpur	06	06	06	17	10	06
KALIGANGA	Taraghat	116	116	116	95	120	00
OLD B.PUTRA	Jamalpur	03	03	03	06	06	00
	Nilukhīrchar	05	06	05	13	13	00
	Toke	03	04	03	79	79	00
LAKHYA	Demra	-18	-18	-18	60	57	02
ATRAI	Baghabari	44	44	44	54	44	00
ARIAL KHAN	Madaripur	18	18	18	-08	20	03
GORAI	Gorai RB	01	01	03	03	03	00



Table 3.4a : Distribution of Peak Discharges for 1988 Flood in Existing Situation, Scenario 3 and Scenario 5

RIVER	STATION	SCENARIOS		
		BASE	3	5
JAMUNA	Chilmari	97800	97800	97800
	Bahadurabad	97600	97400	97400
	Seraiganj	84100	96600	96700
	Out fall	74300	86000	88100
GANGES	Hardinge Bridge	72200	72200	72200
	Out fall	64100	64100	64000
PADMA	Baruria	135300	147000	149000
	Mawa	123200	132500	139800
MEGHNA	Bhairab Bazar	19600	19700	19800
	Out fall	42600	33200	33900
	Chandpur	152000	159800	168000
DHALESWARI	Off take	10100	12600	10600
	Taraghat	3700	6200	5600
	Out fall	23300	14400	15500
OLD B.PUTRA	Jamalpur	5800	5900	5900
	Nilukhirchar	5800	5900	5900
LAKHYA	Demra	4100	4300	4900
ATRAI	Baghabari	4400	4400	3100
ARIAL KHAN	Madaripur	13800	15600	13300
GORAI	Gorai RB	8100	8100	8200

Table 3.4b : Distribution of Peak Velocities (m/s) for 1988 Flood in Existing Situation, Scenario 3 and Scenario 5

RIVER	STATION	SCENARIOS		
		BASE	3	5
JAMUNA	Chilmari	1.43	1.43	1.43
	Bahadurabad	1.64	1.61	1.61
	Serajganj	1.44	1.38	1.37
	Mathura	1.46	1.58	1.59
	Out fall	1.10	1.23	1.25
GANGES	Hardinge Bridge	3.02	3.02	2.99
	Out fall	2.97	2.86	2.85
PADMA	Baruria	2.03	2.12	2.12
	Mawa	1.96	1.95	2.15
MEGHNA	Bhairab Bazar	0.64	0.64	0.67
	Out fall	0.58	0.46	0.45
	Chandpur	1.42	1.42	1.44
DHALESWARI	Off take	0.83	0.74	0.71
	Taraghat	1.15	1.26	1.20
	Out fall	1.06	0.67	0.88
OLD B.PUTRA	Jamalpur	0.65	0.65	0.71
	Nilukhirchar	0.84	0.84	0.81
LAKHYA	Demra	0.59	0.66	1.35
ATRAI	Baghabari	0.45	0.45	0.46
ARIAL KHAN	Madaripur	0.98	0.83	0.79
GORAI	Gorai RB	1.45	1.27	1.06

Table 3.5 : Isolated Effect of the Proposed Jamuna Bridge on Peak Water Levels for 1986, 1987 and 1988

Stations	Changes in Water Level in cm			Remarks
	1986	1987	1988	
Bahadurabad	0	0	0	
Kazipur	1	6	9	
Serajganj	7	14	21	
Jamuna Bridge	-1	0	-2	
Porabari	0	-2	-2	
Mathura	0	-1	0	
Hardinge Bridge	0	0	0	
Sengram	0	0	0	
Mahendrapur	0	0	0	
Baruria	0	0	0	
Mawa	0	-1	0	
Chandpur	0	0	0	
Bhairab Bazar	0	0	0	
Badyer Bazar	0	0	0	
Meghna FG	0	0	0	
Jamalpur	0	0	0	
Nilukhirchar	0	0	0	
Toke	0	0	0	
Demra	0	0	0	
Taraghat	0	0	0	
Gorai RB	0	0	0	
Madaripur	0	0	0	
Baghabari	0	-1	-2	

Table 3.6a) : Changes in Peak Water Level in Jamuna at Different Setback Distances of the Jamuna Left Embankment - 1986 Situation

Chainage	Water Level at Different Scenarios in Meter				Changes in Water level in Meter				Remarks	
	Base	SCE3	SCE3-1KM	SCE3-2KM	SCE3-5KM	SCE3	SCE3-1KM	SCE3-2KM		SCE3-5KM
71.20	19.86	19.88	19.88	19.88	19.88	0.02	0.02	0.02	0.02	Bahadurabad
76.45	19.47	19.49	19.49	19.49	19.49	0.02	0.02	0.02	0.02	
81.70	19.02	19.05	19.05	19.05	19.05	0.03	0.03	0.03	0.03	
84.70	18.74	18.79	18.79	18.79	18.79	0.05	0.05	0.05	0.04	
92.60	18.10	18.17	18.17	18.17	18.16	0.07	0.07	0.07	0.06	Kazipur
100.50	17.30	17.41	17.40	17.40	17.39	0.11	0.10	0.10	0.09	
108.90	16.57	16.67	16.67	16.67	16.65	0.10	0.10	0.10	0.08	
117.75	15.95	16.06	16.06	16.05	16.03	0.11	0.11	0.10	0.08	
126.50	15.55	15.68	15.68	15.67	15.65	0.13	0.13	0.12	0.10	Seraiganj Jamuna Bridge
134.30	15.10	15.27	15.25	15.25	15.22	0.17	0.15	0.15	0.12	
139.00	14.86	15.04	15.03	15.02	14.99	0.18	0.17	0.16	0.13	
142.45	14.69	14.87	14.86	14.85	14.82	0.18	0.17	0.16	0.13	
145.40	14.48	14.68	14.67	14.65	14.62	0.20	0.19	0.17	0.14	Porabari
149.50	14.22	14.43	14.42	14.40	14.37	0.21	0.20	0.18	0.15	
156.60	13.84	14.07	14.06	14.06	14.04	0.23	0.22	0.22	0.20	
162.35	13.40	13.68	13.67	13.67	13.66	0.28	0.27	0.27	0.26	
170.75	12.81	13.01	13.00	13.00	12.99	0.20	0.19	0.19	0.18	Mathura
177.70	12.28	12.47	12.46	12.46	12.45	0.19	0.18	0.18	0.17	
180.60	12.06	12.24	12.24	12.23	12.22	0.18	0.18	0.17	0.16	
188.20	11.36	11.54	11.54	11.54	11.53	0.18	0.18	0.18	0.17	
193.55	10.85	11.06	11.06	11.06	11.05	0.21	0.21	0.21	0.20	
195.75	10.73	10.95	10.95	10.95	10.94	0.22	0.22	0.22	0.21	
201.30	10.37	10.59	10.59	10.59	10.58	0.22	0.22	0.22	0.21	
205.15	10.18	10.40	10.39	10.39	10.39	0.22	0.21	0.21	0.21	
213.20	9.73	9.91	9.91	9.91	9.90	0.18	0.18	0.18	0.17	
213.40	9.72	9.90	9.90	9.89	9.89	0.18	0.18	0.17	0.17	
220.00	9.24	9.38	9.38	9.38	9.38	0.14	0.14	0.14	0.14	

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Table 3.6b) : Changes in Peak Water Level in Jamuna at Different Setback Distances of the Jamuna Left Embankment - 1987 Situation

Chainage	Water Level at Different Scenarios in Meter				Changes in Water level in Meter				Remarks	
	Base	SCE3	SCE3-1KM	SCE3-2KM	SCE3-5KM	SCE3	SCE3-1KM	SCE3-2KM		SCE3-5KM
71.20	21.11	21.14	21.12	21.11	21.07	0.03	0.01	0.00	-0.04	Bahadurabad
76.45	20.75	20.78	20.77	20.75	20.71	0.03	0.02	0.00	-0.04	
81.70	20.36	20.41	20.38	20.37	20.32	0.05	0.02	0.01	-0.04	
84.70	20.09	20.14	20.12	20.11	20.07	0.05	0.03	0.02	-0.02	
92.60	19.37	19.46	19.44	19.43	19.39	0.09	0.07	0.06	0.02	Kazipur
100.50	18.52	18.69	18.68	18.67	18.64	0.17	0.16	0.15	0.12	
108.90	17.78	18.02	17.99	17.97	17.93	0.24	0.21	0.19	0.15	
117.75	17.09	17.39	17.36	17.33	17.26	0.30	0.27	0.24	0.17	
126.50	16.62	16.98	16.95	16.91	16.83	0.36	0.33	0.29	0.21	Seraiganj Jamuna Bridge
134.30	16.19	16.62	16.58	16.54	16.45	0.43	0.39	0.35	0.26	
139.00	15.99	16.43	16.39	16.36	16.27	0.44	0.40	0.37	0.28	
142.45	15.83	16.29	16.25	16.22	16.13	0.46	0.42	0.39	0.30	
145.40	15.65	16.12	16.08	16.05	15.96	0.47	0.43	0.40	0.31	Porabari
149.50	15.38	15.88	15.84	15.81	15.73	0.50	0.46	0.43	0.35	
156.60	14.98	15.51	15.48	15.46	15.40	0.53	0.50	0.48	0.42	
162.35	14.56	15.14	15.13	15.11	15.07	0.58	0.57	0.55	0.51	
170.75	13.95	14.35	14.32	14.31	14.26	0.40	0.37	0.36	0.31	Mathura
177.70	13.33	13.72	13.70	13.69	13.64	0.39	0.37	0.36	0.31	
180.60	13.07	13.46	13.44	13.43	13.39	0.39	0.37	0.36	0.32	
188.20	12.42	12.82	12.82	12.82	12.81	0.40	0.40	0.40	0.39	
193.55	12.05	12.46	12.46	12.47	12.47	0.41	0.41	0.42	0.42	
195.75	11.96	12.37	12.37	12.38	12.38	0.41	0.41	0.42	0.42	
201.30	11.60	12.00	12.00	12.01	12.01	0.40	0.40	0.41	0.41	
205.15	11.36	11.75	11.75	11.76	11.76	0.39	0.39	0.40	0.40	
213.20	10.79	11.14	11.15	11.15	11.15	0.35	0.36	0.36	0.36	
213.40	10.77	11.12	11.13	11.13	11.13	0.35	0.36	0.36	0.36	
220.00	10.21	10.47	10.47	10.47	10.48	0.26	0.26	0.26	0.27	

Table 3.6c) : Changes in Peak Water Level in Jamuna at Different Setback Distances of the Jamuna Left Embankment - 1988 Situation

Chainage	Water Level at Different Scenarios in Meter					Changes in Water level in Meter				Remarks
	Base	SCE3	SCE3-1KM	SCE3-2KM	SCE3-5KM	SCE3	SCE3-1KM	SCE3-2KM	SCE3-5KM	
71.20	21.93	21.98	21.94	21.91	21.83	0.05	0.01	-0.02	-0.10	Bahadurabad
76.75	21.55	21.61	21.57	21.54	21.45	0.06	0.02	-0.01	-0.10	
81.70	21.14	21.21	21.17	21.14	21.05	0.07	0.03	0.00	-0.09	
84.70	20.84	20.93	20.89	20.86	20.78	0.09	0.05	0.02	-0.06	
92.60	20.07	20.22	20.19	20.16	20.08	0.15	0.12	0.09	0.01	
100.50	19.23	19.50	19.47	19.44	19.37	0.27	0.24	0.21	0.14	Kazipur
108.90	18.56	18.91	18.86	18.82	18.74	0.35	0.30	0.26	0.18	
117.75	17.87	18.33	18.27	18.23	18.11	0.46	0.40	0.36	0.24	
126.50	17.40	17.93	17.87	17.82	17.69	0.53	0.47	0.42	0.29	
134.30	16.97	17.59	17.53	17.48	17.34	0.62	0.56	0.51	0.37	
139.00	16.77	17.41	17.36	17.31	17.17	0.64	0.59	0.54	0.40	Seraiganj Jamuna Bridge
142.45	16.61	17.27	17.22	17.17	17.04	0.66	0.61	0.56	0.43	
145.40	16.42	17.10	17.05	17.01	16.88	0.68	0.63	0.59	0.46	
149.50	16.16	16.86	16.82	16.77	16.66	0.70	0.66	0.61	0.50	
156.60	15.73	16.49	16.46	16.43	16.34	0.76	0.73	0.70	0.61	
162.35	15.30	16.13	16.10	16.08	16.01	0.83	0.80	0.78	0.71	Porabari
170.75	14.66	15.22	15.19	15.16	15.07	0.56	0.53	0.50	0.41	
177.70	14.04	14.59	14.56	14.54	14.46	0.55	0.52	0.50	0.42	
180.60	13.78	14.33	14.31	14.29	14.23	0.55	0.53	0.51	0.45	
188.20	13.16	13.70	13.70	13.70	13.69	0.54	0.54	0.54	0.53	
193.55	12.81	13.36	13.37	13.37	13.37	0.55	0.56	0.56	0.56	Mathura
195.75	12.73	13.28	13.29	13.29	13.29	0.55	0.56	0.56	0.56	
201.30	12.38	12.92	12.92	12.93	12.92	0.54	0.54	0.55	0.54	
205.15	12.13	12.64	12.65	12.65	12.65	0.51	0.52	0.52	0.52	
213.20	11.54	11.99	11.99	12.00	12.00	0.45	0.45	0.46	0.46	
213.40	11.52	11.97	11.97	11.98	11.98	0.45	0.45	0.46	0.46	Mathura
220.00	10.91	11.30	11.30	11.31	11.31	0.39	0.39	0.40	0.40	

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Table 3.7 (21 Pages)
Statistical Analysis of Water Level Differences
Between Existing Situation and Scenario 3 (25 Years)

STATISTICAL ANALYSIS OF CHANGES

DATA : WATER LEVEL

RIVER : JAMUNA

STATION : 46.9L BAHADURABAD

YEARS	PEAK RUN6	PEAK SCEN3	PEAK	AVG1	AVG2	AVG3	AVGS
1965	19.69	19.73	0.04	0.02	0.04	0.03	0.03
1966	20.01	20.06	0.05	0.03	0.05	0.03	0.04
1967	19.94	19.98	0.04	0.02	0.04	0.03	0.03
1968	19.66	19.70	0.04	0.03	0.04	0.03	0.03
1969	19.33	19.38	0.05	0.03	0.04	0.03	0.03
1970	20.05	20.10	0.05	0.03	0.04	0.03	0.03
1972	19.92	19.96	0.04	0.03	0.04	0.03	0.03
1973	19.82	19.86	0.04	0.02	0.03	0.03	0.03
1974	20.44	20.51	0.07	0.02	0.04	0.03	0.03
1975	19.39	19.43	0.04	0.02	0.04	0.03	0.03
1976	19.76	19.80	0.04	0.02	0.04	0.03	0.03
1977	19.81	19.84	0.04	0.03	0.04	0.03	0.03
1978	19.25	19.30	0.05	0.03	0.04	0.03	0.03
1979	19.52	19.55	0.03	0.02	0.04	0.04	0.03
1980	20.56	20.64	0.08	0.02	0.05	0.03	0.03
1981	19.73	19.76	0.04	0.02	0.04	0.03	0.03
1982	19.63	19.67	0.04	0.02	0.04	0.03	0.03
1983	19.89	19.93	0.04	0.02	0.04	0.03	0.03
1984	20.17	20.22	0.05	0.03	0.04	0.03	0.03
1985	19.73	19.77	0.04	0.04	0.04	0.01	0.03
1986	18.74	18.79	0.05	0.04	0.03	0.02	0.03
1987	20.09	20.14	0.05	0.04	0.04	0.03	0.04
1988	20.84	20.93	0.09	0.02	0.04	0.04	0.03
1989	19.84	19.88	0.03	0.04	0.05	0.03	0.04
AVG	19.83	19.87	0.05	0.03	0.04	0.03	0.03
STD	0.43	0.44	0.01	0.01	0.00	0.01	0.00
MAX	20.84	20.93	0.09	0.04	0.05	0.04	0.04
MIN	18.74	18.79	0.03	0.02	0.03	0.01	0.03

- NOTES :
1. AVG1 = Mean relative changes for period May-Jun.
 2. AVG2 = Mean relative changes for period Jul-Aug.
 3. AVG3 = Mean relative changes for period Sep-Oct.
 4. AVGS = Mean relative changes for period May-Oct.
 5. Scenario3-Run6 is termed as Change

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STATISTICAL ANALYSIS OF CHANGES

DATA : WATER LEVEL

RIVER : JAMUNA

STATION : 49A KAZIPUR

YEARS	PEAK RUN6	PEAK SCEN3	PEAK	AVG1	AVG2	AVG3	AVGS
1965	15.56	15.90	0.34	0.14	0.18	0.15	0.16
1966	15.90	16.32	0.42	0.16	0.22	0.20	0.19
1967	15.82	16.23	0.40	0.14	0.21	0.17	0.17
1968	15.52	15.85	0.33	0.16	0.19	0.16	0.17
1969	15.23	15.47	0.24	0.14	0.17	0.16	0.15
1970	15.94	16.38	0.44	0.17	0.23	0.16	0.19
1972	15.78	16.18	0.39	0.16	0.19	0.16	0.17
1973	15.69	16.07	0.38	0.18	0.20	0.17	0.19
1974	16.35	16.87	0.52	0.17	0.29	0.19	0.22
1975	15.27	15.52	0.25	0.15	0.17	0.17	0.16
1976	15.64	15.99	0.36	0.15	0.18	0.17	0.17
1977	15.67	16.05	0.38	0.16	0.21	0.17	0.18
1978	15.16	15.38	0.22	0.16	0.15	0.17	0.16
1979	15.39	15.68	0.29	0.14	0.19	0.20	0.18
1980	16.48	17.05	0.56	0.16	0.30	0.16	0.21
1981	15.58	15.93	0.35	0.14	0.22	0.17	0.18
1982	15.48	15.80	0.32	0.15	0.19	0.17	0.17
1983	15.74	16.13	0.39	0.16	0.16	0.18	0.17
1984	16.08	16.54	0.46	0.16	0.23	0.20	0.19
1985	15.65	16.01	0.35	0.16	0.20	0.15	0.17
1986	14.86	15.04	0.18	0.16	0.16	0.15	0.16
1987	15.99	16.43	0.44	0.17	0.24	0.17	0.19
1988	16.77	17.41	0.64	0.16	0.24	0.21	0.20
1989	15.70	16.08	0.39	0.17	0.23	0.18	0.19
AVG	15.72	16.09	0.38	0.16	0.21	0.17	0.18
STD	0.42	0.52	0.10	0.01	0.04	0.02	0.02
MAX	16.77	17.41	0.64	0.18	0.30	0.21	0.22
MIN	14.86	15.04	0.18	0.14	0.15	0.15	0.15

- NOTES :
1. AVG1 = Mean relative changes for period May-Jun.
 2. AVG2 = Mean relative changes for period Jul-Aug.
 3. AVG3 = Mean relative changes for period Sep-Oct.
 4. AVGS = Mean relative changes for period May-Oct.
 5. Scenario3-Run6 is termed as Change

STATISTICAL ANALYSIS OF CHANGES

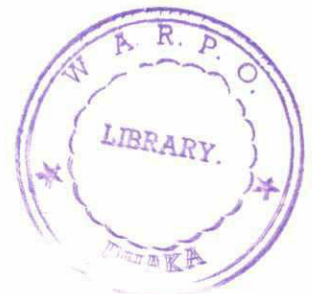
DATA : WATER LEVEL

RIVER : JAMUNA

STATION : 49 SERAJGANJ

YEARS	PEAK RUN6	PEAK SCEN3	PEAK	AVG1	AVG2	AVG3	AVGS
1965	14.13	14.60	0.47	0.18	0.28	0.21	0.22
1966	14.47	15.02	0.55	0.20	0.32	0.26	0.26
1967	14.38	14.92	0.54	0.18	0.30	0.22	0.23
1968	14.10	14.55	0.46	0.19	0.28	0.22	0.23
1969	13.79	14.13	0.34	0.18	0.25	0.20	0.21
1970	14.52	15.09	0.57	0.22	0.33	0.22	0.26
1972	14.35	14.88	0.53	0.20	0.27	0.20	0.23
1973	14.27	14.78	0.51	0.22	0.27	0.22	0.24
1974	14.90	15.59	0.69	0.21	0.40	0.26	0.29
1975	13.83	14.19	0.36	0.17	0.25	0.22	0.22
1976	14.19	14.68	0.48	0.19	0.27	0.20	0.22
1977	14.25	14.76	0.51	0.22	0.31	0.24	0.26
1978	13.71	14.04	0.33	0.20	0.23	0.22	0.21
1979	13.96	14.35	0.39	0.16	0.28	0.28	0.24
1980	15.03	15.76	0.73	0.20	0.42	0.22	0.28
1981	14.15	14.62	0.47	0.16	0.31	0.22	0.23
1982	14.06	14.50	0.44	0.18	0.27	0.22	0.22
1983	14.32	14.84	0.52	0.19	0.24	0.25	0.23
1984	14.66	15.25	0.60	0.20	0.32	0.26	0.26
1985	14.23	14.72	0.49	0.21	0.29	0.21	0.23
1986	13.40	13.68	0.28	0.18	0.22	0.21	0.21
1987	14.57	15.15	0.58	0.20	0.35	0.23	0.26
1988	15.30	16.13	0.83	0.21	0.35	0.29	0.28
1989	14.26	14.77	0.51	0.21	0.33	0.27	0.27
AVG	14.28	14.79	0.51	0.19	0.30	0.23	0.24
STD	0.41	0.54	0.12	0.02	0.05	0.03	0.02
MAX	15.30	16.13	0.83	0.22	0.42	0.29	0.29
MIN	13.40	13.68	0.28	0.16	0.22	0.20	0.21

- NOTES : 1. AVG1 = Mean relative changes for period May-Jun.
 2. AVG2 = Mean relative changes for period Jul-Aug.
 3. AVG3 = Mean relative changes for period Sep-Oct.
 4. AVGS = Mean relative changes for period May-Oct.
 5. Scenario3-Run6 is termed as Change



STATISTICAL ANALYSIS OF CHANGES

DATA : WATER LEVEL
RIVER : JAMUNA
STATION : 50 PORABARI

YEARS	PEAK RUN6	PEAK SCEN3	PEAK	AVG1	AVG2	AVG3	AVGS
1965	11.98	12.30	0.32	0.14	0.22	0.17	0.17
1966	12.31	12.69	0.38	0.16	0.22	0.19	0.19
1967	12.16	12.53	0.37	0.14	0.23	0.17	0.18
1968	11.96	12.26	0.30	0.14	0.20	0.18	0.18
1969	11.66	11.89	0.23	0.14	0.19	0.15	0.16
1970	12.34	12.73	0.39	0.17	0.24	0.18	0.20
1972	12.16	12.52	0.36	0.15	0.21	0.16	0.18
1973	12.14	12.49	0.35	0.16	0.20	0.16	0.17
1974	12.75	13.22	0.47	0.16	0.28	0.20	0.21
1975	11.76	12.00	0.24	0.13	0.19	0.18	0.17
1976	11.96	12.29	0.33	0.14	0.20	0.15	0.17
1977	12.14	12.48	0.34	0.18	0.22	0.19	0.20
1978	11.55	11.75	0.20	0.15	0.19	0.17	0.17
1979	11.80	12.07	0.27	0.13	0.21	0.20	0.18
1980	12.87	13.37	0.49	0.16	0.29	0.17	0.21
1981	11.93	12.25	0.32	0.13	0.22	0.16	0.17
1982	11.95	12.24	0.29	0.14	0.20	0.16	0.17
1983	12.19	12.53	0.33	0.15	0.20	0.19	0.18
1984	12.52	12.92	0.39	0.16	0.23	0.20	0.19
1985	12.08	12.40	0.32	0.17	0.21	0.16	0.18
1986	11.36	11.54	0.18	0.14	0.18	0.17	0.16
1987	12.43	12.82	0.39	0.16	0.24	0.16	0.18
1988	13.16	13.70	0.54	0.17	0.24	0.22	0.21
1989	12.04	12.40	0.36	0.17	0.22	0.20	0.21
AVG	12.13	12.47	0.34	0.15	0.22	0.18	0.18
STD	0.40	0.48	0.08	0.02	0.03	0.02	0.02
MAX	13.16	13.70	0.54	0.18	0.29	0.22	0.21
MIN	11.36	11.54	0.18	0.13	0.18	0.15	0.16

- NOTES : 1. AVG1 = Mean relative changes for period May-Jun.
2. AVG2 = Mean relative changes for period Jul-Aug.
3. AVG3 = Mean relative changes for period Sep-Oct.
4. AVGS = Mean relative changes for period May-Oct.
5. Scenario3-Run6 is termed as Change

STATISTICAL ANALYSIS OF CHANGES

DATA : WATER LEVEL

RIVER : JAMUNA

STATION : 50.3 MATHURA

YEARS	PEAK RUN6	PEAK SCEN3	PEAK	AVG1	AVG2	AVG3	AVGS
1965	9.61	9.83	0.23	0.13	0.18	0.13	0.15
1966	10.00	10.27	0.27	0.15	0.20	0.16	0.17
1967	9.68	9.95	0.27	0.12	0.18	0.12	0.14
1968	9.66	9.87	0.21	0.13	0.17	0.13	0.15
1969	9.42	9.54	0.12	0.12	0.15	0.10	0.12
1970	9.93	10.22	0.29	0.15	0.19	0.13	0.16
1972	9.65	9.92	0.26	0.14	0.17	0.11	0.14
1973	9.88	10.12	0.24	0.14	0.14	0.10	0.13
1974	10.42	10.76	0.34	0.14	0.22	0.15	0.17
1975	9.68	9.86	0.18	0.12	0.14	0.12	0.13
1976	9.47	9.61	0.14	0.13	0.17	0.10	0.13
1977	9.92	10.15	0.23	0.15	0.17	0.14	0.16
1978	9.37	9.48	0.11	0.13	0.13	0.11	0.13
1979	9.53	9.71	0.18	0.12	0.18	0.19	0.16
1980	10.57	10.94	0.37	0.14	0.22	0.12	0.16
1981	9.69	9.87	0.18	0.12	0.18	0.12	0.14
1982	9.78	9.97	0.19	0.13	0.17	0.11	0.14
1983	10.01	10.23	0.23	0.13	0.16	0.13	0.14
1984	10.25	10.53	0.28	0.14	0.17	0.14	0.15
1985	9.74	9.96	0.22	0.15	0.18	0.10	0.14
1986	9.30	9.41	0.11	0.13	0.12	0.12	0.12
1987	10.23	10.47	0.24	0.15	0.20	0.13	0.16
1988	10.91	11.30	0.39	0.14	0.19	0.16	0.16
1989	9.54	9.76	0.22	2.05	0.67	-0.17	0.85
AVG	9.84	10.07	0.23	0.22	0.19	0.12	0.17
STD	0.39	0.46	0.07	0.38	0.10	0.06	0.14
MAX	10.91	11.30	0.39	2.05	0.67	0.19	0.85
MIN	9.30	9.41	0.11	0.12	0.12	-0.17	0.12

- NOTES :
1. AVG1 = Mean relative changes for period May-Jun.
 2. AVG2 = Mean relative changes for period Jul-Aug.
 3. AVG3 = Mean relative changes for period Sep-Oct.
 4. AVGS = Mean relative changes for period May-Oct.
 5. Scenario3-Run6 is termed as Change

STATISTICAL ANALYSIS OF CHANGES

DATA : WATER LEVEL

RIVER : GANGES

STATION : 90 HARDINGE BRIDGE

YEARS	PEAK RUN6	PEAK SCEN3	PEAK	AVG1	AVG2	AVG3	AVGS
1965	13.41	13.41	0.00	0.01	0.01	0.00	0.01
1966	13.60	13.60	0.00	0.02	0.01	0.00	0.01
1967	14.03	14.03	0.00	0.01	0.01	0.00	0.01
1968	13.74	13.74	0.00	0.01	0.00	0.00	0.00
1969	14.36	14.36	0.00	0.01	0.00	0.00	0.00
1970	13.55	13.55	0.00	0.01	0.00	0.00	0.01
1972	13.37	13.37	0.00	0.01	0.01	0.00	0.01
1973	13.99	13.99	0.00	0.01	0.00	0.00	0.00
1974	14.24	14.24	0.00	0.01	0.01	0.00	0.01
1975	14.08	14.08	0.00	0.01	0.00	0.00	0.00
1976	14.57	14.57	0.00	0.01	0.01	0.00	0.01
1977	13.98	13.98	0.00	0.02	0.00	0.00	0.01
1978	14.63	14.63	0.00	0.01	0.00	0.00	0.00
1979	13.45	13.45	0.00	0.01	0.01	0.01	0.01
1980	14.43	14.44	0.00	0.01	0.00	0.00	0.01
1981	13.96	13.96	0.00	0.00	0.01	0.00	0.00
1982	14.59	14.59	0.00	0.01	0.01	0.00	0.00
1983	14.44	14.44	0.00	0.01	0.01	0.00	0.01
1984	14.34	14.34	0.00	0.01	0.00	0.00	0.00
1985	13.95	13.95	0.00	0.02	0.01	0.00	0.01
1986	14.17	14.17	0.00	0.00	0.00	0.00	0.00
1987	15.00	15.00	0.00	0.01	0.01	0.00	0.01
1988	15.08	15.08	0.00	0.02	0.00	0.00	0.01
1989	13.18	13.18	0.00	-0.02	0.01	0.00	0.00
AVG	14.09	14.09	0.00	0.01	0.00	0.00	0.01
STD	0.50	0.50	0.00	0.01	0.00	0.00	0.00
MAX	15.08	15.08	0.00	0.02	0.01	0.01	0.01
MIN	13.18	13.18	0.00	-0.02	0.00	0.00	0.00

- NOTES :
1. AVG1 = Mean relative changes for period May-Jun.
 2. AVG2 = Mean relative changes for period Jul-Aug.
 3. AVG3 = Mean relative changes for period Sep-Oct.
 4. AVGS = Mean relative changes for period May-Oct.
 5. Scenario3-Run6 is termed as Change

STATISTICAL ANALYSIS OF CHANGES

DATA : WATER LEVEL

RIVER : GANGES

STATION : 91.1 SENGRAM

YEARS	PEAK RUN6	PEAK SCEN3	PEAK	AVG1	AVG2	AVG3	AVGS
1965	11.37	11.37	0.00	0.04	0.03	0.01	0.03
1966	11.56	11.57	0.01	0.07	0.03	0.01	0.04
1967	11.88	11.88	0.00	0.05	0.03	0.01	0.03
1968	11.66	11.66	0.00	0.04	0.01	0.01	0.02
1969	12.15	12.16	0.00	0.03	0.02	0.00	0.02
1970	11.49	11.50	0.00	0.05	0.01	0.01	0.02
1972	11.33	11.34	0.00	0.04	0.02	0.01	0.02
1973	11.86	11.86	0.00	0.04	0.01	0.00	0.02
1974	12.05	12.05	0.00	0.05	0.03	0.01	0.03
1975	11.93	11.93	0.00	0.03	0.00	0.00	0.01
1976	12.34	12.35	0.00	0.06	0.03	0.00	0.03
1977	11.86	11.86	0.00	0.07	0.01	0.01	0.03
1978	12.41	12.41	0.00	0.03	0.01	0.00	0.01
1979	11.42	11.42	0.00	0.04	0.02	0.04	0.04
1980	12.27	12.31	0.03	0.07	0.02	0.01	0.03
1981	11.84	11.84	0.00	0.03	0.02	0.00	0.02
1982	12.36	12.36	0.00	0.04	0.03	0.01	0.02
1983	12.24	12.24	0.00	0.06	0.02	0.00	0.03
1984	12.16	12.16	0.00	0.05	0.01	0.01	0.02
1985	11.83	11.83	0.00	0.08	0.03	0.00	0.04
1986	12.00	12.00	0.00	0.04	0.01	0.00	0.02
1987	12.77	12.77	0.00	0.06	0.03	0.01	0.04
1988	12.89	12.92	0.03	0.07	0.02	0.01	0.03
1989	11.16	11.16	0.00	0.08	0.03	0.01	0.04
AVG	11.95	11.95	0.00	0.05	0.02	0.01	0.03
STD	0.43	0.44	0.01	0.02	0.01	0.01	0.01
MAX	12.89	12.92	0.03	0.08	0.03	0.04	0.04
MIN	11.16	11.16	0.00	0.03	0.00	0.00	0.01

NOTES : 1. AVG1 = Mean relative changes for period May-Jun.
2. AVG2 = Mean relative changes for period Jul-Aug.
3. AVG3 = Mean relative changes for period Sep-Oct.
4. AVGS = Mean relative changes for period May-Oct.
5. Scenario3-Run6 is termed as Change

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STATISTICAL ANALYSIS OF CHANGES

DATA : WATER LEVEL

RIVER : GANGES

STATION : 91.2 MAHENDRAPUR

YEARS	PEAK RUN6	PEAK SCEN3	PEAK	AVG1	AVG2	AVG3	AVGS
1965	10.20	10.21	0.00	0.07	0.05	0.02	0.04
1966	10.42	10.45	0.03	0.10	0.05	0.03	0.06
1967	10.60	10.61	0.01	0.08	0.04	0.01	0.04
1968	10.43	10.44	0.01	0.07	0.02	0.02	0.04
1969	10.86	10.87	0.01	0.06	0.03	0.01	0.03
1970	10.30	10.31	0.01	0.08	0.03	0.01	0.04
1972	10.17	10.17	0.01	0.07	0.04	0.01	0.04
1973	10.62	10.63	0.01	0.06	0.02	0.01	0.03
1974	10.79	10.83	0.03	0.07	0.05	0.02	0.05
1975	10.65	10.66	0.01	0.06	0.01	0.01	0.03
1976	10.98	10.98	0.01	0.09	0.04	0.01	0.05
1977	10.63	10.64	0.01	0.10	0.03	0.01	0.04
1978	11.04	11.04	0.00	0.06	0.01	0.01	0.03
1979	10.28	10.29	0.01	0.08	0.04	0.07	0.06
1980	11.05	11.13	0.08	0.10	0.04	0.01	0.05
1981	10.61	10.63	0.01	0.07	0.04	0.01	0.04
1982	10.98	10.99	0.01	0.08	0.04	0.01	0.04
1983	10.93	10.95	0.01	0.09	0.03	0.01	0.04
1984	10.89	10.91	0.02	0.08	0.02	0.02	0.04
1985	10.59	10.59	0.01	0.11	0.05	0.00	0.05
1986	10.72	10.73	0.00	0.08	0.01	0.01	0.03
1987	11.33	11.35	0.01	0.11	0.05	0.02	0.06
1988	11.53	11.60	0.07	0.09	0.03	0.03	0.05
1989	10.03	10.04	0.01	0.10	0.05	0.03	0.06
AVG	10.69	10.71	0.02	0.08	0.03	0.02	0.04
STD	0.36	0.37	0.02	0.02	0.01	0.01	0.01
MAX	11.53	11.60	0.08	0.11	0.05	0.07	0.06
MIN	10.03	10.04	0.00	0.06	0.01	0.00	0.03

- NOTES :
1. AVG1 = Mean relative changes for period May-Jun.
 2. AVG2 = Mean relative changes for period Jul-Aug.
 3. AVG3 = Mean relative changes for period Sep-Oct.
 4. AVGS = Mean relative changes for period May-Oct.
 5. Scenario3-Run6 is termed as Change

STATISTICAL ANALYSIS OF CHANGES

DATA : WATER LEVEL
RIVER : PADMA
STATION : 91.9L BARURIA

YEARS	PEAK RUN6	PEAK SCEN3	PEAK	AVG1	AVG2	AVG3	AVGS
1965	8.00	8.16	0.16	0.10	0.13	0.09	0.11
1966	8.47	8.64	0.17	0.12	0.14	0.11	0.12
1967	7.98	8.16	0.18	0.10	0.13	0.08	0.10
1968	8.19	8.32	0.13	0.11	0.11	0.09	0.10
1969	8.29	8.35	0.06	0.09	0.10	0.07	0.09
1970	8.31	8.50	0.18	0.12	0.13	0.09	0.11
1972	7.96	8.15	0.18	0.11	0.12	0.08	0.10
1973	8.38	8.53	0.15	0.11	0.09	0.07	0.09
1974	8.85	9.06	0.21	0.11	0.15	0.10	0.12
1975	8.32	8.43	0.11	0.09	0.09	0.08	0.09
1976	8.20	8.29	0.09	0.10	0.12	0.07	0.10
1977	8.46	8.60	0.14	0.12	0.12	0.10	0.11
1978	8.30	8.36	0.06	0.10	0.09	0.08	0.09
1979	8.11	8.22	0.11	0.10	0.12	0.14	0.12
1980	9.04	9.26	0.22	0.11	0.14	0.08	0.11
1981	8.32	8.43	0.11	0.09	0.13	0.09	0.10
1982	8.36	8.49	0.12	0.10	0.12	0.08	0.10
1983	8.61	8.75	0.14	0.11	0.11	0.09	0.10
1984	8.73	8.89	0.16	0.10	0.12	0.10	0.11
1985	8.21	8.35	0.14	0.12	0.12	0.07	0.10
1986	8.13	8.20	0.07	0.10	0.08	0.07	0.08
1987	8.90	9.04	0.14	0.11	0.13	0.08	0.11
1988	9.37	9.60	0.23	0.11	0.12	0.10	0.11
1989	7.97	8.11	0.14	0.12	0.15	0.12	0.14
AVG	8.39	8.54	0.14	0.11	0.12	0.09	0.11
STD	0.35	0.38	0.05	0.01	0.02	0.02	0.01
MAX	9.37	9.60	0.23	0.12	0.15	0.14	0.14
MIN	7.96	8.11	0.06	0.09	0.08	0.07	0.08

- NOTES :
1. AVG1 = Mean relative changes for period May-Jun.
 2. AVG2 = Mean relative changes for period Jul-Aug.
 3. AVG3 = Mean relative changes for period Sep-Oct.
 4. AVGS = Mean relative changes for period May-Oct.
 5. Scenario3-Run6 is termed as Change

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STATISTICAL ANALYSIS OF CHANGES

DATA : WATER LEVEL

RIVER : PADMA

STATION : 93.5L MAWA

YEARS	PEAK RUN6	PEAK SCEN3	PEAK	AVG1	AVG2	AVG3	AVGS
1965	5.63	5.74	0.11	0.04	0.08	0.04	0.06
1966	6.08	6.20	0.13	0.06	0.09	0.05	0.07
1967	5.64	5.76	0.12	0.04	0.07	0.05	0.05
1968	5.85	5.94	0.08	0.04	0.06	0.05	0.05
1969	5.89	5.93	0.04	0.04	0.06	0.04	0.05
1970	5.96	6.09	0.13	0.06	0.08	0.05	0.06
1972	5.59	5.72	0.13	0.05	0.07	0.04	0.05
1973	5.98	6.09	0.11	0.05	0.05	0.04	0.05
1974	6.45	6.60	0.15	0.05	0.09	0.06	0.06
1975	5.91	5.99	0.07	0.03	0.06	0.05	0.05
1976	5.82	5.88	0.06	0.04	0.07	0.04	0.05
1977	6.03	6.14	0.11	0.06	0.08	0.05	0.06
1978	5.91	5.95	0.04	0.05	0.05	0.04	0.05
1979	5.74	5.82	0.08	0.03	0.08	0.07	0.06
1980	6.56	6.74	0.17	0.05	0.10	0.04	0.06
1981	5.91	5.99	0.08	0.03	0.08	0.05	0.05
1982	5.87	5.96	0.10	0.04	0.07	0.04	0.05
1983	6.15	6.25	0.11	0.04	0.07	0.05	0.05
1984	6.26	6.40	0.14	0.05	0.07	0.05	0.06
1985	5.81	5.91	0.10	0.05	0.07	0.04	0.05
1986	5.72	5.76	0.04	0.03	0.05	0.03	0.04
1987	6.48	6.56	0.08	0.04	0.07	0.04	0.05
1988	6.91	7.08	0.17	0.04	0.07	0.05	0.05
1989	5.69	5.77	0.08	0.06	0.07	0.06	0.08
AVG	5.99	6.09	0.10	0.04	0.07	0.05	0.05
STD	0.32	0.34	0.04	0.01	0.01	0.01	0.01
MAX	6.91	7.08	0.17	0.06	0.10	0.07	0.08
MIN	5.59	5.72	0.04	0.03	0.05	0.03	0.04

NOTES : 1. AVG1 = Mean relative changes for period May-Jun.
2. AVG2 = Mean relative changes for period Jul-Aug.
3. AVG3 = Mean relative changes for period Sep-Oct.
4. AVGS = Mean relative changes for period May-Oct.
5. Scenario3-Run6 is termed as Change

STATISTICAL ANALYSIS OF CHANGES

DATA : WATER LEVEL

RIVER : U MEGHNA

STATION : 273 BHAIKAB BAZAR

YEARS	PEAK RUN6	PEAK SCEN3	PEAK	AVG1	AVG2	AVG3	AVGS
1965	6.19	6.18	-0.02	-0.01	-0.02	-0.03	-0.02
1966	6.35	6.32	-0.03	0.01	-0.02	-0.04	-0.02
1967	6.20	6.17	-0.03	-0.01	-0.03	-0.02	-0.02
1968	6.47	6.45	-0.02	-0.01	-0.02	-0.03	-0.02
1969	6.43	6.41	-0.01	-0.01	-0.02	-0.02	-0.02
1970	6.51	6.46	-0.05	-0.01	-0.03	-0.03	-0.02
1972	6.19	6.17	-0.02	-0.01	-0.03	-0.02	-0.02
1973	6.92	6.90	-0.03	-0.02	-0.02	-0.02	-0.02
1974	6.44	6.41	-0.03	-0.01	-0.04	-0.04	-0.03
1975	6.46	6.45	-0.02	-0.01	-0.02	-0.02	-0.02
1976	7.04	7.03	-0.02	-0.01	-0.02	-0.02	-0.01
1977	6.20	6.18	-0.02	-0.06	-0.02	-0.04	-0.04
1978	5.82	5.80	-0.02	0.01	-0.02	-0.02	-0.01
1979	6.52	6.50	-0.02	0.00	-0.02	-0.04	-0.02
1980	6.03	5.99	-0.04	-0.01	-0.03	-0.05	-0.03
1981	6.28	6.25	-0.02	-0.01	-0.03	-0.03	-0.02
1982	6.39	6.36	-0.02	-0.01	-0.02	-0.03	-0.02
1983	6.83	6.82	-0.01	-0.01	-0.02	-0.02	-0.02
1984	6.78	6.77	-0.01	-0.01	-0.03	-0.03	-0.02
1985	6.34	6.31	-0.03	-0.02	-0.03	-0.02	-0.03
1986	6.04	6.02	-0.02	-0.01	-0.02	-0.02	-0.02
1987	6.85	6.82	-0.03	0.00	-0.03	-0.03	-0.02
1988	7.51	7.45	-0.06	-0.01	-0.02	-0.04	-0.02
1989	6.50	6.47	-0.03	-0.01	-0.03	-0.04	-0.02
AVG	6.47	6.45	-0.02	-0.01	-0.03	-0.03	-0.02
STD	0.36	0.36	0.01	0.01	0.01	0.01	0.01
MAX	7.51	7.45	-0.01	0.01	-0.02	-0.02	-0.01
MIN	5.82	5.80	-0.06	-0.06	-0.04	-0.05	-0.04

- NOTES :
1. AVG1 = Mean relative changes for period May-Jun.
 2. AVG2 = Mean relative changes for period Jul-Aug.
 3. AVG3 = Mean relative changes for period Sep-Oct.
 4. AVGS = Mean relative changes for period May-Oct.
 5. Scenario3-Run6 is termed as Change

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STATISTICAL ANALYSIS OF CHANGES

DATA : WATER LEVEL

RIVER : U MEGHNA

STATION : 275.5 MEGHNA FERRY GHAT

YEARS	PEAK RUN6	PEAK SCEN3	PEAK	AVG1	AVG2	AVG3	AVGS
1965	5.04	4.97	-0.06	-0.02	-0.06	-0.06	-0.05
1966	5.41	5.33	-0.08	-0.02	-0.06	-0.08	-0.06
1967	5.11	5.00	-0.11	-0.02	-0.07	-0.04	-0.04
1968	5.28	5.22	-0.06	-0.02	-0.06	-0.05	-0.04
1969	5.19	5.15	-0.04	-0.02	-0.05	-0.03	-0.03
1970	5.41	5.33	-0.08	-0.02	-0.08	-0.05	-0.05
1972	5.07	4.98	-0.08	-0.02	-0.07	-0.03	-0.04
1973	5.29	5.21	-0.08	-0.02	-0.06	-0.04	-0.04
1974	5.72	5.63	-0.09	-0.02	-0.09	-0.06	-0.06
1975	5.27	5.21	-0.06	-0.02	-0.04	-0.04	-0.03
1976	5.27	5.19	-0.08	-0.02	-0.06	-0.04	-0.04
1977	5.20	5.12	-0.08	-0.06	-0.06	-0.07	-0.06
1978	4.94	4.91	-0.03	-0.01	-0.05	-0.04	-0.03
1979	5.24	5.17	-0.07	-0.01	-0.06	-0.08	-0.05
1980	5.61	5.54	-0.07	-0.03	-0.07	-0.07	-0.05
1981	5.17	5.10	-0.07	-0.02	-0.06	-0.05	-0.04
1982	5.14	5.08	-0.06	-0.01	-0.06	-0.04	-0.04
1983	5.37	5.34	-0.02	-0.02	-0.05	-0.05	-0.04
1984	5.55	5.50	-0.05	-0.03	-0.07	-0.05	-0.05
1985	5.24	5.15	-0.09	-0.03	-0.07	-0.05	-0.05
1986	4.90	4.85	-0.05	-0.01	-0.04	-0.05	-0.03
1987	5.72	5.61	-0.11	-0.01	-0.08	-0.07	-0.05
1988	6.22	6.13	-0.09	-0.03	-0.05	-0.09	-0.06
1989	5.21	5.12	-0.09	-0.04	-0.07	-0.07	-0.06
AVG	5.31	5.24	-0.07	-0.02	-0.06	-0.05	-0.05
STD	0.28	0.28	0.02	0.01	0.01	0.02	0.01
MAX	6.22	6.13	-0.02	-0.01	-0.04	-0.03	-0.03
MIN	4.90	4.85	-0.11	-0.06	-0.09	-0.09	-0.06

- NOTES :
1. AVG1 = Mean relative changes for period May-Jun.
 2. AVG2 = Mean relative changes for period Jul-Aug.
 3. AVG3 = Mean relative changes for period Sep-Oct.
 4. AVGS = Mean relative changes for period May-Oct.
 5. Scenario3-Run6 is termed as Change

STATISTICAL ANALYSIS OF CHANGES

DATA : WATER LEVEL
RIVER : L MEGHNA
STATION : 277 CHANDPUR

YEARS	PEAK RUN6	PEAK SCEN3	PEAK	AVG1	AVG2	AVG3	AVGS
1965	4.03	4.06	0.03	0.00	0.00	-0.01	0.00
1966	4.48	4.51	0.03	0.00	0.01	-0.01	0.00
1967	4.09	4.10	0.01	0.00	0.00	0.00	0.00
1968	4.37	4.38	0.02	0.00	0.00	0.00	0.00
1969	4.30	4.30	0.00	0.00	0.00	0.00	0.00
1970	4.44	4.47	0.03	0.00	0.00	0.00	0.00
1972	4.17	4.18	0.01	0.00	0.00	0.00	0.00
1973	4.53	4.51	-0.01	0.01	-0.01	0.00	0.00
1974	4.94	4.97	0.03	0.00	0.00	0.00	0.00
1975	4.40	4.40	0.00	0.00	0.00	0.00	0.00
1976	4.28	4.29	0.00	0.00	0.00	0.00	0.00
1977	4.37	4.38	0.01	0.00	0.00	-0.01	0.00
1978	4.26	4.26	0.00	0.01	0.00	0.00	0.00
1979	4.37	4.36	-0.01	0.00	0.00	-0.01	0.00
1980	4.87	4.92	0.05	0.00	0.01	-0.02	0.00
1981	4.30	4.31	0.01	0.00	0.00	-0.01	0.00
1982	4.15	4.16	0.01	0.00	0.00	0.00	0.00
1983	4.48	4.52	0.04	0.00	0.00	0.00	0.00
1984	4.65	4.69	0.03	0.00	0.00	0.00	0.00
1985	4.37	4.36	-0.00	0.00	-0.01	-0.01	-0.01
1986	4.07	4.06	-0.01	0.00	-0.01	-0.01	-0.01
1987	4.83	4.81	-0.02	0.00	-0.02	-0.02	-0.01
1988	5.22	5.28	0.06	0.00	-0.01	-0.03	-0.01
1989	4.41	4.40	-0.01	0.00	0.00	-0.01	0.00
AVG	4.43	4.45	0.01	0.00	0.00	-0.01	0.00
STD	0.28	0.30	0.02	0.00	0.01	0.01	0.00
MAX	5.22	5.28	0.06	0.01	0.01	0.00	0.00
MIN	4.03	4.06	-0.02	0.00	-0.02	-0.03	-0.01

NOTES : 1. AVG1 = Mean relative changes for period May-Jun.
2. AVG2 = Mean relative changes for period Jul-Aug.
3. AVG3 = Mean relative changes for period Sep-Oct.
4. AVGS = Mean relative changes for period May-Oct.
5. Scenario3-Run6 is termed as Change

STATISTICAL ANALYSIS OF CHANGES

DATA : WATER LEVEL
RIVER : OLD BRAHMAPUTRA
STATION : 225 JAMALPUR

YEARS	PEAK RUN6	PEAK SCEN3	PEAK	AVG1	AVG2	AVG3	AVGS
1965	16.46	16.47	0.02	0.00	0.02	0.01	0.01
1966	16.86	16.88	0.02	0.01	0.02	0.01	0.01
1967	16.79	16.81	0.02	0.01	0.01	0.01	0.01
1968	16.40	16.41	0.02	0.01	0.02	0.01	0.01
1969	16.21	16.22	0.01	0.01	0.01	0.01	0.01
1970	16.83	16.86	0.02	0.01	0.02	0.01	0.01
1972	16.74	16.76	0.02	0.01	0.01	0.01	0.01
1973	16.60	16.62	0.02	0.01	0.01	0.01	0.01
1974	17.20	17.24	0.03	0.00	0.02	0.01	0.01
1975	16.29	16.30	0.01	0.00	0.01	0.01	0.01
1976	16.58	16.60	0.02	0.00	0.02	0.01	0.01
1977	16.56	16.58	0.02	0.01	0.02	0.01	0.01
1978	16.20	16.21	0.01	0.01	0.02	0.01	0.01
1979	16.36	16.37	0.01	0.00	0.02	0.01	0.01
1980	17.32	17.36	0.04	0.01	0.02	0.01	0.01
1981	16.55	16.57	0.02	0.00	0.02	0.01	0.01
1982	16.42	16.44	0.01	0.00	0.01	0.01	0.01
1983	16.64	16.66	0.02	0.00	0.02	0.01	0.01
1984	17.00	17.03	0.02	0.01	0.02	0.01	0.01
1985	16.79	16.80	0.01	0.01	0.01	0.00	0.01
1986	15.79	15.81	0.02	0.01	0.01	0.00	0.01
1987	16.93	16.95	0.02	0.01	0.01	0.01	0.01
1988	17.64	17.67	0.03	0.00	0.02	0.01	0.01
1989	16.68	16.70	0.01	0.02	0.02	0.01	0.01
AVG	16.66	16.68	0.02	0.01	0.02	0.01	0.01
STD	0.39	0.39	0.01	0.00	0.00	0.00	0.00
MAX	17.64	17.67	0.04	0.02	0.02	0.01	0.01
MIN	15.79	15.81	0.01	0.00	0.01	0.00	0.01

- NOTES :
1. AVG1 = Mean relative changes for period May-Jun.
 2. AVG2 = Mean relative changes for period Jul-Aug.
 3. AVG3 = Mean relative changes for period Sep-Oct.
 4. AVGS = Mean relative changes for period May-Oct.
 5. Scenario3-Run6 is termed as Change

STATISTICAL ANALYSIS OF CHANGES

DATA : WATER LEVEL

RIVER : OLD BRAHMAPUTRA

STATION : 228.5 NILUKHIRCHAR

YEARS	PEAK RUN6	PEAK SCEN3	PEAK	AVG1	AVG2	AVG3	AVGS
1965	11.76	11.77	0.02	0.01	0.01	0.01	0.01
1966	12.12	12.14	0.02	0.01	0.02	0.01	0.01
1967	12.00	12.02	0.01	0.01	0.01	0.01	0.01
1968	11.58	11.59	0.00	0.01	0.02	0.01	0.01
1969	11.52	11.52	0.00	0.01	0.01	0.01	0.01
1970	12.01	12.03	0.02	0.01	0.01	0.01	0.01
1972	12.00	12.01	0.01	0.01	0.02	0.01	0.01
1973	12.05	12.06	0.01	0.01	0.01	0.01	0.01
1974	12.40	12.45	0.05	0.00	0.02	0.02	0.01
1975	11.59	11.63	0.04	0.01	0.03	0.01	0.02
1976	11.90	11.91	0.01	0.01	0.02	0.01	0.01
1977	11.81	11.82	0.01	0.01	0.02	0.01	0.01
1978	11.54	11.55	0.01	0.01	0.02	0.01	0.01
1979	11.75	11.76	0.01	0.01	0.02	0.01	0.01
1980	12.61	12.68	0.06	0.01	0.02	0.01	0.01
1981	11.88	11.89	0.01	0.00	0.02	0.01	0.01
1982	11.85	11.86	0.01	0.01	0.02	0.01	0.01
1983	11.87	11.88	0.01	0.01	0.02	0.01	0.01
1984	12.24	12.27	0.02	0.01	0.01	0.01	0.01
1985	12.11	12.13	0.02	0.02	0.01	0.00	0.01
1986	11.49	11.50	0.01	0.01	0.01	0.00	0.01
1987	12.37	12.39	0.02	0.02	0.01	0.01	0.01
1988	13.17	13.23	0.06	0.01	0.02	0.01	0.01
1989	11.95	11.96	0.01	0.02	0.02	0.00	0.01
AVG	11.98	12.00	0.02	0.01	0.02	0.01	0.01
STD	0.38	0.39	0.02	0.00	0.00	0.00	0.00
MAX	13.17	13.23	0.06	0.02	0.03	0.02	0.02
MIN	11.49	11.50	0.00	0.00	0.01	0.00	0.01

- NOTES :
1. AVG1 = Mean relative changes for period May-Jun.
 2. AVG2 = Mean relative changes for period Jul-Aug.
 3. AVG3 = Mean relative changes for period Sep-Oct.
 4. AVGS = Mean relative changes for period May-Oct.
 5. Scenario3-Run6 is termed as Change





STATISTICAL ANALYSIS OF CHANGES

DATA : WATER LEVEL
RIVER : OLD BRAHMAPUTRA
STATION : 229 TOKE

YEARS	PEAK RUN6	PEAK SCEN3	PEAK	AVG1	AVG2	AVG3	AVGS
1965	8.65	8.68	0.03	-0.01	0.02	0.01	0.01
1966	9.25	9.27	0.02	0.00	0.02	0.01	0.01
1967	9.04	9.07	0.03	-0.01	0.02	-0.01	0.00
1968	8.75	8.77	0.02	-0.01	0.03	-0.01	0.00
1969	8.13	8.15	0.02	0.00	0.02	0.00	0.00
1970	9.16	9.19	0.03	-0.01	0.02	0.00	0.01
1972	8.89	8.91	0.02	-0.01	0.02	-0.02	0.00
1973	9.42	9.43	0.01	0.00	0.02	0.01	0.01
1974	9.56	9.59	0.04	0.00	0.02	0.02	0.01
1975	8.53	8.54	0.01	-0.01	0.01	0.00	0.00
1976	8.76	8.78	0.02	0.00	0.02	-0.01	0.00
1977	8.67	8.70	0.03	-0.01	0.03	0.01	0.01
1978	8.32	8.33	0.01	0.00	0.02	-0.02	0.00
1979	8.53	8.54	0.01	0.00	0.02	0.02	0.01
1980	9.66	9.70	0.05	0.00	0.02	0.00	0.01
1981	8.48	8.50	0.02	-0.01	0.03	0.01	0.01
1982	8.99	9.01	0.02	-0.01	0.02	-0.01	0.00
1983	8.54	8.56	0.02	-0.01	0.01	0.02	0.01
1984	9.38	9.41	0.03	0.00	0.02	0.01	0.01
1985	9.00	9.01	0.01	0.00	0.01	-0.01	0.00
1986	8.54	8.54	0.00	-0.01	0.00	-0.01	-0.01
1987	9.48	9.49	0.01	0.00	0.02	0.01	0.01
1988	10.01	10.05	0.04	-0.01	0.02	-0.01	0.00
1989	8.69	8.73	0.04	0.00	0.03	0.02	0.02
AVG	8.93	8.96	0.02	-0.00	0.02	0.00	0.01
STD	0.46	0.47	0.01	0.00	0.01	0.01	0.01
MAX	10.01	10.05	0.05	0.00	0.03	0.02	0.02
MIN	8.13	8.15	0.00	-0.01	0.00	-0.02	-0.01

NOTES : 1. AVG1 = Mean relative changes for period May-Jun.
2. AVG2 = Mean relative changes for period Jul-Aug.
3. AVG3 = Mean relative changes for period Sep-Oct.
4. AVGS = Mean relative changes for period May-Oct.
5. Scenario3-Run6 is termed as Change



STATISTICAL ANALYSIS OF CHANGES

DATA : WATER LEVEL

RIVER : LAKHYA

STATION : 7.5 DEMRA

YEARS	PEAK RUN6	PEAK SCEN3	PEAK	AVG1	AVG2	AVG3	AVGS
1965	5.26	5.20	-0.06	-0.02	-0.05	-0.03	-0.04
1966	5.77	5.70	-0.07	-0.03	-0.06	-0.05	-0.05
1967	5.39	5.30	-0.09	-0.02	-0.05	-0.05	-0.04
1968	5.40	5.35	-0.05	-0.02	-0.04	-0.06	-0.04
1969	5.17	5.16	-0.02	-0.02	-0.04	-0.03	-0.03
1970	5.67	5.57	-0.09	-0.03	-0.06	-0.05	-0.05
1972	5.33	5.26	-0.07	-0.02	-0.06	-0.04	-0.04
1973	5.46	5.38	-0.08	-0.03	-0.04	-0.01	-0.03
1974	6.11	6.01	-0.09	-0.03	-0.05	-0.04	-0.04
1975	5.36	5.32	-0.04	-0.02	-0.03	-0.04	-0.03
1976	5.28	5.22	-0.05	-0.03	-0.04	-0.04	-0.04
1977	5.44	5.38	-0.06	-0.05	-0.04	-0.05	-0.05
1978	4.96	4.94	-0.02	-0.02	-0.04	-0.04	-0.04
1979	5.35	5.30	-0.05	-0.01	-0.04	-0.05	-0.03
1980	6.08	5.97	-0.11	-0.03	-0.06	-0.05	-0.05
1981	5.35	5.31	-0.04	-0.02	-0.04	-0.04	-0.03
1982	5.33	5.28	-0.05	-0.02	-0.04	-0.04	-0.03
1983	5.47	5.41	-0.06	-0.03	-0.05	-0.03	-0.04
1984	5.74	5.67	-0.07	-0.03	-0.05	-0.04	-0.04
1985	5.47	5.36	-0.11	-0.04	-0.08	-0.05	-0.06
1986	4.94	4.88	-0.06	-0.01	-0.05	-0.06	-0.04
1987	6.01	5.87	-0.14	-0.02	-0.09	-0.07	-0.07
1988	6.53	6.35	-0.18	-0.03	-0.07	-0.11	-0.07
1989	5.38	5.29	-0.09	-0.10	-0.07	-0.06	-0.07
AVG	5.51	5.44	-0.07	-0.03	-0.05	-0.05	-0.04
STD	0.36	0.33	0.04	0.02	0.01	0.02	0.01
MAX	6.53	6.35	-0.02	-0.01	-0.03	-0.01	-0.03
MIN	4.94	4.88	-0.18	-0.10	-0.09	-0.11	-0.07

- NOTES :
1. AVG1 = Mean relative changes for period May-Jun.
 2. AVG2 = Mean relative changes for period Jul-Aug.
 3. AVG3 = Mean relative changes for period Sep-Oct.
 4. AVGS = Mean relative changes for period May-Oct.
 5. Scenario3-Run6 is termed as Change



STATISTICAL ANALYSIS OF CHANGES

DATA : WATER LEVEL

RIVER : KALIGANGA

STATION : 137A TARAGHAT

YEARS	PEAK RUN6	PEAK SCEN3	PEAK	AVG1	AVG2	AVG3	AVGS
1965	8.83	9.67	0.83	0.28	0.85	0.58	0.57
1966	9.23	10.06	0.83	0.44	0.91	0.57	0.64
1967	8.95	9.84	0.88	0.28	0.87	0.65	0.60
1968	8.56	9.54	0.98	0.29	0.87	0.68	0.62
1969	8.23	9.14	0.91	0.37	0.86	0.53	0.59
1970	9.22	10.07	0.86	0.51	0.90	0.71	0.71
1972	8.88	9.77	0.89	0.34	0.83	0.51	0.56
1973	8.90	9.81	0.91	0.24	0.72	0.51	0.49
1974	9.60	10.48	0.88	0.33	0.81	0.72	0.62
1975	8.35	9.26	0.91	0.23	0.89	0.72	0.61
1976	8.59	9.52	0.94	0.30	0.83	0.52	0.55
1977	8.90	9.78	0.88	0.51	0.96	0.76	0.74
1978	8.20	8.92	0.72	0.31	0.98	0.67	0.66
1979	8.53	9.38	0.85	0.22	0.84	0.80	0.62
1980	9.70	10.66	0.96	0.35	0.89	0.67	0.64
1981	8.47	9.49	1.01	0.15	0.94	0.61	0.57
1982	8.66	9.51	0.85	0.32	0.85	0.56	0.58
1983	8.86	9.74	0.88	0.26	0.84	0.73	0.61
1984	9.41	10.23	0.82	0.42	0.82	0.59	0.61
1985	8.80	9.66	0.86	0.44	0.88	0.74	0.69
1986	7.92	8.62	0.70	0.10	0.71	0.66	0.49
1987	9.23	10.10	0.87	0.20	0.82	0.80	0.60
1988	9.92	11.08	1.16	0.43	0.93	0.73	0.70
1989	8.59	9.63	1.04	0.59	0.99	0.87	0.82
AVG	8.86	9.75	0.89	0.33	0.87	0.66	0.62
STD	0.48	0.53	0.09	0.12	0.07	0.10	0.07
MAX	9.92	11.08	1.16	0.59	0.99	0.87	0.82
MIN	7.92	8.62	0.70	0.10	0.71	0.51	0.49

- NOTES :
1. AVG1 = Mean relative changes for period May-Jun.
 2. AVG2 = Mean relative changes for period Jul-Aug.
 3. AVG3 = Mean relative changes for period Sep-Oct.
 4. AVGS = Mean relative changes for period May-Oct.
 5. Scenario3-Run6 is termed as Change

STATISTICAL ANALYSIS OF CHANGES

DATA : WATER LEVEL

RIVER : GORAI

STATION : 99 GORAI RAILWAY BRIDGE

YEARS	PEAK RUN6	PEAK SCEN3	PEAK	AVG1	AVG2	AVG3	AVGS
1965	12.19	12.19	0.00	0.02	0.01	0.00	0.01
1966	12.43	12.43	0.00	0.03	0.01	0.01	0.02
1967	12.80	12.80	0.00	0.02	0.02	0.00	0.01
1968	12.56	12.56	0.00	0.02	0.01	0.00	0.01
1969	13.10	13.10	0.00	0.01	0.01	0.00	0.01
1970	12.37	12.37	0.00	0.02	0.01	0.00	0.01
1972	12.15	12.15	0.00	0.02	0.01	0.00	0.01
1973	12.76	12.76	0.00	0.02	0.00	0.00	0.01
1974	12.98	12.98	0.00	0.02	0.02	0.00	0.01
1975	12.84	12.84	0.00	0.01	0.00	0.00	0.01
1976	13.31	13.31	0.00	0.02	0.02	0.00	0.01
1977	12.76	12.76	0.00	0.03	0.01	0.00	0.01
1978	13.36	13.36	0.00	0.00	0.00	0.00	0.00
1979	12.26	12.26	0.00	0.00	0.01	0.02	0.01
1980	13.18	13.19	0.01	0.03	0.01	0.00	0.01
1981	12.74	12.74	0.00	0.01	0.01	0.00	0.01
1982	13.33	13.33	0.00	0.01	0.02	0.00	0.01
1983	13.19	13.19	0.00	0.03	0.01	0.00	0.01
1984	13.09	13.09	0.00	0.02	0.00	0.00	0.01
1985	12.73	12.73	0.00	0.05	0.02	0.00	0.02
1986	12.93	12.93	0.00	0.01	0.00	0.00	0.00
1987	13.64	13.64	0.00	0.02	0.02	0.00	0.02
1988	13.70	13.71	0.01	0.04	0.01	0.01	0.02
1989	11.89	11.89	0.00	-0.03	0.02	0.01	-0.00
AVG	12.85	12.85	0.00	0.02	0.01	0.00	0.01
STD	0.46	0.46	0.00	0.01	0.01	0.00	0.00
MAX	13.70	13.71	0.01	0.05	0.02	0.02	0.02
MIN	11.89	11.89	0.00	-0.03	0.00	0.00	-0.00

- NOTES :
1. AVG1 = Mean relative changes for period May-Jun.
 2. AVG2 = Mean relative changes for period Jul-Aug.
 3. AVG3 = Mean relative changes for period Sep-Oct.
 4. AVGS = Mean relative changes for period May-Oct.
 5. Scenario3-Run6 is termed as Change

STATISTICAL ANALYSIS OF CHANGES

DATA : WATER LEVEL

RIVER : ATRAI

STATION : 151 BAGHABARI

YEARS	PEAK RUN6	PEAK SCEN3	PEAK	AVG1	AVG2	AVG3	AVGS
1965	10.33	10.59	0.26	0.13	0.20	0.14	0.16
1966	10.68	10.98	0.31	0.15	0.23	0.17	0.19
1967	10.44	10.74	0.30	0.13	0.20	0.13	0.15
1968	10.34	10.58	0.24	0.14	0.18	0.15	0.16
1969	10.05	10.28	0.23	0.13	0.16	0.10	0.13
1970	10.66	10.97	0.31	0.16	0.21	0.14	0.17
1972	10.35	10.66	0.30	0.15	0.19	0.13	0.16
1973	10.54	10.81	0.27	0.15	0.16	0.11	0.14
1974	11.13	11.51	0.38	0.15	0.24	0.17	0.19
1975	10.26	10.47	0.21	0.13	0.16	0.14	0.14
1976	10.10	10.39	0.30	0.14	0.18	0.11	0.14
1977	10.54	10.80	0.26	0.16	0.19	0.16	0.18
1978	9.79	9.93	0.14	0.14	0.15	0.12	0.14
1979	10.17	10.37	0.21	0.12	0.19	0.20	0.17
1980	11.22	11.64	0.42	0.15	0.25	0.13	0.18
1981	10.29	10.50	0.21	0.12	0.21	0.14	0.16
1982	10.35	10.58	0.23	0.13	0.18	0.13	0.15
1983	10.57	10.84	0.27	0.14	0.18	0.14	0.15
1984	11.00	11.31	0.31	0.14	0.19	0.15	0.16
1985	10.44	10.69	0.25	0.15	0.20	0.13	0.16
1986	9.77	9.94	0.17	0.12	0.14	0.13	0.13
1987	10.99	11.28	0.29	0.13	0.21	0.15	0.17
1988	11.57	12.01	0.44	0.15	0.17	0.15	0.16
1989	10.21	10.49	0.28	0.17	0.24	0.21	0.20
AVG	10.49	10.76	0.27	0.14	0.19	0.14	0.16
STD	0.43	0.49	0.07	0.01	0.03	0.03	0.02
MAX	11.57	12.01	0.44	0.17	0.25	0.21	0.20
MIN	9.77	9.93	0.14	0.12	0.14	0.10	0.13

- NOTES :
1. AVG1 = Mean relative changes for period May-Jun.
 2. AVG2 = Mean relative changes for period Jul-Aug.
 3. AVG3 = Mean relative changes for period Sep-Oct.
 4. AVGS = Mean relative changes for period May-Oct.
 5. Scenario3-Run6 is termed as Change

STATISTICAL ANALYSIS OF CHANGES

DATA : WATER LEVEL
RIVER : ARIAL KHAN
STATION : 5 MADARIPUR

YEARS	PEAK RUN6	PEAK SCEN3	PEAK	AVG1	AVG2	AVG3	AVGS
1965	4.42	4.65	0.23	-0.18	0.15	0.00	-0.01
1966	4.97	5.25	0.28	-0.13	0.17	0.03	0.02
1967	4.44	4.68	0.24	-0.17	0.14	0.09	0.02
1968	4.70	4.94	0.24	-0.10	0.15	0.10	0.05
1969	4.74	4.94	0.20	-0.20	0.14	0.03	-0.01
1970	4.82	5.11	0.29	-0.11	0.17	0.10	0.06
1972	4.41	4.65	0.24	-0.20	0.13	-0.00	-0.02
1973	4.85	5.12	0.27	-0.09	0.15	0.10	0.05
1974	5.39	5.67	0.28	-0.14	0.19	0.12	0.05
1975	4.79	5.01	0.22	-0.21	0.14	0.10	0.01
1976	4.65	4.86	0.21	-0.16	0.14	0.03	0.00
1977	4.89	5.15	0.25	-0.04	0.17	0.11	0.08
1978	4.79	4.97	0.19	-0.08	0.15	0.09	0.06
1979	4.57	4.80	0.23	-0.28	0.14	0.13	-0.00
1980	5.50	5.78	0.29	-0.19	0.21	0.08	0.04
1981	4.76	5.00	0.24	-0.16	0.16	0.04	0.01
1982	4.64	4.88	0.24	-0.23	0.14	-0.02	-0.04
1983	4.99	5.24	0.25	-0.19	0.11	0.12	0.01
1984	5.12	5.41	0.29	-0.07	0.15	0.09	0.06
1985	4.77	4.90	0.13	0.07	0.10	0.07	0.08
1986	4.61	4.70	0.09	0.03	0.06	0.06	0.06
1987	5.51	5.61	0.10	0.04	0.11	0.06	0.07
1988	5.96	6.14	0.18	0.05	0.11	0.04	0.07
1989	4.62	4.72	0.10	0.05	0.07	0.06	0.06
AVG	4.87	5.09	0.22	-0.11	0.14	0.07	0.03
STD	0.37	0.38	0.06	0.10	0.03	0.04	0.03
MAX	5.96	6.14	0.29	0.07	0.21	0.13	0.08
MIN	4.41	4.65	0.09	-0.28	0.06	-0.02	-0.04

NOTES : 1. AVG1 = Mean relative changes for period May-Jun.
2. AVG2 = Mean relative changes for period Jul-Aug.
3. AVG3 = Mean relative changes for period Sep-Oct.
4. AVGS = Mean relative changes for period May-Oct.
5. Scenario3-Run6 is termed as Change

Table 3.8 (5 Pages)
Statistical Analysis of Discharge Differences
Between Existing Situation and Scenario 3 (25 Years)



STATISTICAL ANALYSIS OF CHANGES

DATA : DISCHARGE

RIVER : JAMUNA

STATION : 46.9L BAHADURABAD

YEARS	PEAK RUN6	PEAK SCEN3	PEAK	AVG1	AVG2	AVG3	AVGS
1965	65071	65035	-36	-3	-20	-6	-9
1966	73344	73285	-59	-5	-28	-11	-15
1967	71892	71833	-59	-3	-16	-2	-7
1968	64464	64422	-42	-7	-18	-5	-10
1969	56849	56830	-19	-2	-13	-2	-6
1970	74492	74434	-58	-6	-21	-8	-12
1972	70880	70827	-53	-6	-14	-3	-8
1973	68163	68123	-40	-7	-12	-4	-8
1974	85301	85184	-117	-5	-31	-13	-17
1975	58086	58078	-8	-2	-14	-5	-7
1976	66792	66750	-42	-3	-17	-1	-7
1977	67963	67924	-39	-8	-26	-7	-14
1978	55476	55451	-25	-4	-12	-3	-6
1979	60762	60742	-20	-0	-21	-14	-12
1980	88880	88750	-130	-5	-38	-6	-16
1981	66053	66015	-38	0	-21	-10	-10
1982	63642	63606	-36	-3	-15	-5	-8
1983	70305	70249	-56	-2	-14	-11	-9
1984	77936	77857	-79	-3	-19	-13	-12
1985	66394	66352	-42	142	-40	-159	-19
1986	47835	47803	-32	145	-23	-127	-2
1987	75503	75470	-33	177	-123	-116	-21
1988	97568	97394	-174	-5	-56	-26	-29
1989	68884	68604	-280	152	-16	-131	2
AVG	69272	69209	-63	22	-26	-29	-11
STD	10631	10598	58	59	23	48	6
MAX	97568	97394	-8	177	-12	-1	2
MIN	47835	47803	-280	-8	-123	-159	-29

- NOTES :
1. AVG1 = Mean relative changes for period May-Jun.
 2. AVG2 = Mean relative changes for period Jul-Aug.
 3. AVG3 = Mean relative changes for period Sep-Oct.
 4. AVGS = Mean relative changes for period May-Oct.
 5. Scenario3-Run6 is termed as Change

STATISTICAL ANALYSIS OF CHANGES

DATA : DISCHARGE

RIVER : GANGES

STATION : 90 HARDINGE BRIDGE

YEARS	PEAK RUN6	PEAK SCEN3	PEAK	AVG1	AVG2	AVG3	AVGS
1965	36359	36359	0	0	0	0	0
1966	40369	40369	0	0	0	0	0
1967	49055	49055	0	0	1	0	0
1968	43009	43009	0	0	1	0	0
1969	56039	56039	0	0	0	0	0
1970	39186	39186	0	0	0	0	0
1972	35515	35515	0	0	0	0	0
1973	48081	48081	0	0	0	0	0
1974	53510	53510	0	0	0	0	0
1975	50010	50010	0	0	0	0	0
1976	60708	60708	0	0	0	0	0
1977	47952	47952	0	0	0	0	0
1978	62173	62173	0	0	0	0	0
1979	37149	37149	0	0	0	0	0
1980	57541	57541	0	0	0	0	0
1981	47447	47447	0	0	1	0	0
1982	61192	61192	0	0	0	0	0
1983	57842	57842	0	0	0	0	0
1984	55529	55529	0	0	0	0	0
1985	47305	47305	0	0	0	0	0
1986	51995	51995	0	0	0	0	0
1987	70593	70593	0	0	0	0	0
1988	72198	72198	0	0	0	0	0
1989	31695	31695	0	0	0	0	0
AVG	50519	50519	0	0	0	0	0
STD	10562	10562	0	0	0	0	0
MAX	72198	72198	0	0	1	0	0
MIN	31695	31695	0	0	0	0	0

- NOTES :
1. AVG1 = Mean relative changes for period May-Jun.
 2. AVG2 = Mean relative changes for period Jul-Aug.
 3. AVG3 = Mean relative changes for period Sep-Oct.
 4. AVGS = Mean relative changes for period May-Oct.
 5. Scenario3-Run6 is termed as Change

STATISTICAL ANALYSIS OF CHANGES

DATA : DISCHARGE

RIVER : PADMA

STATION : 91.9L BARURIA

YEARS	PEAK RUN6	PEAK SCEN3	PEAK	AVG1	AVG2	AVG3	AVGS
1965	78740	84217	5477	1110	3202	1766	2033
1966	95510	102666	7156	1563	3889	2603	2691
1967	77841	84415	6574	1141	3365	1741	2089
1968	84879	89721	4842	1295	3162	1994	2156
1969	88795	91356	2561	1129	2730	1488	1787
1970	89589	97033	7444	1645	3938	2039	2548
1972	77431	83803	6372	1397	2900	1516	1943
1973	92370	98500	6130	1677	2829	1701	2073
1974	111541	121249	9708	1479	4932	2695	3046
1975	90273	94746	4473	975	2743	1951	1894
1976	85500	89020	3520	1235	2971	1465	1896
1977	95916	101647	5731	7226	11650	-5934	4906
1978	89441	91771	2330	12022	4642	-2218	4993
1979	82177	86506	4329	8223	9567	-2514	5138
1980	120319	130798	10479	1387	5243	1925	2865
1981	90258	94451	4193	825	3819	2094	2255
1982	92165	97141	4976	1124	2919	1834	1964
1983	101580	107646	6066	1154	2548	2477	2062
1984	106746	113928	7182	1417	3597	2573	2535
1985	85764	91415	5651	1548	3300	1773	2213
1986	83411	86005	2594	906	1983	1678	1525
1987	113934	120131	6197	1181	3889	2401	2498
1988	135322	146996	11674	1461	4072	2970	2841
1989	78174	82356	4182	-1395	3688	3145	1823
AVG	93653	99480	5827	2155	4066	1382	2574
STD	14323	16116	2311	2805	2131	2010	994
MAX	135322	146996	11674	12022	11650	3145	5138
MIN	77431	82356	2330	-1395	1983	-5934	1525

- NOTES :
1. AVG1 = Mean relative changes for period May-Jun.
 2. AVG2 = Mean relative changes for period Jul-Aug.
 3. AVG3 = Mean relative changes for period Sep-Oct.
 4. AVGS = Mean relative changes for period May-Oct.
 5. Scenario3-Run6 is termed as Change

YB

STATISTICAL ANALYSIS OF CHANGES

DATA : DISCHARGE

RIVER : UPPER MEGHNA

STATION : 273 BHAIRAB BAZAR

YEARS	PEAK RUN6	PEAK SCEN3	PEAK	AVG1	AVG2	AVG3	AVGS
1965	12023	12017	-6	-1	11	-13	-1
1966	13724	13735	11	63	1	-5	20
1967	11835	11880	45	4	5	-4	1
1968	13770	13768	-2	4	4	-3	2
1969	13435	13441	6	3	2	-5	0
1970	13616	13632	16	2	14	-12	1
1972	13286	13318	32	-0	9	-11	-1
1973	17004	17066	62	-23	11	-10	-8
1974	11662	11675	13	3	22	-21	1
1975	13405	13414	9	-1	4	-2	0
1976	17860	17856	-4	5	2	-5	1
1977	13252	13254	2	-129	6	-7	-43
1978	10540	10542	2	79	4	-5	26
1979	14355	14364	9	51	9	0	20
1980	8904	8925	21	2	31	-34	-0
1981	13017	12994	-23	2	8	-8	1
1982	12974	12970	-4	2	6	-7	1
1983	17477	17468	-9	3	2	3	2
1984	15031	15003	-28	7	6	-8	2
1985	12297	12307	10	-12	3	-3	-4
1986	11482	11491	9	1	4	1	2
1987	15684	15738	54	3	23	-19	2
1988	19596	19672	76	6	-2	3	2
1989	14240	14237	-3	8	0	1	3
AVG	13770	13782	12	3	8	-7	1
STD	2375	2383	25	35	8	8	12
MAX	19596	19672	76	79	31	3	26
MIN	8904	8925	-28	-129	-2	-34	-43

- NOTES :
1. AVG1 = Mean relative changes for period May-Jun.
 2. AVG2 = Mean relative changes for period Jul-Aug.
 3. AVG3 = Mean relative changes for period Sep-Oct.
 4. AVGS = Mean relative changes for period May-Oct.
 5. Scenario3-Run6 is termed as Change

STATISTICAL ANALYSIS OF CHANGES

DATA : DISCHARGE

RIVER : OLD BRAHMAPUTRA

STATION : 228.5 NILUKHIRCHAR

YEARS	PEAK RUN6	PEAK SCEN3	PEAK	AVG1	AVG2	AVG3	AVGS
1965	2655	2692	37	2	22	7	10
1966	3669	3709	40	5	30	13	16
1967	3339	3379	40	2	17	3	7
1968	2478	2505	27	-4	15	7	6
1969	2261	2311	50	2	20	3	9
1970	3407	3454	47	4	20	8	11
1972	3333	3371	38	-3	16	3	5
1973	3450	3473	23	5	14	4	8
1974	4234	4333	99	6	32	15	18
1975	2535	2556	21	1	8	5	5
1976	3051	3087	36	3	17	2	8
1977	2795	2834	39	7	28	9	15
1978	2371	2393	22	3	14	3	7
1979	2635	2656	21	0	23	22	15
1980	4642	4759	117	4	36	7	16
1981	2958	2987	29	0	20	11	10
1982	2933	2958	25	2	1	5	3
1983	2951	2990	39	1	14	12	9
1984	3920	3975	55	3	17	11	11
1985	3682	3711	29	8	17	3	9
1986	2264	2264	0	3	5	6	5
1987	4178	4206	28	5	25	11	14
1988	5773	5922	149	3	23	18	14
1989	3196	3225	29	14	30	7	17
AVG	3280	3323	43	3	19	8	10
STD	819	846	32	4	8	5	4
MAX	5773	5922	149	14	36	22	18
MIN	2261	2264	0	-4	1	2	3

- NOTES :
1. AVG1 = Mean relative changes for period May-Jun.
 2. AVG2 = Mean relative changes for period Jul-Aug.
 3. AVG3 = Mean relative changes for period Sep-Oct.
 4. AVGS = Mean relative changes for period May-Oct.
 5. Scenario3-Run6 is termed as Change

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Table 4.1 : Peak Design Water Levels (m PWD) at Key Stations along the Major Rivers and Old Brahmaputra for Scenario 3 (25 Years)

STATIONS	RETURN PERIODS					
	2	5	10	25	50	100
CHILMARI	23.85	24.23	24.45	24.70	24.88	25.04
BAHADURABAD	19.86	20.24	20.44	20.65	20.80	20.92
KAZIPUR	16.02	16.51	16.78	17.10	17.32	17.52
SERAJGANJ	14.71	15.22	15.51	15.82	16.03	16.23
PORABARI	12.40	12.86	13.12	13.42	13.62	13.82
MATHURA	9.97	10.39	10.67	11.02	11.28	11.53
HARDINGE BRIDGE	14.68	14.79	14.86	14.96	15.02	15.09
SENGRAM	11.94	12.32	12.53	12.76	12.92	13.07
MAHENDRAPUR	10.69	11.01	11.20	11.40	11.54	11.68
BARURIA	8.42	8.76	9.02	9.38	9.69	10.01
MAWA	5.98	6.29	6.53	6.87	7.16	7.47
BHAIRAB BAZAR	6.40	6.72	6.92	7.16	7.34	7.51
CHANDPUR	4.38	4.65	4.83	5.07	5.25	5.44
JAMALPUR	16.66	17.00	17.19	17.41	17.56	17.69
NILUKHIRCHAR	11.92	12.27	12.51	12.82	13.06	13.31

Notes : Log Normal distribution & the data for the period of 1965-89 is considered for all the stations except for Hardinge Bridge where Gumbel is applied with left censoring for the period of data of 1910-89.

Table 4.2 : Peak & Mean Seasonal (May to October) Design Discharges (m³/s) along the Major Rivers and Old Brahmaputra for Scenario 3 (25 Years)

a): Peak Design Discharges

STATIONS	RETURN PERIODS					
	2	5	10	25	50	100
BAHADURABAD	67600	78200	85300	94200	100800	107400
HARDINGE BRIDGE	48800	59600	66800	75800	82500	89200
BARURIA	94000	107700	120600	143300	166400	196400
BHAIRAB BAZAR	13300	15700	17200	19200	20700	22100
NILUKHIRCHAR	3180	3870	4330	4910	5340	5760

Notes : Gumbel distribution is applied for all the stations except for Baruria and Bhairab Bazar where GEV II is applied. Period of data is 1965-89.

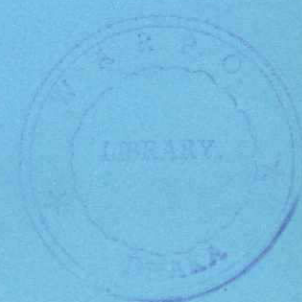
b): Mean Seasonal Design Discharges

STATIONS	RETURN PERIODS					
	2	5	10	25	50	100
BAHADURABAD	33600	36900	38900	41200	42800	44300
HARDINGE BRIDGE	19000	21900	23400	25000	26100	27100
BARURIA	50200	54400	56700	59200	60900	62500
BHAIRAB BAZAR	7500	8600	9400	10500	11400	12300
NILUKHIRCHAR	930	1150	1300	1480	1610	1740

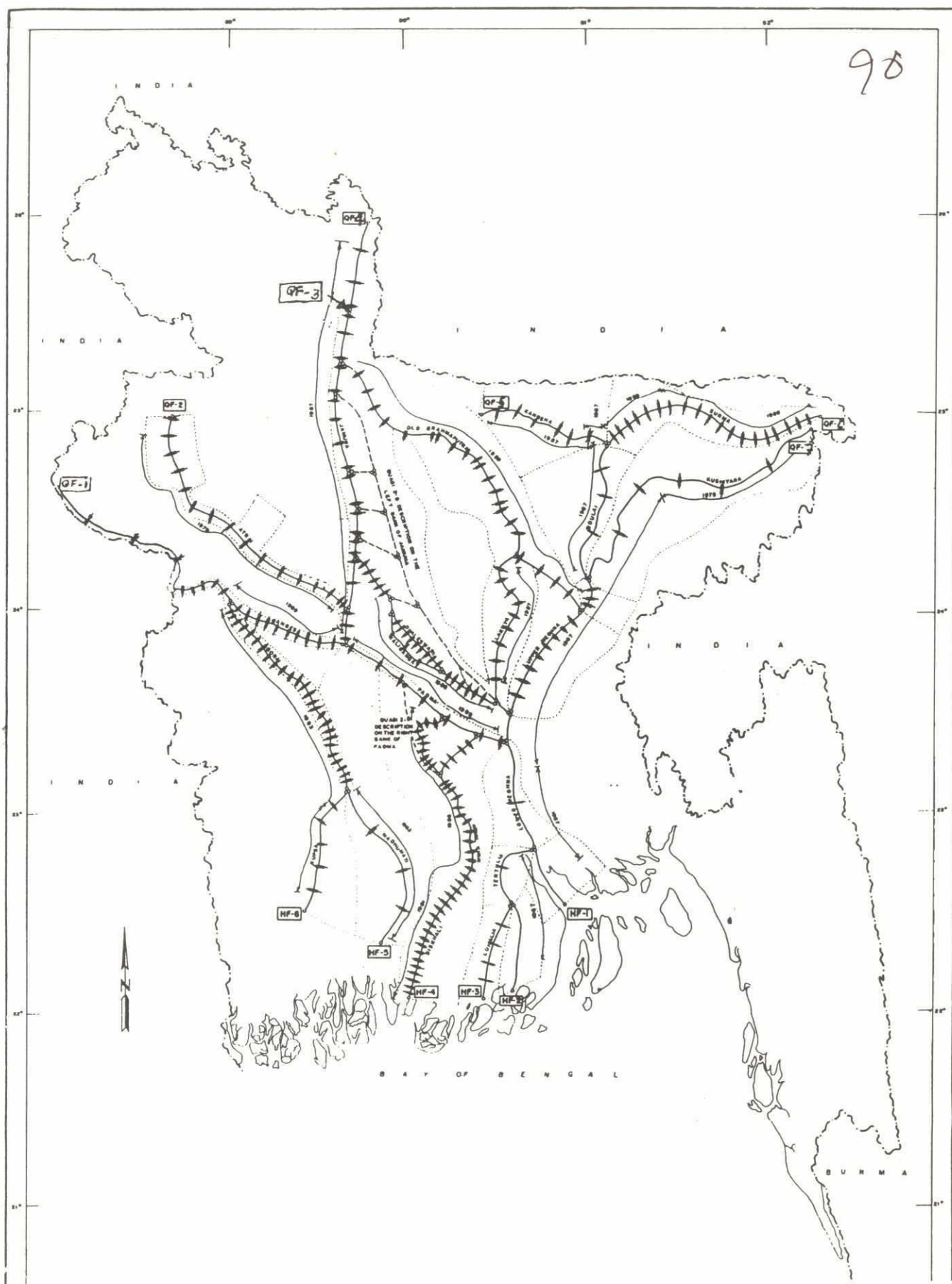
Notes : Log Normal distribution & the data for the period of 1965-89 is applied for all the stations.

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FIGURES



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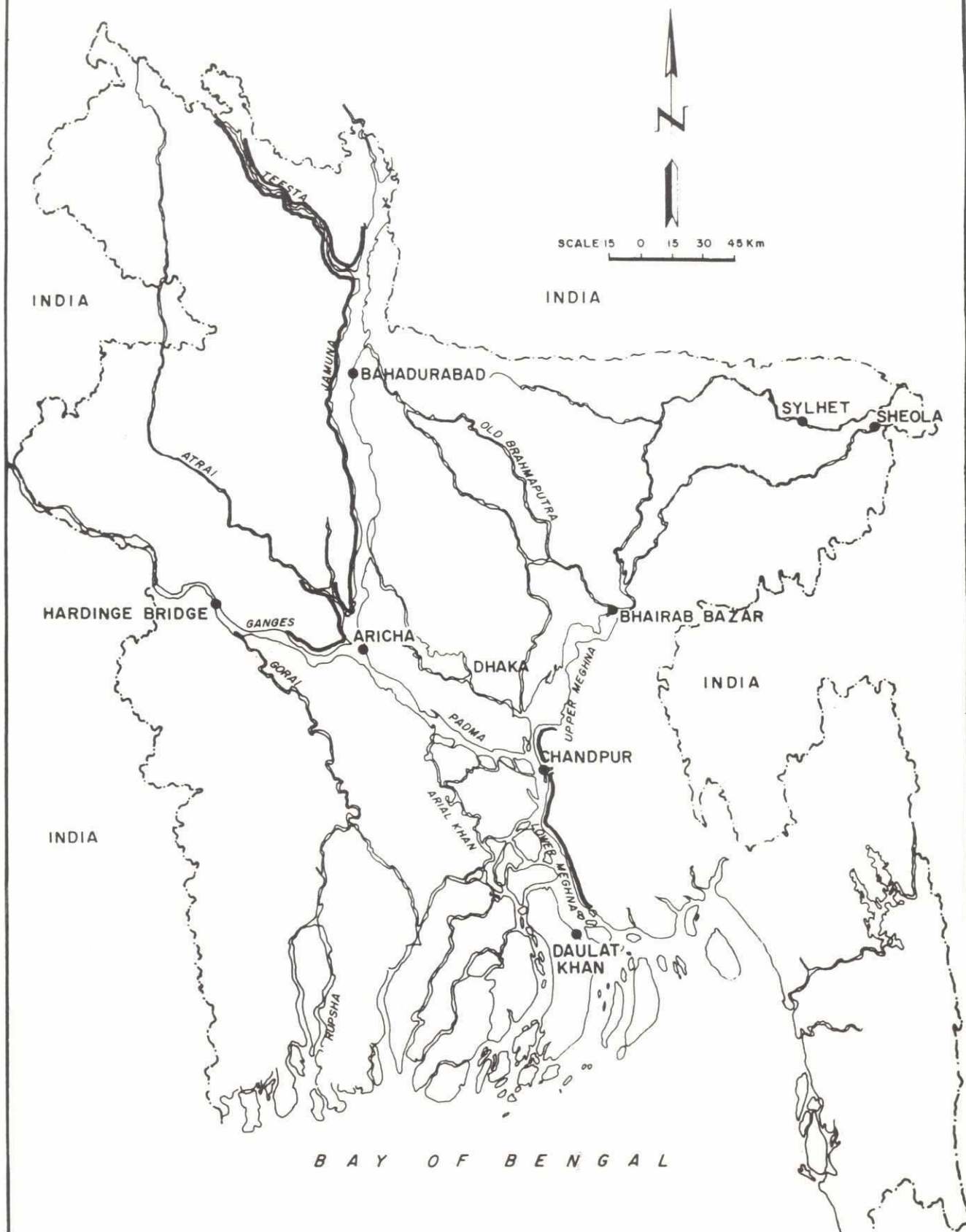
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Location of Model Cross Sections
in the General Model

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FIGURE 2.2



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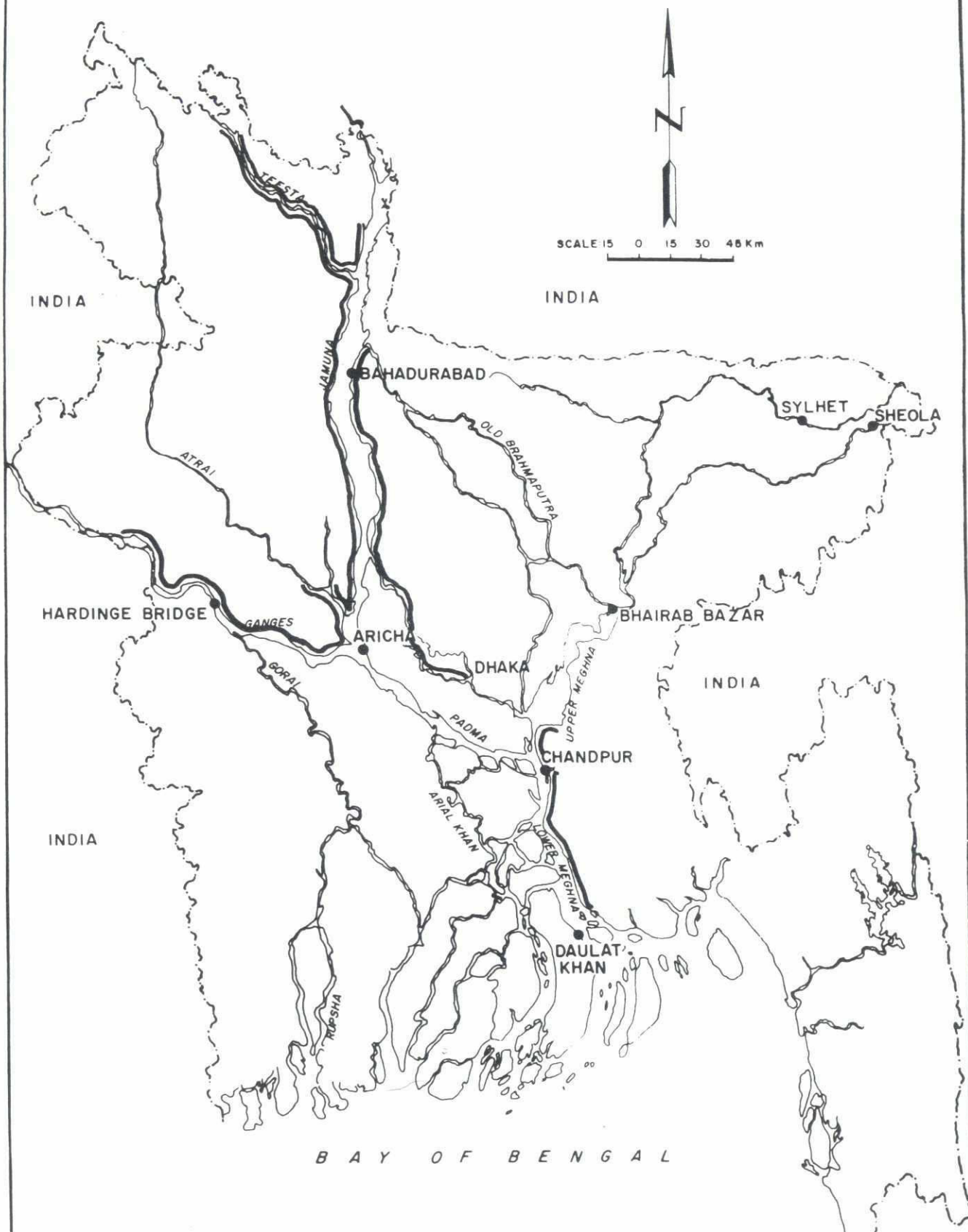
FLOOD HYDROLOGY STUDY

Scenario 1 : Plan View

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FIGURE 2.3 a)

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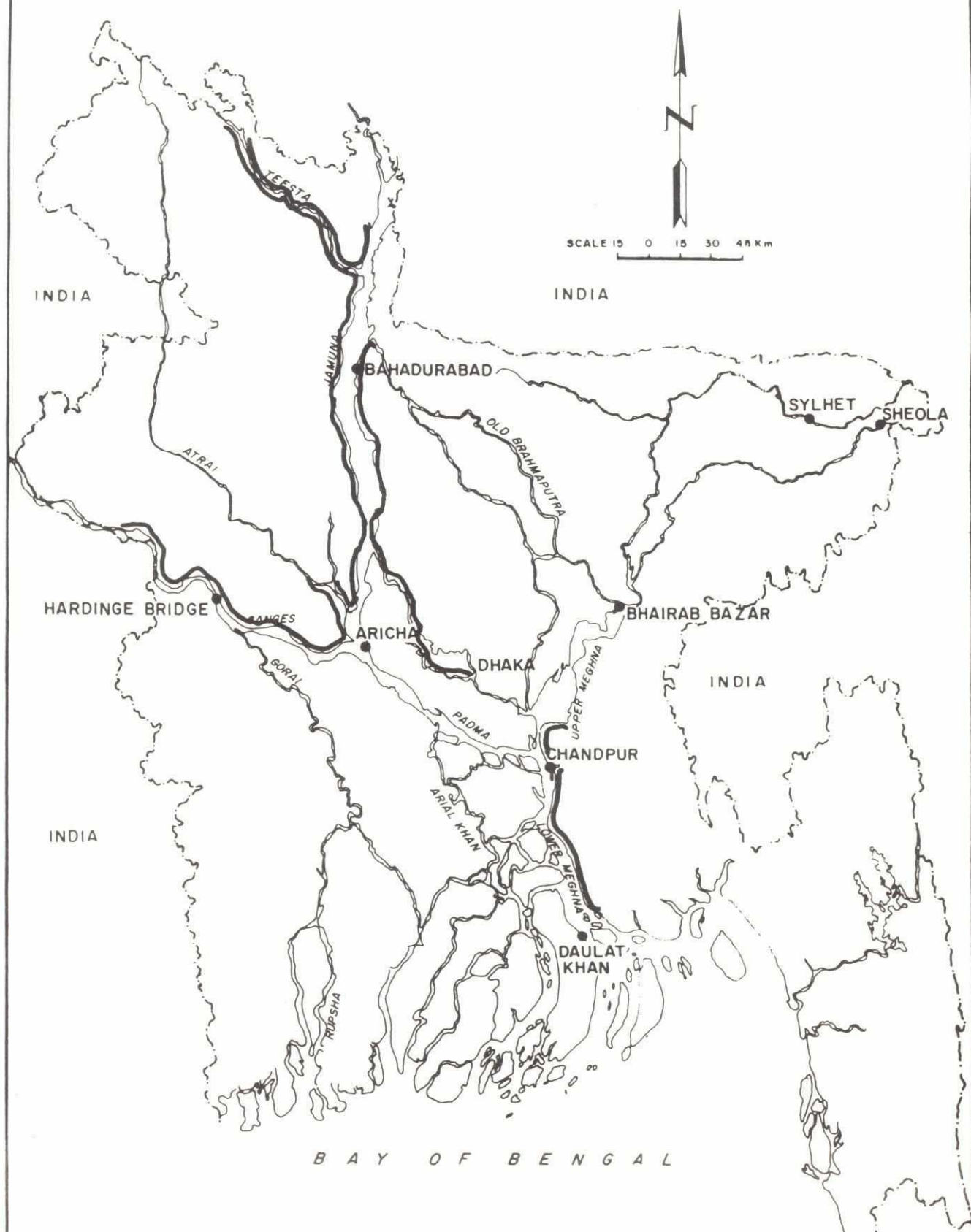
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Scenario 2 : Plan View

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FIGURE 2.3 b)



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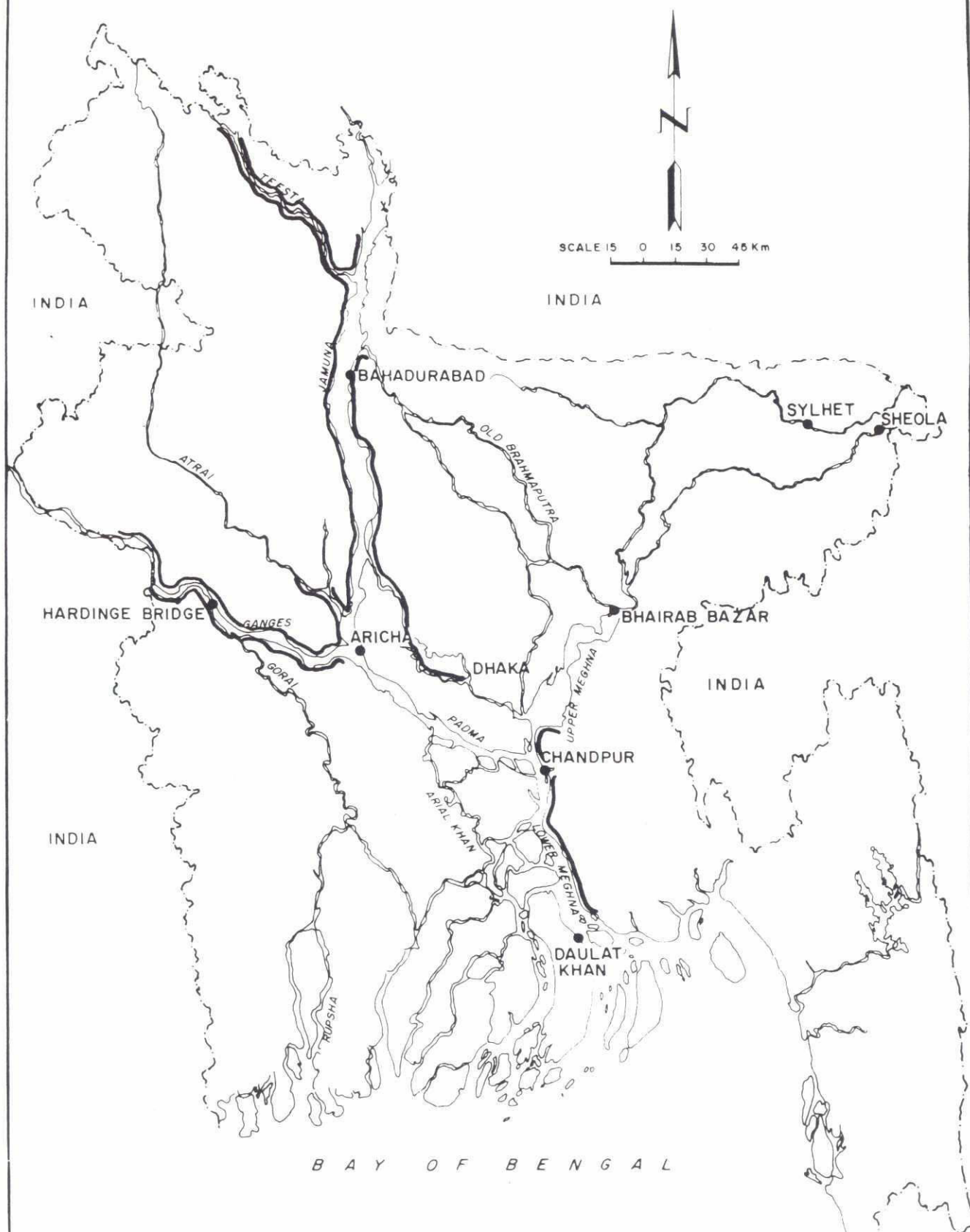
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Scenario 3 : Plan View

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FIGURE 2.3 c)

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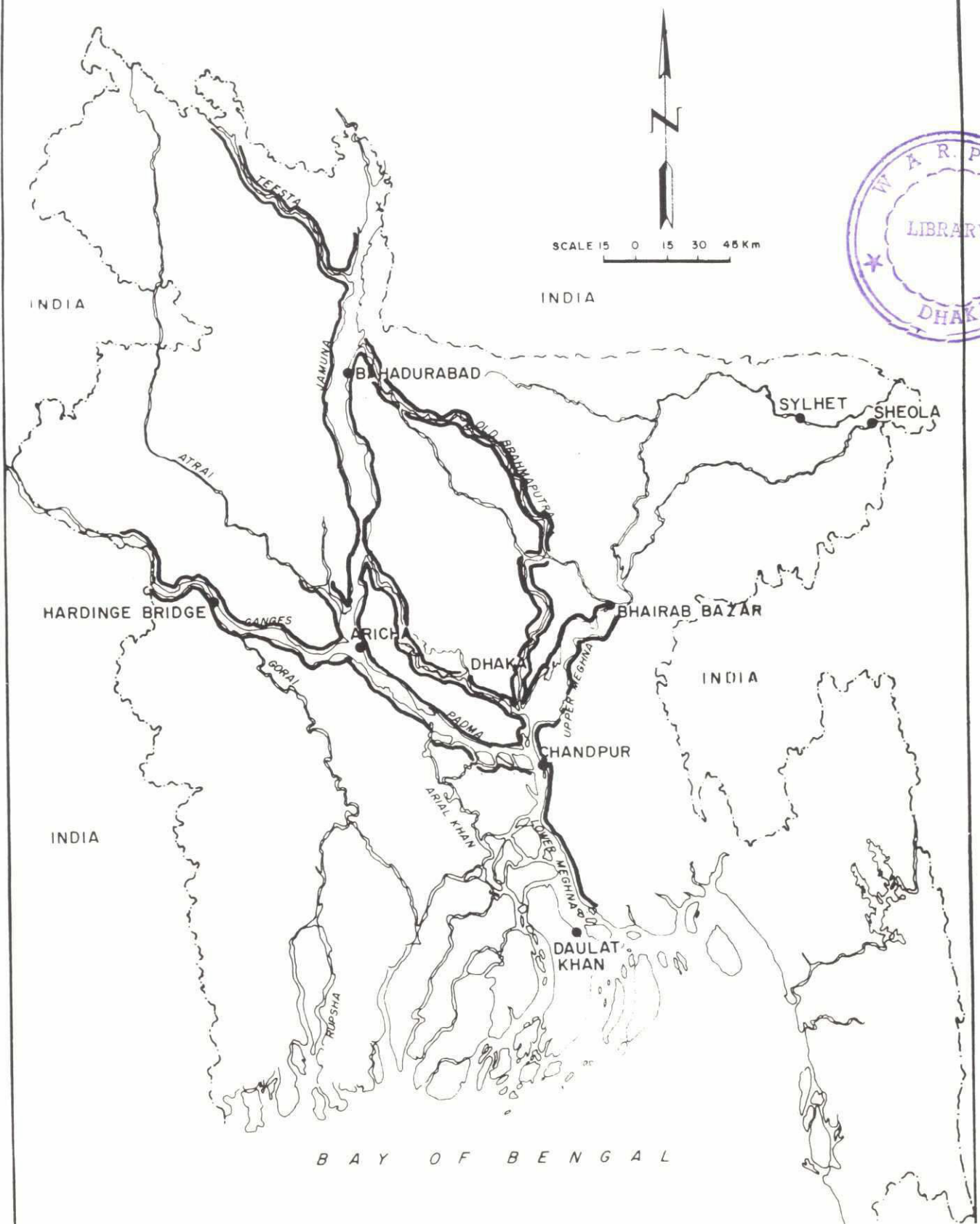
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Scenario 4 : Plan View

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FIGURE 2.3 d)



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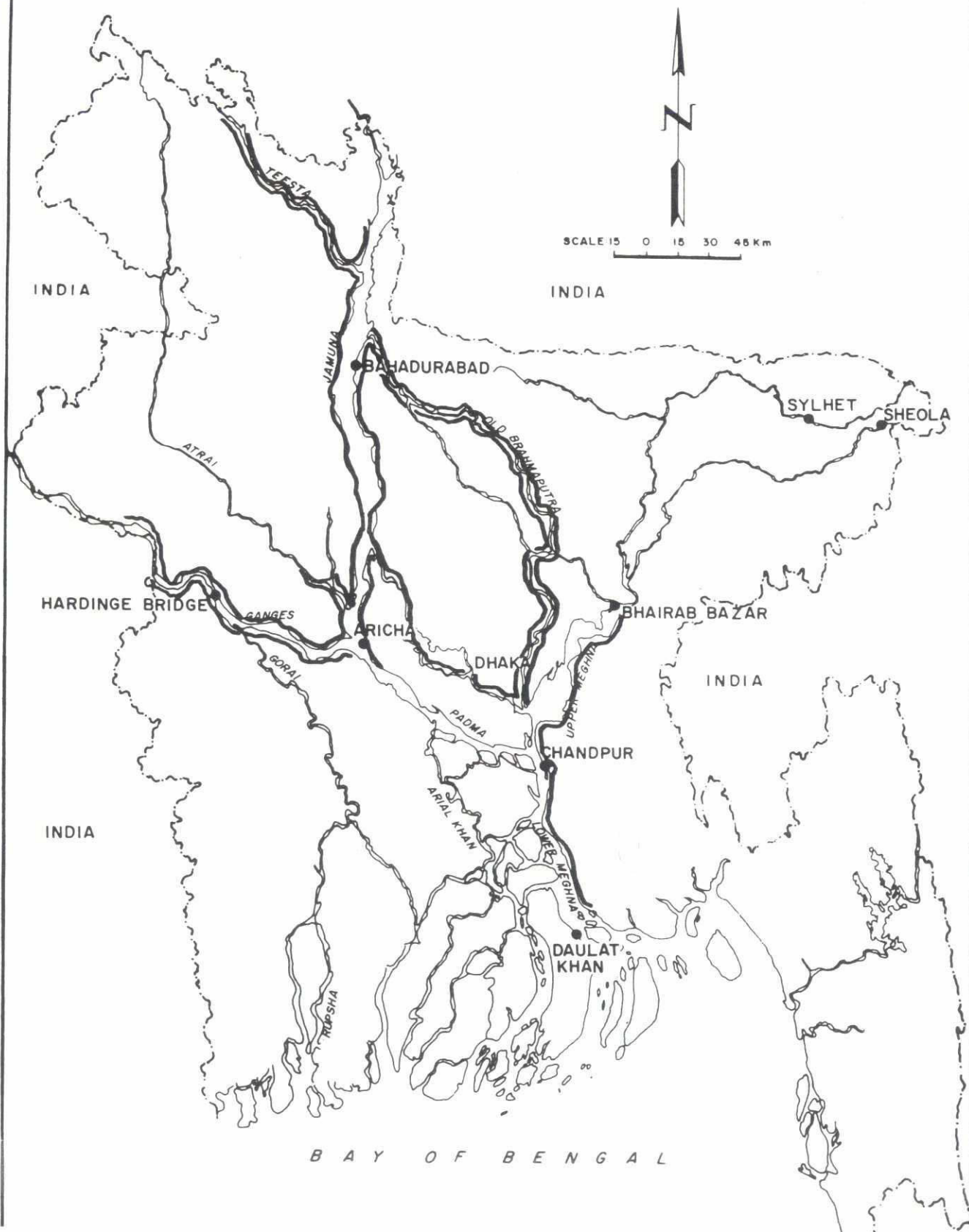
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Scenario 5 : Plan View

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FIGURE 2.3 e)

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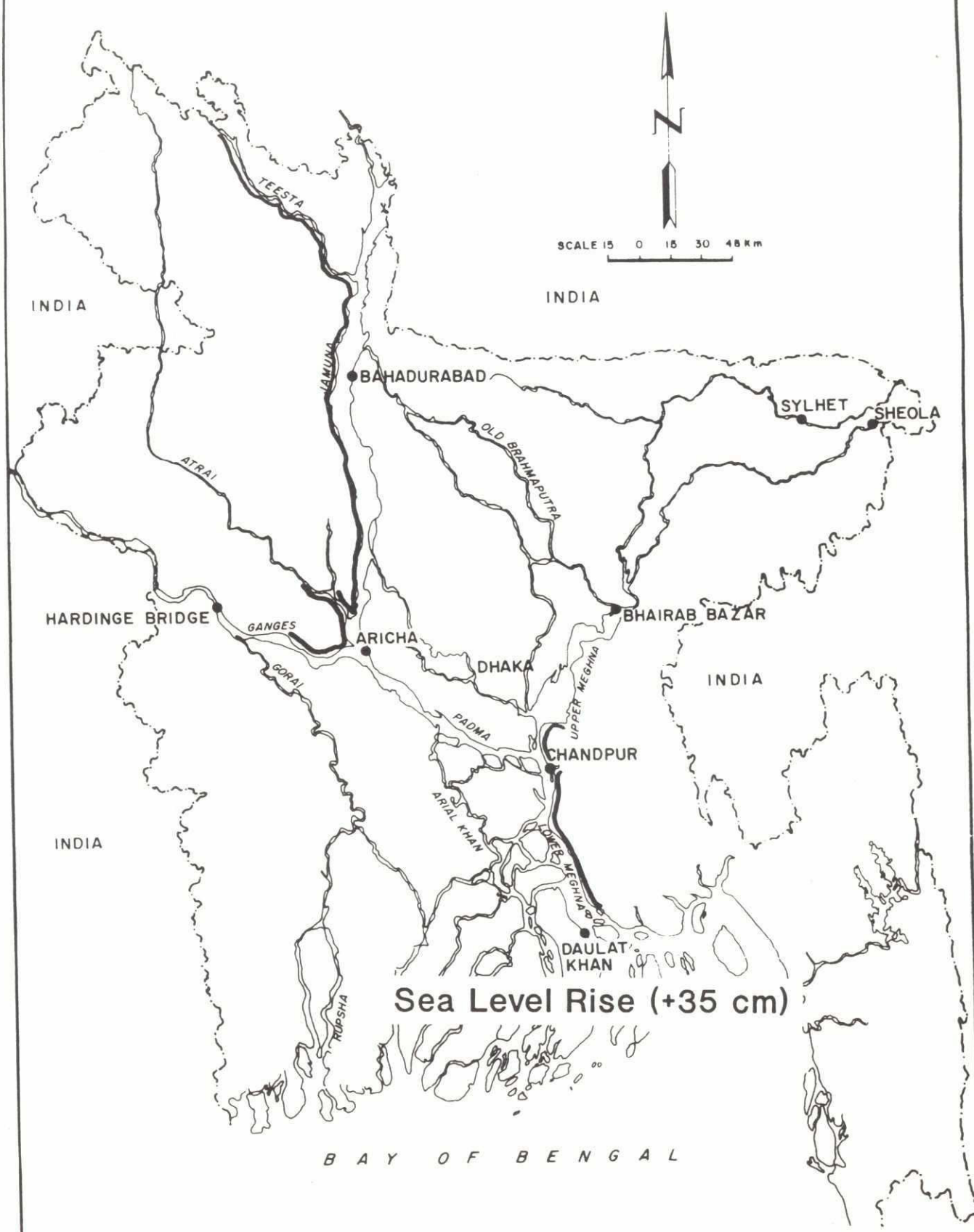
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Scenario 6 : Plan View

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FIGURE 2.3 f)



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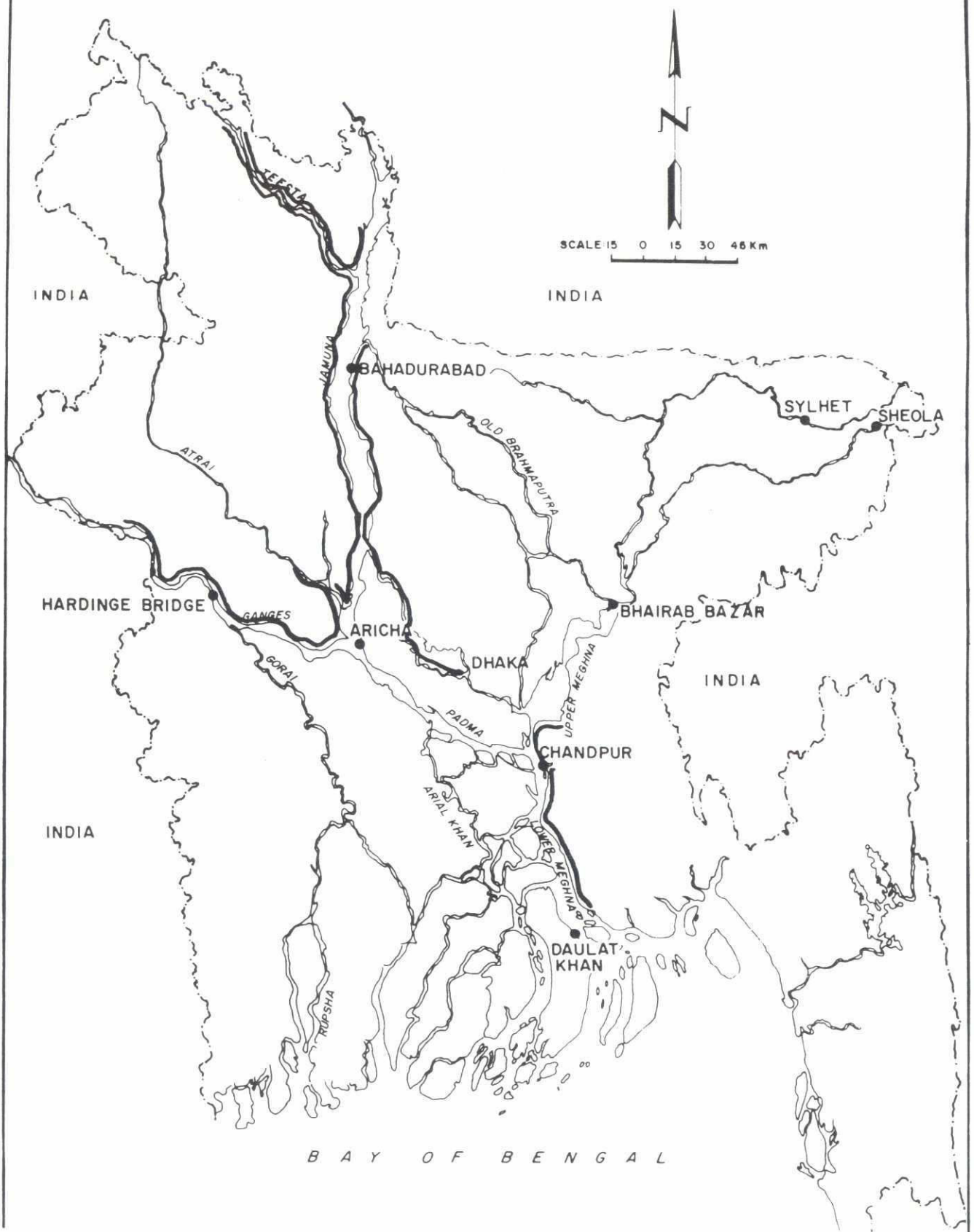
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Scenario 7 : Plan View

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FIGURE 2.3 g)



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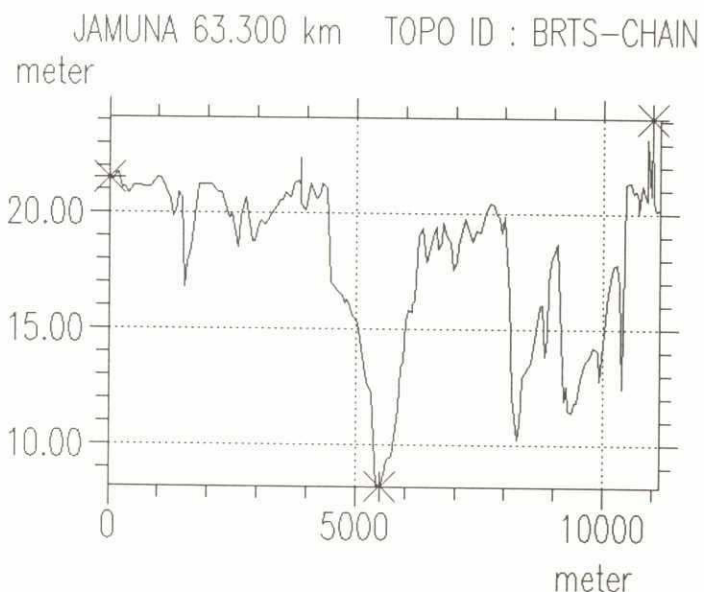
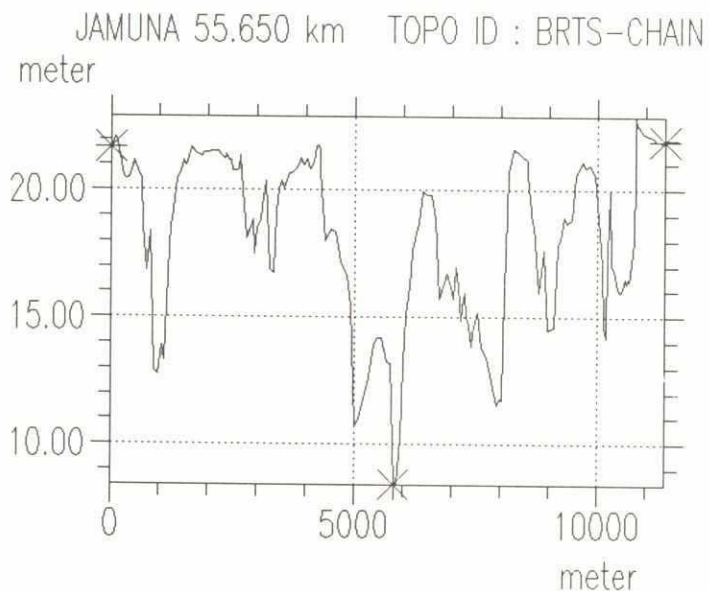
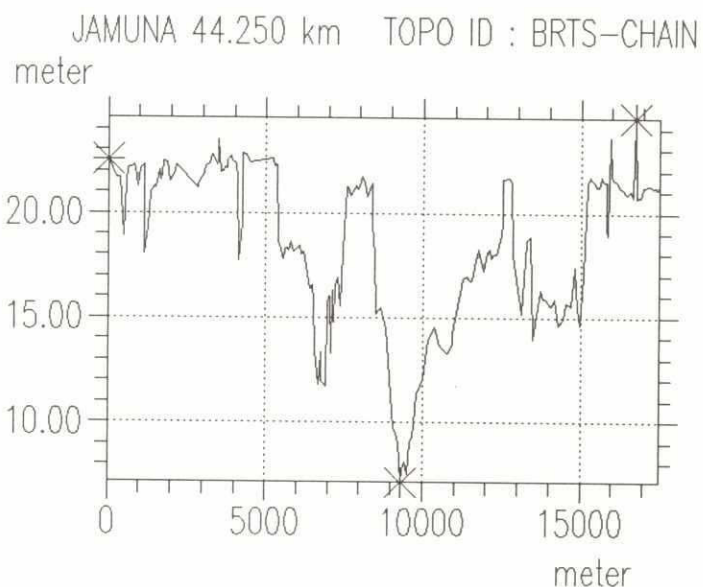
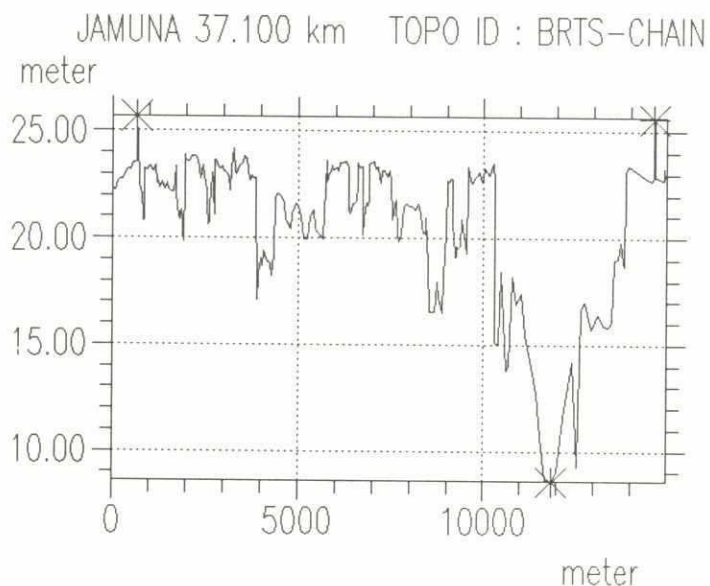
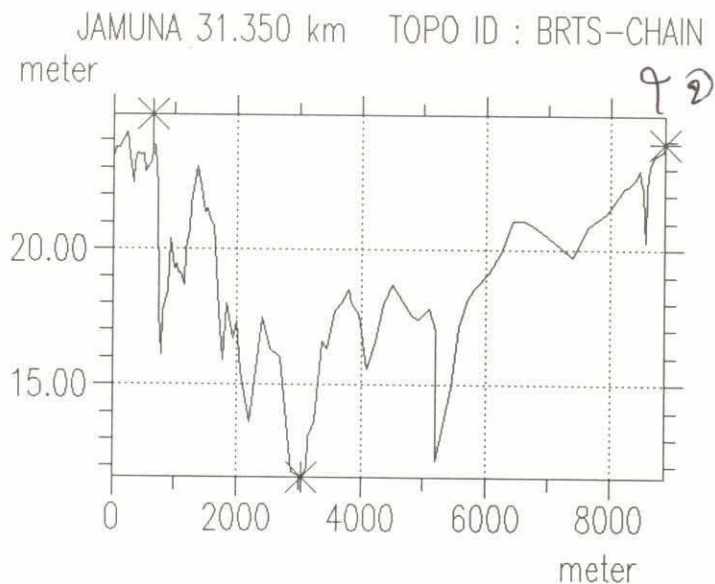
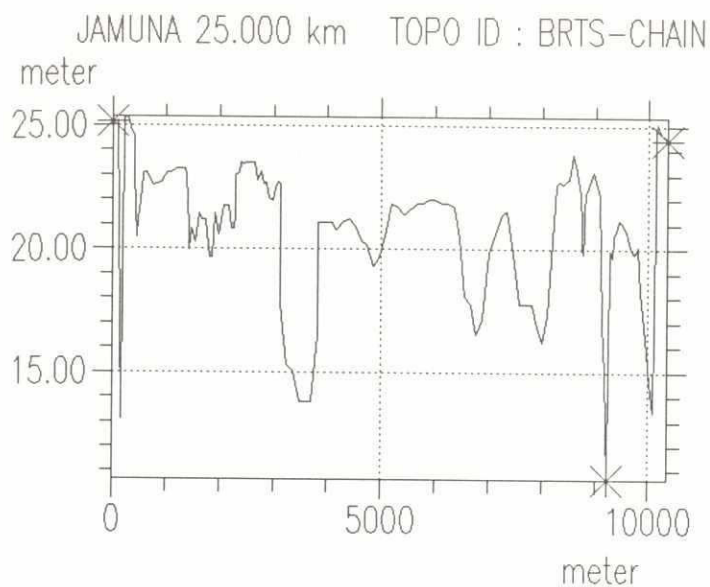
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Scenario 3-25 Years : Plan View

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FIGURE 2.3 h)



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FLOOD MODELLING & MANAGEMENT

FLOOD HYDROLOGY STUDY

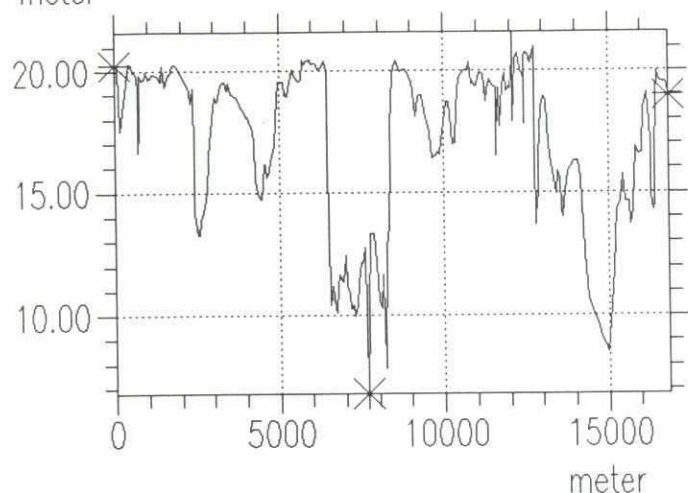
River Cross Section With Location of Embankment Positions

Legend : Arrow Head Indicates Location of Embankment

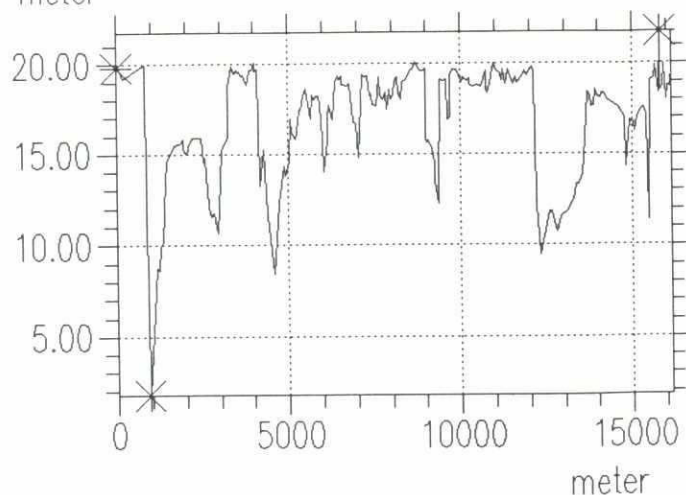
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FIGURE 2.4 a)

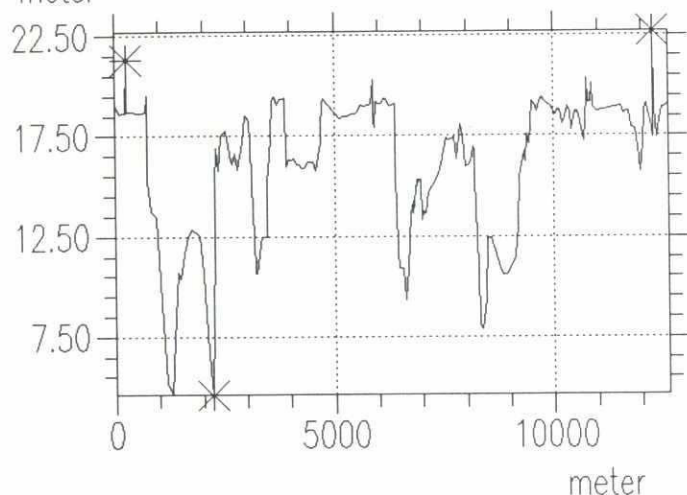
80 JAMUNA 71.200 km TOPO ID : BRTS-CHAIN
meter



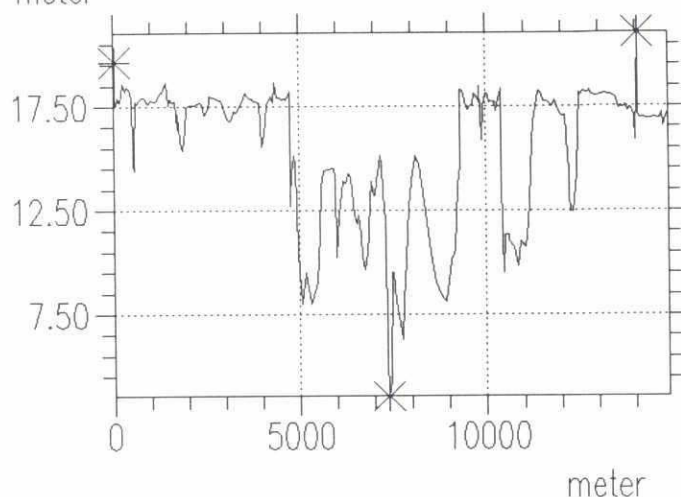
JAMUNA 81.700 km TOPO ID : BRTS-CHAIN
meter



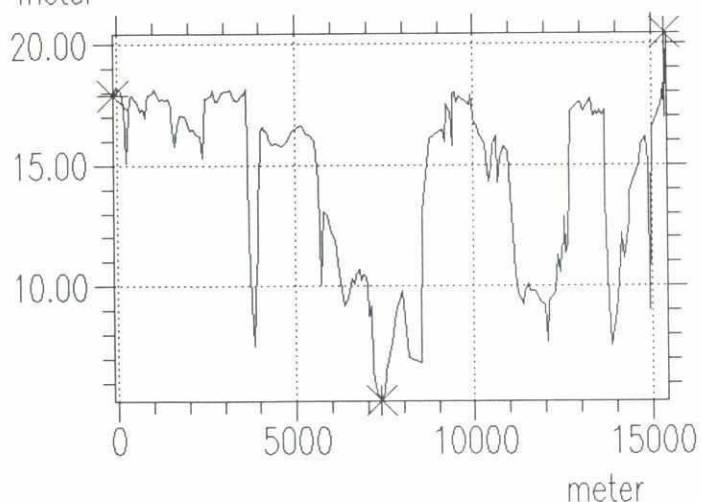
JAMUNA 84.700 km TOPO ID : BRTS-CHAIN
meter



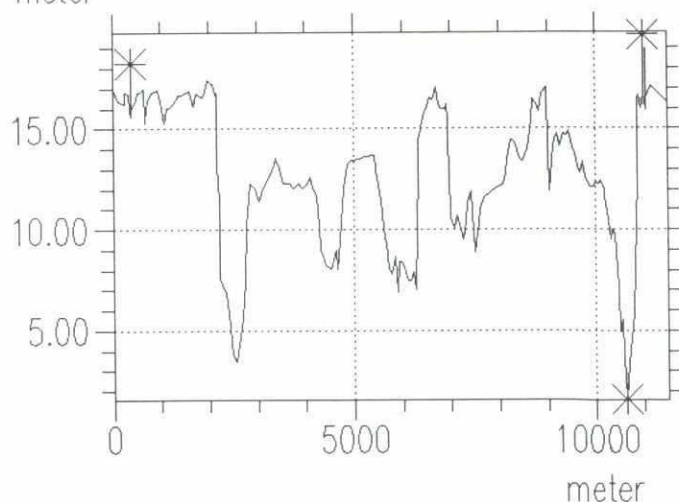
JAMUNA 100.500 km TOPO ID : BRTS-CHAIN
meter



JAMUNA 108.900 km TOPO ID : BRTS-CHAIN
meter



JAMUNA 117.750 km TOPO ID : BRTS-CHAIN
meter



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FLOOD HYDROLOGY STUDY

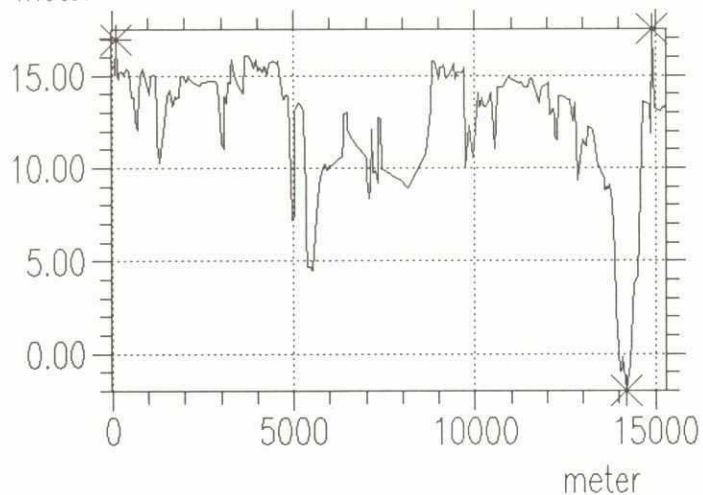
River Cross Section With Location of
Embankment Positions

Legend : Arrow Head Indicates Location of Embankment

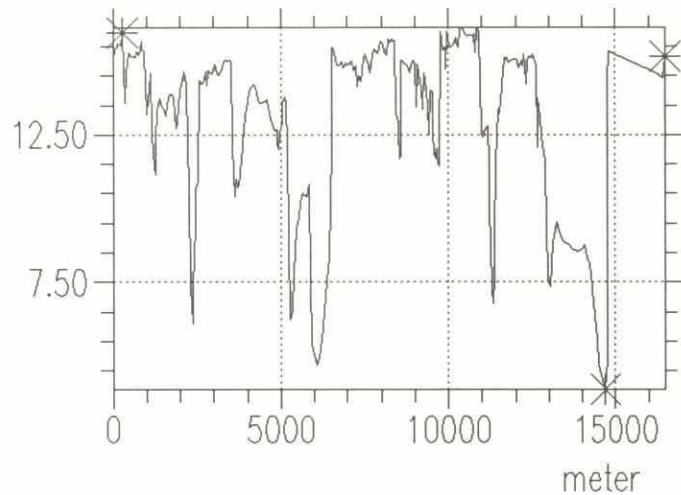
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FIGURE 2.4 b)

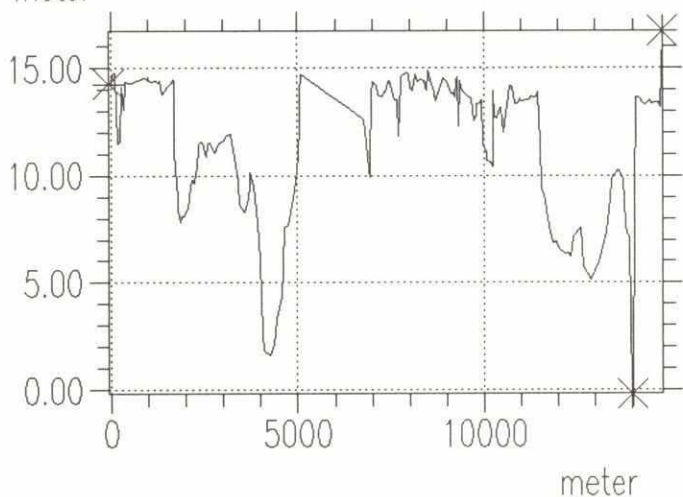
JAMUNA 126.500 km TOPO ID : BRTS-CHAIN
meter



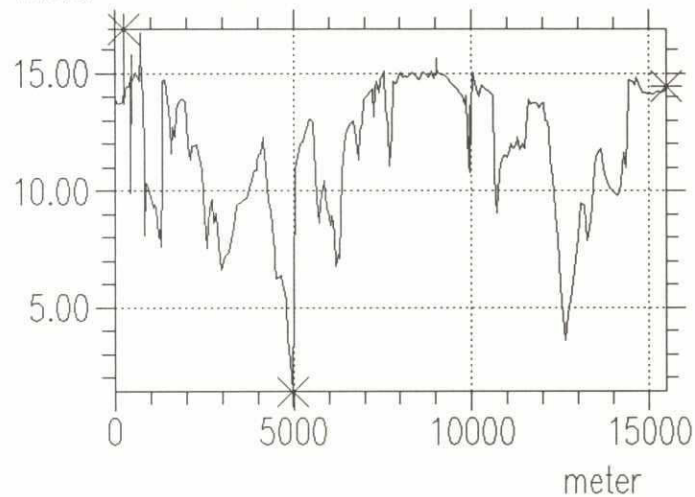
JAMUNA 134.300 km TOPO ID : BRTS-CHAIN
meter



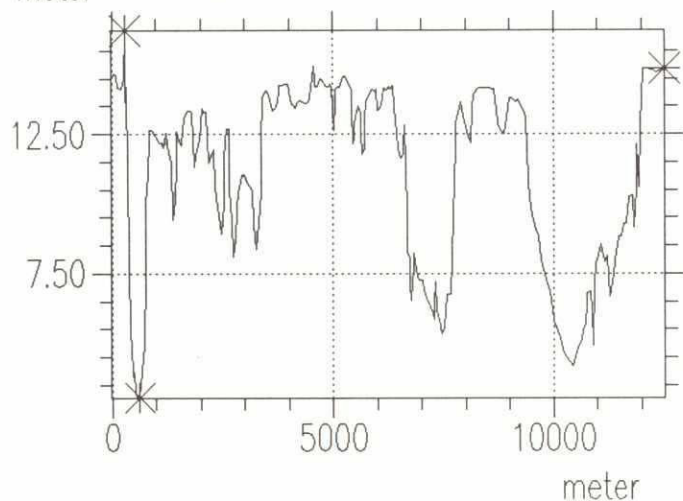
JAMUNA 139.000 km TOPO ID : BRTS-CHAIN
meter



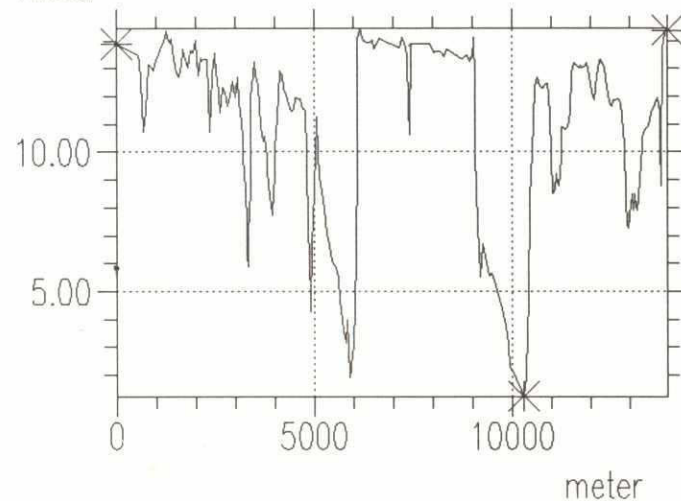
JAMUNA 142.450 km TOPO ID : BRTS-CHAIN
meter



JAMUNA 145.400 km TOPO ID : BRTS-CHAIN
meter



JAMUNA 149.500 km TOPO ID : BRTS-CHAIN
meter



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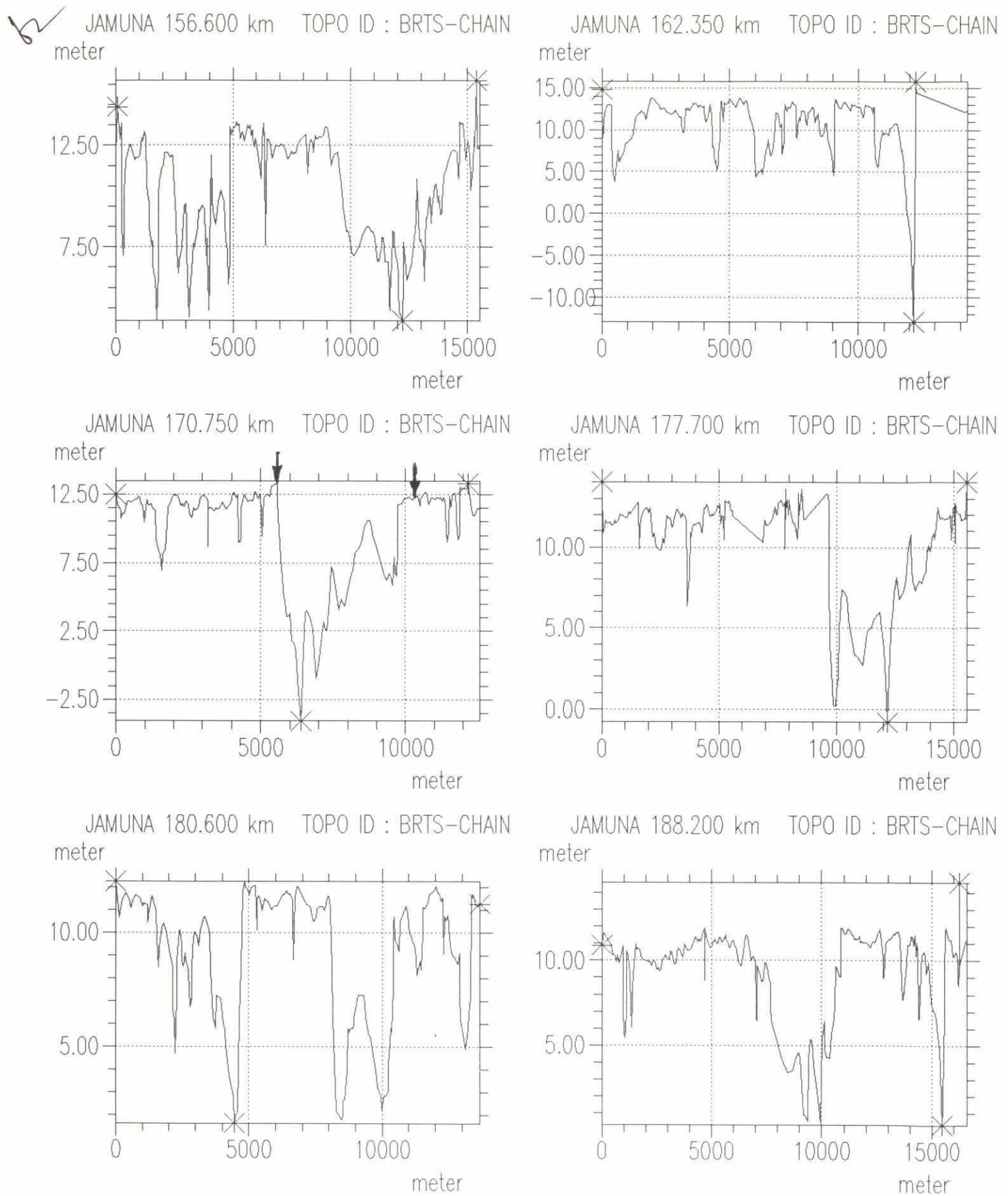
FLOOD HYDROLOGY STUDY

River Cross Section With Location of
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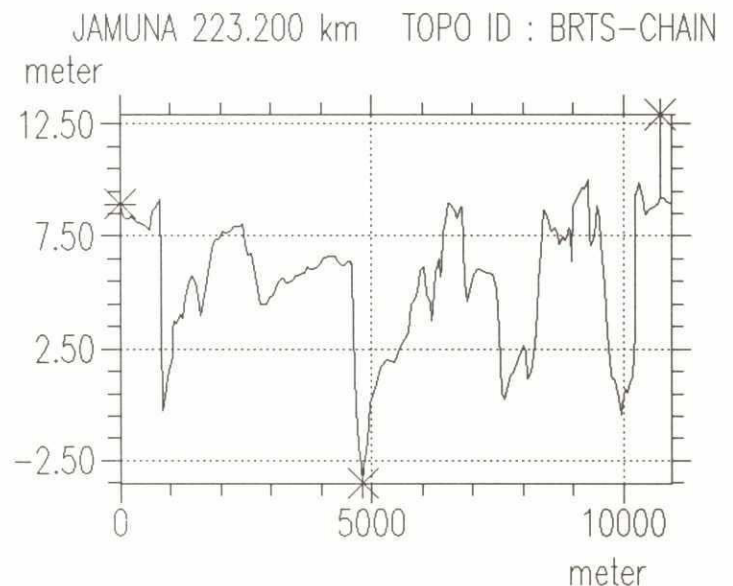
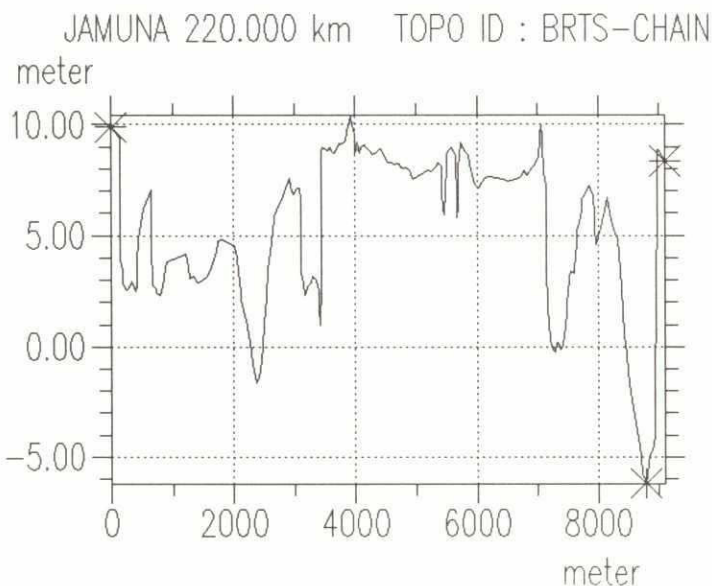
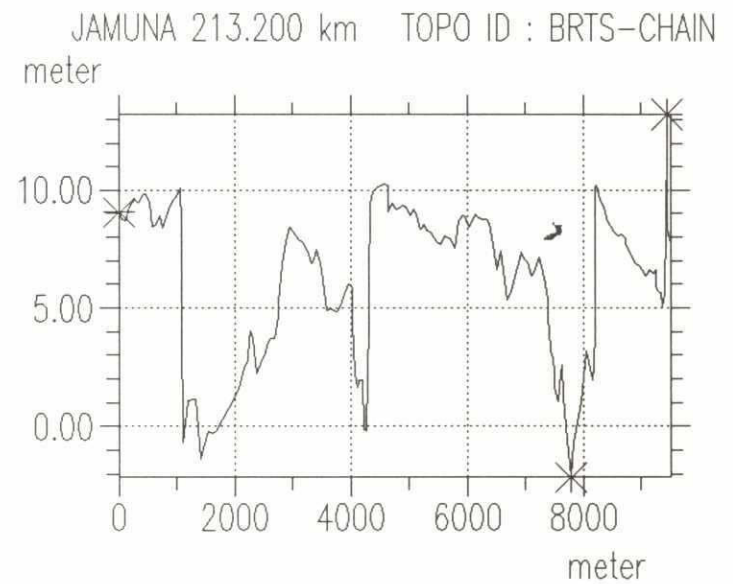
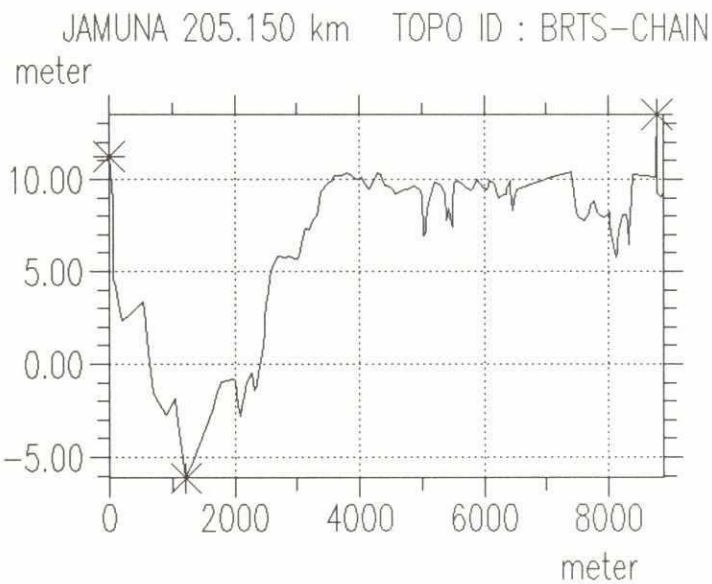
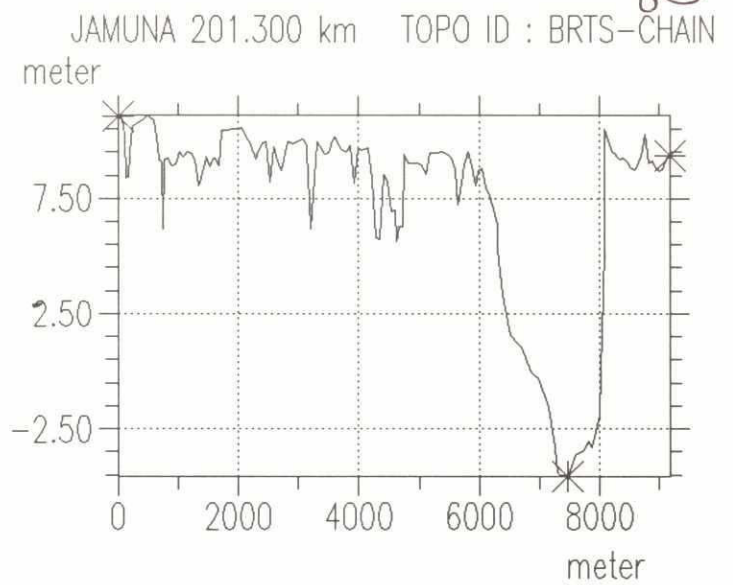
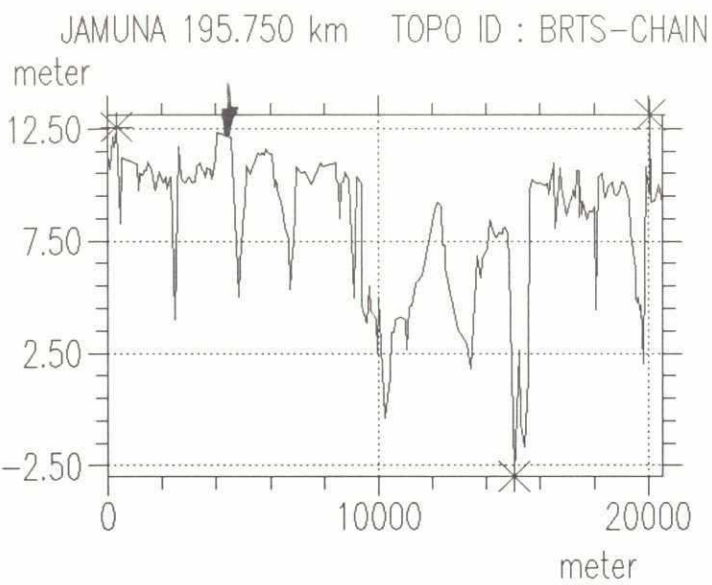
Legend : Arrow Head Indicates Location of Embankment

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FIGURE 2.4 c)

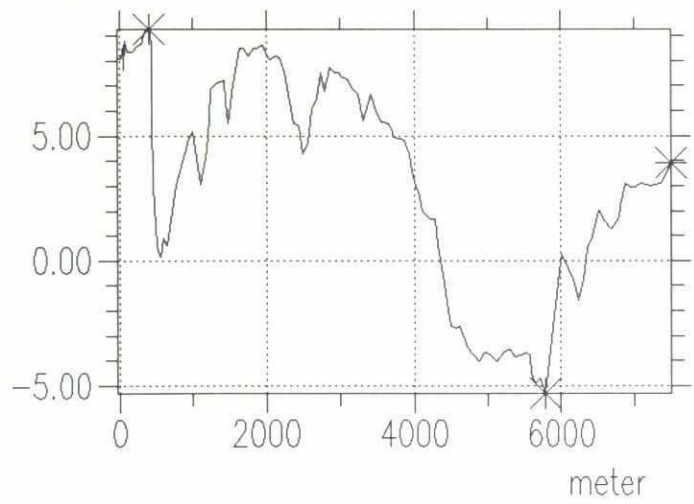


<div>FAP25</div> <div>FLOOD MODELLING & MANAGEMENT</div>	FLOOD HYDROLOGY STUDY	
	River Cross Section With Location of Embankment Positions	
	Legend : Arrow Head Indicates Location of Embankment	
	FEBRUARY 1993	FIGURE 2.4 d)

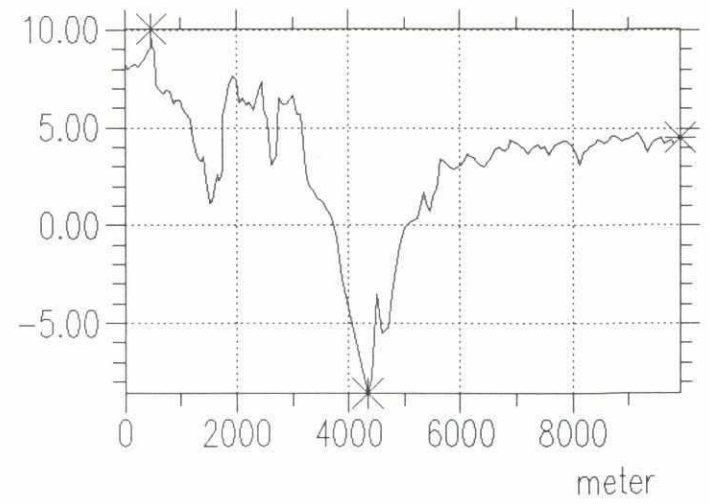


FAP25 FLOOD MODELLING & MANAGEMENT	FLOOD HYDROLOGY STUDY	
	River Cross Section With Location of Embankment Positions	
	Legend : Arrow Head Indicates Location of Embankment	
	FEBRUARY 1993	FIGURE 2.4 e)

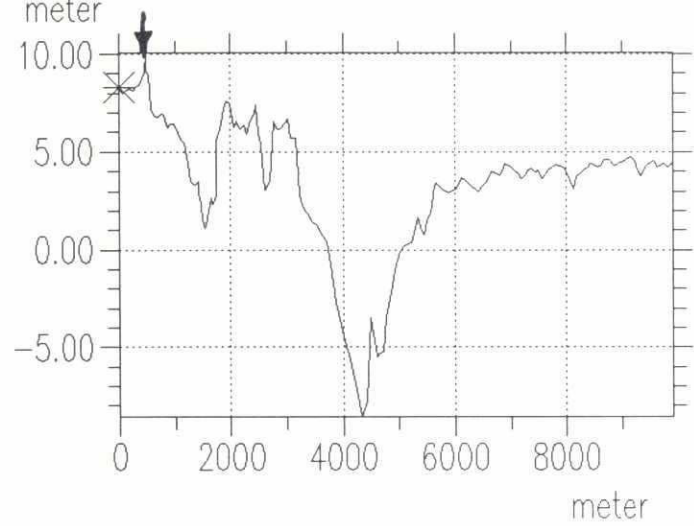
✓ 6 JAMUNA 229.400 km TOPO ID : BRTS-CHAIN
meter



JAMUNA 230.750 km TOPO ID : BRTS-CHAIN
meter



JAMUNA 235.400 km TOPO ID : BRTS-CHAIN
meter



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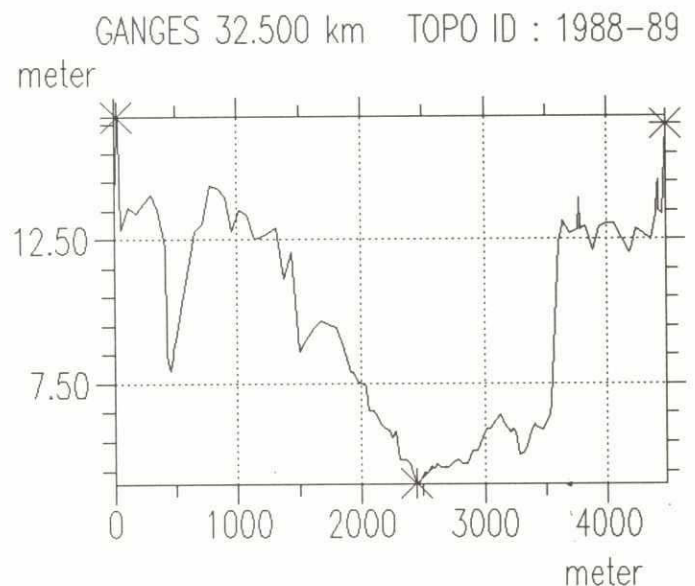
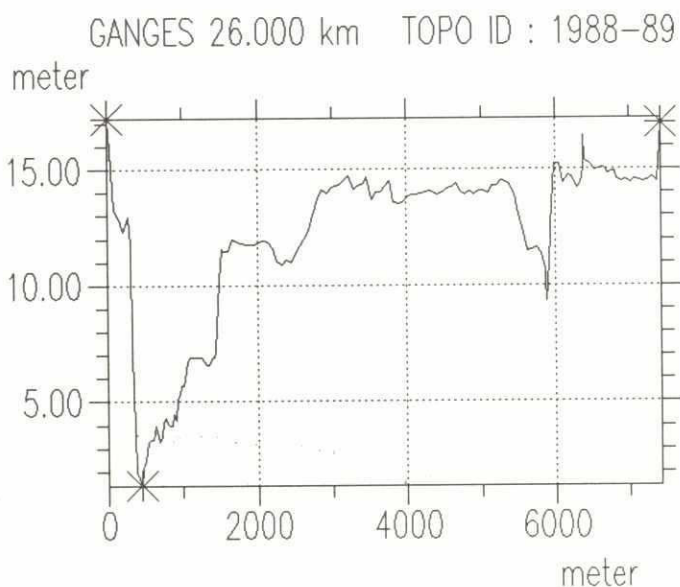
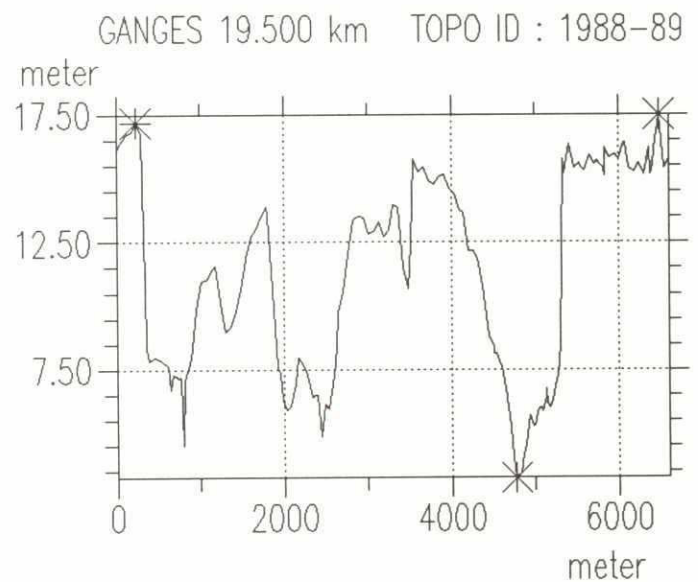
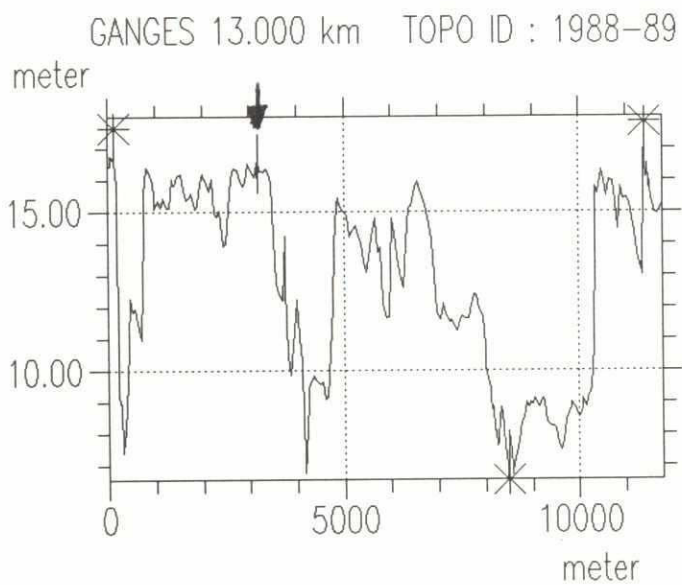
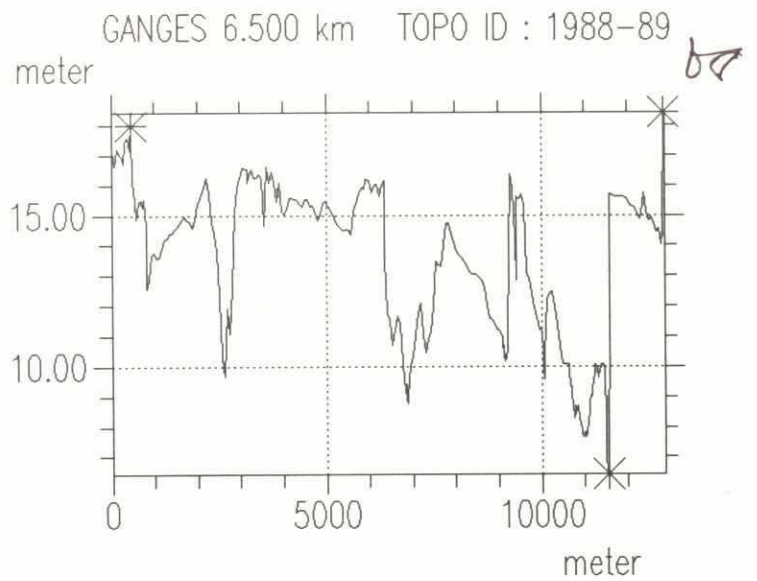
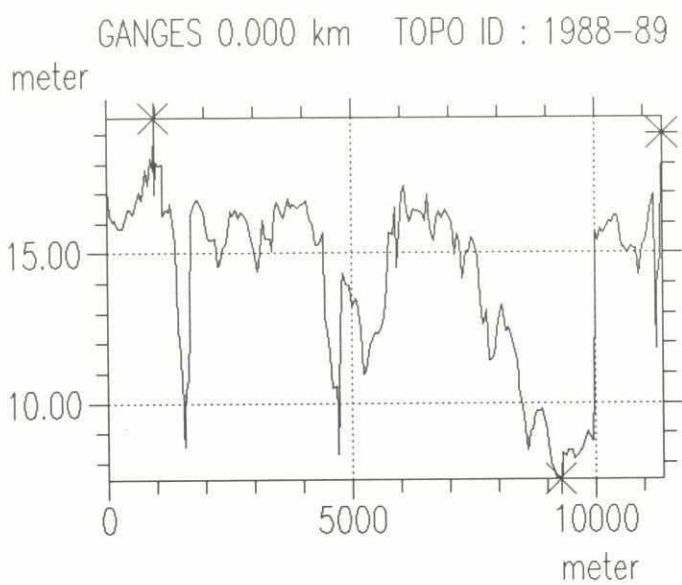
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River Cross Section With Location of
Embankment Positions

Legend : Arrow Head Indicates Location of Embankment

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FIGURE 2.4 f)



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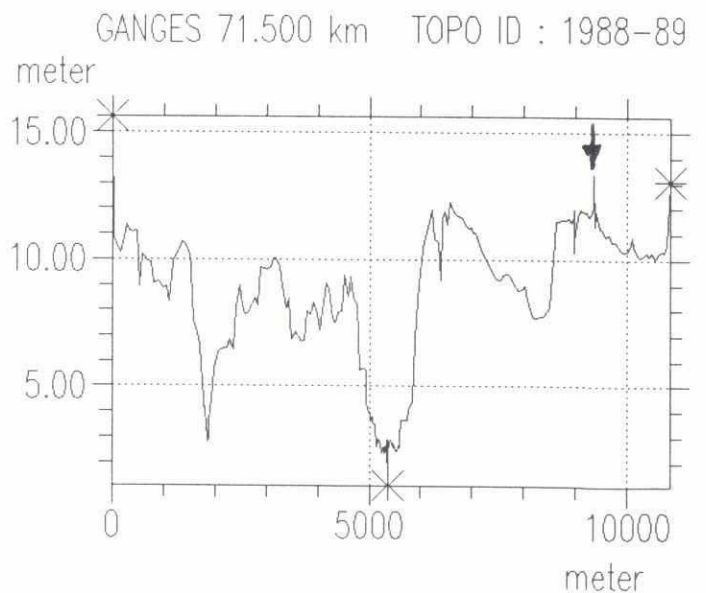
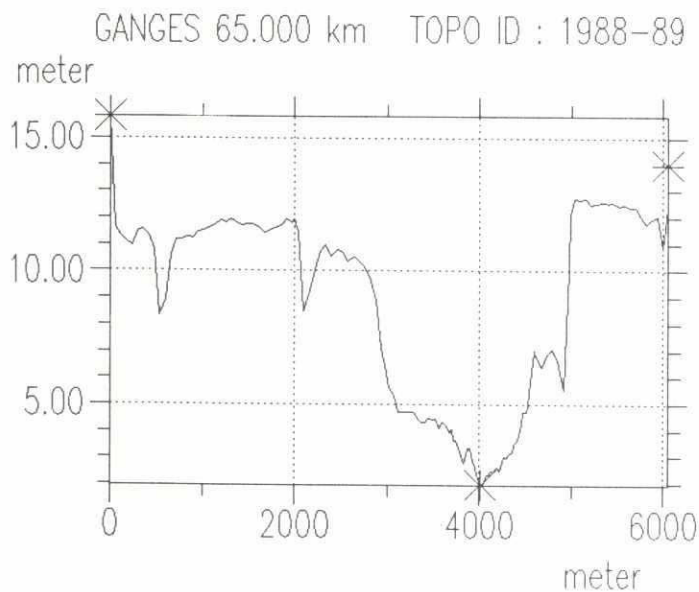
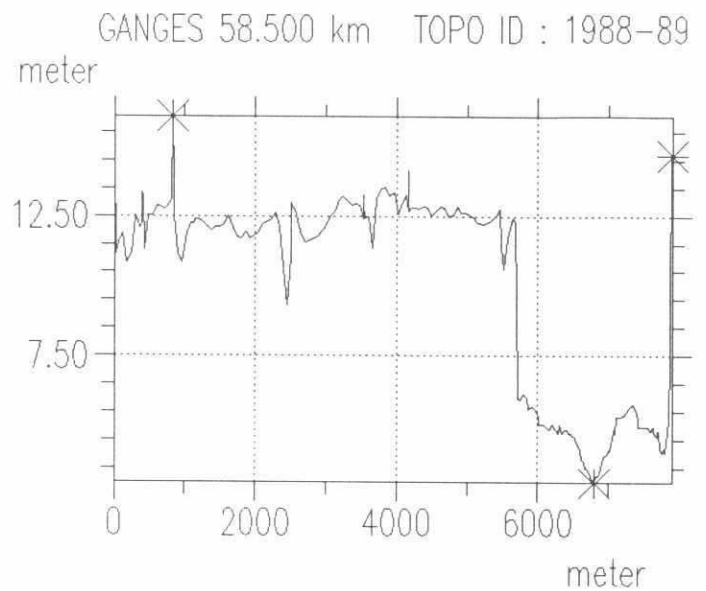
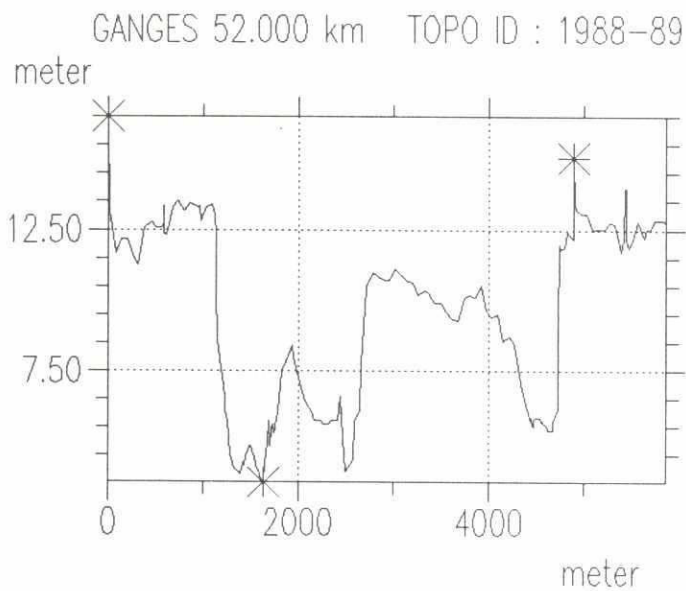
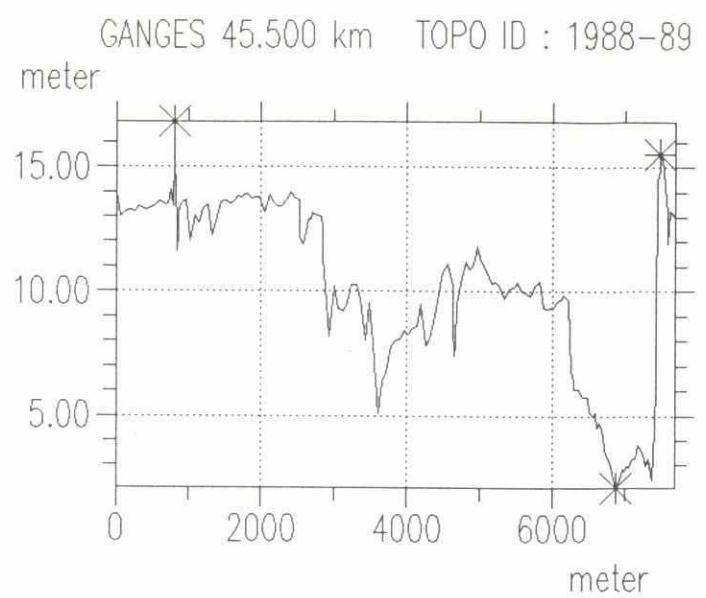
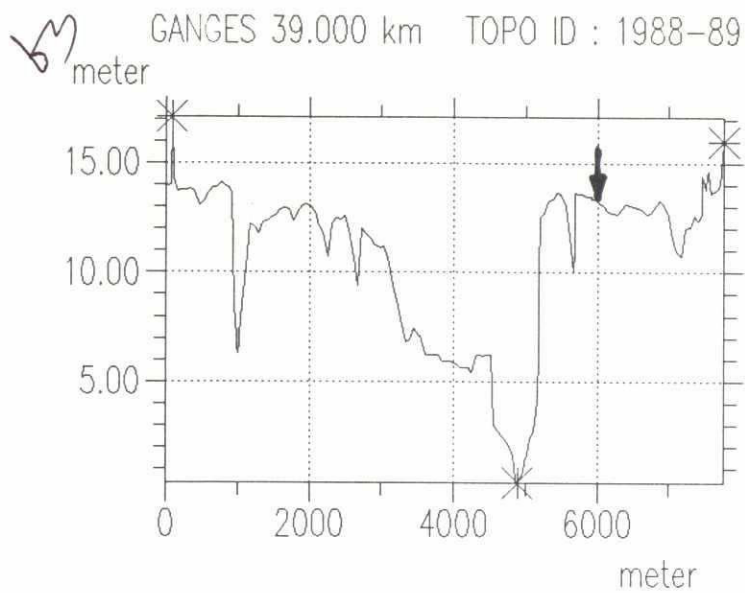
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River Cross Section With Location of
Embankment Positions

Legend : Arrow Head Indicates Location of Embankment

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FIGURE 2.4 g)



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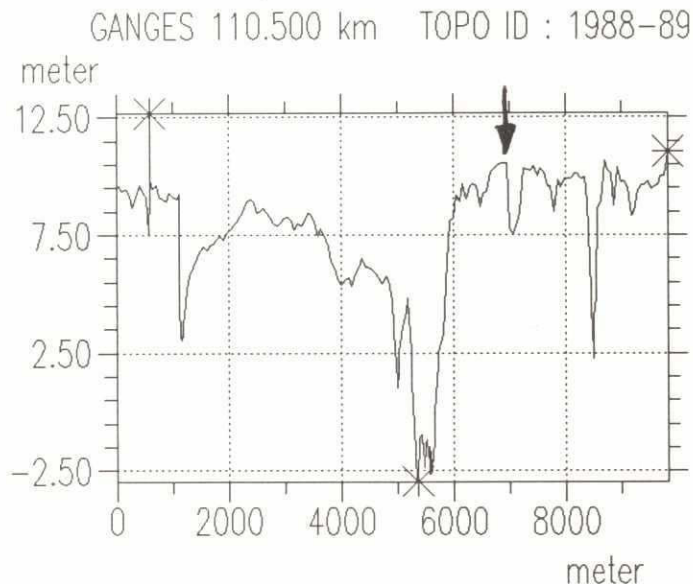
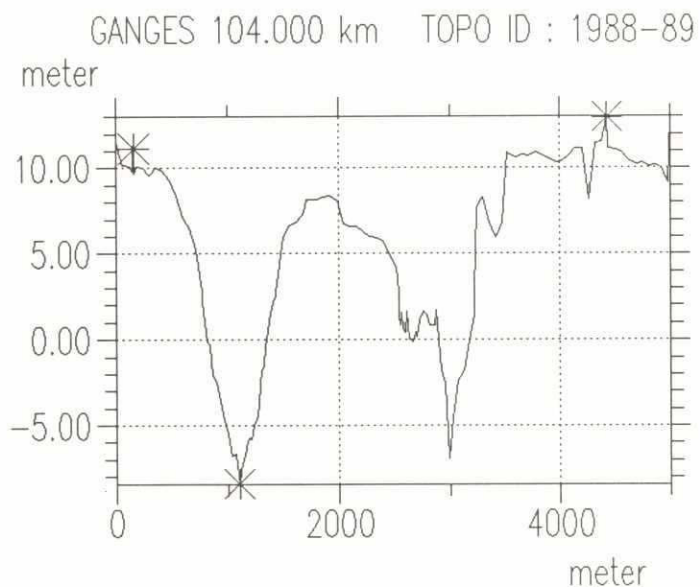
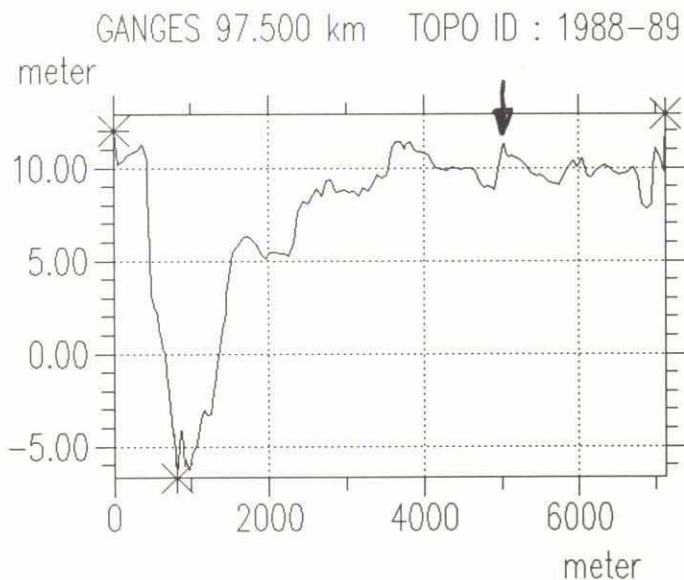
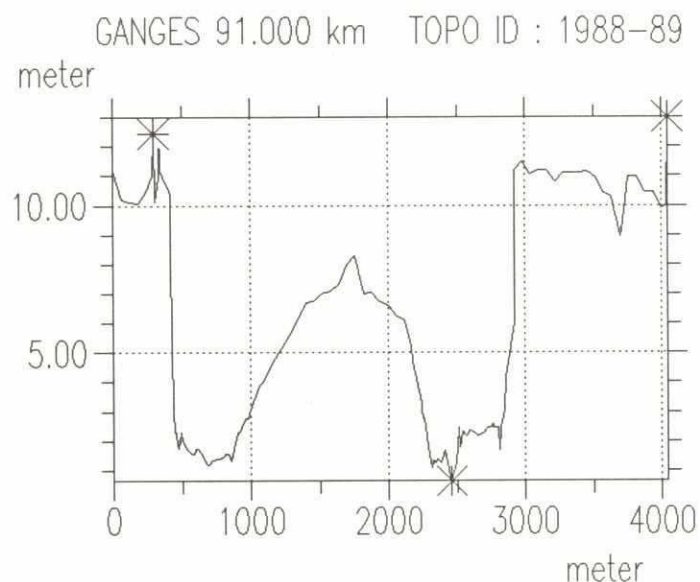
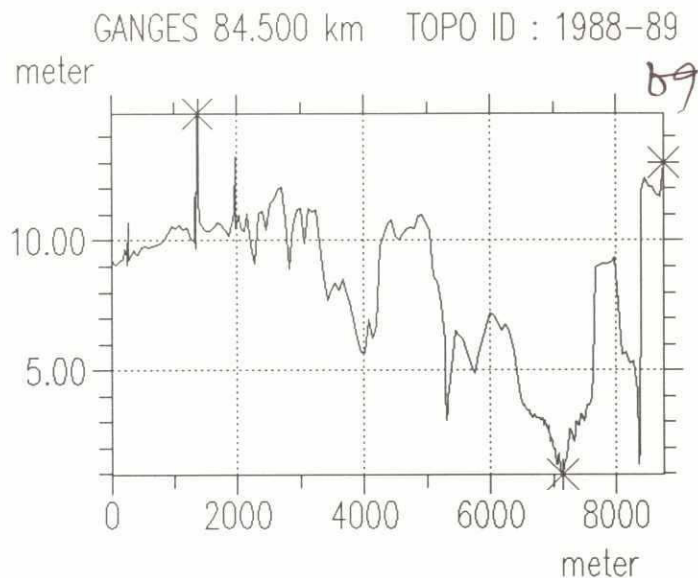
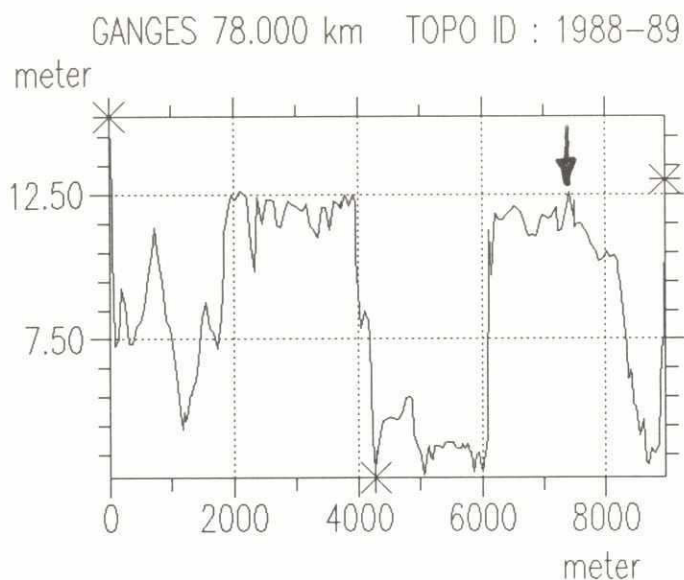
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River Cross Section With Location of
Embankment Positions

Legend : Arrow Head Indicates Location of Embankment

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FIGURE 2.4 h)



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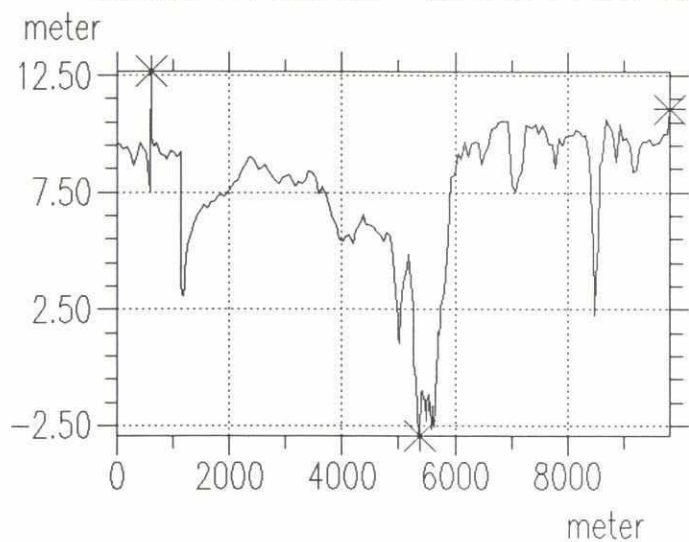
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River Cross Section With Location of
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Legend : Arrow Head Indicates Location of Embankment

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FIGURE 2.4 i)



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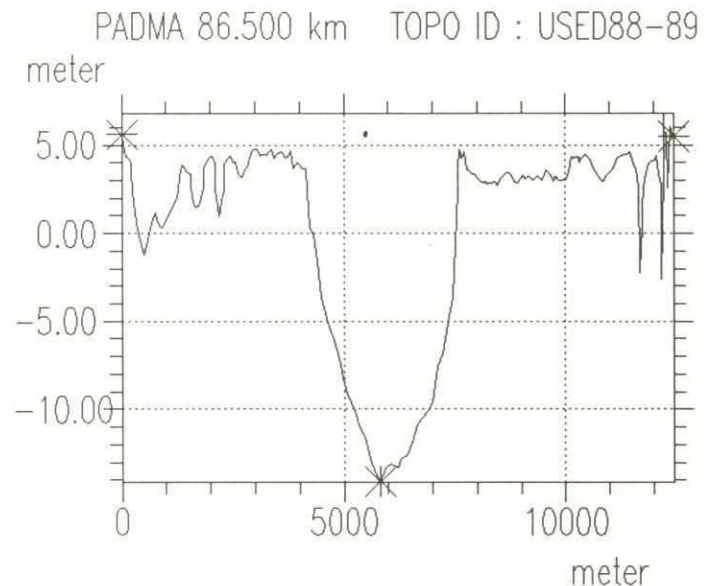
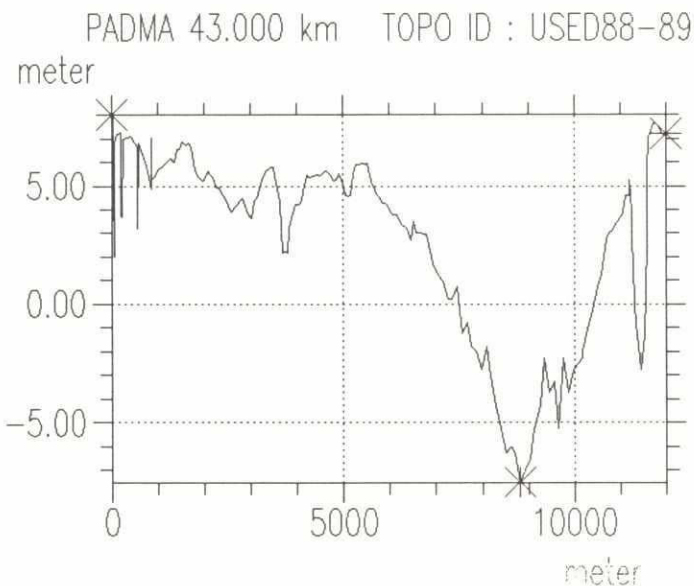
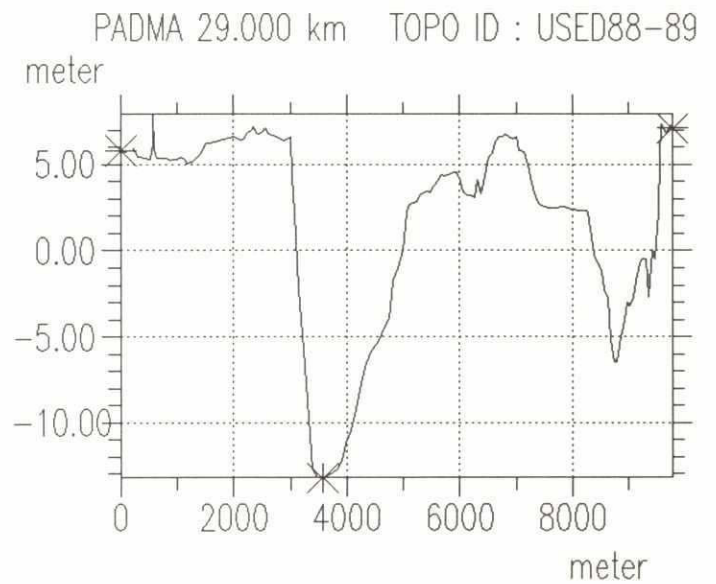
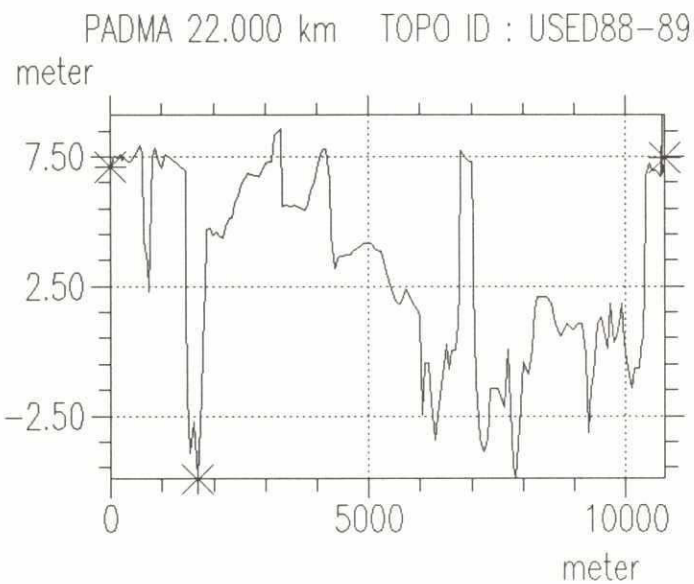
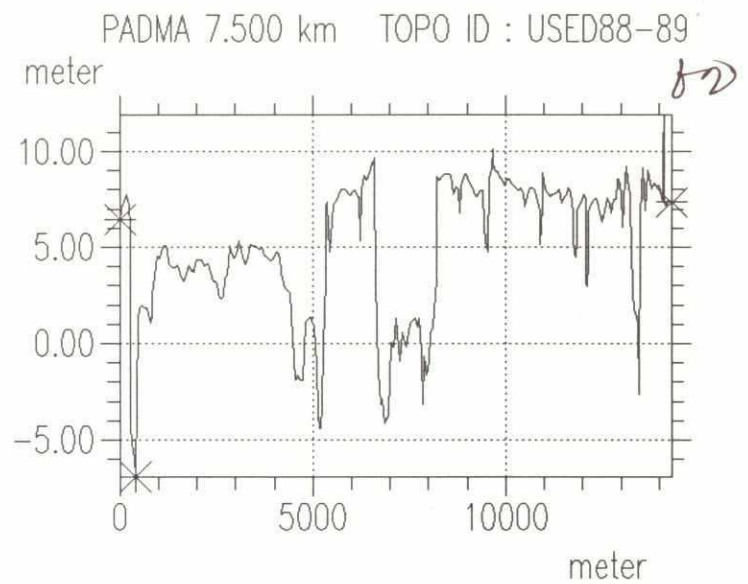
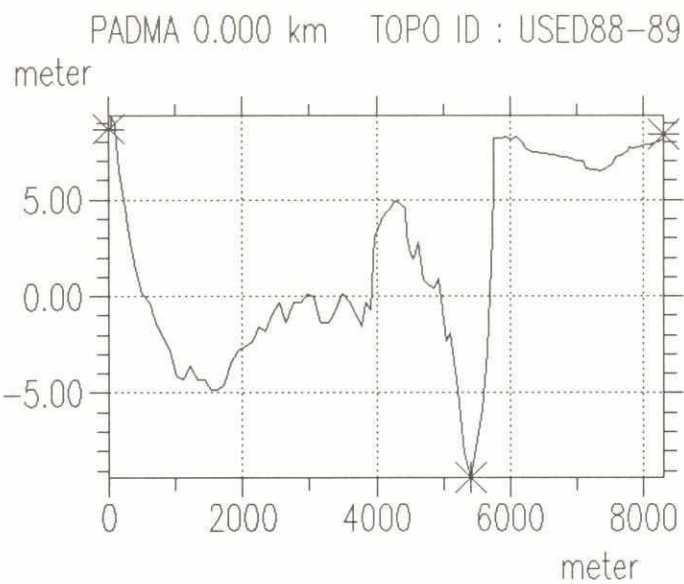
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River Cross Section With Location of
Embankment Positions

Legend : Arrow Head Indicates Location of Embankment

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FIGURE 2.4 j)



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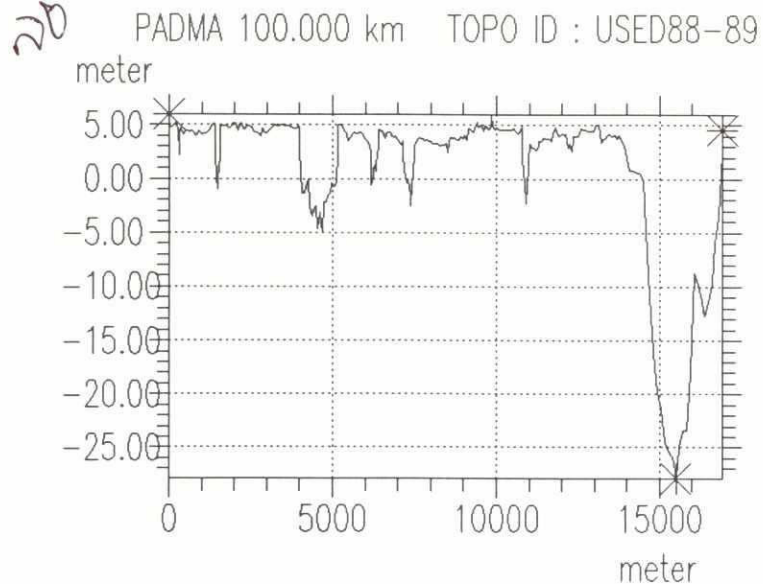
FLOOD HYDROLOGY STUDY

River Cross Section With Location of
Embankment Positions

Legend : Arrow Head Indicates Location of Embankment

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FIGURE 2.4 k)



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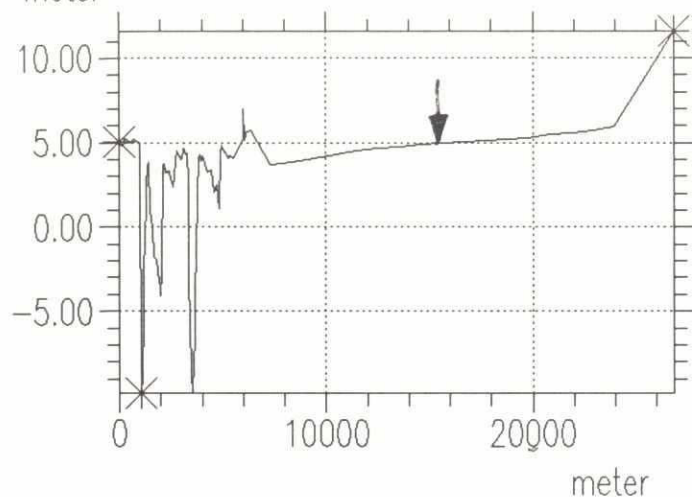
River Cross Section With Location of
Embankment Positions

Legend : Arrow Head Indicates Location of Embankment

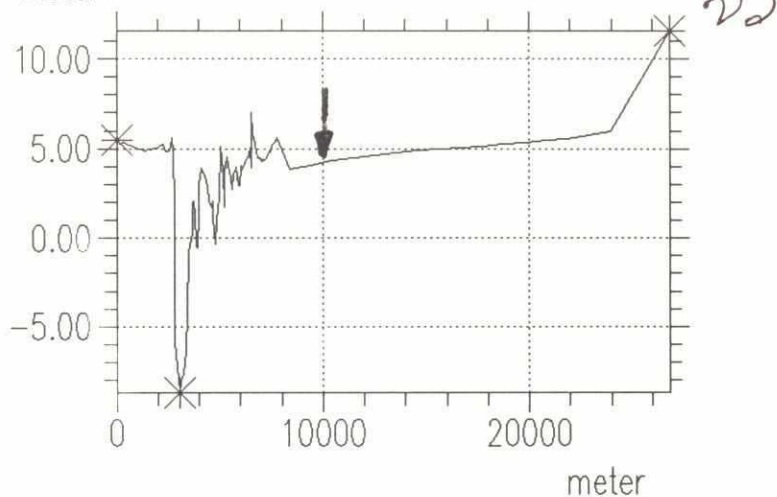
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FIGURE 2.4 I)

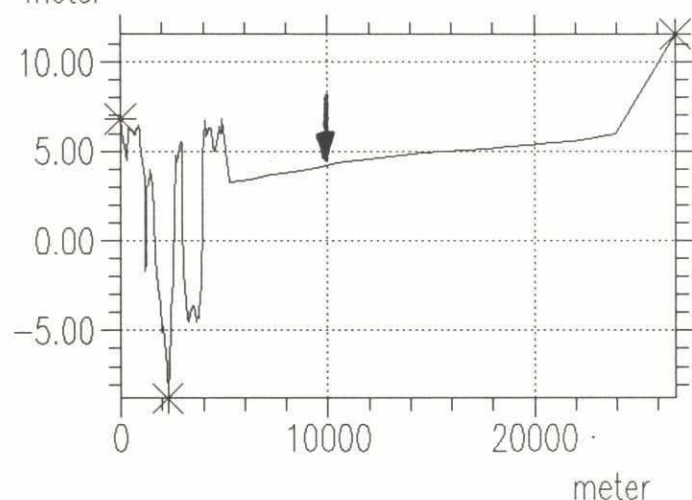
UPPER MEGHNA 0.000 km TOPO ID : 1986-87
meter



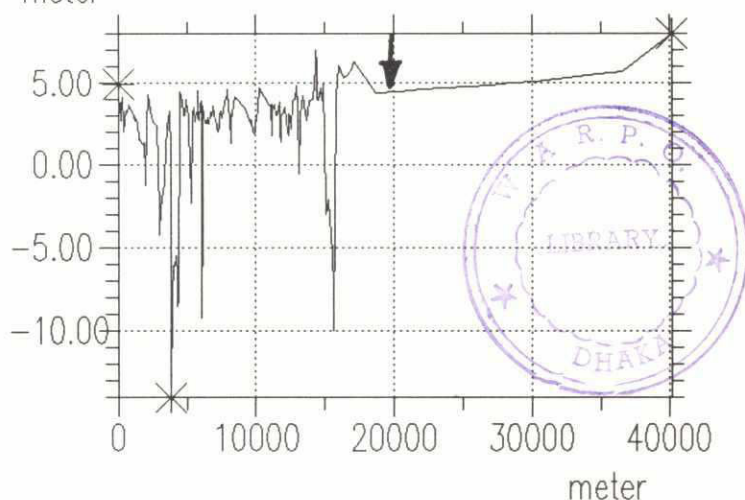
UPPER MEGHNA 10.000 km TOPO ID : 1986-87
meter



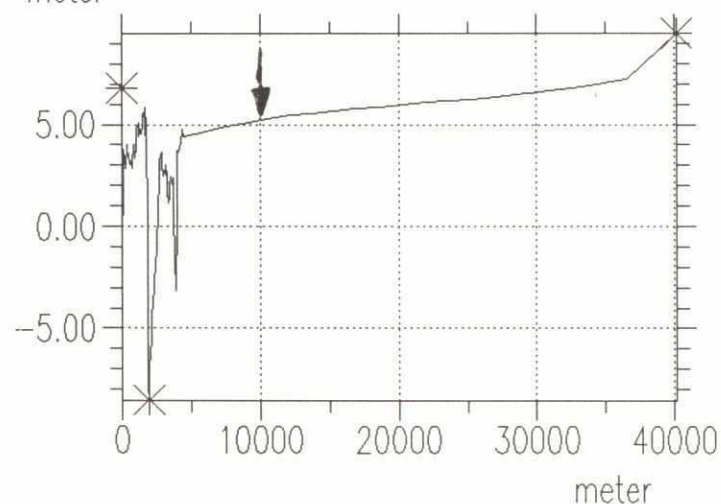
UPPER MEGHNA 20.000 km TOPO ID : 1986-87
meter



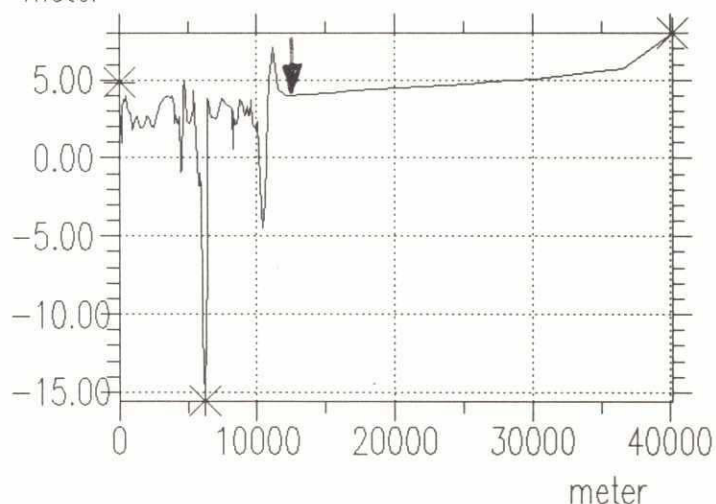
UPPER MEGHNA 32.000 km TOPO ID : 1986-87
meter



UPPER MEGHNA 44.000 km TOPO ID : 1986-87
meter



UPPER MEGHNA 56.000 km TOPO ID : 1986-87
meter



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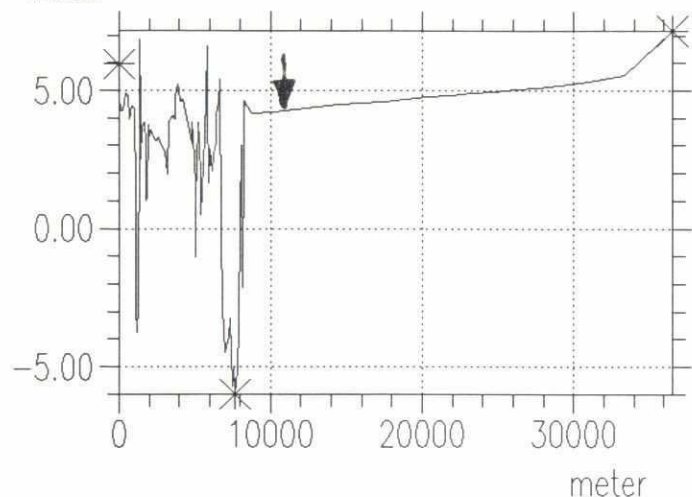
River Cross Section With Location of
Embankment Positions

Legend : Arrow Head Indicates Location of Embankment

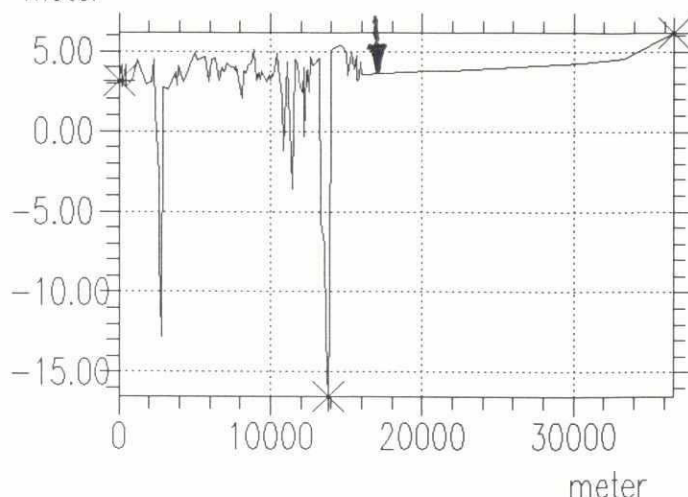
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FIGURE 2.4 m)

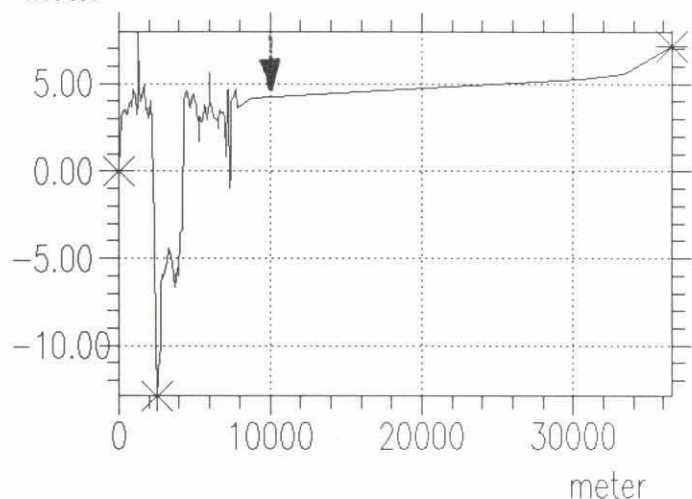
22 ✓ UPPER MEGHNA 68.000 km TOPO ID : 1986-87 meter



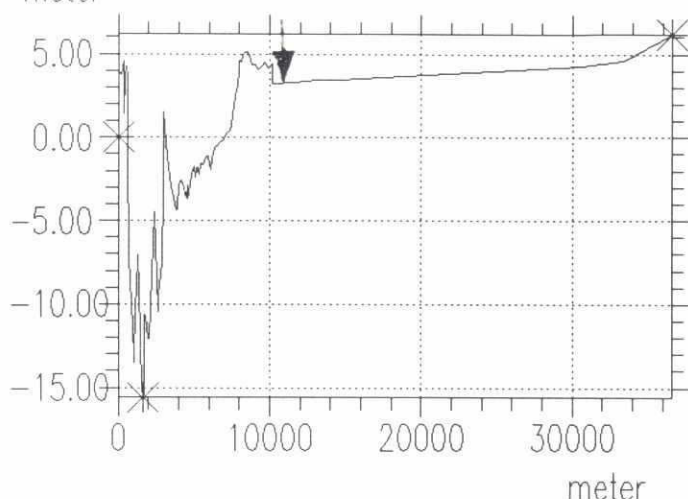
UPPER MEGHNA 80.000 km TOPO ID : 1986-87 meter



UPPER MEGHNA 95.000 km TOPO ID : 1986-87 meter



UPPER MEGHNA 110.000 km TOPO ID : 1986-87 meter



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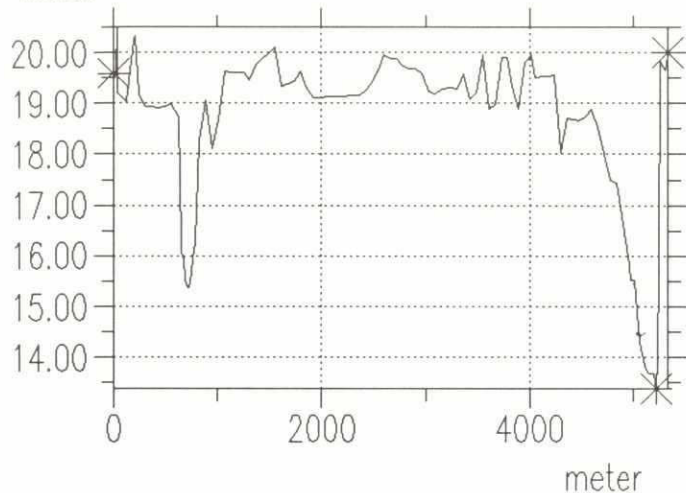
River Cross Section With Location of Embankment Positions

Legend : Arrow Head Indicates Location of Embankment

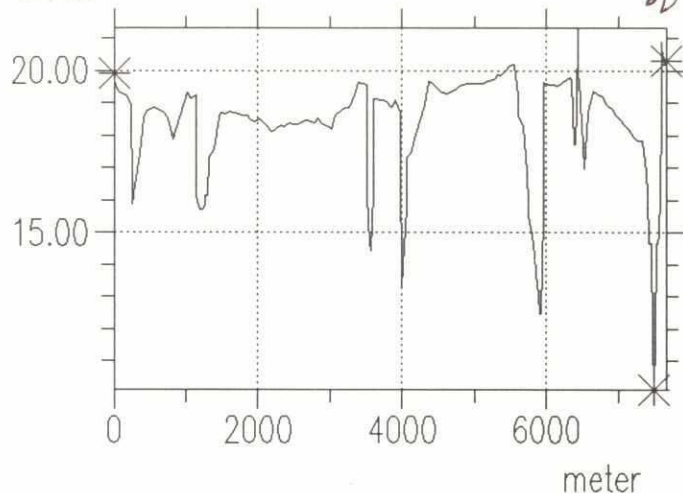
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FIGURE 2.4 n)

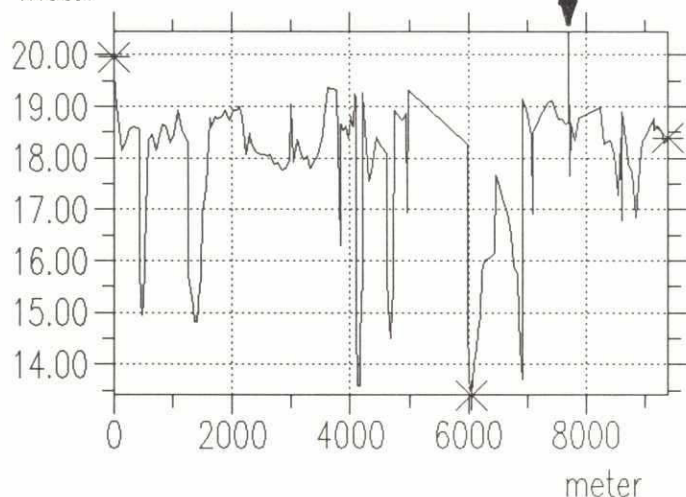
OLD B.PUTRA 0.000 km TOPO ID : 1988-89
meter



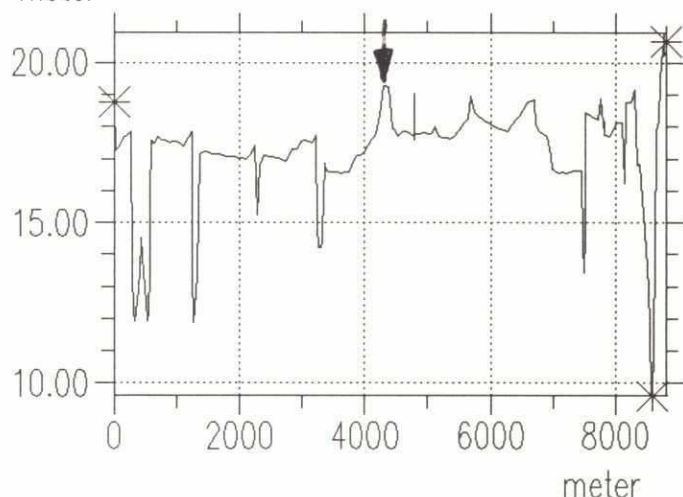
OLD B.PUTRA 6.000 km TOPO ID : 1988-89
meter



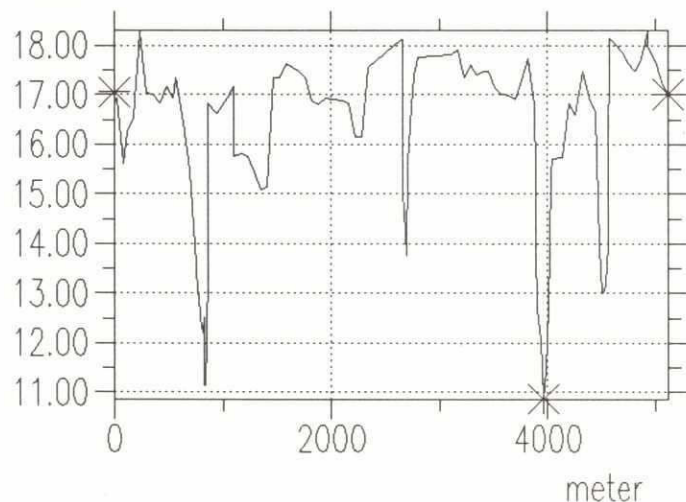
OLD B.PUTRA 12.000 km TOPO ID : 1988-89
meter



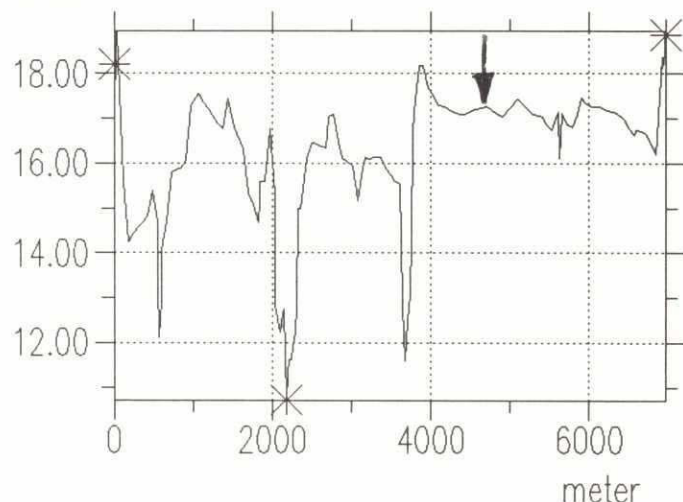
OLD B.PUTRA 18.000 km TOPO ID : 1988-89
meter



OLD B.PUTRA 24.000 km TOPO ID : 1988-89
meter



OLD B.PUTRA 36.000 km TOPO ID : 1988-89
meter



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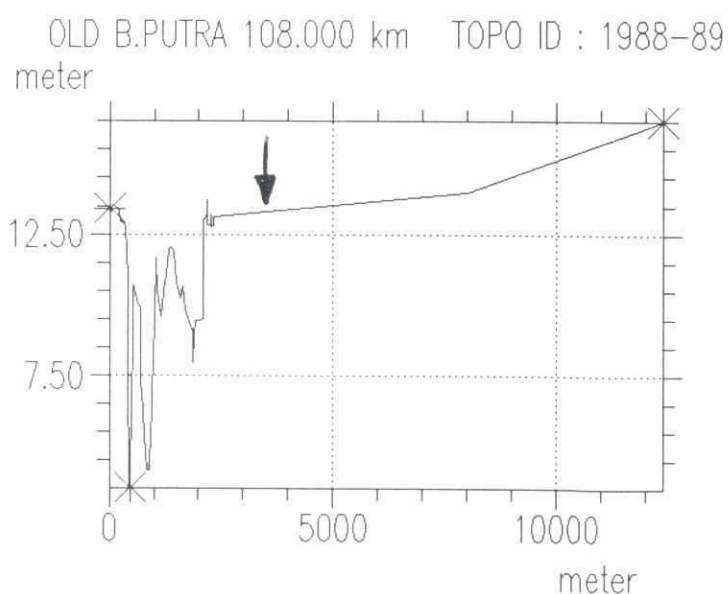
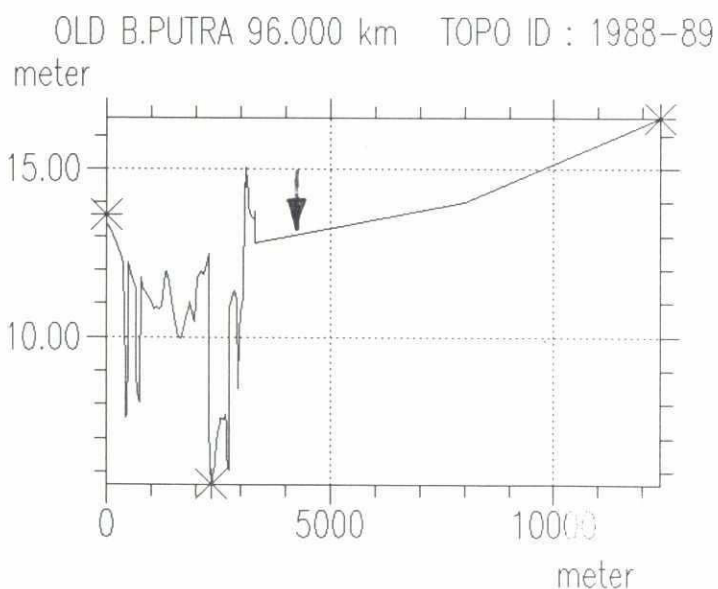
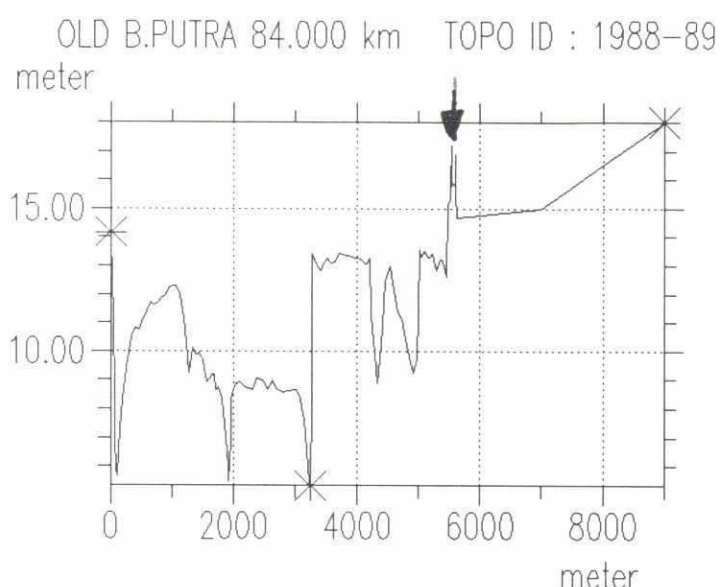
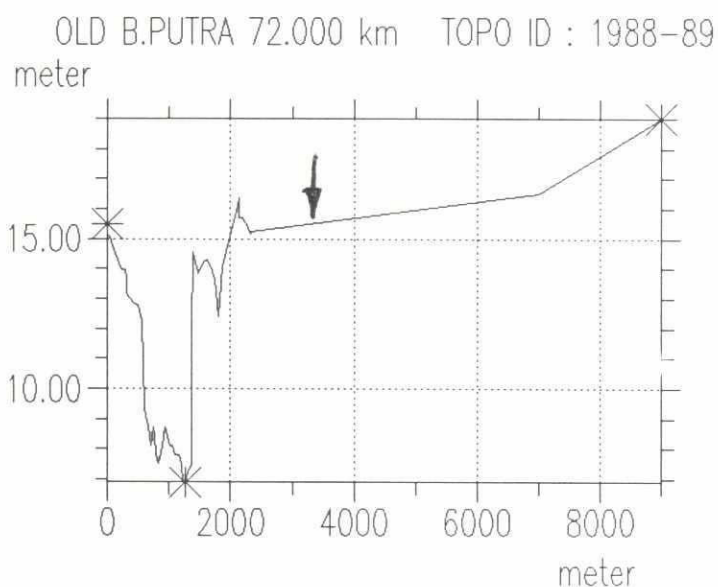
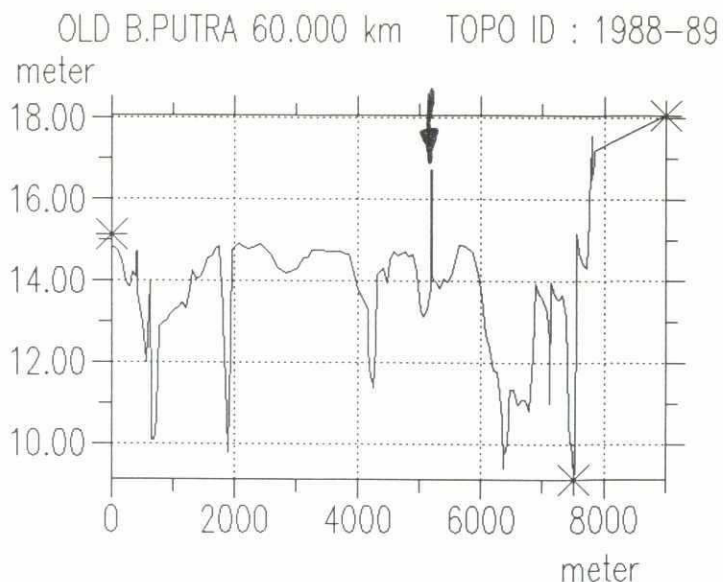
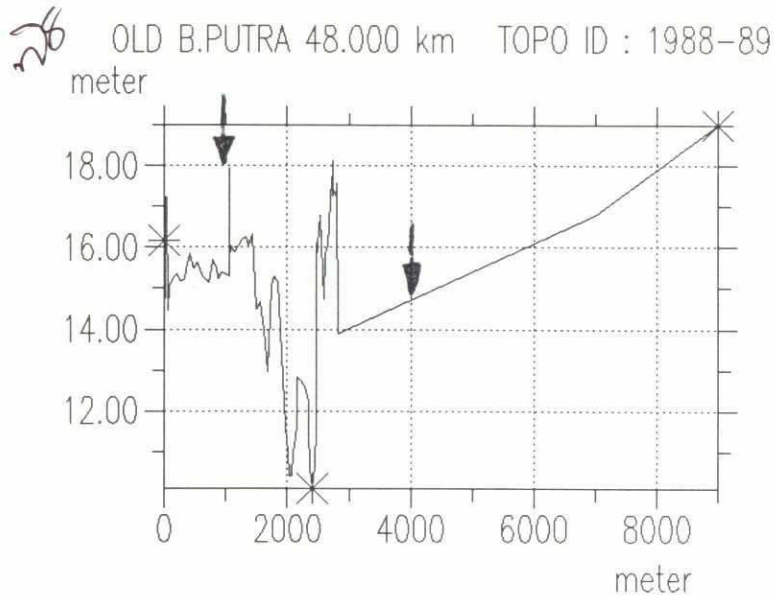
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FIGURE 2.4 o)



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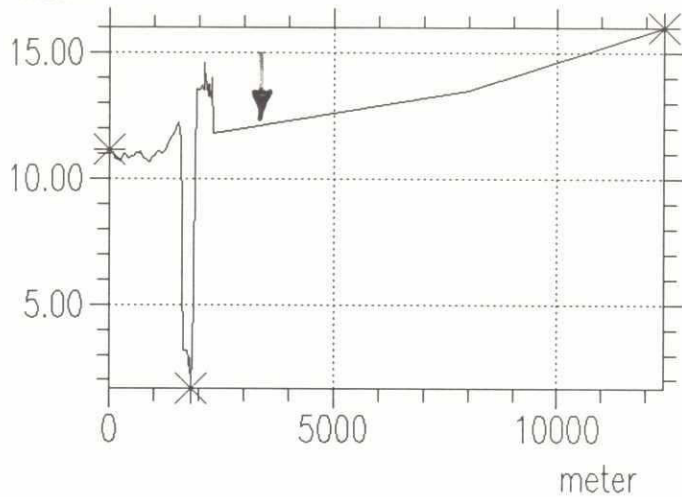
River Cross Section With Location of
Embankment Positions

Legend : Arrow Head Indicates Location of Embankment

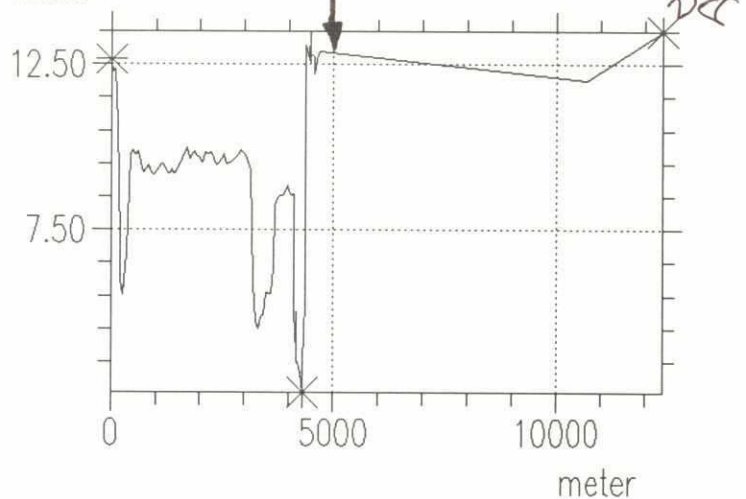
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FIGURE 2.4 p)

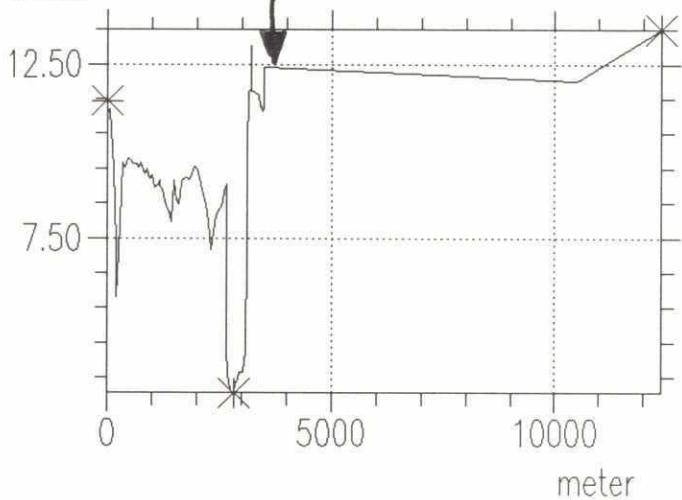
OLD B.PUTRA 120.000 km TOPO ID : 1988-89
meter



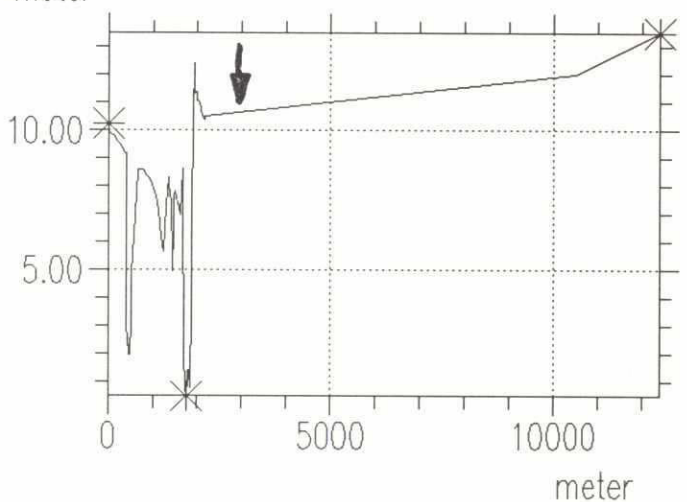
OLD B.PUTRA 132.000 km TOPO ID : 1988-89
meter



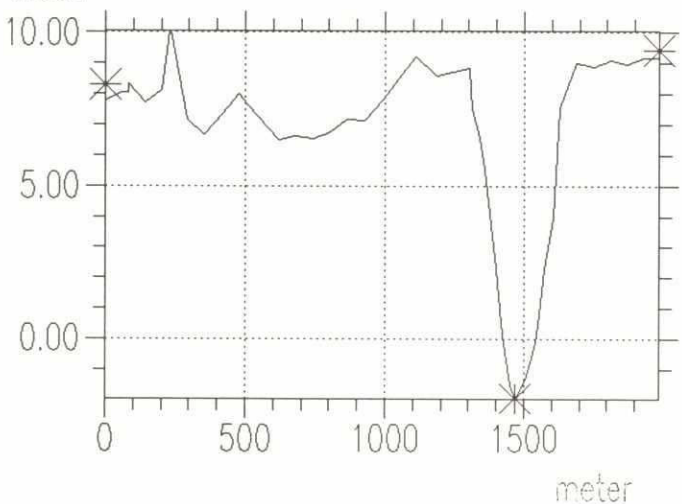
OLD B.PUTRA 144.000 km TOPO ID : 1988-89
meter



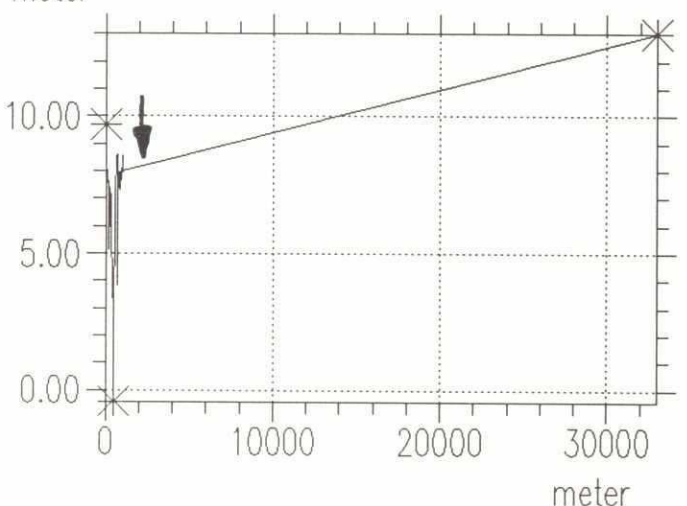
OLD B.PUTRA 156.000 km TOPO ID : 1988-89
meter



OLD B.PUTRA 162.000 km TOPO ID : 1988-89
meter



OLD B.PUTRA 168.000 km TOPO ID : 1988-89
meter



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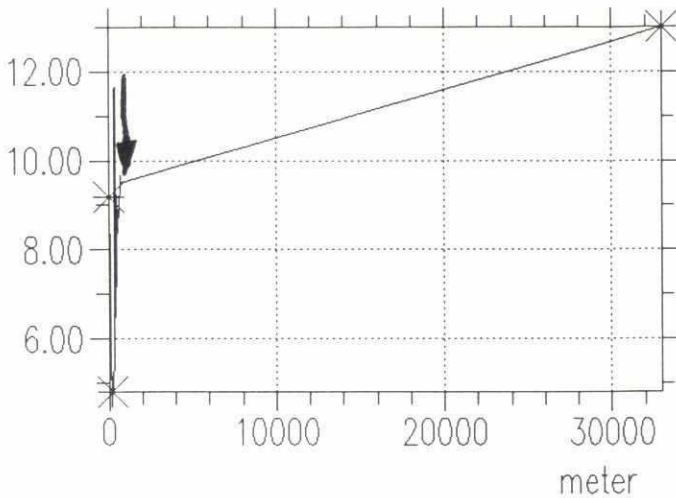
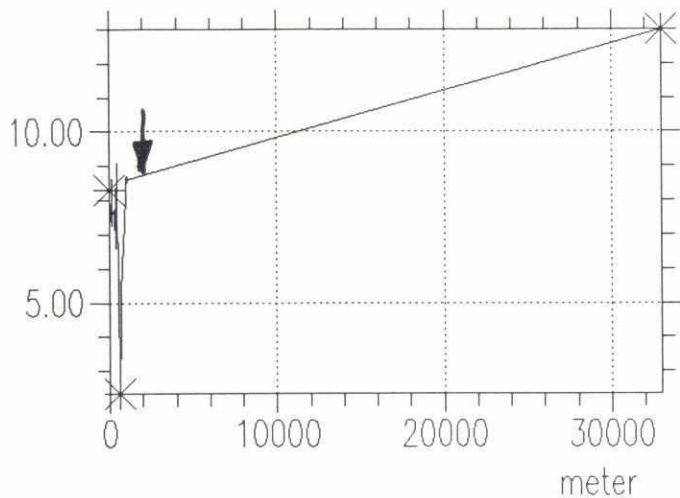
River Cross Section With Location of
Embankment Positions

Legend : Arrow Head Indicates Location of Embankment

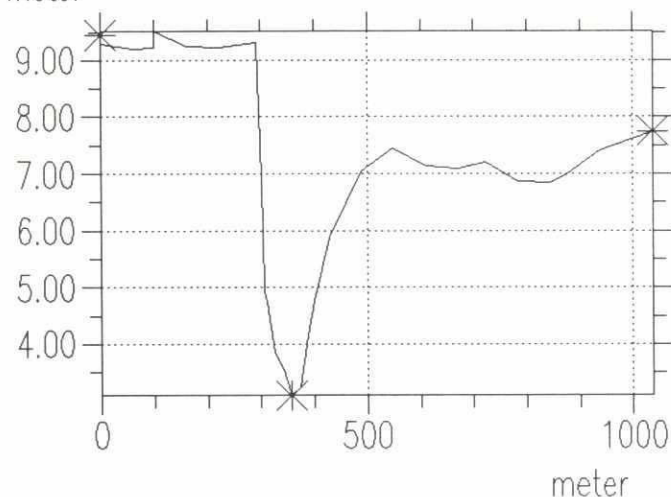
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FIGURE 2.4 q)

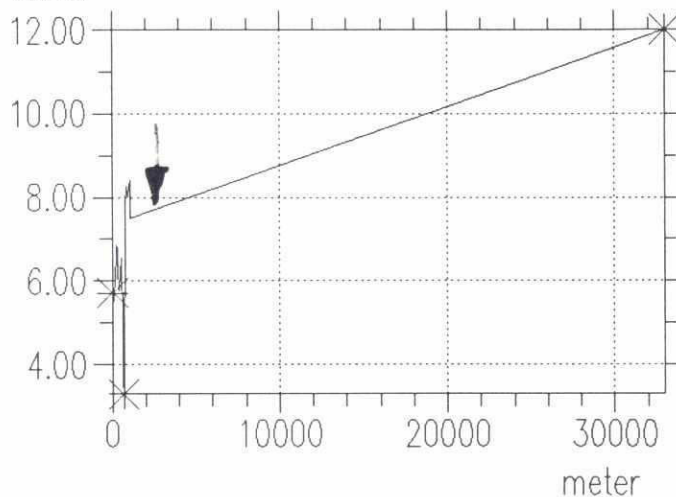
OLD B.PUTRA 174.000 km TOPO ID : 1988-89 meter



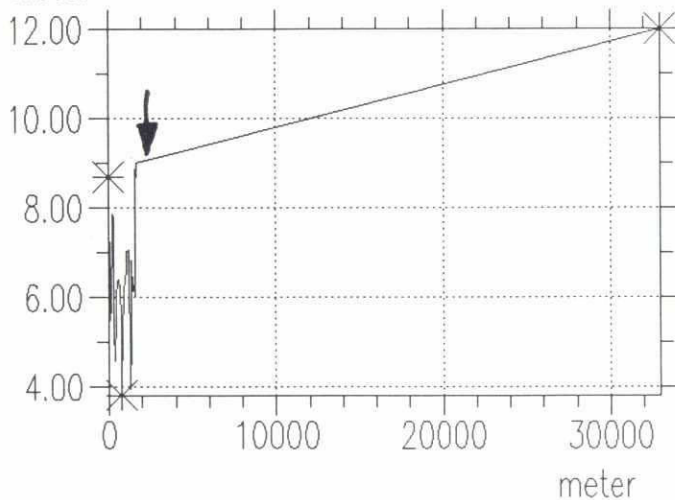
OLD B.PUTRA 186.000 km TOPO ID : 1988-89 meter



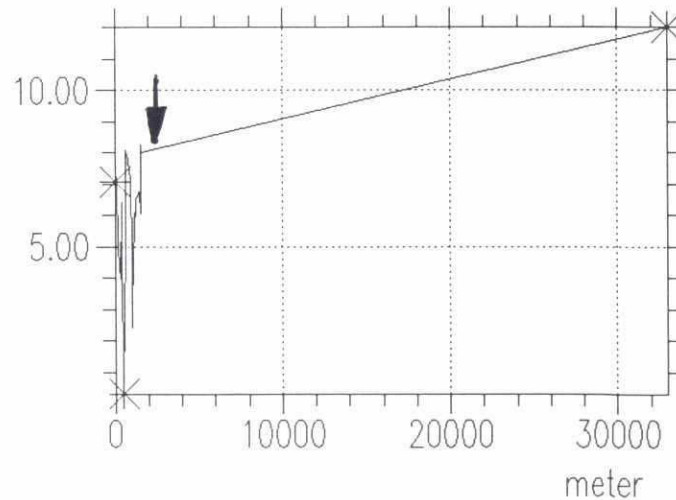
OLD B.PUTRA 192.000 km TOPO ID : 1988-89 meter



OLD B.PUTRA 198.000 km TOPO ID : 1988-89 meter



OLD B.PUTRA 204.000 km TOPO ID : 1988-89 meter



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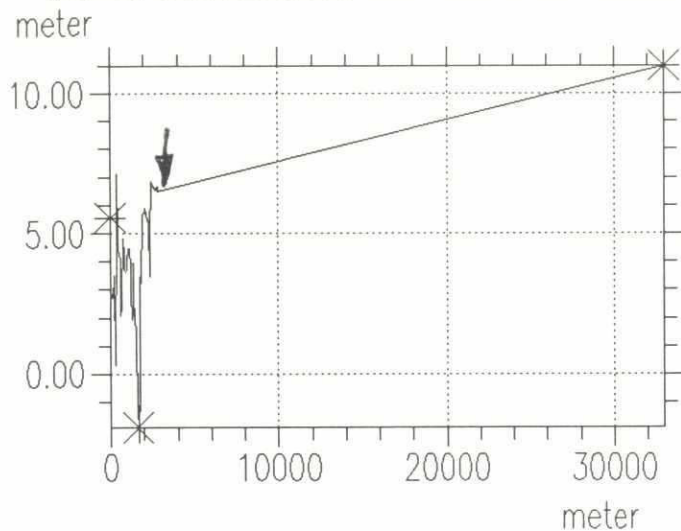
FLOOD HYDROLOGY STUDY

River Cross Section With Location of
Embankment Positions

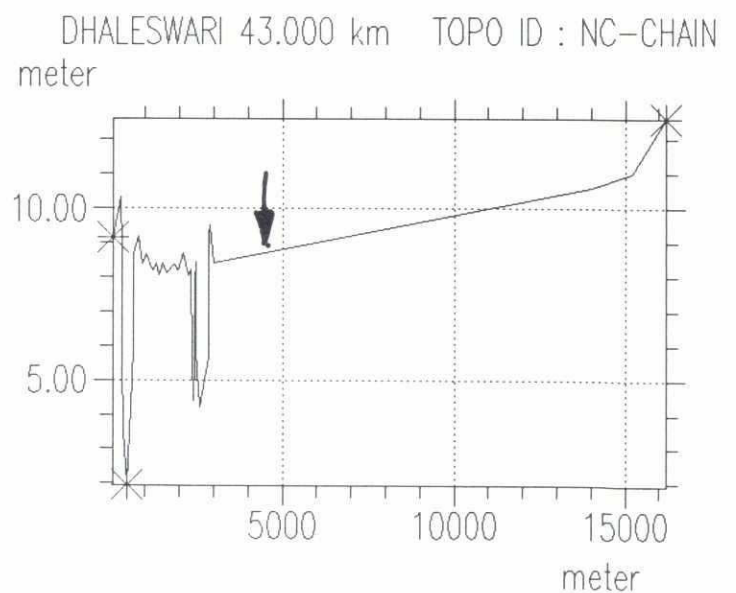
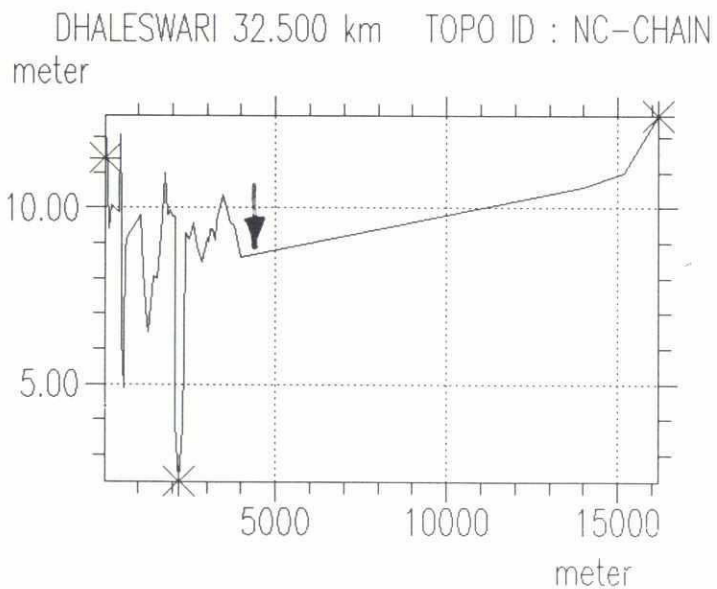
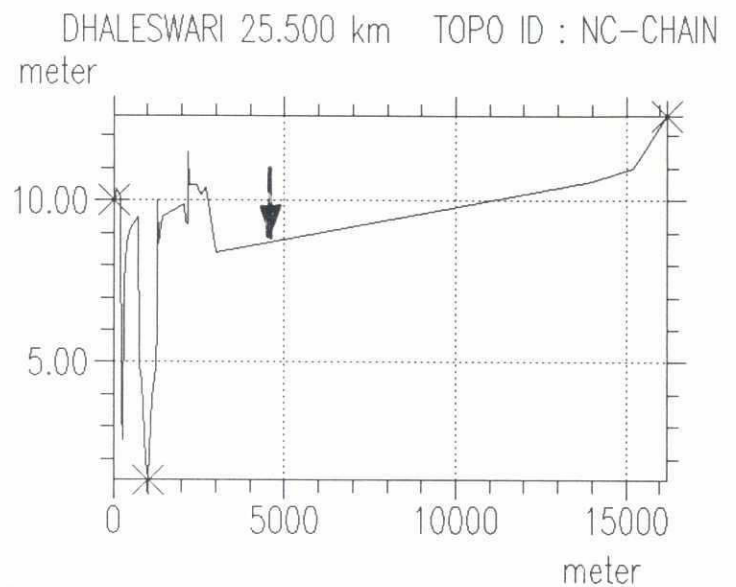
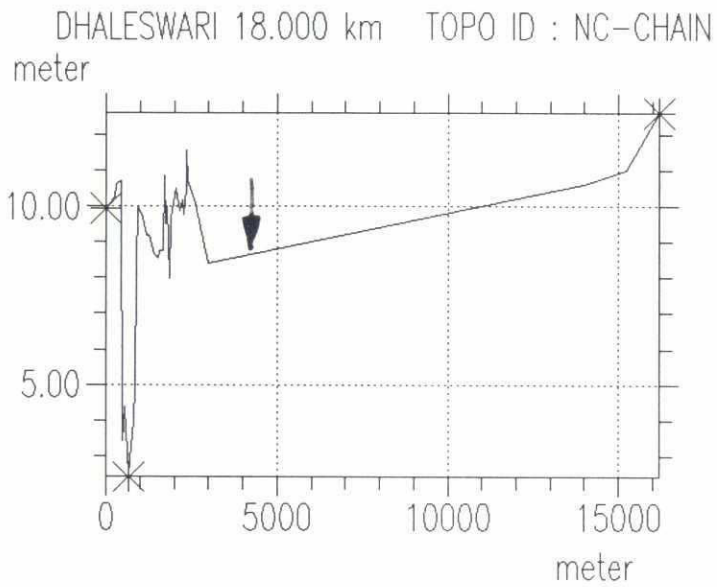
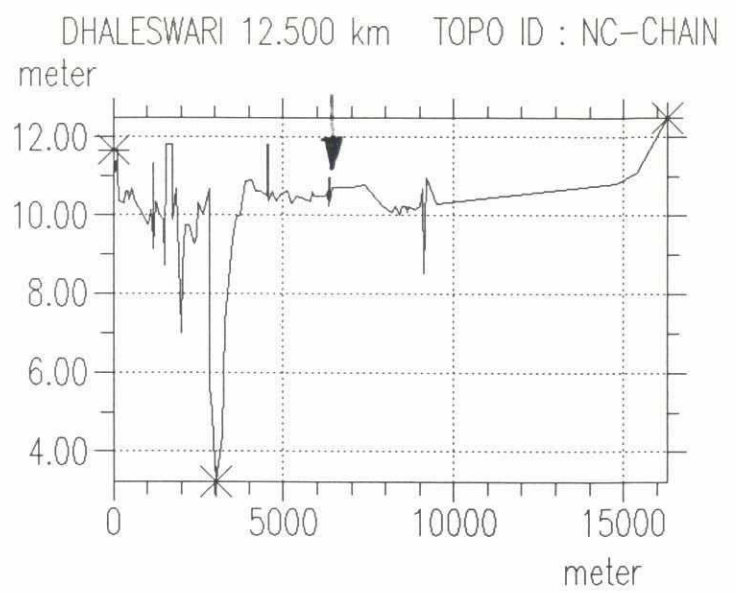
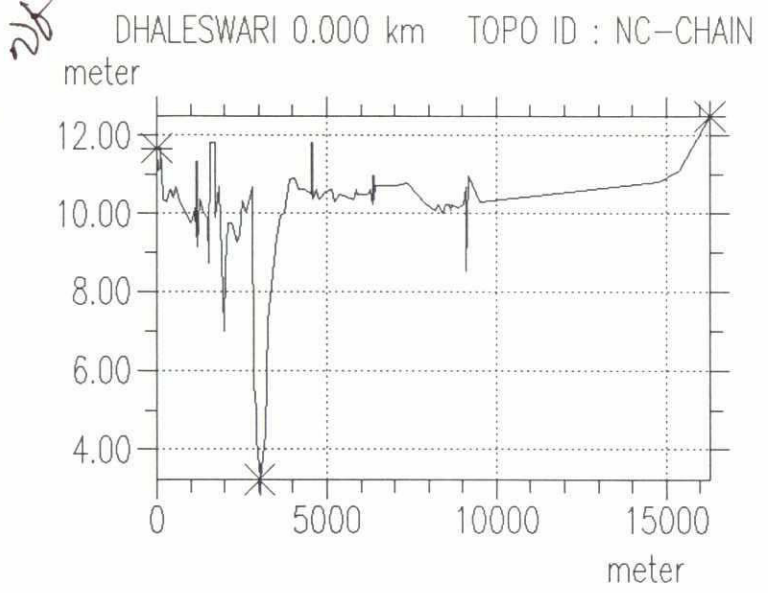
Legend : Arrow Head Indicates Location of Embankment

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FIGURE 2.4 r)



FAP25 FLOOD MODELLING & MANAGEMENT	FLOOD HYDROLOGY STUDY	
	River Cross Section With Location of Embankment Positions Legend : Arrow Head Indicates Location of Embankment	
	FEBRUARY 1993	FIGURE 2.4 s)



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FLOOD HYDROLOGY STUDY

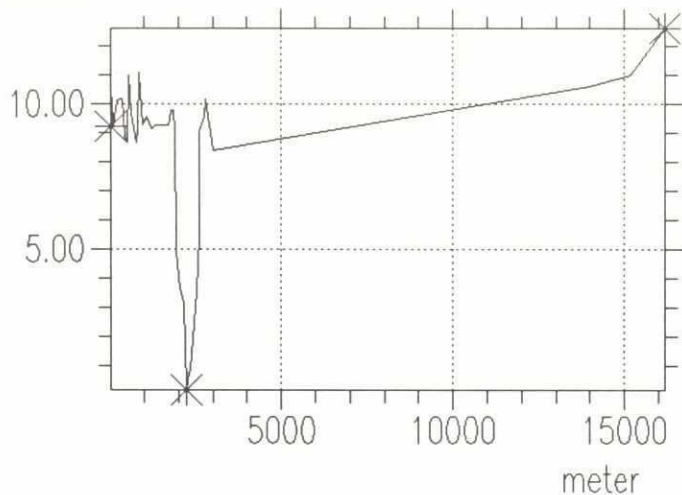
River Cross Section With Location of
Embankment Positions

Legend : Arrow Head Indicates Location of Embankment

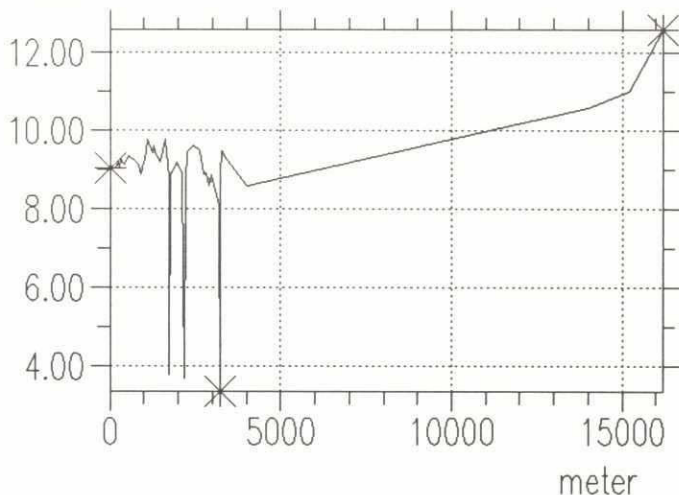
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FIGURE 2.4 t)

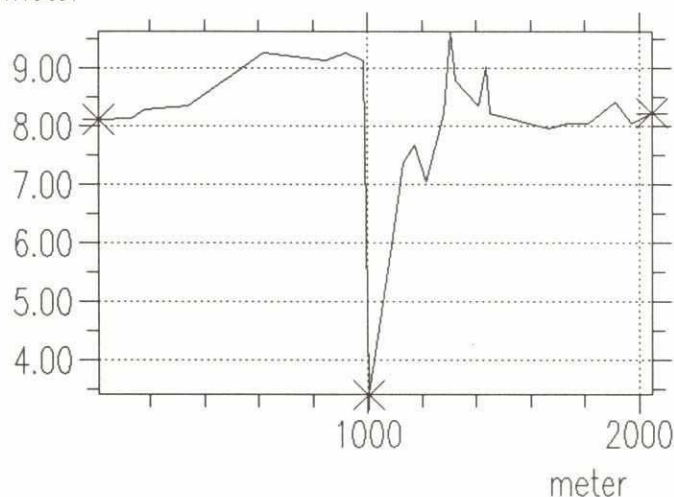
DHALESWARI 49.000 km TOPO ID : NC-CHAIN
meter



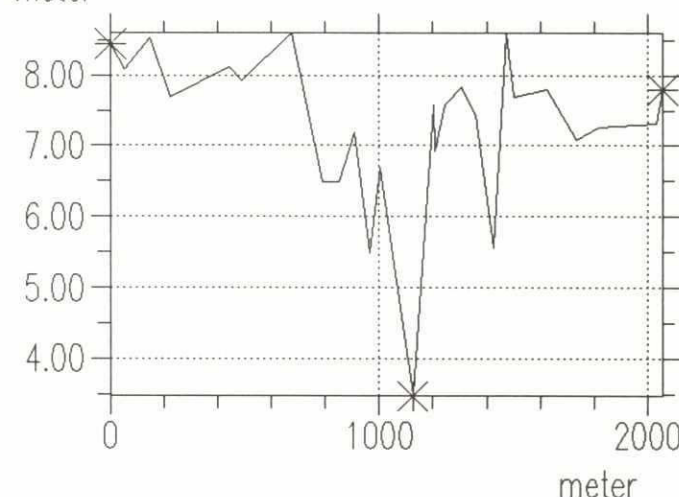
DHALESWARI 57.500 km TOPO ID : NC-CHAIN
meter



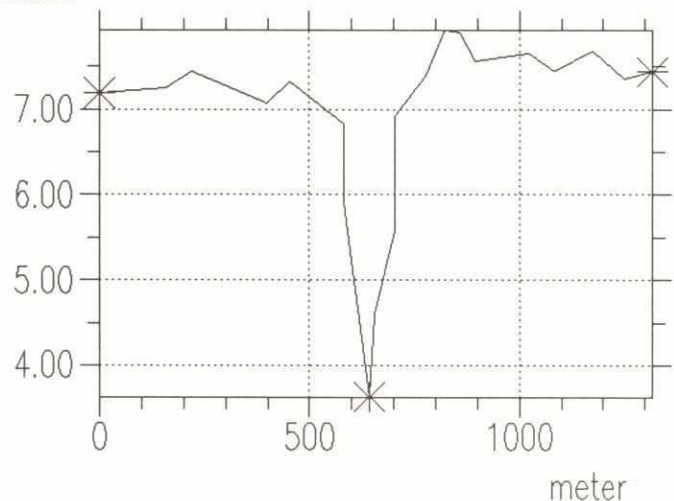
DHALESWARI 66.000 km TOPO ID : NC-CHAIN
meter



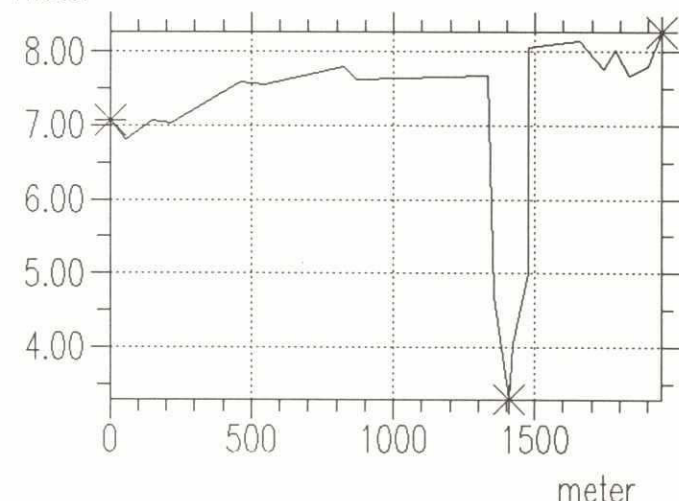
DHALESWARI 72.500 km TOPO ID : NC-CHAIN
meter



DHALESWARI 80.000 km TOPO ID : NC-CHAIN
meter



DHALESWARI 86.000 km TOPO ID : NC-CHAIN
meter



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FLOOD HYDROLOGY STUDY

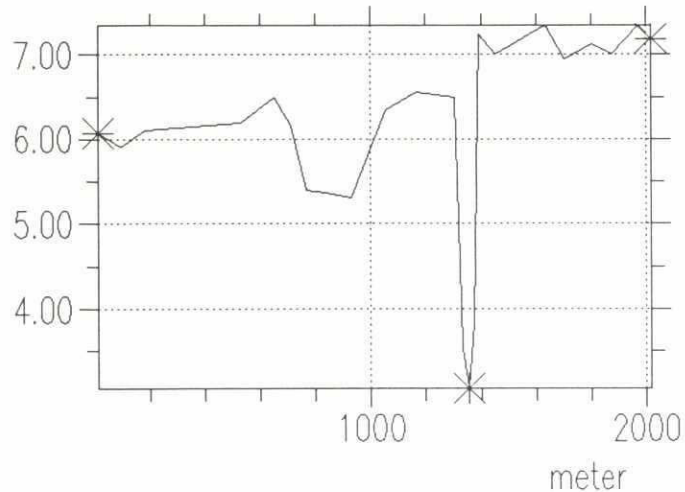
River Cross Section With Location of
Embankment Positions

Legend : Arrow Head Indicates Location of Embankment

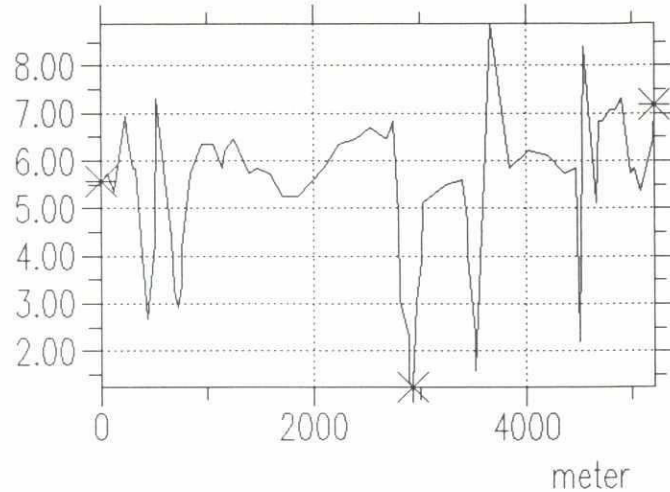
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FIGURE 2.4 u)

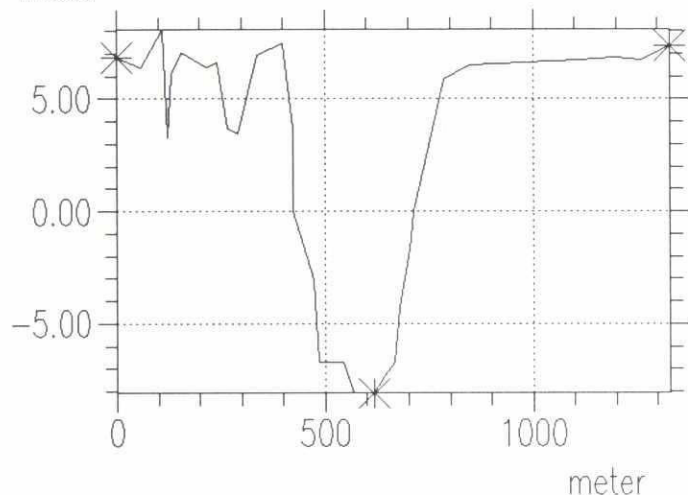
200 DHALESWARI 92.000 km TOPO ID : NC-CHAIN
meter



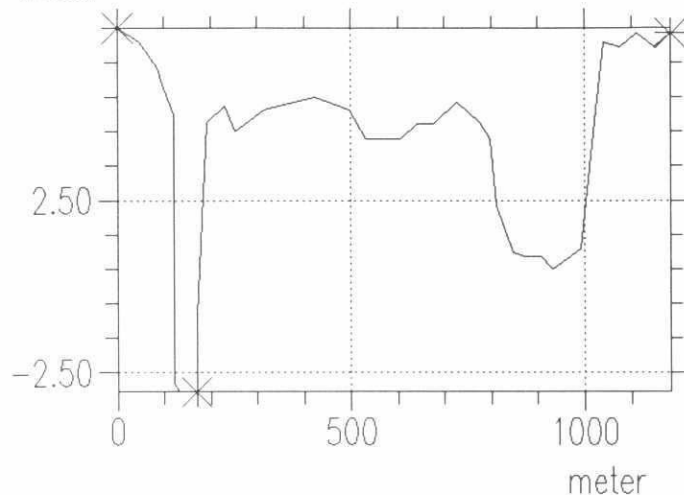
DHALESWARI 97.000 km TOPO ID : NC-CHAIN
meter



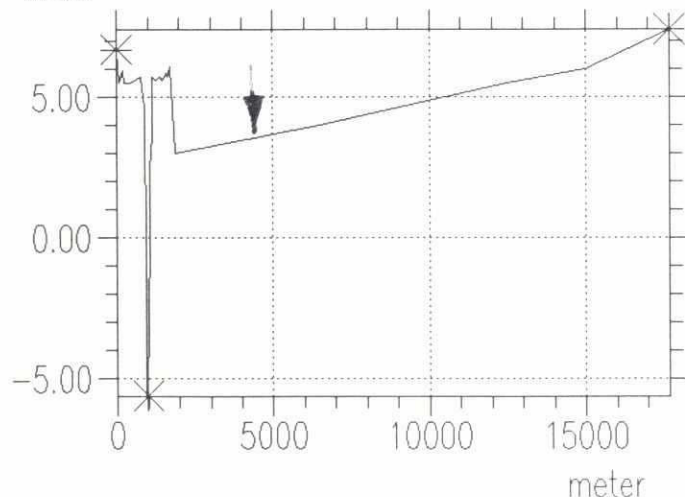
DHALESWARI 101.500 km TOPO ID : NC-CHAIN
meter



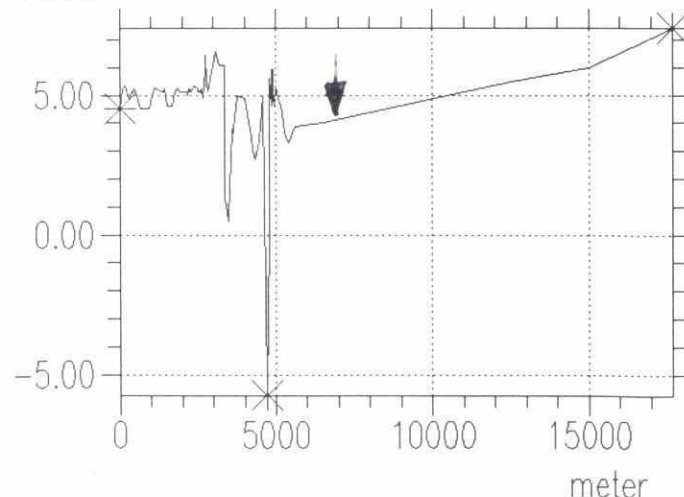
DHALESWARI 107.500 km TOPO ID : NC-CHAIN
meter



DHALESWARI 112.500 km TOPO ID : NC-CHAIN
meter



DHALESWARI 117.500 km TOPO ID : NC-CHAIN
meter



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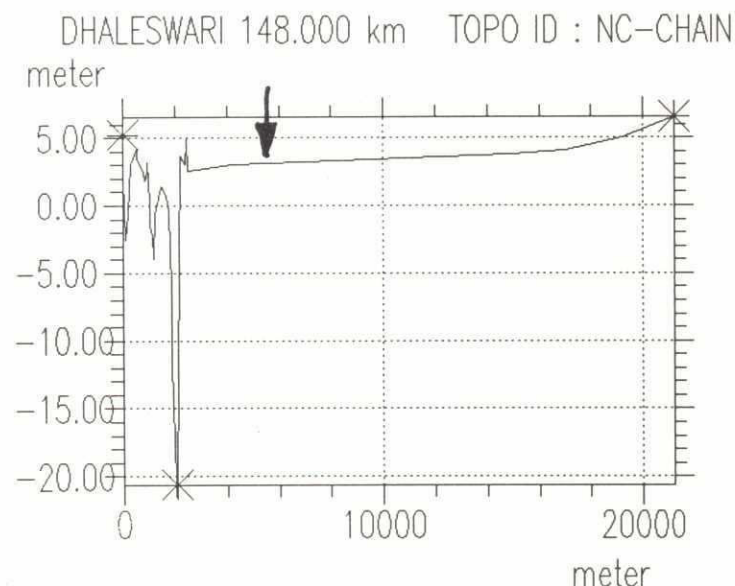
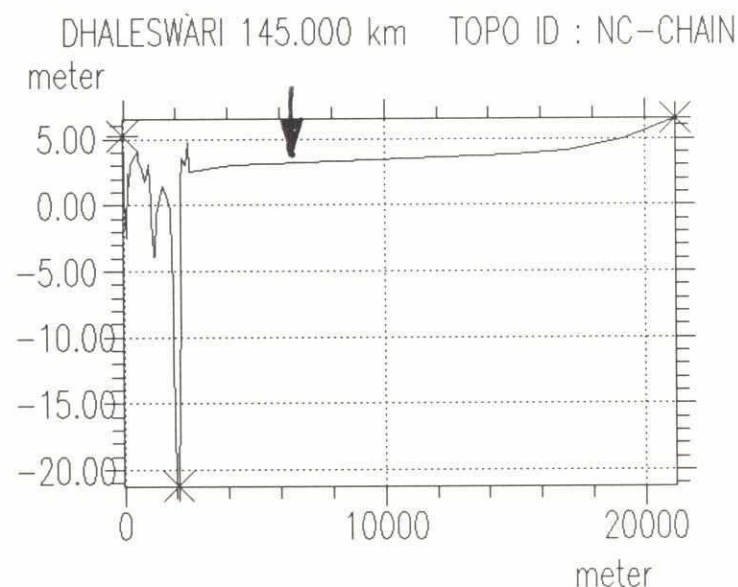
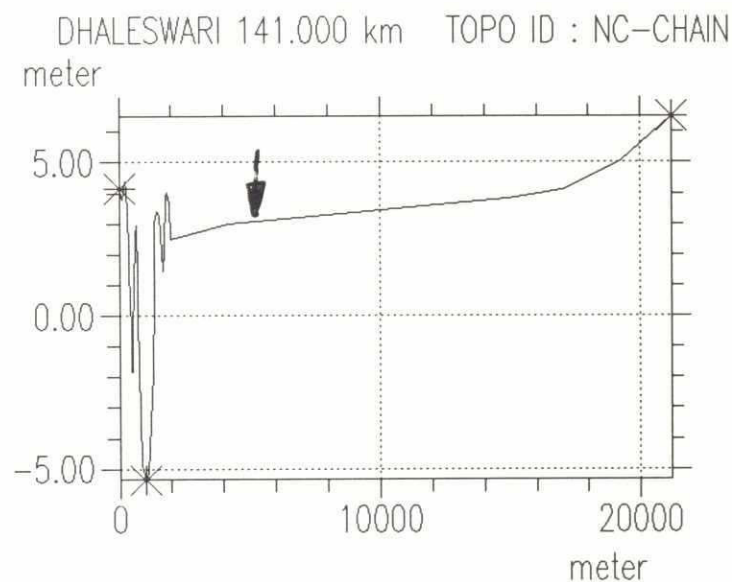
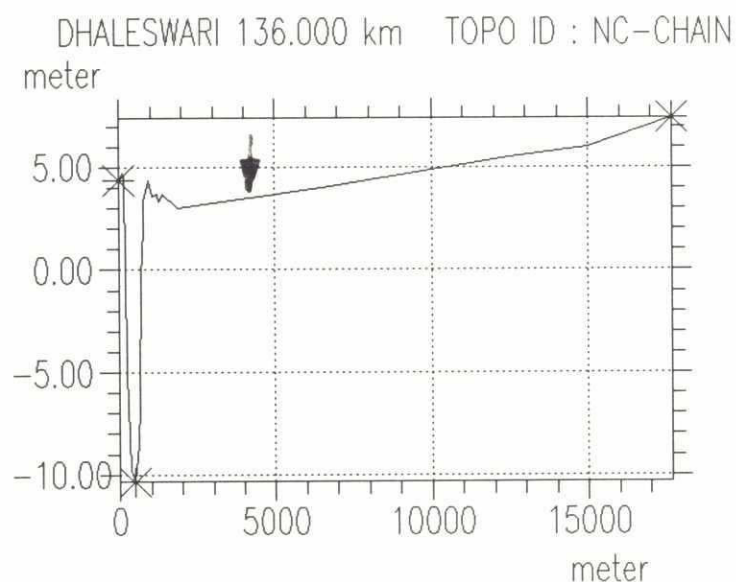
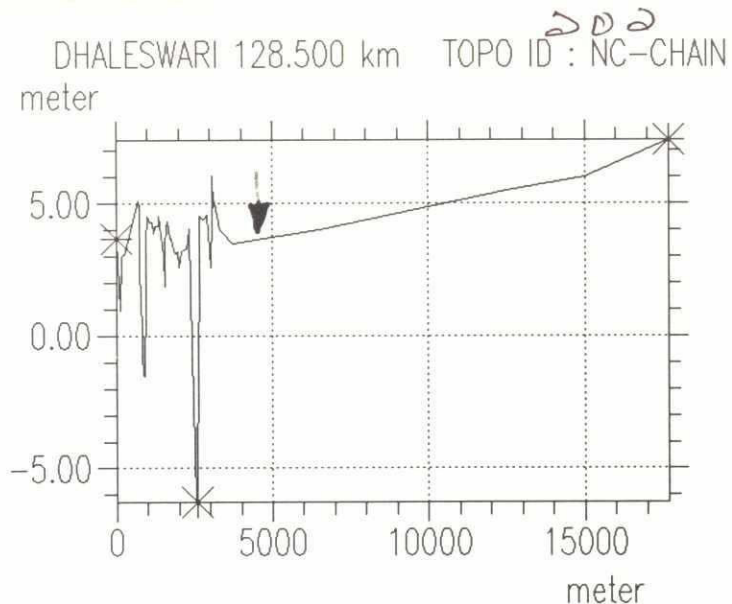
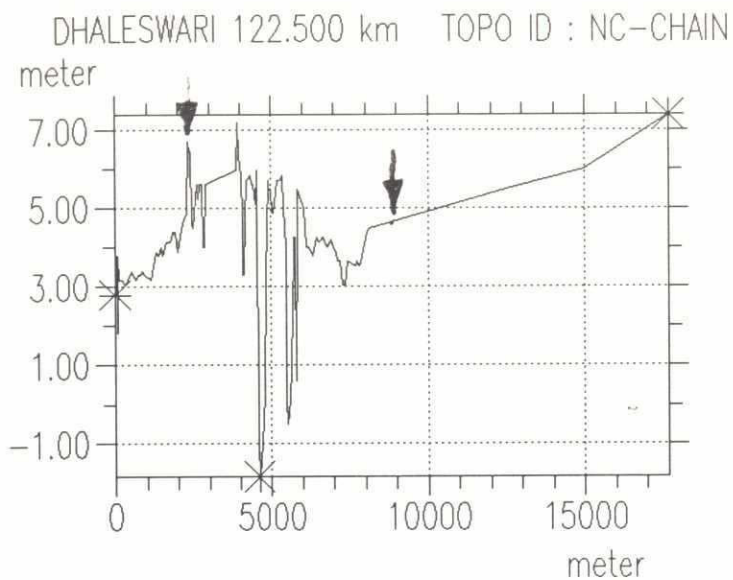
FLOOD HYDROLOGY STUDY

River Cross Section With Location of
Embankment Positions

Legend : Arrow Head Indicates Location of Embankment

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FIGURE 2.4 v)



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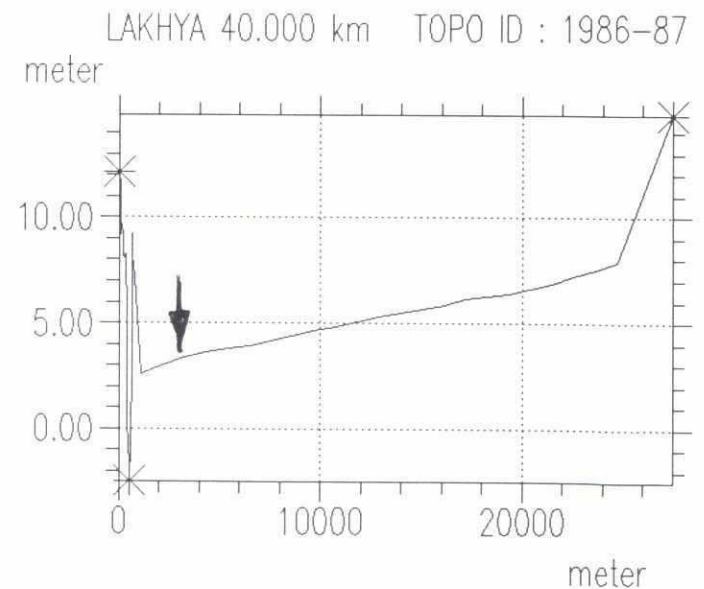
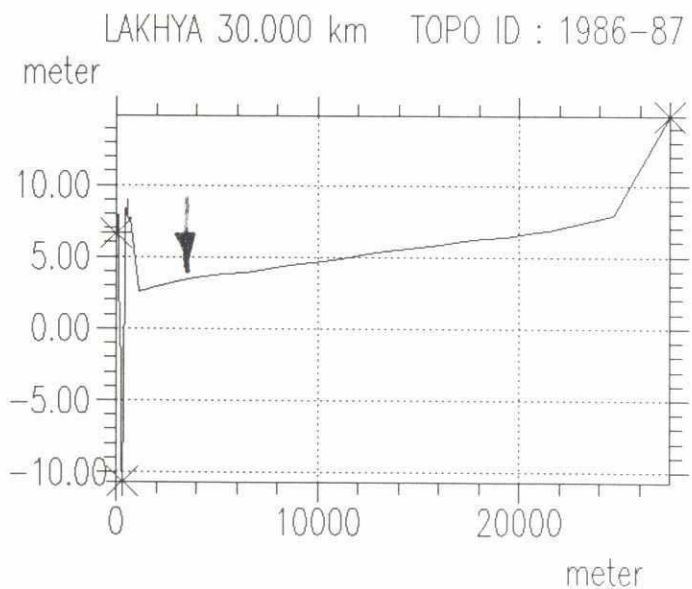
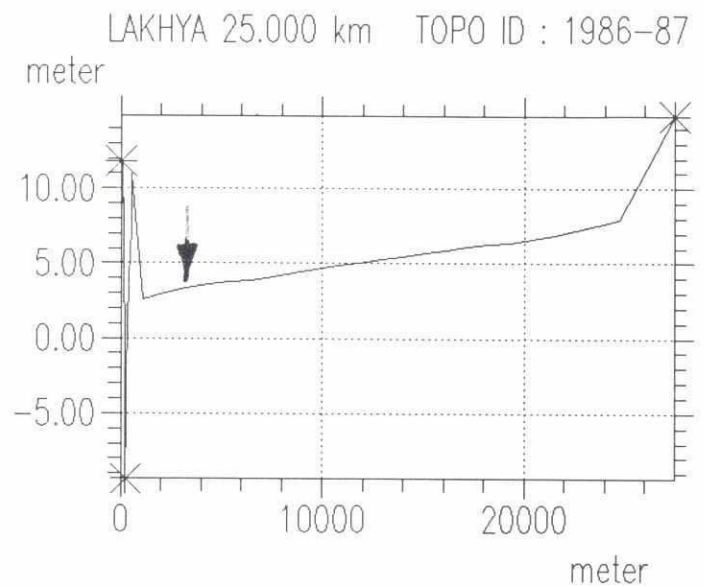
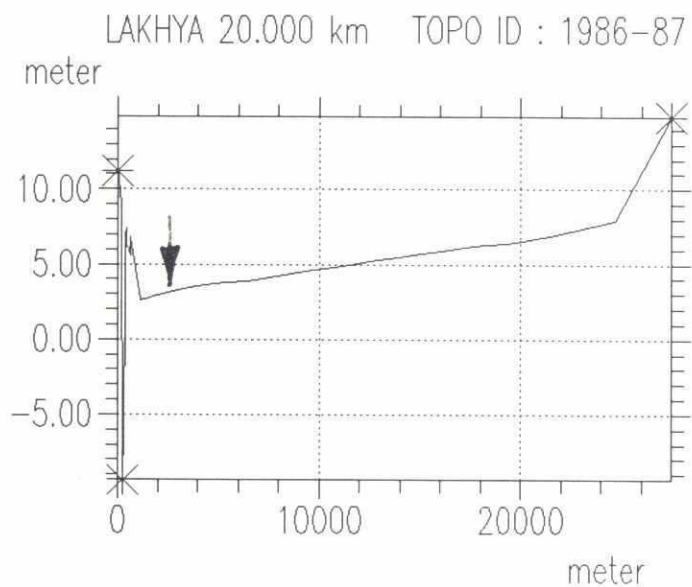
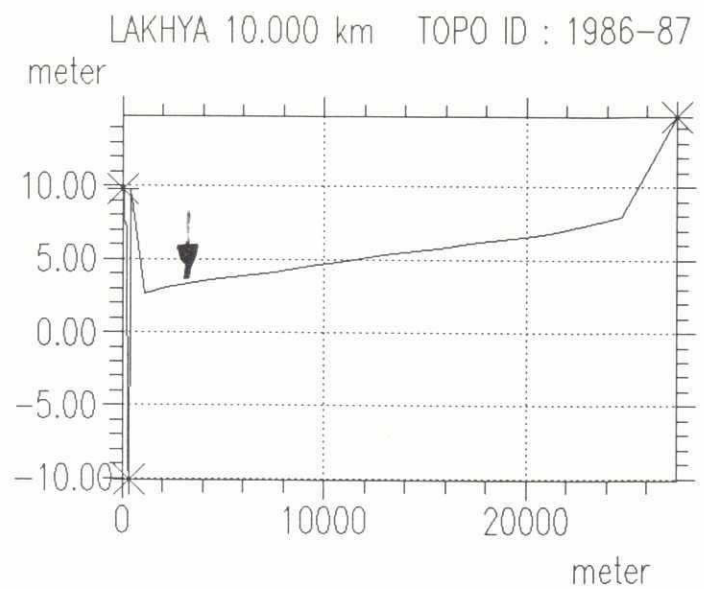
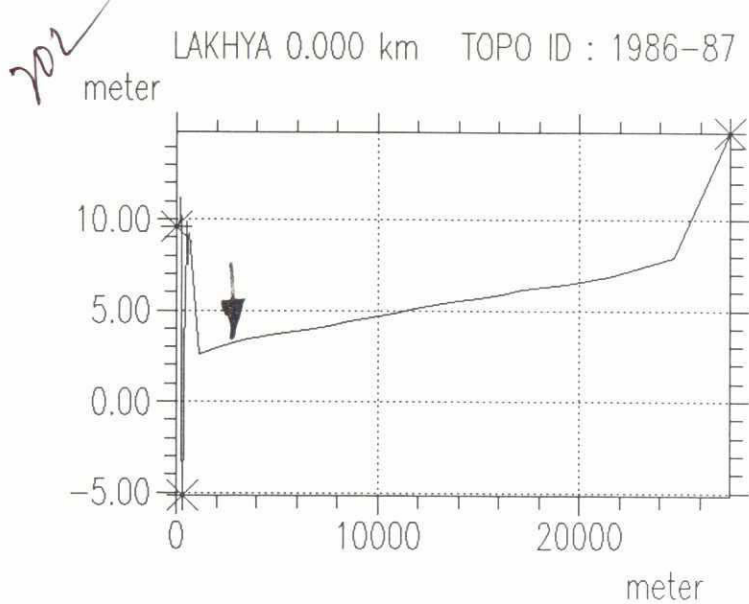
FLOOD HYDROLOGY STUDY

River Cross Section With Location of
Embankment Positions

Legend : Arrow Head Indicates Location of Embankment

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FIGURE 2.4 w)



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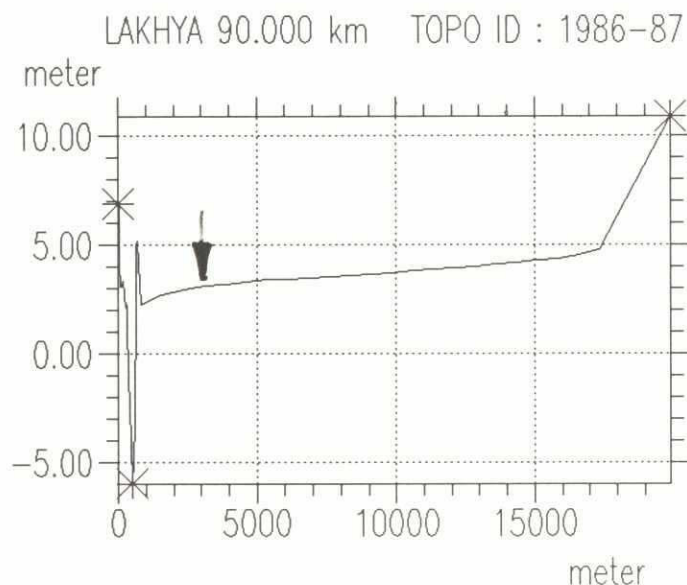
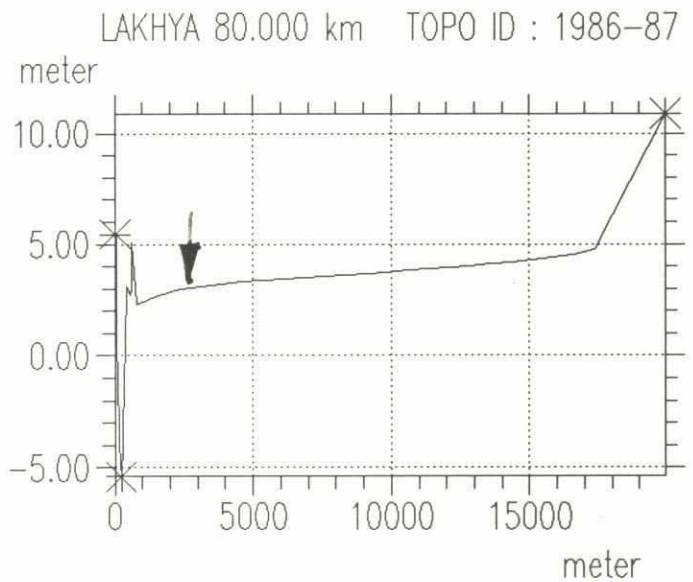
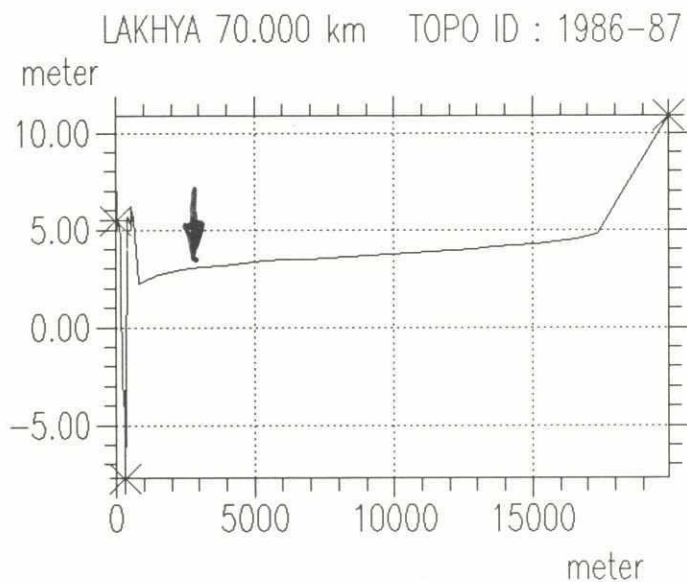
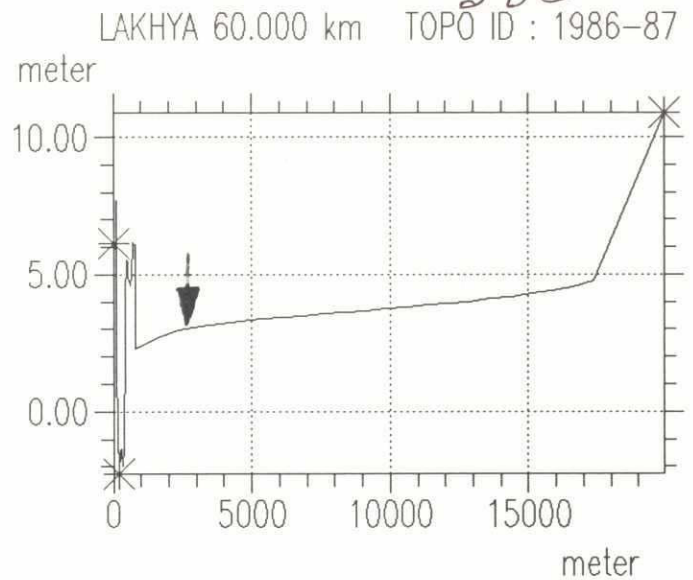
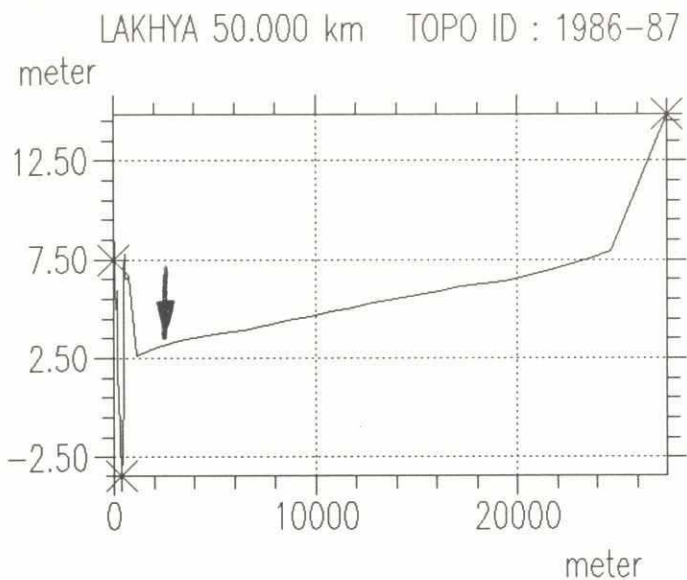
FLOOD HYDROLOGY STUDY

River Cross Section With Location of
Embankment Positions

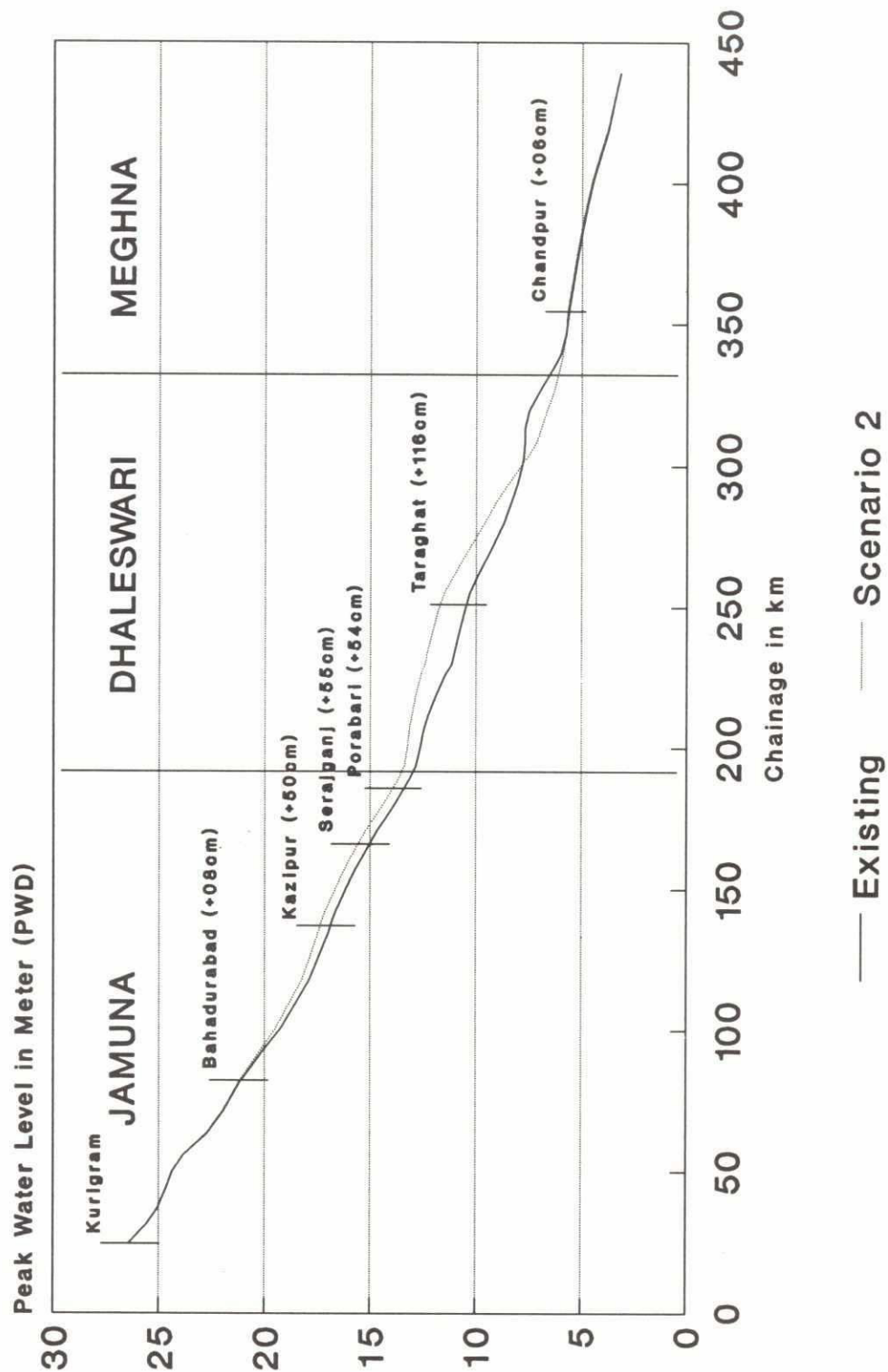
Legend : Arrow Head Indicates Location of Embankment

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FIGURE 2.4 x)



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	River Cross Section With Location of Embankment Positions	
	Legend : Arrow Head Indicates Location of Embankment	
	FEBRUARY 1993	FIGURE 2.4 y)



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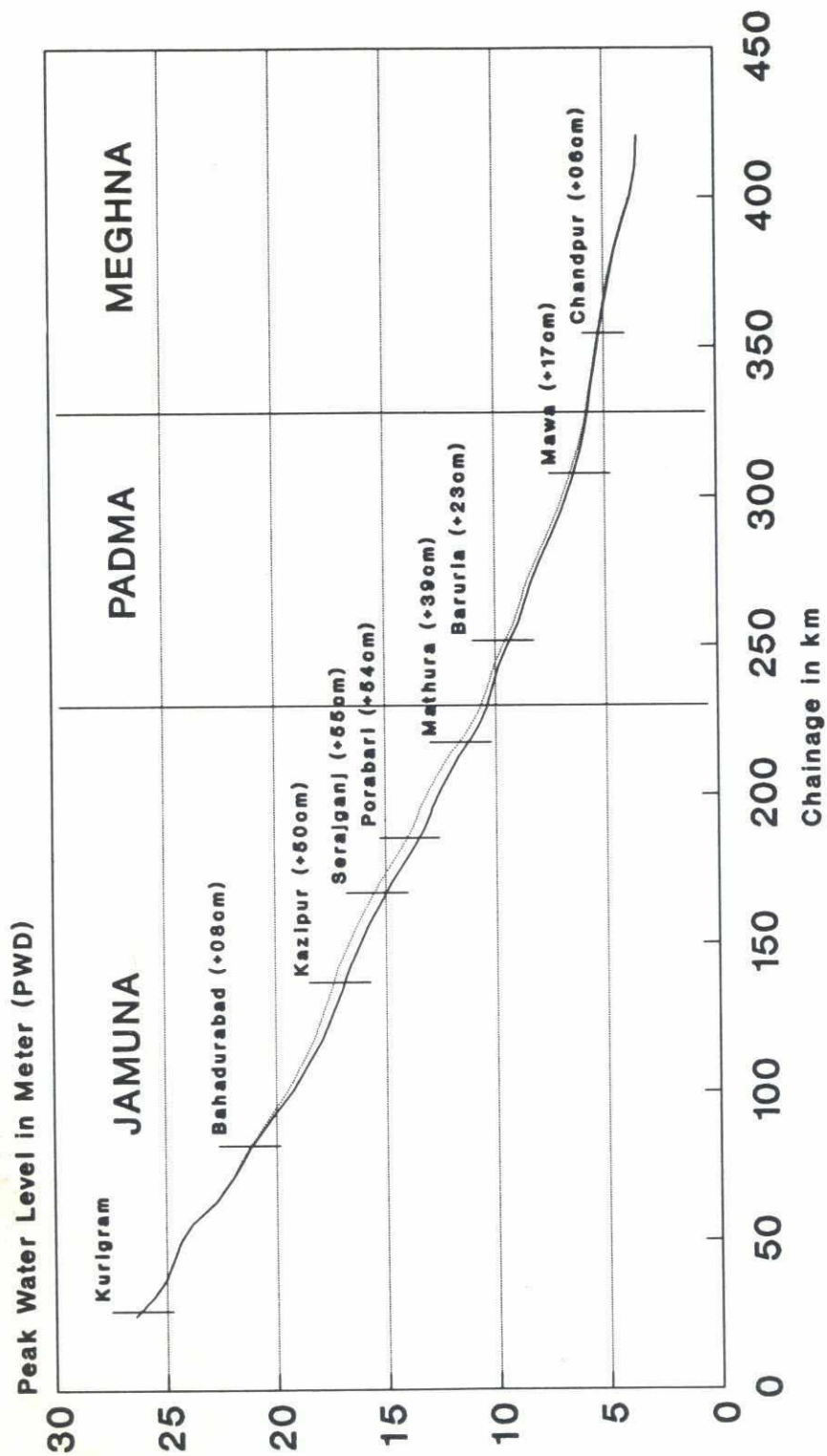
FLOOD HYDROLOGY STUDY

Scenario 2 : Peak Water Level Profile for the
Jamuna-Dhaleswari-Meghna System in 1988

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FIGURE 3.1 a)

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— Existing Scenario 2

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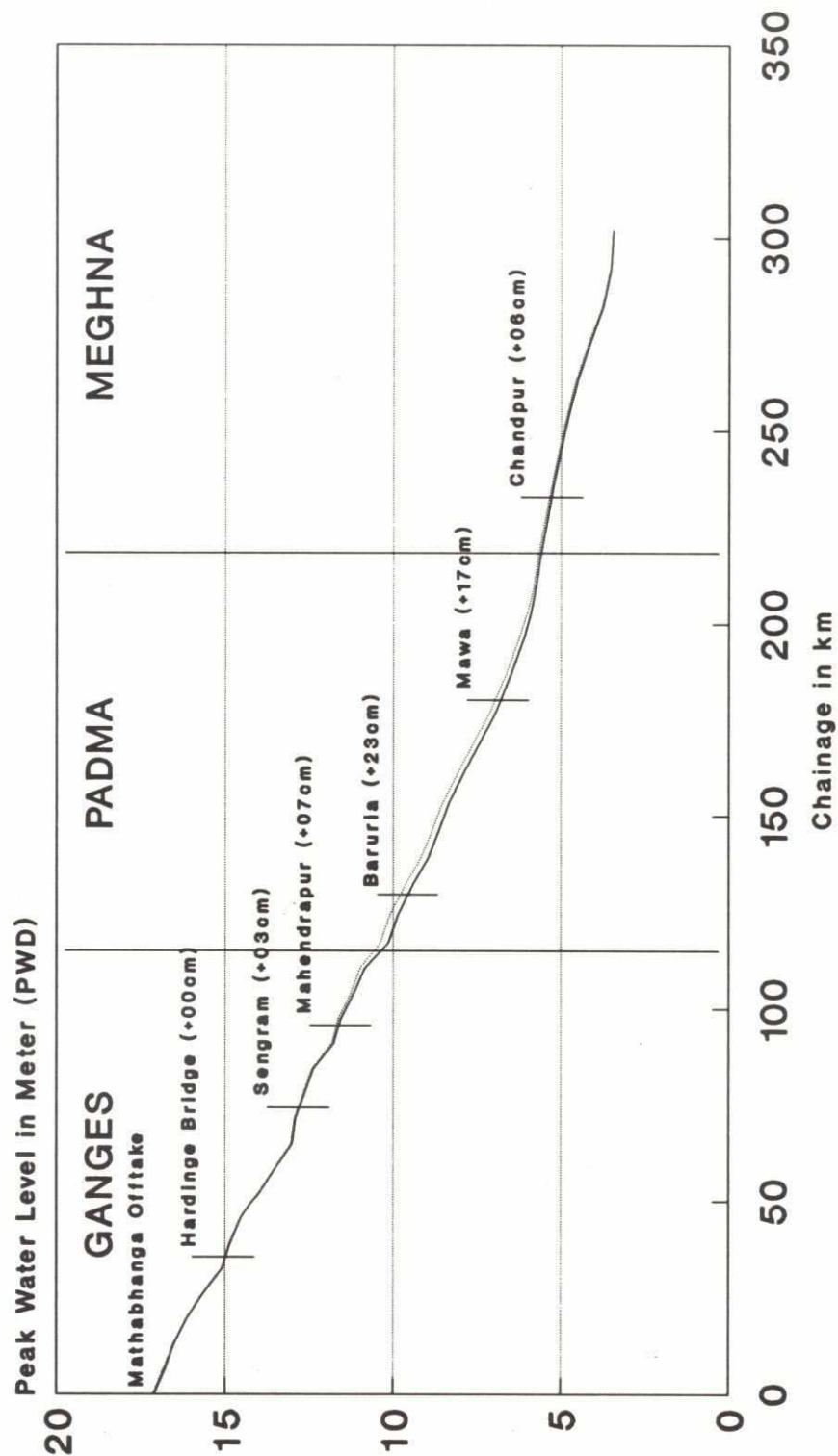
FLOOD MODELLING & MANAGEMENT

FLOOD HYDROLOGY STUDY

Scenario 2 : Peak Water Level Profile for the Jamuna-Padma-Meghna System in 1988

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FIGURE 3.1 b)



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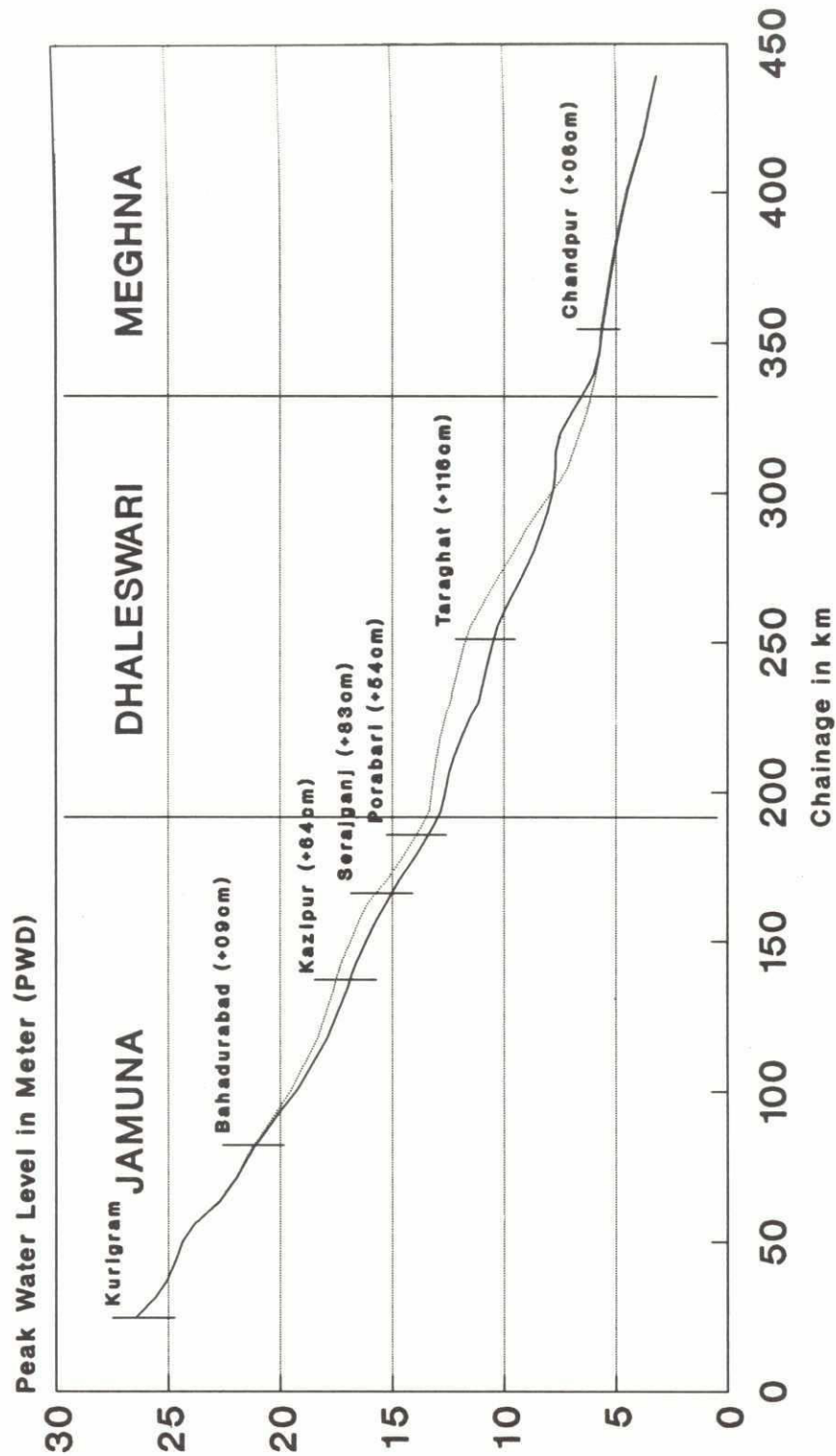
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FLOOD HYDROLOGY STUDY

Scenario 2 : Peak Water Level Profile for the Ganges-Padma-Meghna System in 1988

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FIGURE 3.1 c)



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FLOOD HYDROLOGY STUDY

Scenario 3 : Peak Water Level Profile for the Jamuna-Dhaleswari-Meghna System in 1988

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FIGURE 3.2 a)

FAP25

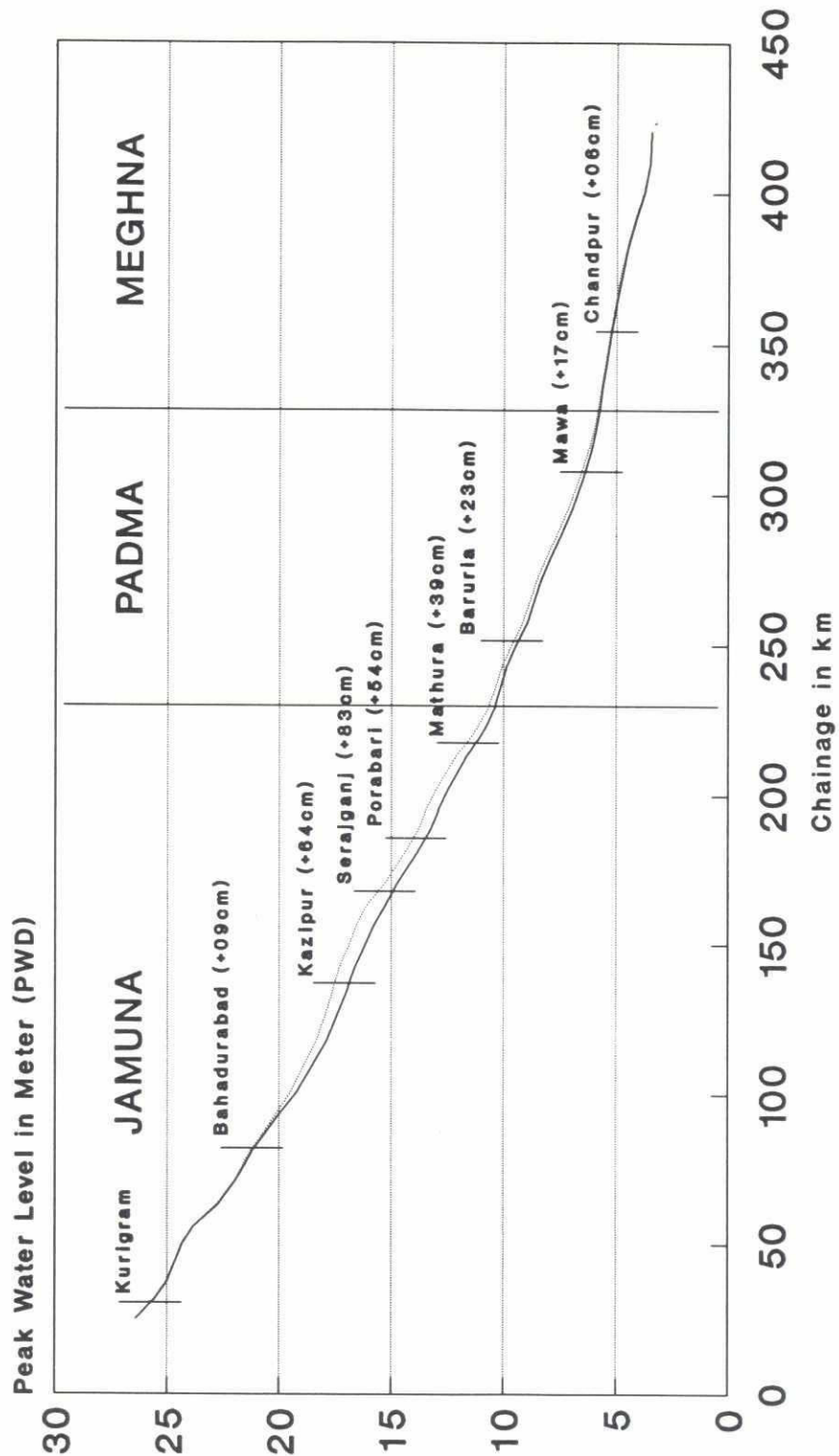
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MANAGEMENT

FLOOD HYDROLOGY STUDY

Scenario 3 : Peak Water Level Profile for the
Jamuna-Padma-Meghna System in 1988

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FIGURE 3.2 b)



— Existing Scenario 3

FAP25

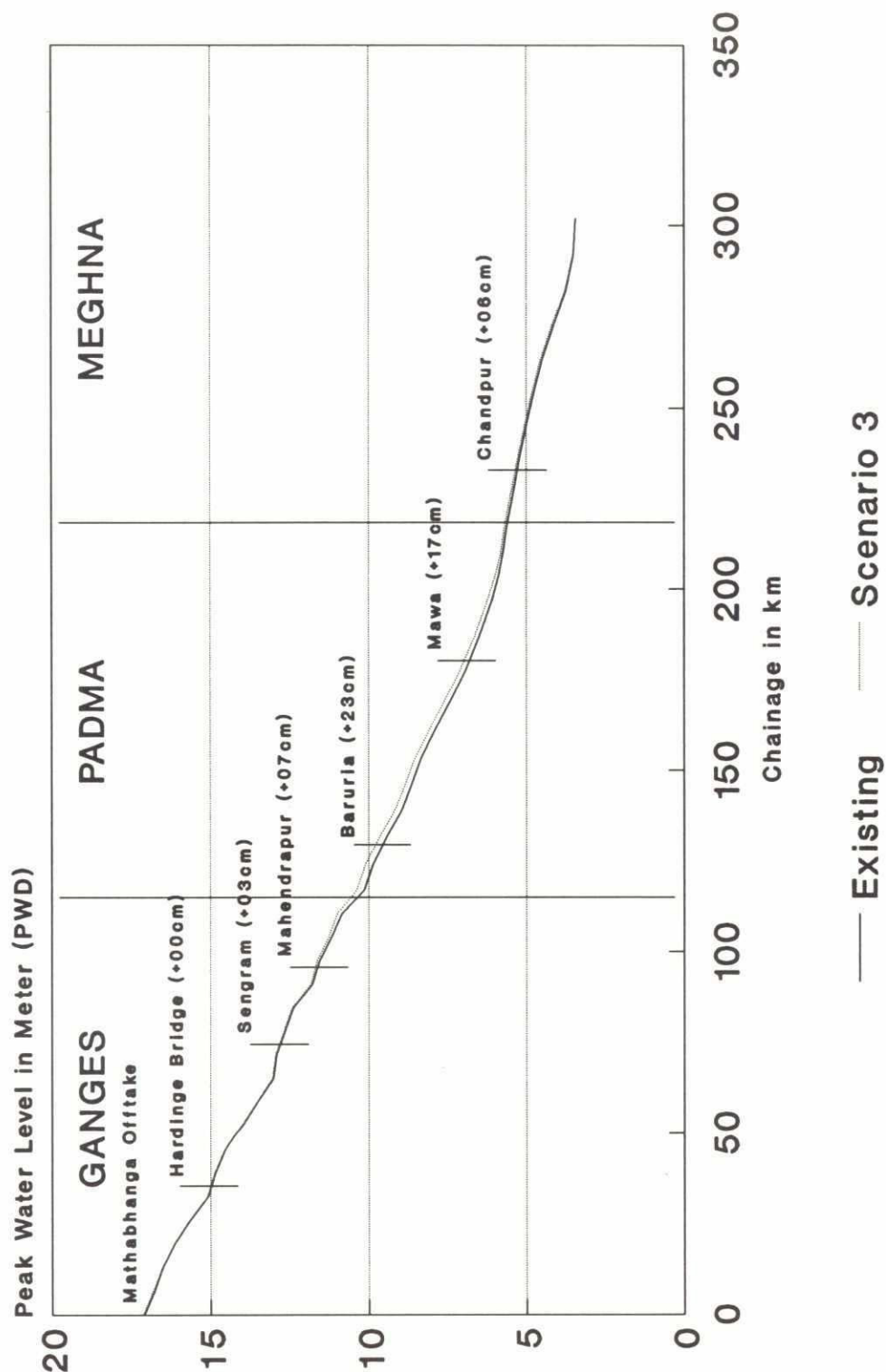
FLOOD MODELLING &
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FLOOD HYDROLOGY STUDY

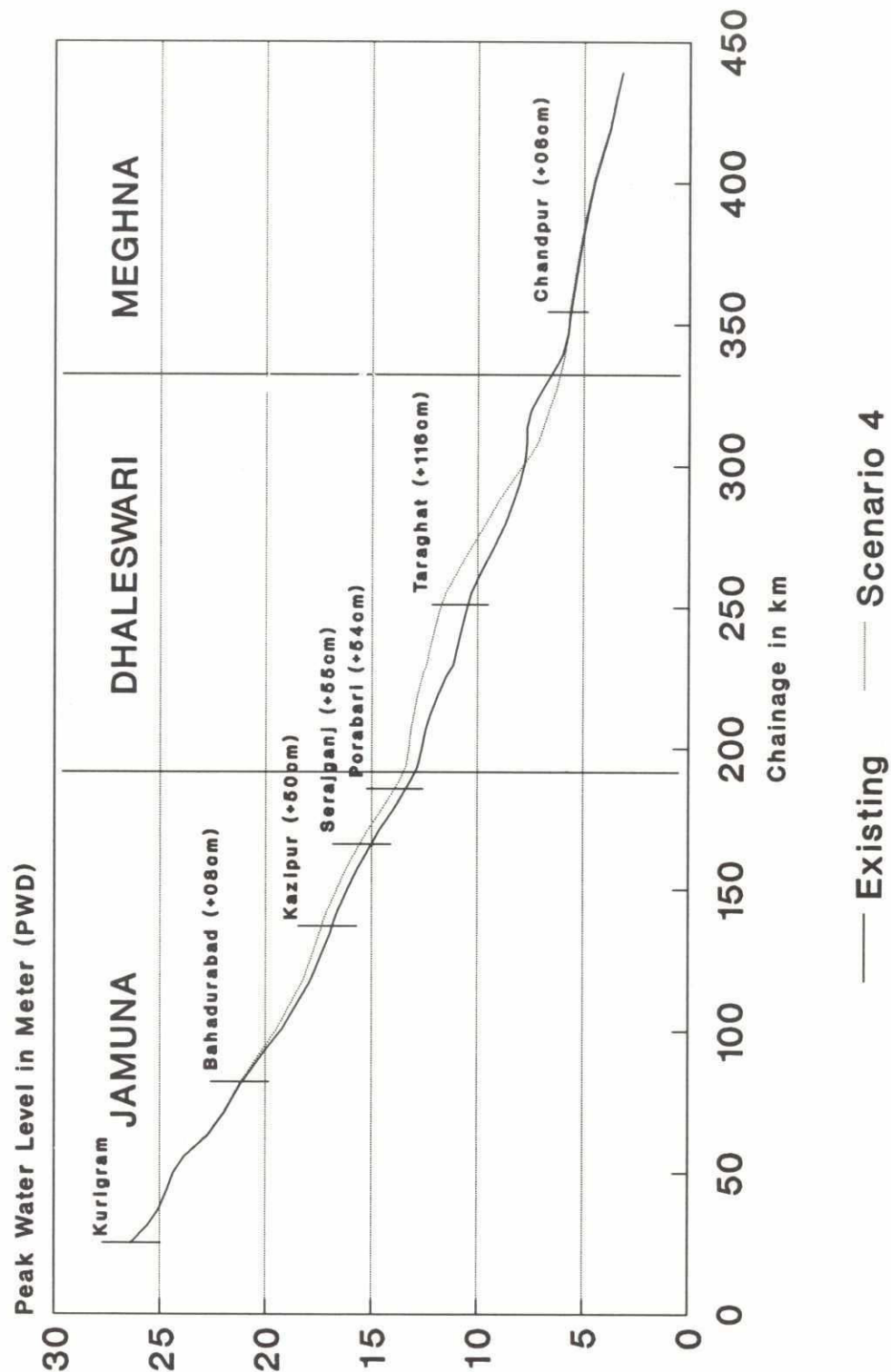
Scenario 3 : Peak Water Level Profile for the
Ganges-Padma-Meghna System in 1988

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FIGURE 3.2 c)



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FLOOD HYDROLOGY STUDY

Scenario 4 : Peak Water Level Profile for the
Jamuna-Dhaleswari-Meghna System in 1988

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FIGURE 3.3 a)

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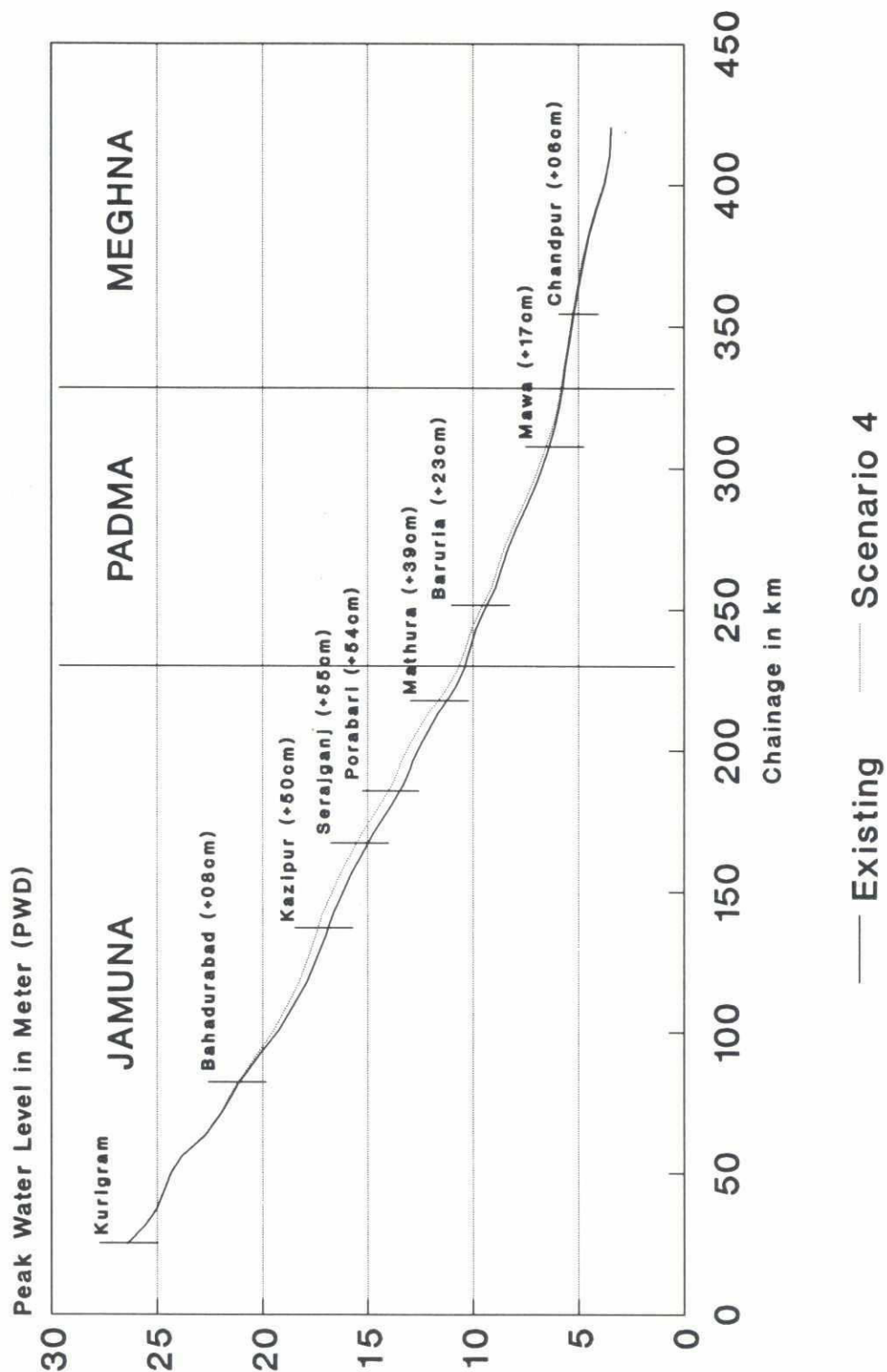
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FLOOD HYDROLOGY STUDY

Scenario 4 : Peak Water Level Profile for the
Jamuna-Padma-Meghna System in 1988

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FIGURE 3.3 b)



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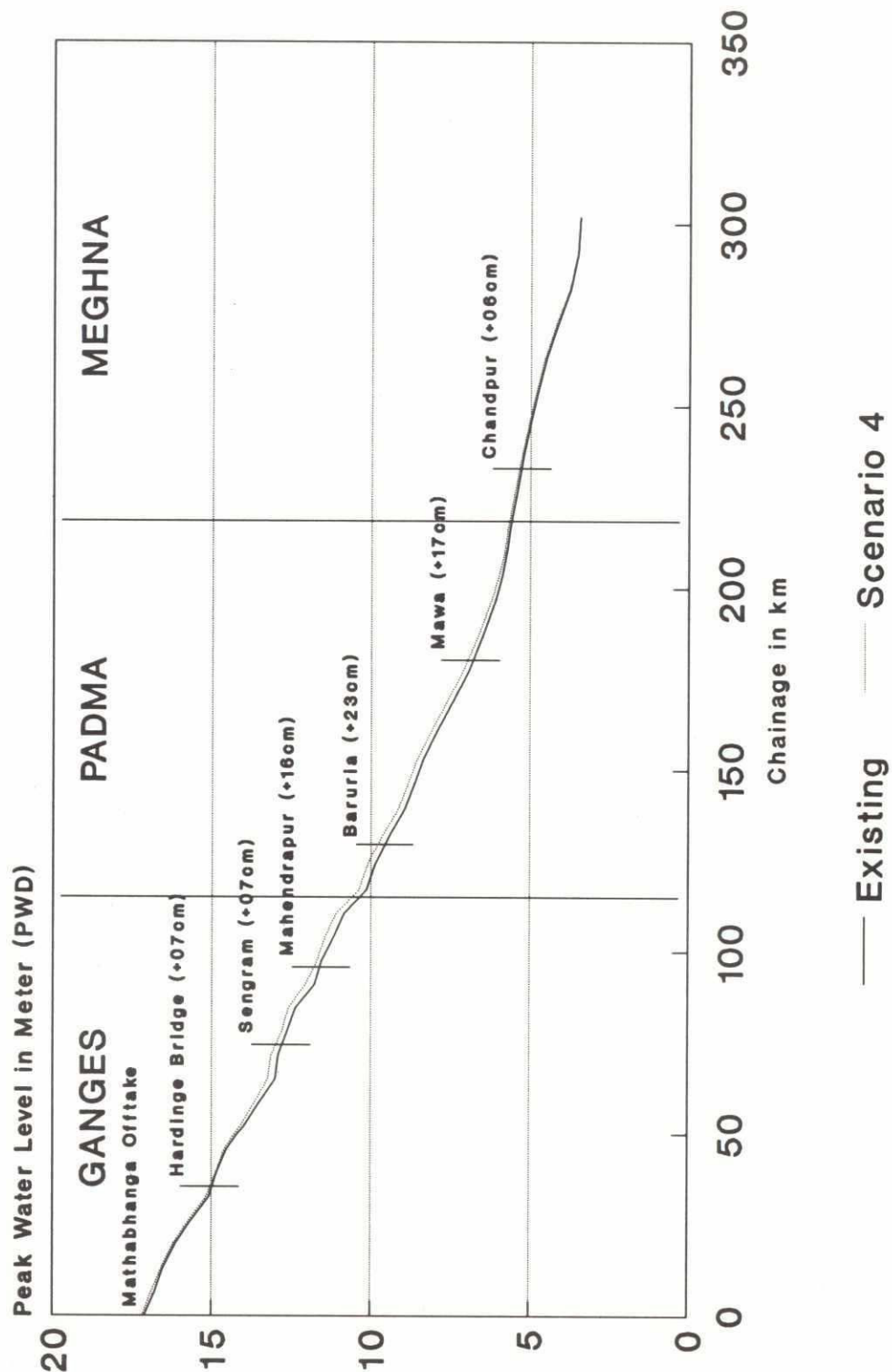
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FLOOD HYDROLOGY STUDY

Scenario 4 : Peak Water Level Profile for the Ganges-Padma-Meghna System in 1988

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FIGURE 3.3 c)



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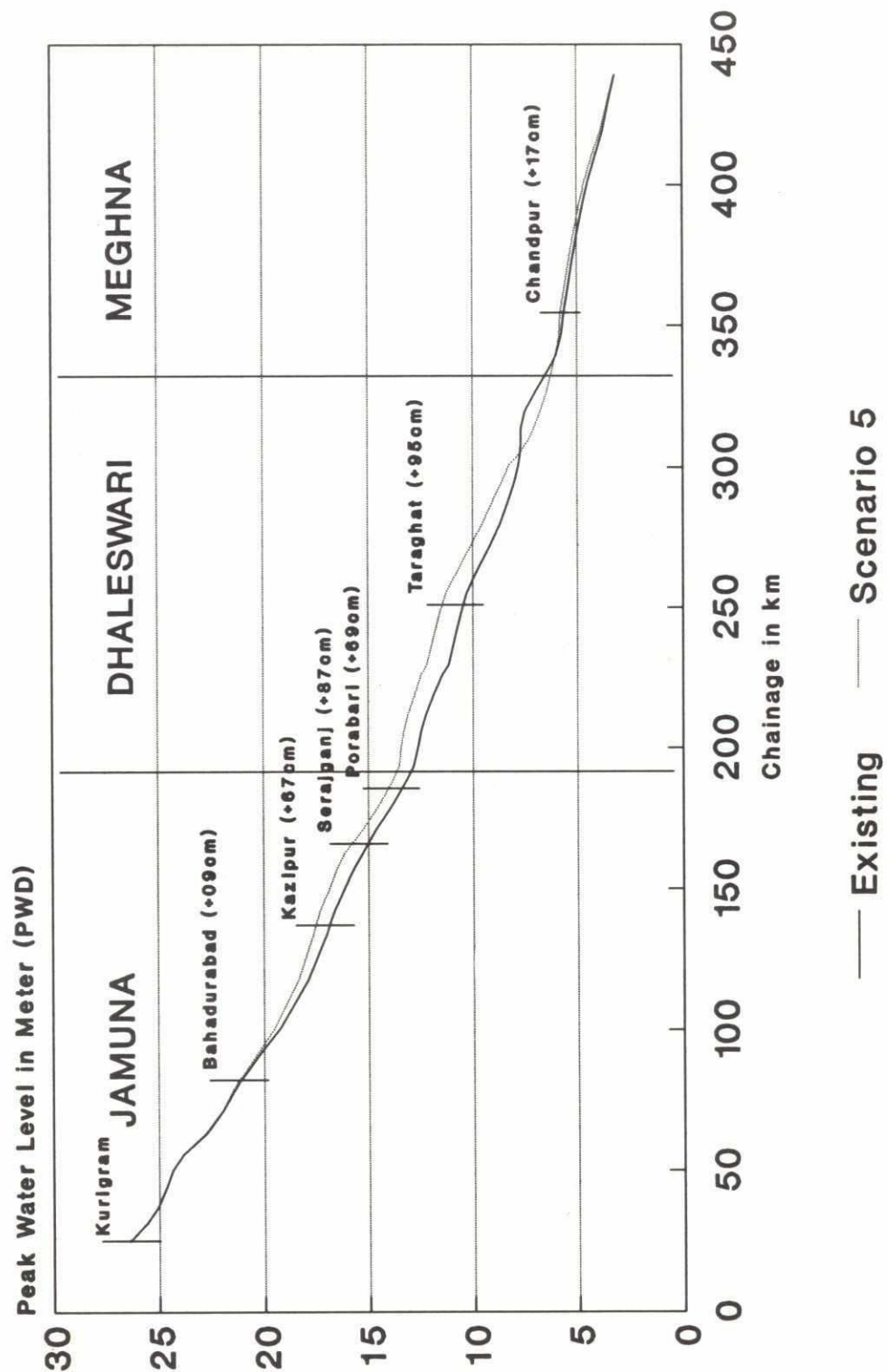
FLOOD MODELLING &
MANAGEMENT

FLOOD HYDROLOGY STUDY

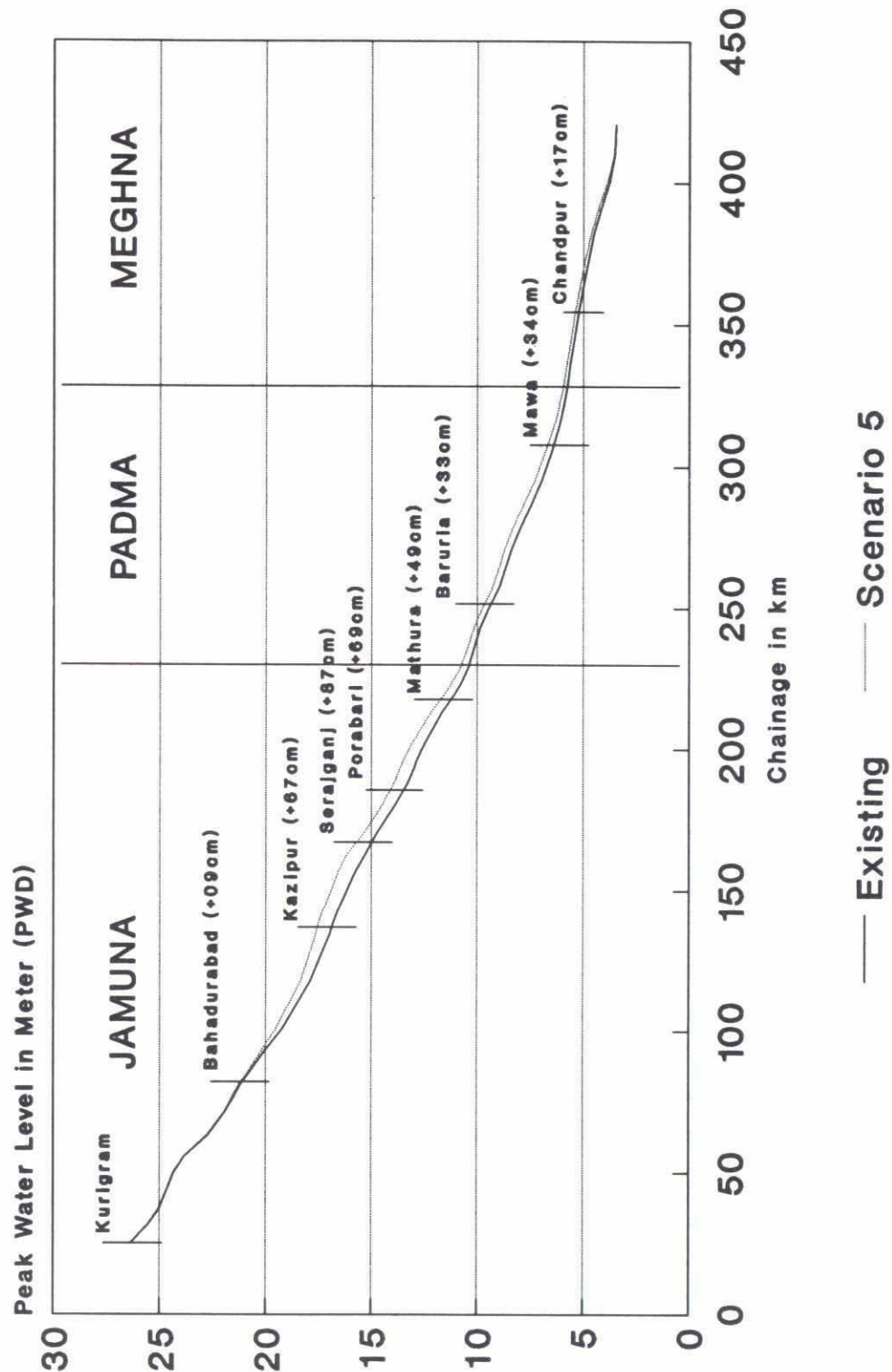
Scenario 5 : Peak Water Level Profile for the
Jamuna-Dhaleswari-Meghna System in 1988

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FIGURE 3.4 a)



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Scenario 5 : Peak Water Level Profile for the Jamuna-Padma-Meghna System in 1988

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FIGURE 3.4 b)

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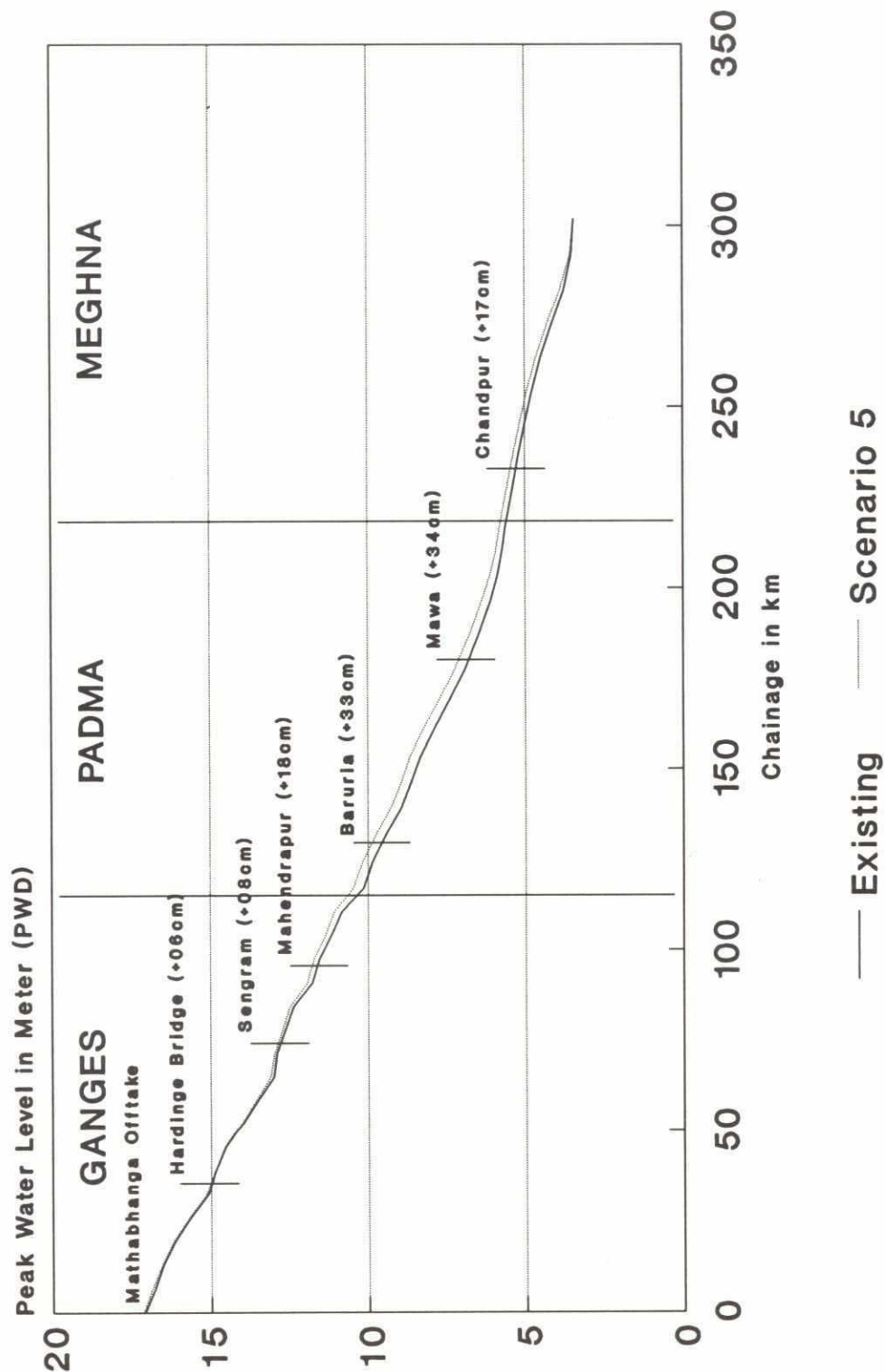
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FLOOD HYDROLOGY STUDY

Scenario 5 : Peak Water Level Profile for the
Ganges-Padma-Meghna System in 1988

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FIGURE 3.4 c)



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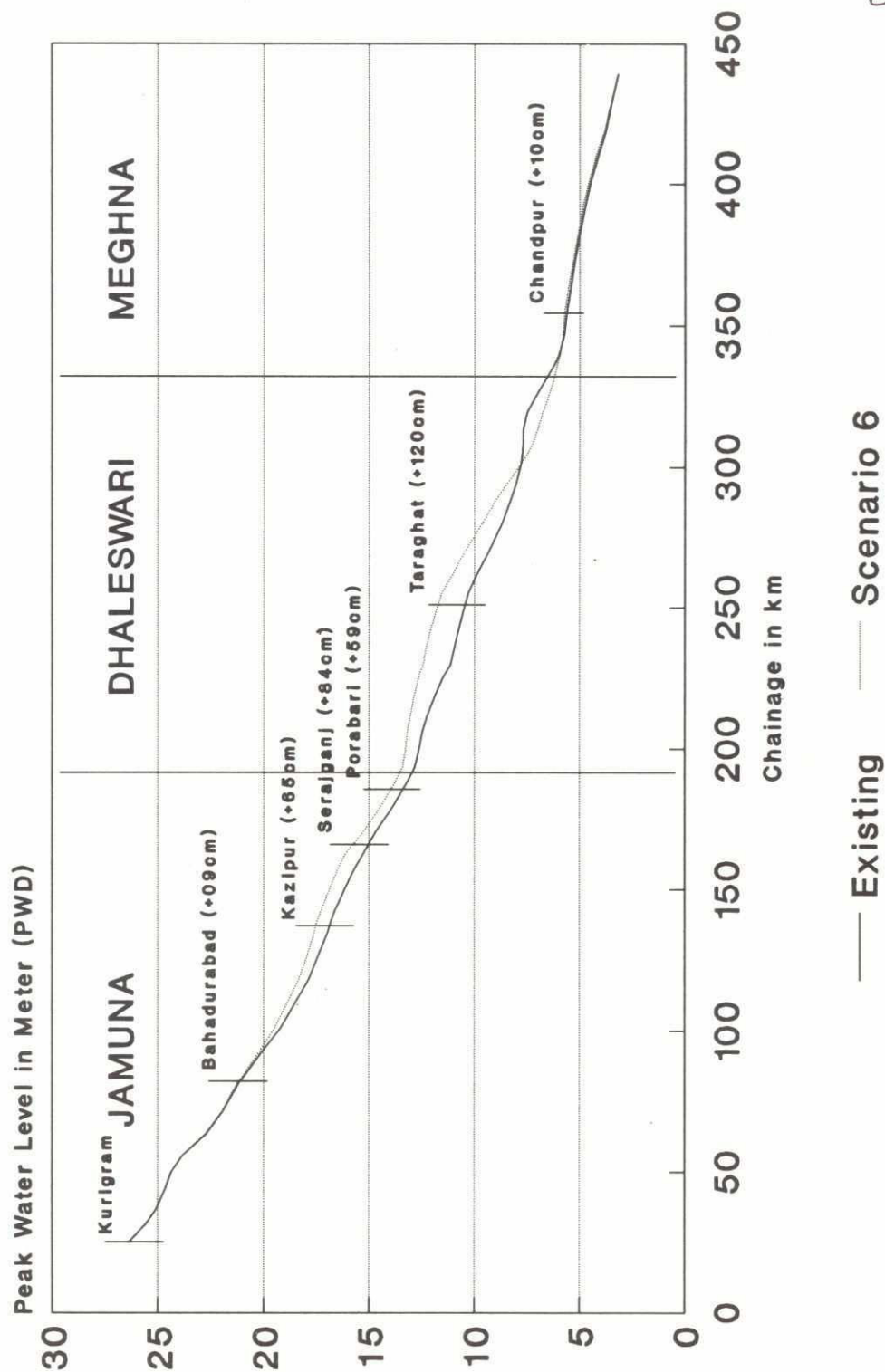
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MANAGEMENT

FLOOD HYDROLOGY STUDY

Scenario 6 : Peak Water Level Profile for the
Jamuna-Dhaleswari-Meghna System in 1988

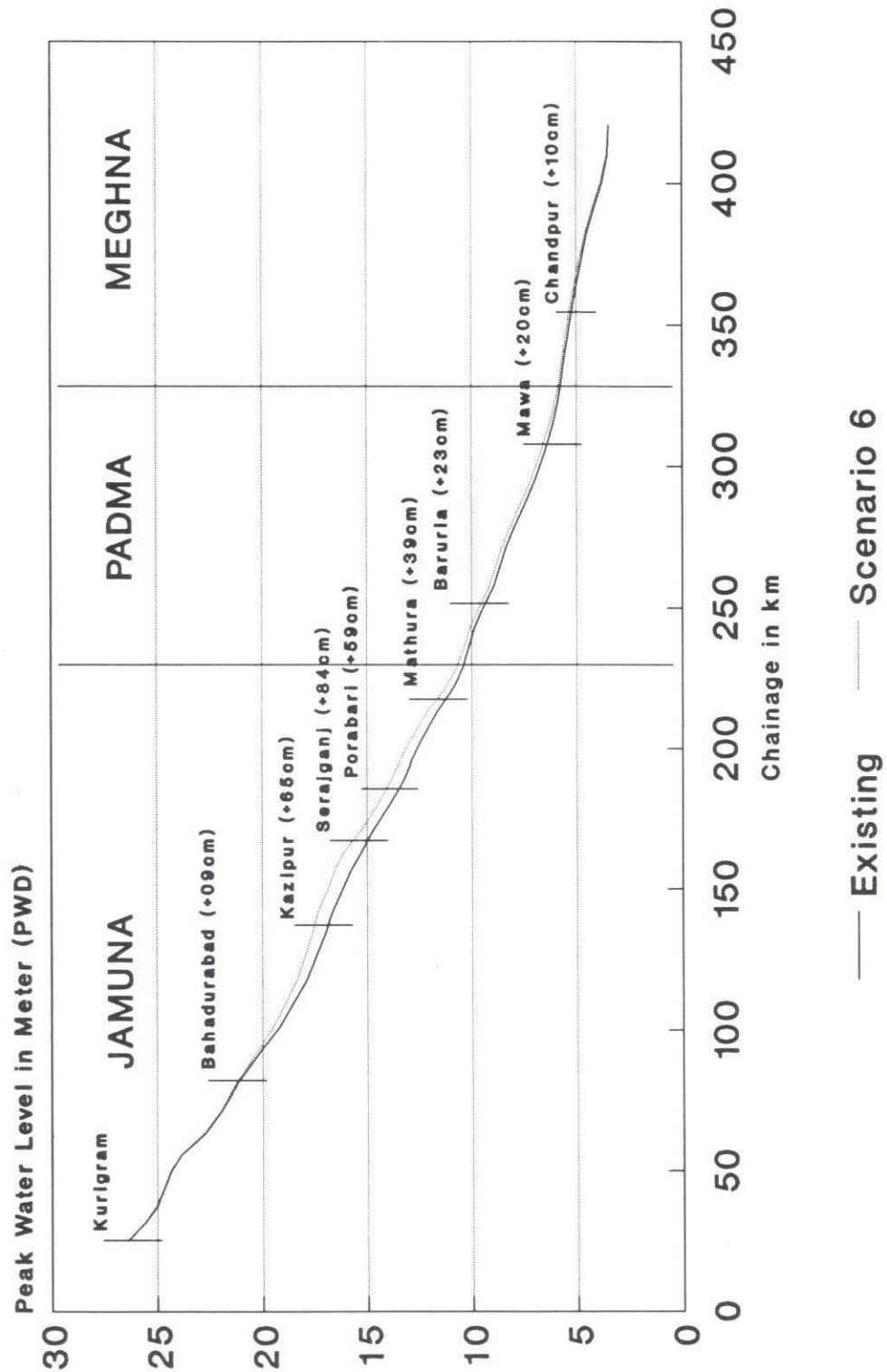
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FIGURE 3.5 a)



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FLOOD HYDROLOGY STUDY

Scenario 6 : Peak Water Level Profile for the Jamuna-Padma-Meghna System in 1988

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FIGURE 3.5 b)

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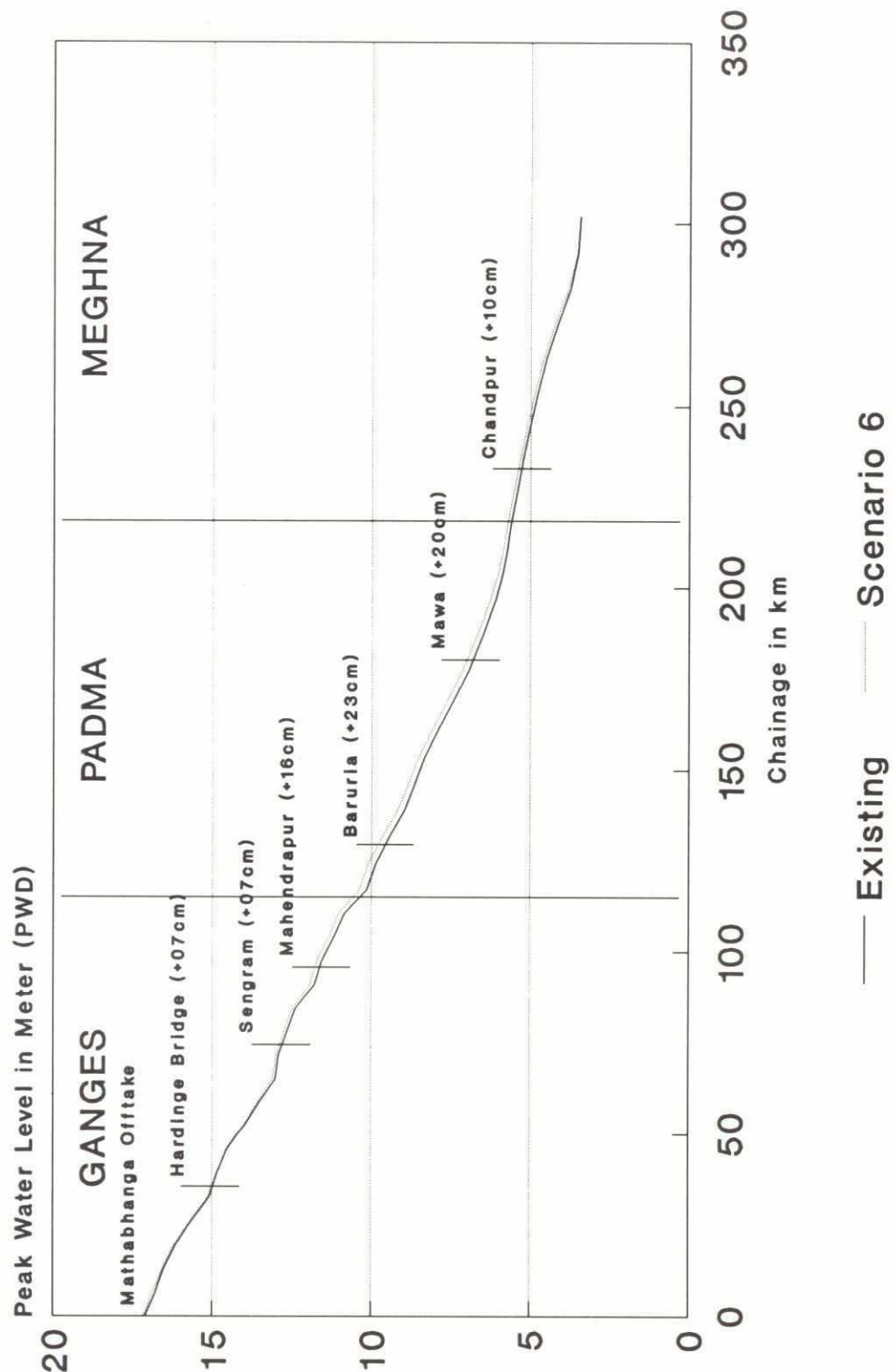
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FLOOD HYDROLOGY STUDY

Scenario 6 : Peak Water Level Profile for the Ganges-Padma-Meghna System in 1988

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FIGURE 3.5 c)



22b

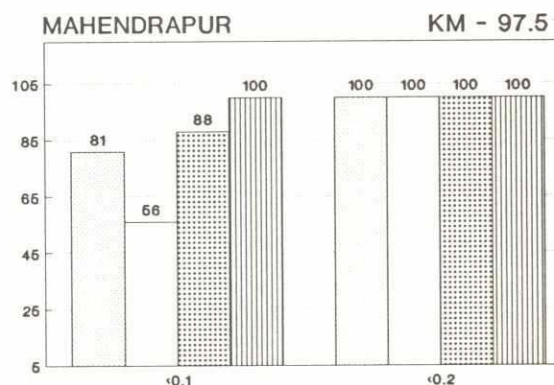
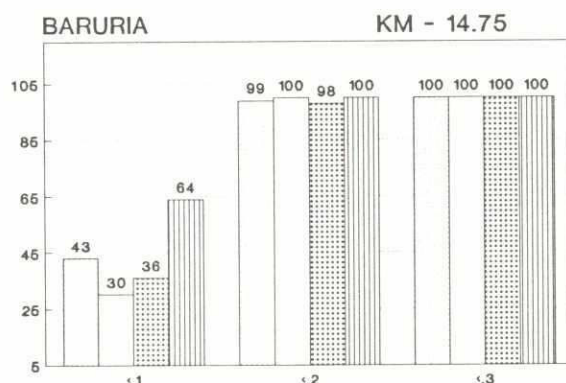
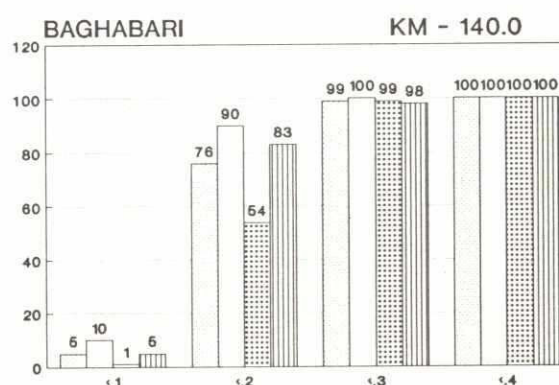
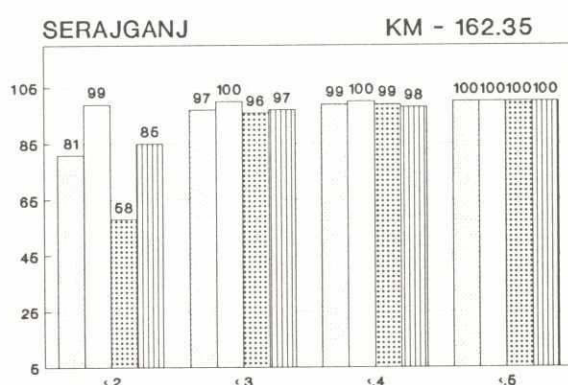
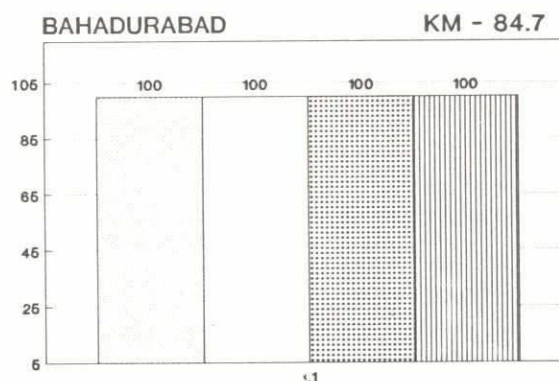
SCENARIO 2 : DISTRIBUTION OF CHANGES IN WATER LEVEL

LEGEND :

X-axis ■ Difference in Level in Meter
Y-axis ■ Non Exceedance Percentage



- May to October
- May to June
- July to August
- September to October



FLOOD HYDROLOGY STUDY

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MANAGEMENT

Scenario 2 : Distribution of Water Level Changes
Compared to Existing Situation at Bahadurabad,
Serajganj, Baghabari, Baruria and Mahendrapur

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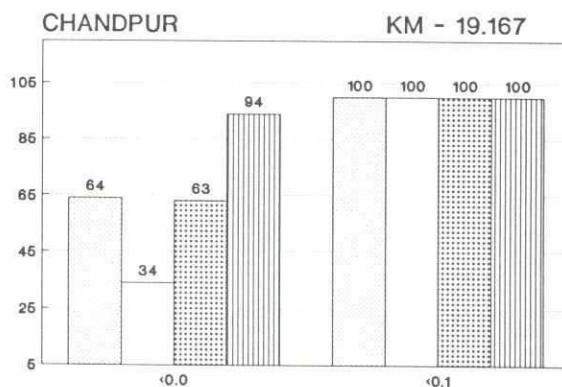
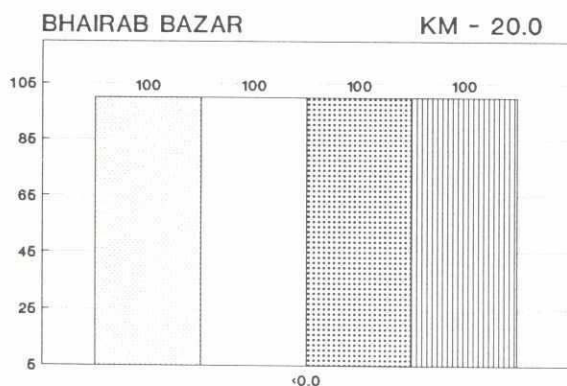
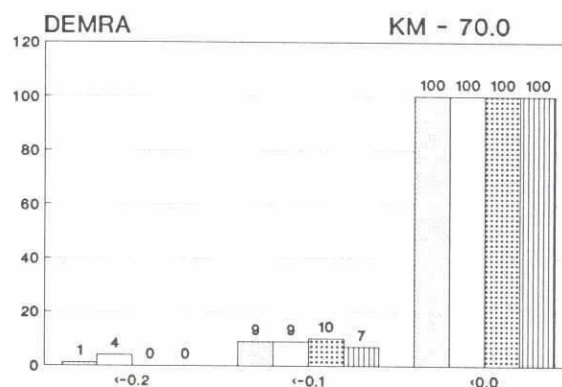
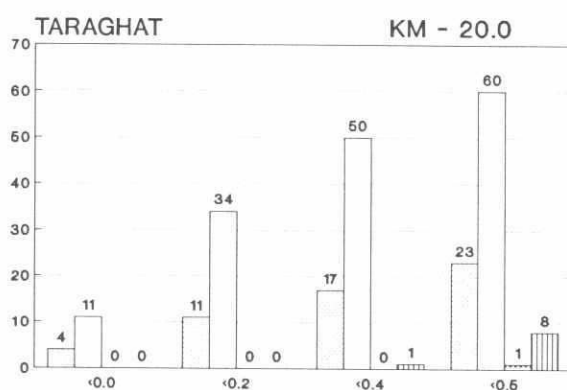
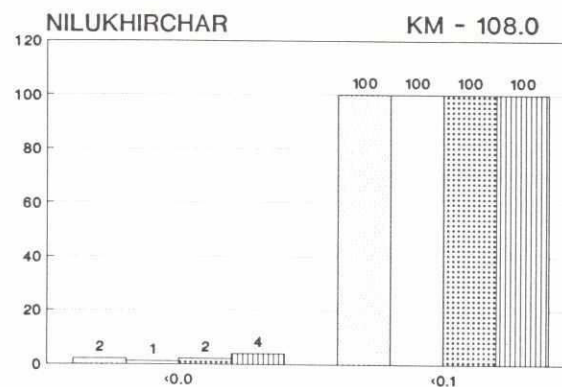
FIGURE 3.6 a)

SCENARIO 2 : DISTRIBUTION OF CHANGES IN WATER LEVEL

LEGEND :

X-axis ■ Difference in Level in Meter
Y-axis ■ Non Exceedance Percentage

- May to October
- May to June
- July to August
- September to October



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FLOOD HYDROLOGY STUDY

Scenario 2 : Distribution of Water Level Changes
Compared to Existing Situation at Nilukhirchar,
Taraghat, Demra, Bhairab Bazar and Chandpur

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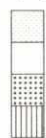
FIGURE 3.6 b)

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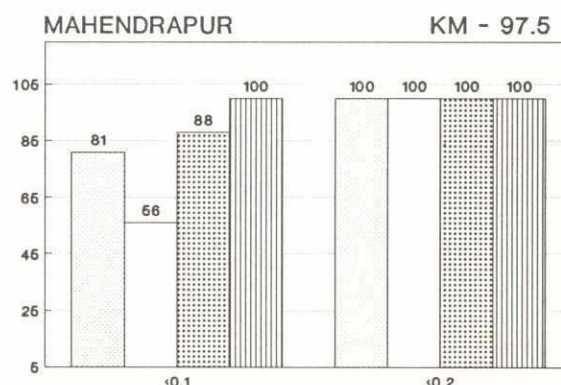
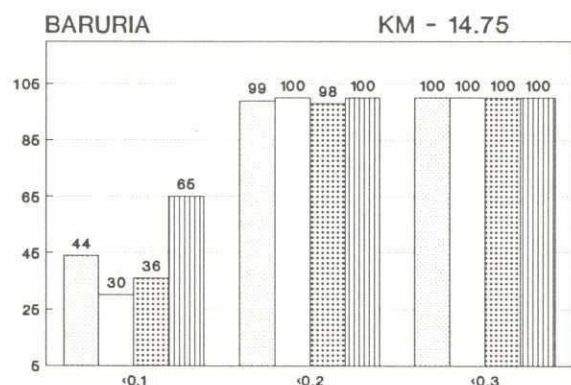
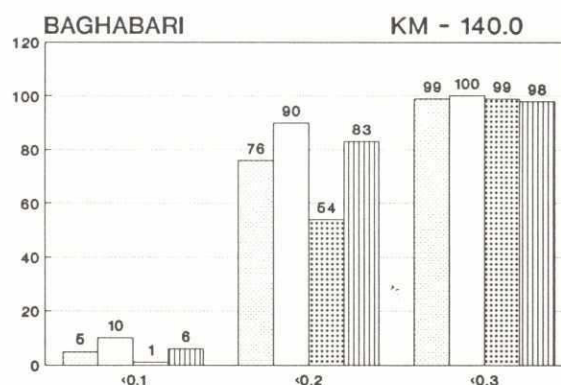
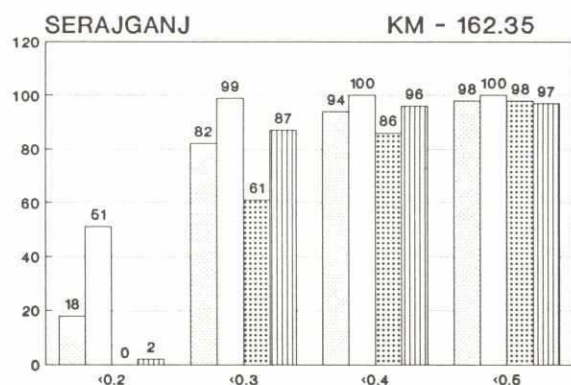
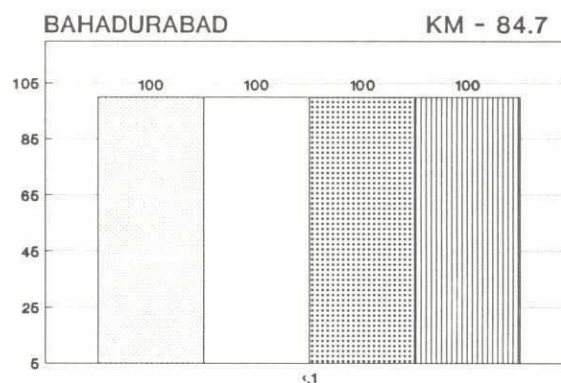
SCENARIO 3 : DISTRIBUTION OF CHANGES IN WATER LEVEL

LEGEND :

X-axis ▪ Difference in Level in Meter
Y-axis ▪ Non Exceedance Percentage



- May to October
- May to June
- July to August
- September to October



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FLOOD HYDROLOGY STUDY

Scenario 3 : Distribution of Water Level Changes
Compared to Existing Situation at Bahadurabad,
Serajganj, Baghabari, Baruria and Mahendrapur

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FIGURE 3.7 a)

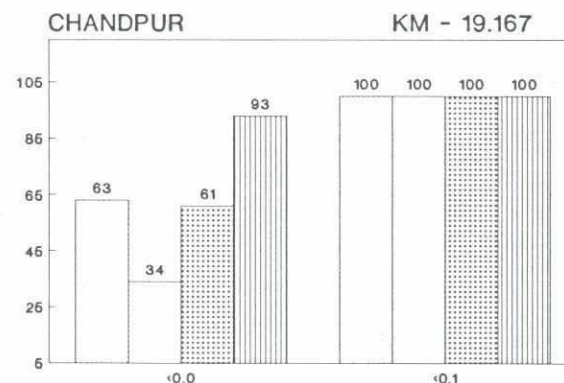
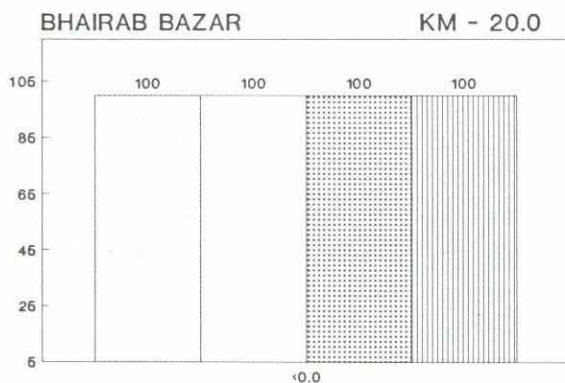
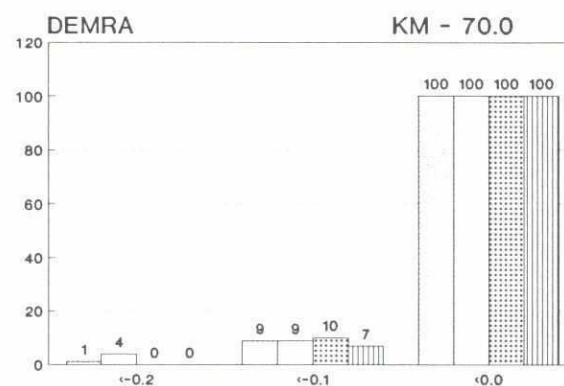
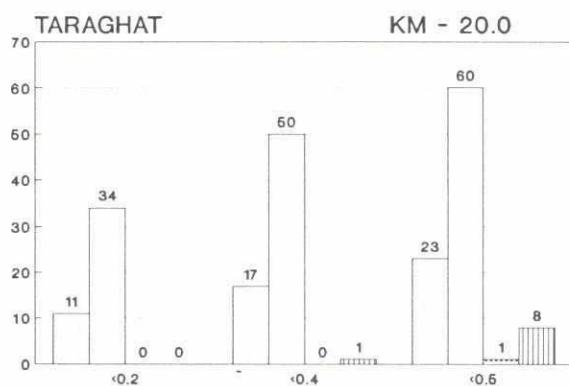
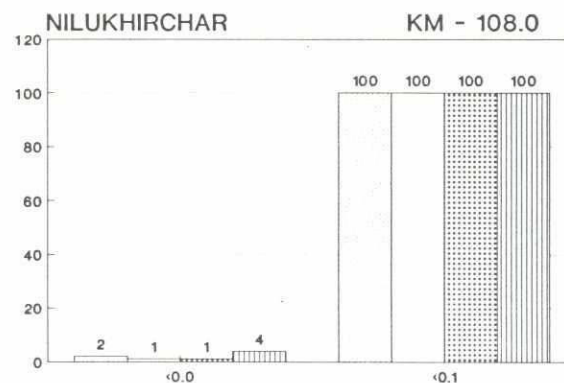
SCENARIO 3 : DISTRIBUTION OF CHANGES IN WATER LEVEL

LEGEND :

X-axis = Difference in Level in Meter
Y-axis = Non Exceedance Percentage



- May to October
- May to June
- July to August
- September to October



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FLOOD HYDROLOGY STUDY

Scenario 3 : Distribution of Water Level Changes
Compared to Existing Situation at Nilukhirchar,
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FIGURE 3.7 b)

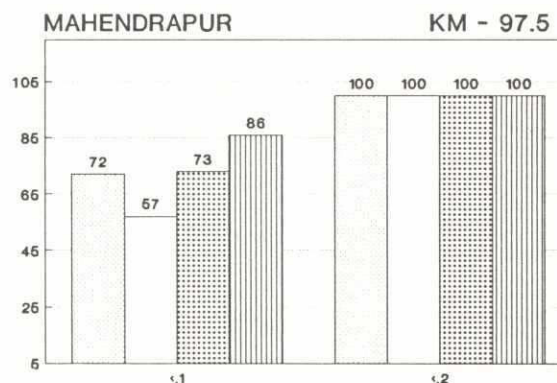
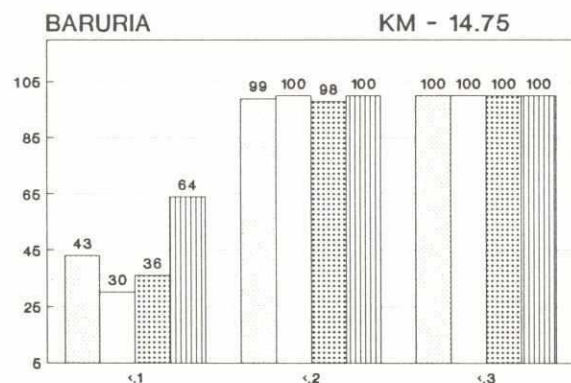
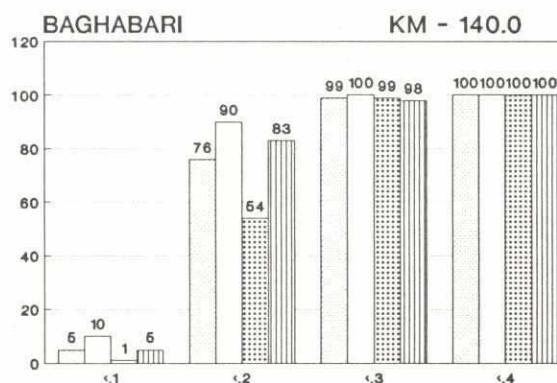
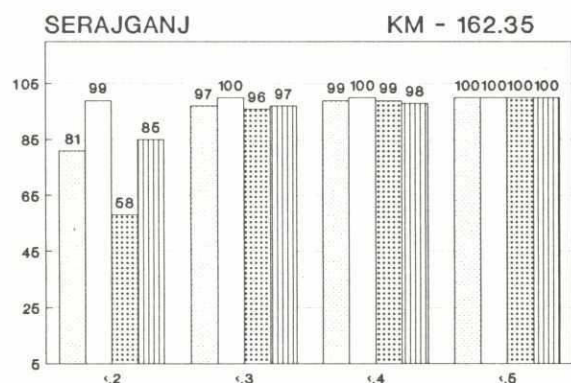
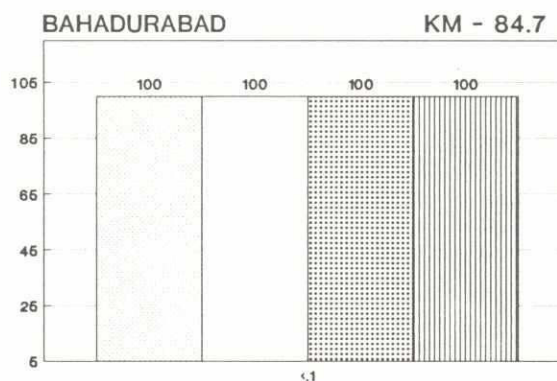
SCENARIO 4 : DISTRIBUTION OF CHANGES IN WATER LEVEL

LEGEND :

X-axis ■ Difference in Level in Meter
Y-axis ■ Non Exceedance Percentage



- May to October
- May to June
- July to August
- September to October



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Scenario 4 : Distribution of Water Level Changes
Compared to Existing Situation at Bahadurabad,
Serajganj, Baghabari, Baruria and Mahendrapur

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FIGURE 3.8 a)

FIGURE 3.8 b)

RD

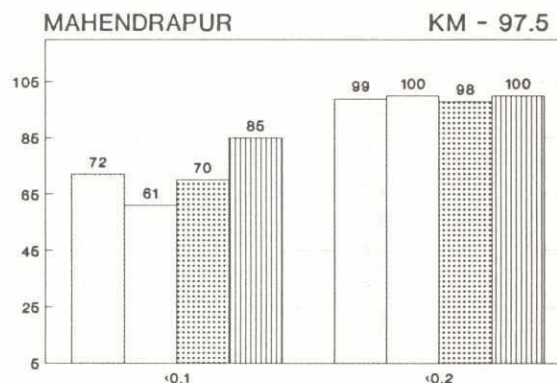
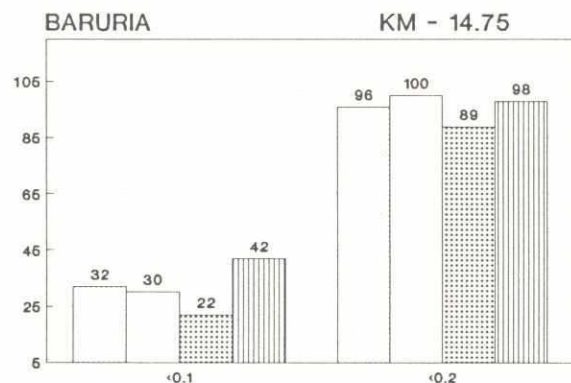
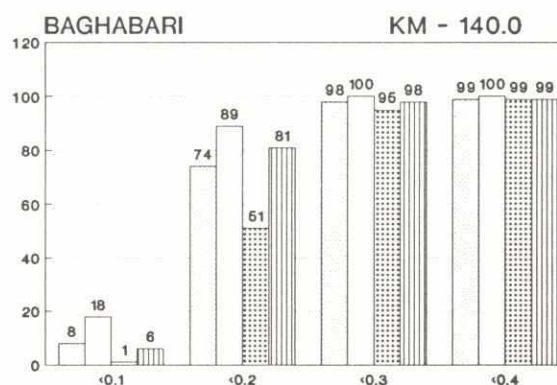
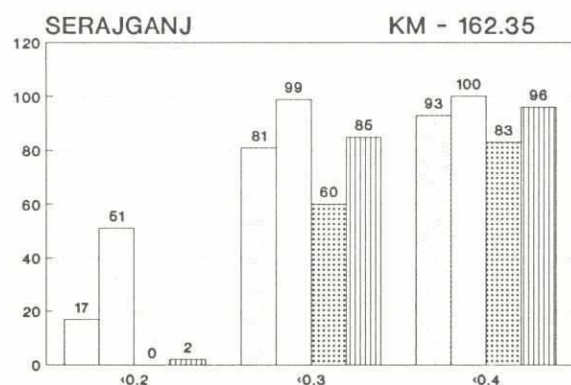
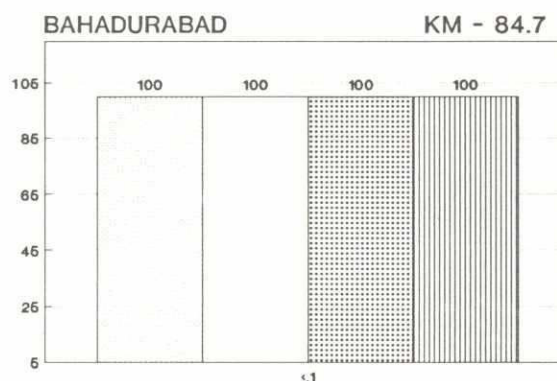
SCENARIO 5 : DISTRIBUTION OF CHANGES IN WATER LEVEL

LEGEND :

X-axis ■ Difference in Level in Meter
Y-axis ■ Non Exceedance Percentage



- May to October
- May to June
- July to August
- September to October



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Scenario 5 : Distribution of Water Level Changes
Compared to Existing Situation at Bahadurabad,
Serajganj, Baghabari, Baruria and Mahendrapur

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FIGURE 3.9 a)

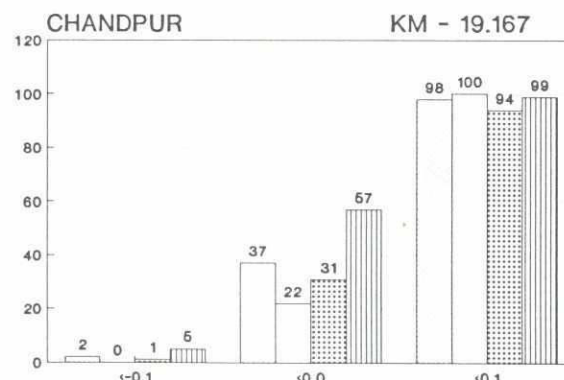
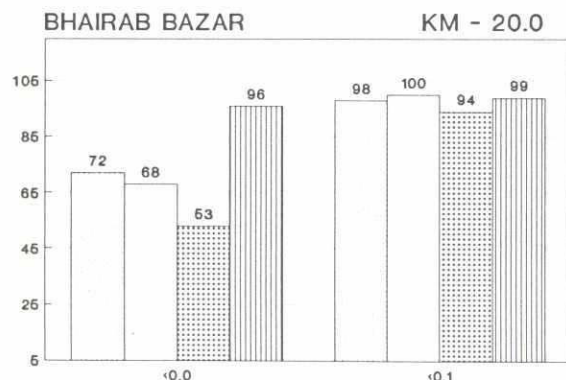
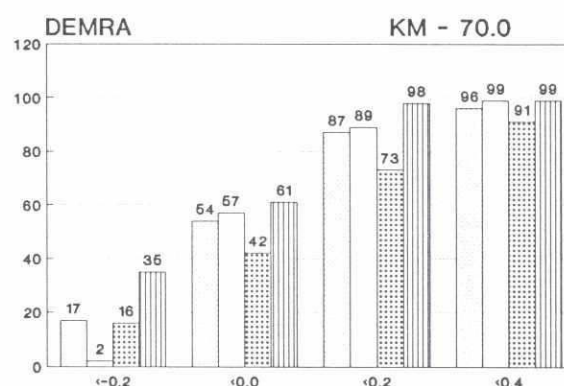
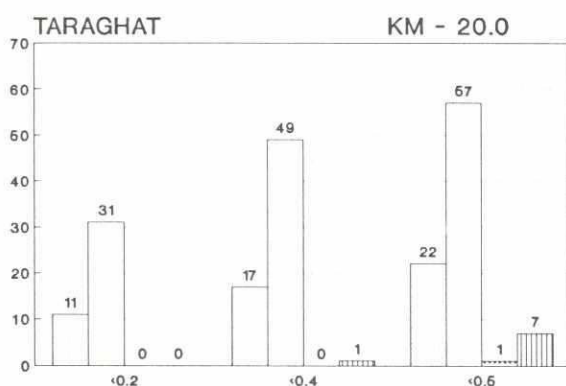
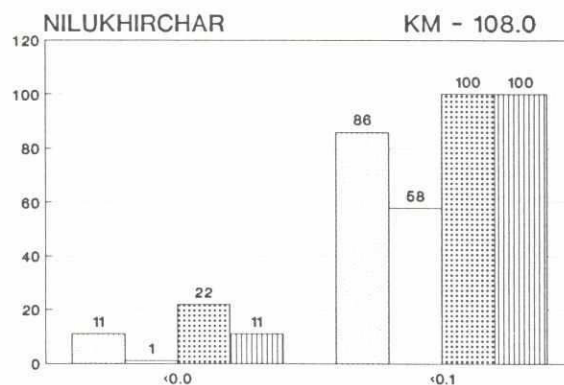
SCENARIO 5 : DISTRIBUTION OF CHANGES IN WATER LEVEL

LEGEND :

X-axis ▪ Difference in Level in Meter
Y-axis ▪ Non Exceedance Percentage



- May to October
- May to June
- July to August
- September to October



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Scenario 5 : Distribution of Water Level Changes
Compared to Existing Situation at Nilukhirchar,
Taraghat, Demra, Bhairab Bazar and Chandpur

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FIGURE 3.9 b)

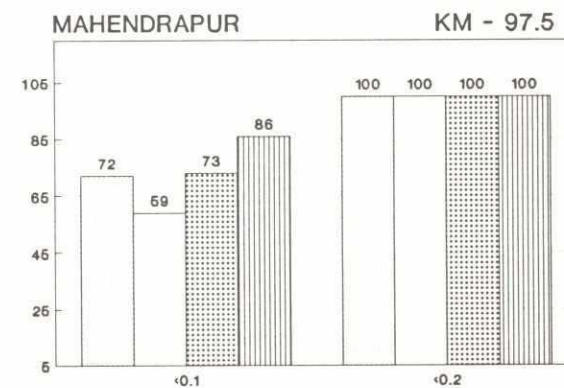
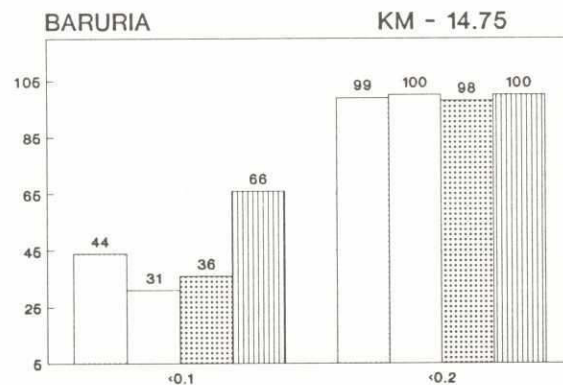
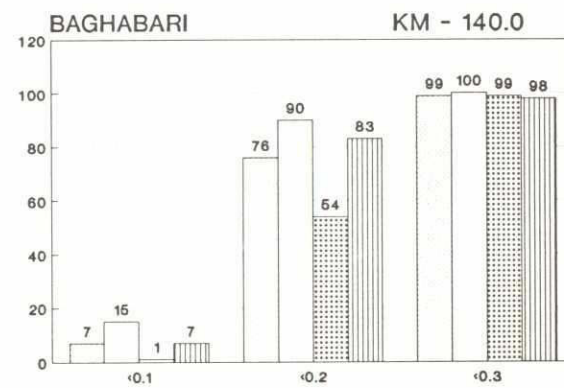
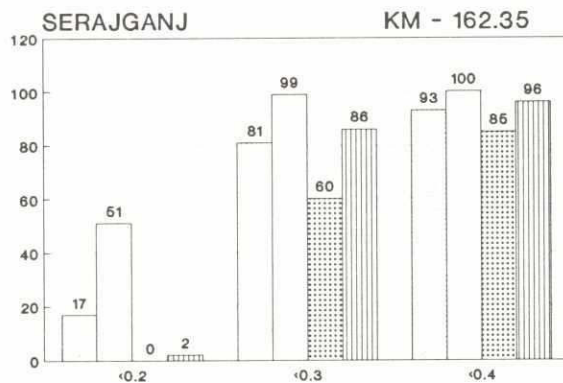
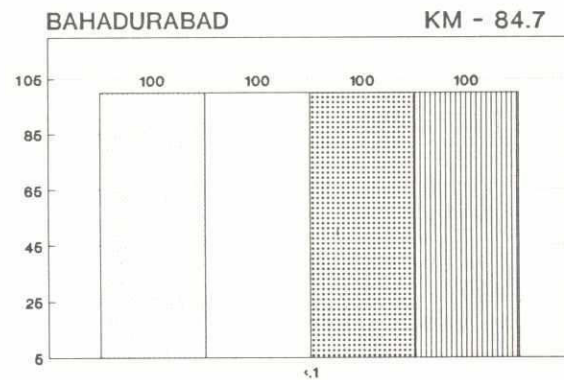
SCENARIO 6 : DISTRIBUTION OF CHANGES IN WATER LEVEL

LEGEND :

X-axis ▪ Difference in Level in Meter
Y-axis ▪ Non Exceedance Percentage



- May to October
- May to June
- July to August
- September to October



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Scenario 6 : Distribution of Water Level Changes
Compared to Existing Situation at Bahadurabad,
Serajganj, Baghabari, Baruria and Mahendrapur

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FIGURE 3.10 a)

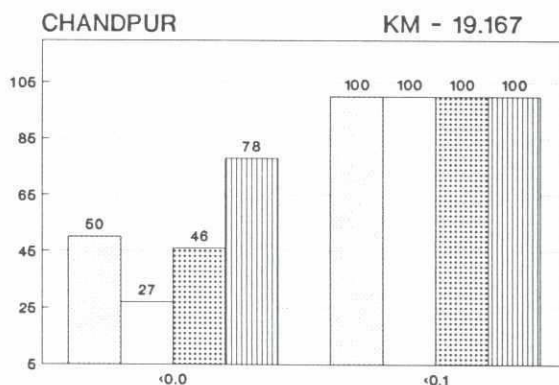
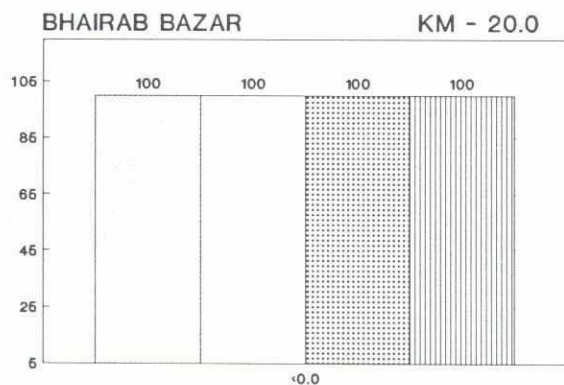
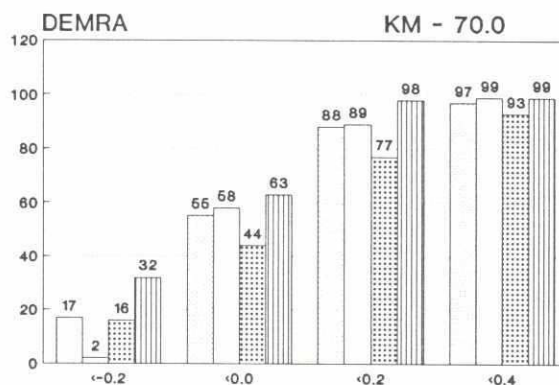
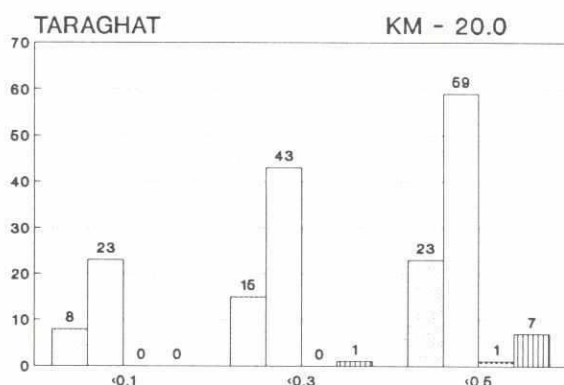
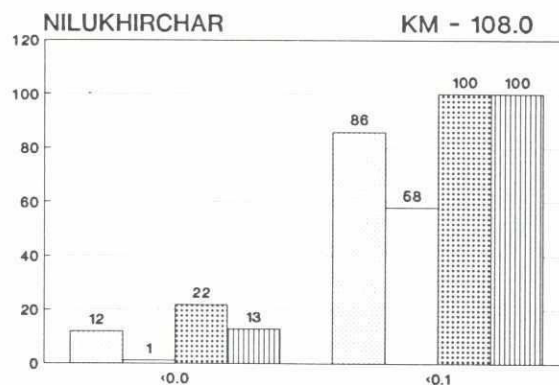
SCENARIO 6 : DISTRIBUTION OF CHANGES IN WATER LEVEL

LEGEND :

X-axis ■ Difference in Level in Meter
Y-axis ■ Non Exceedance Percentage



- May to October
- May to June
- July to August
- September to October



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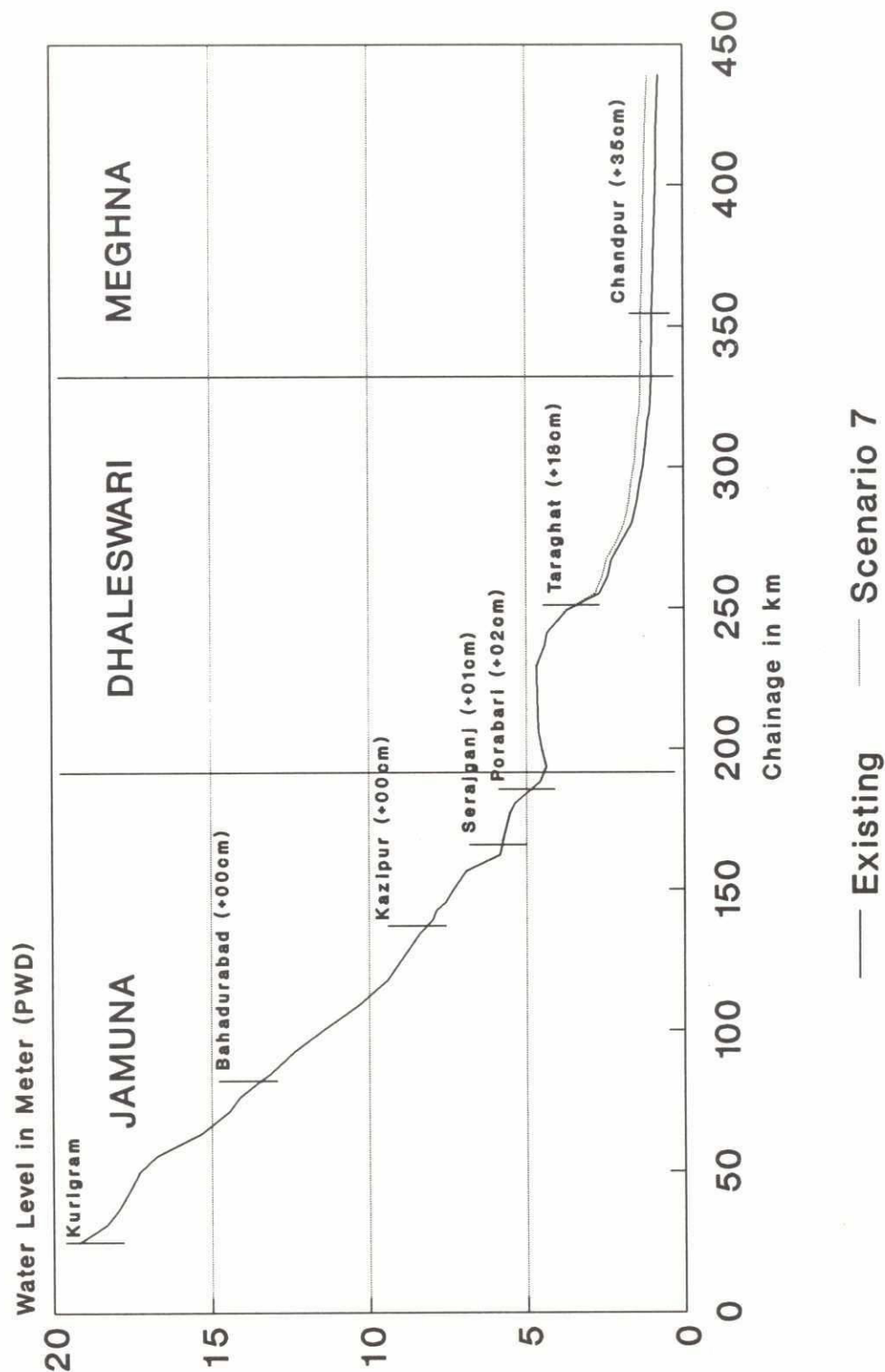
FLOOD HYDROLOGY STUDY

Scenario 6 : Distribution of Water Level Changes
Compared to Existing Situation at Nilukhirchar,
Taraghat, Demra, Bhairab Bazar and Chandpur

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FIGURE 3.10 b)

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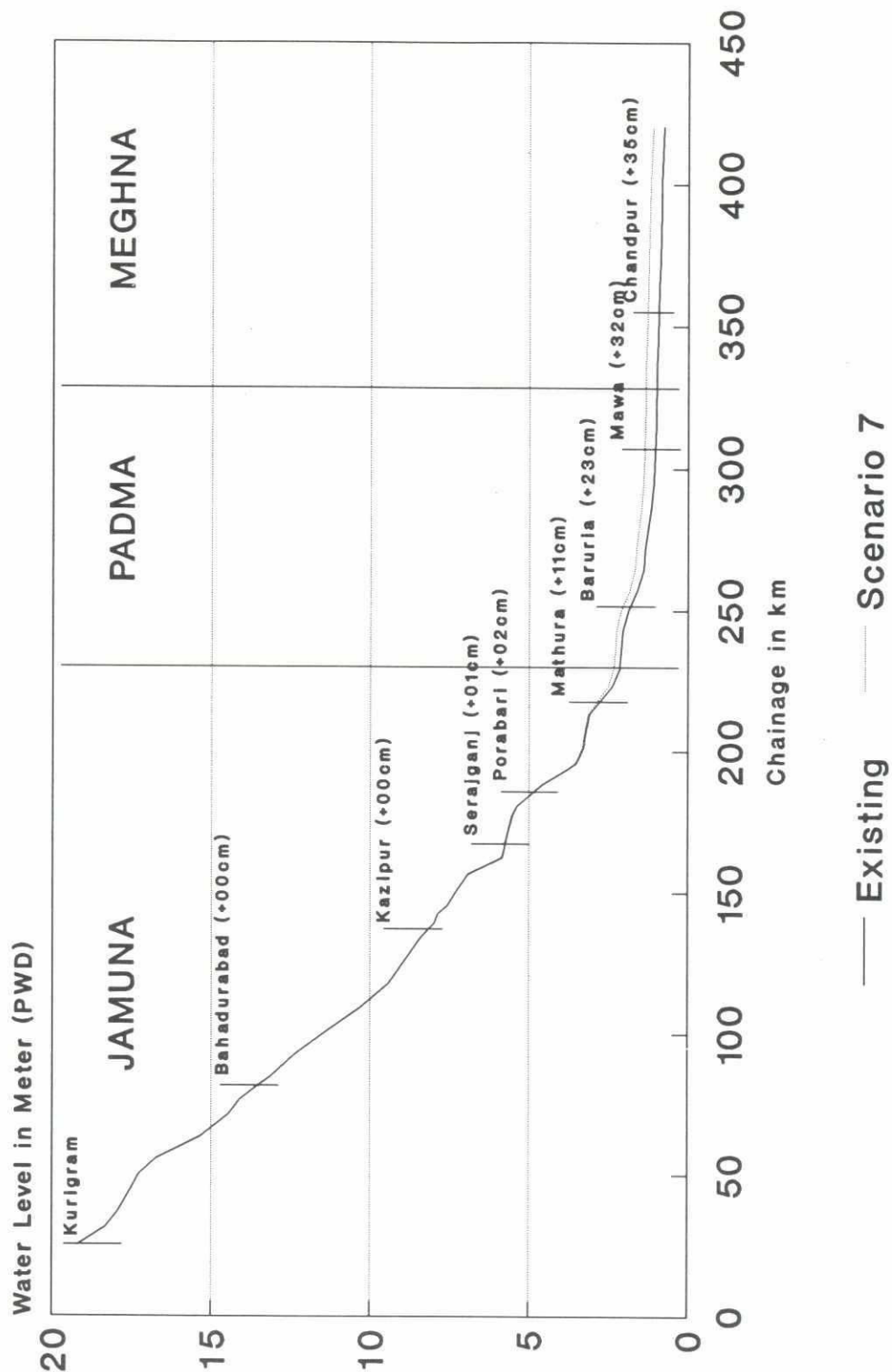
FLOOD HYDROLOGY STUDY

Scenario 7 : Minimum Water Level Profile for the Jamuna-Dhaleswari-Meghna System in March, 1988

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FIGURE 3.11 a)

26b



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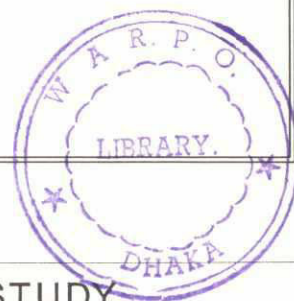
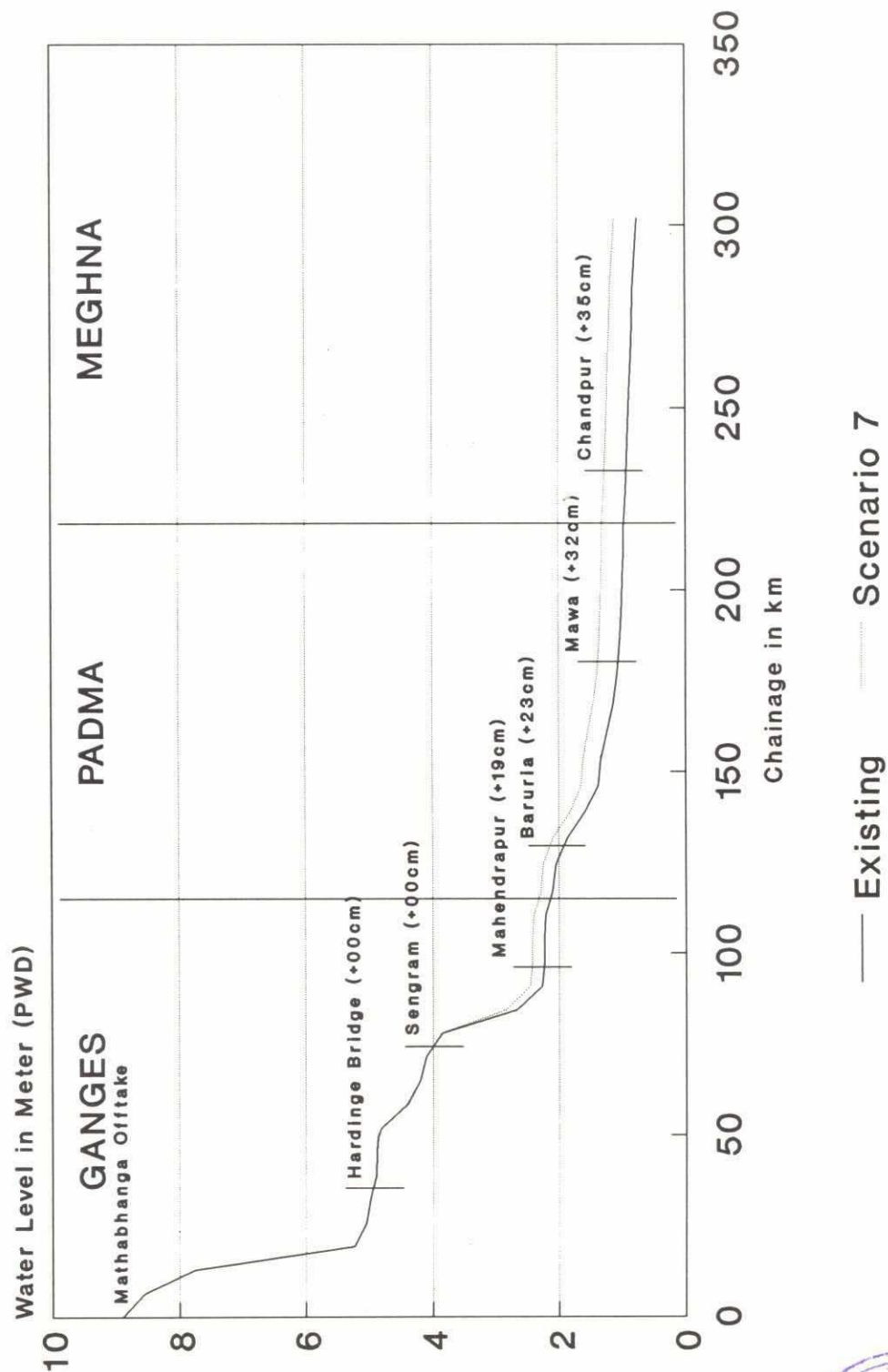
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FLOOD HYDROLOGY STUDY

Scenario 7 : Minimum Water Level Profile for the Jamuna-Padma-Meghna System in March, 1988

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FIGURE 3.11 b)



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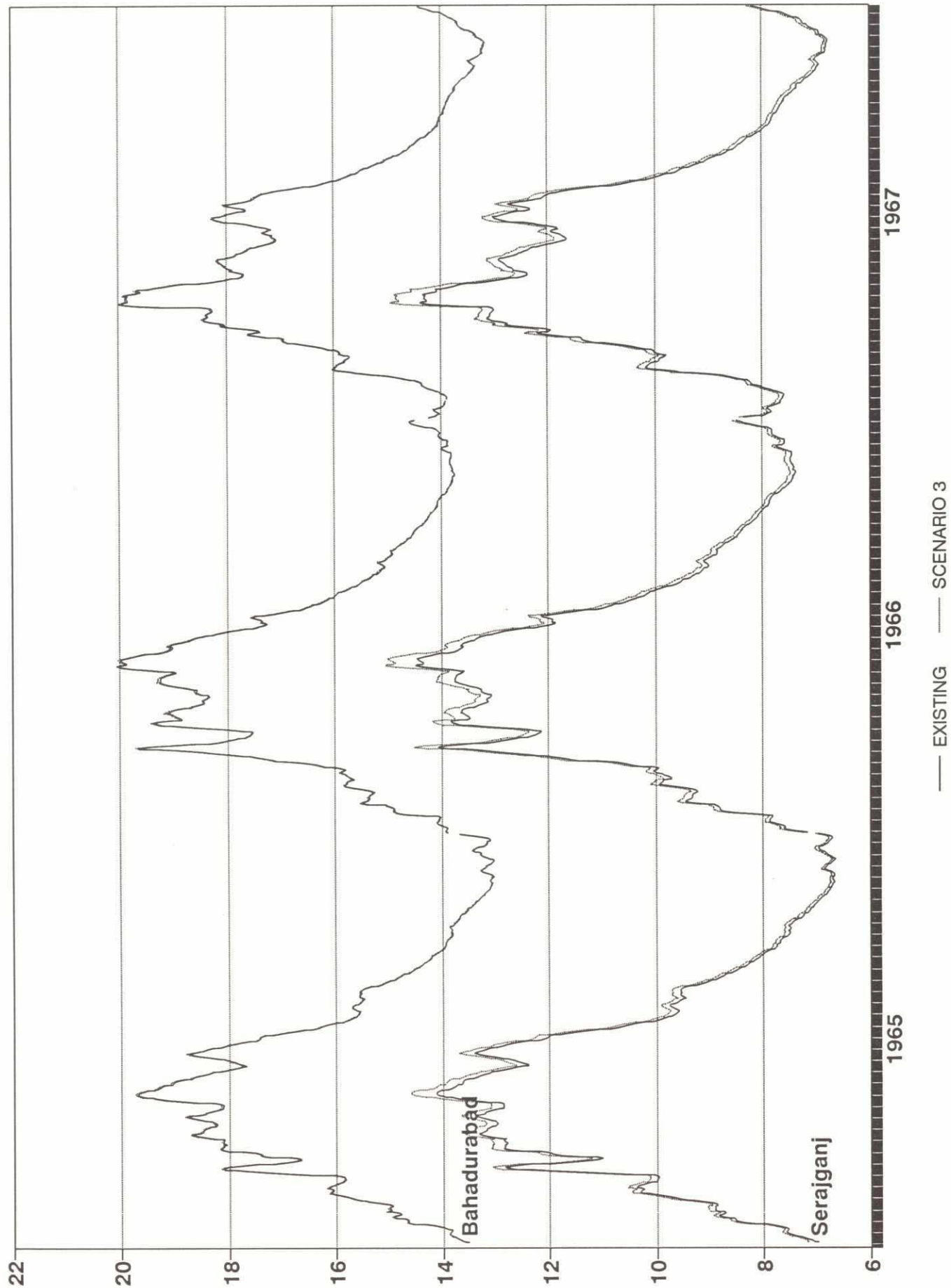
FLOOD HYDROLOGY STUDY

Scenario 7 : Minimum Water Level Profile for the Ganges-Padma-Meghna System in March, 1988

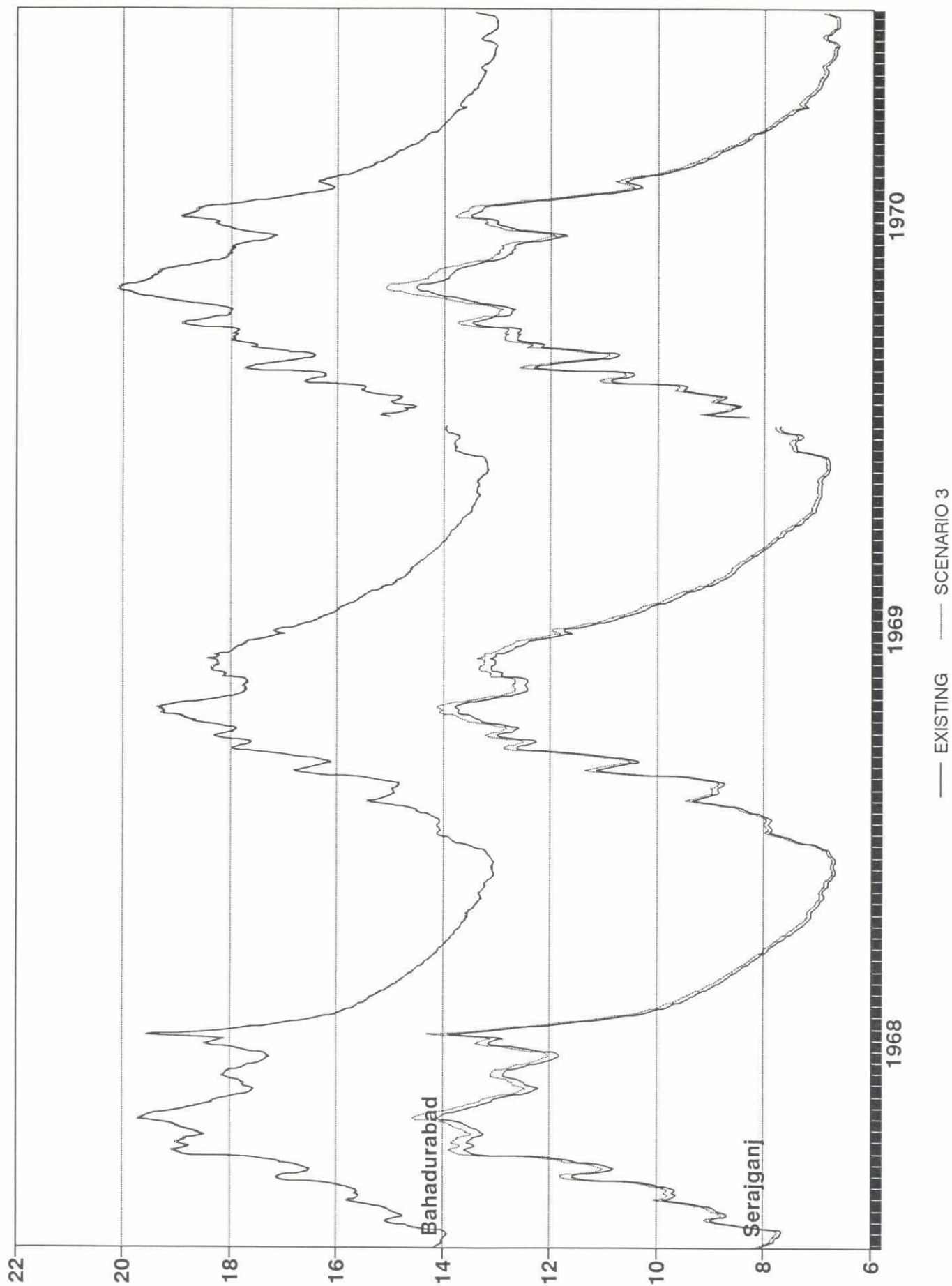
FEBRUARY 1993

FIGURE 3.11 c)

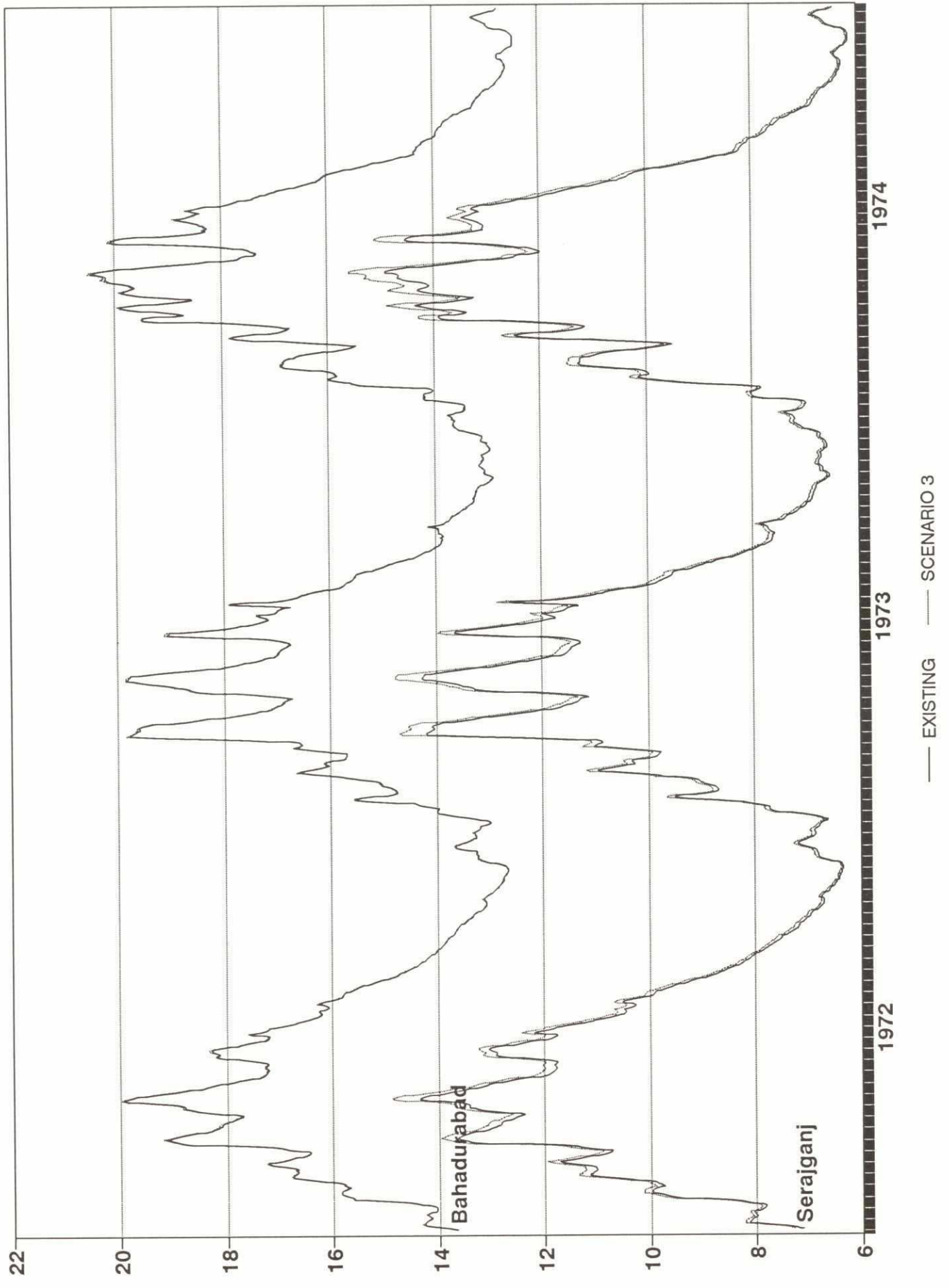
Figure 3.12 a) (8 Pages)
Water Level Hydrographs Compared to Existing
Situation at Bahadurabad and Serajganj



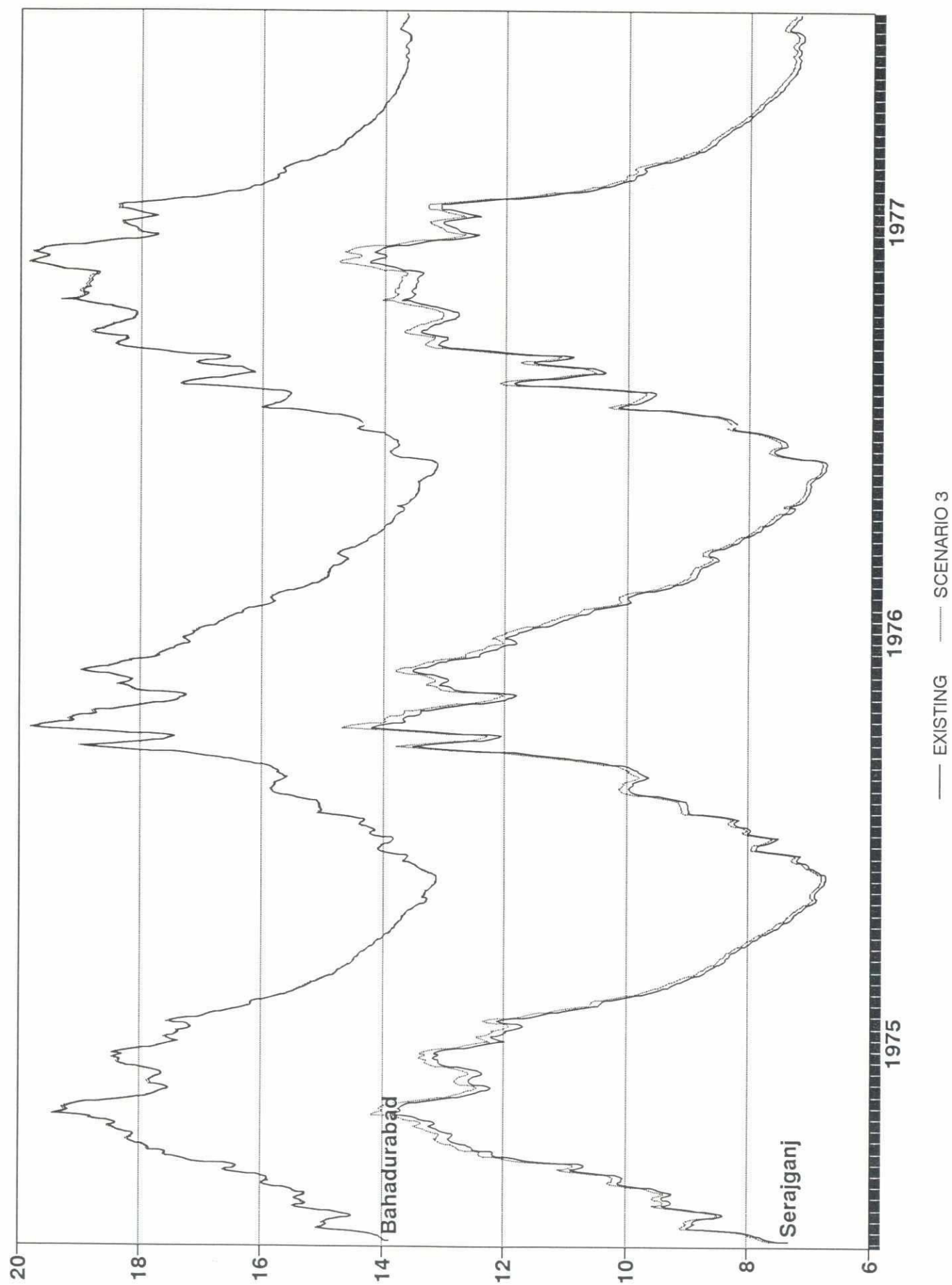
268

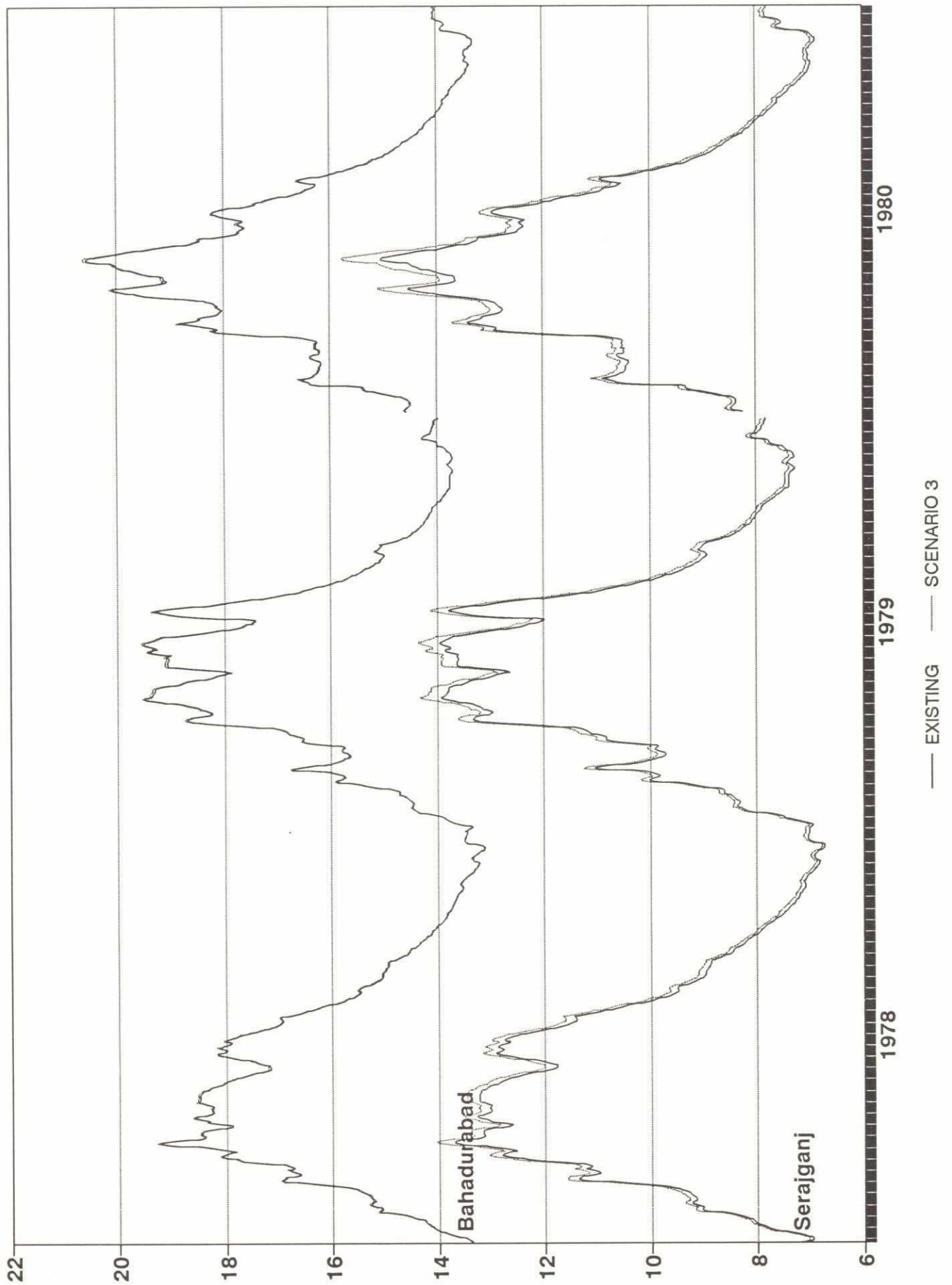


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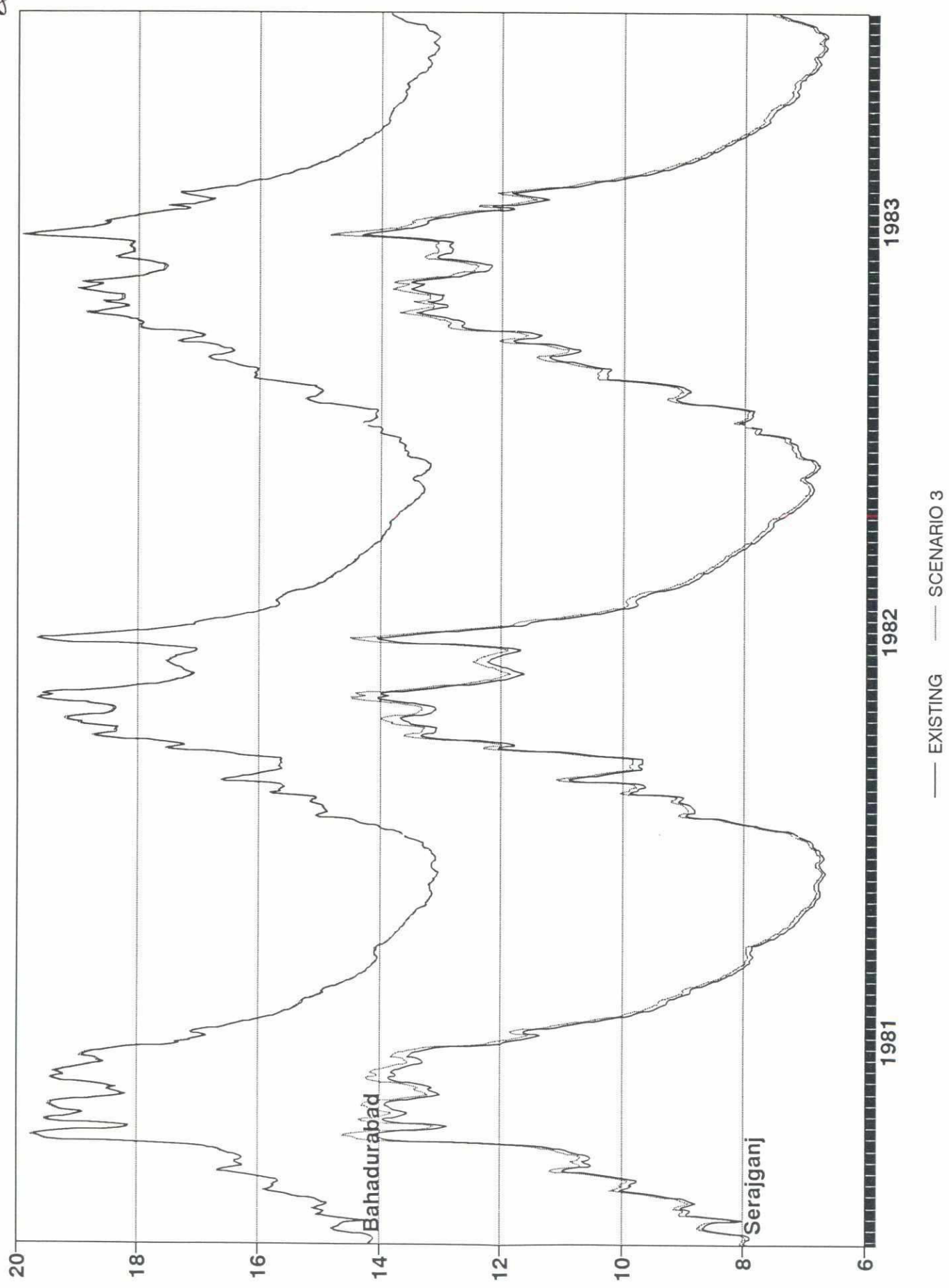


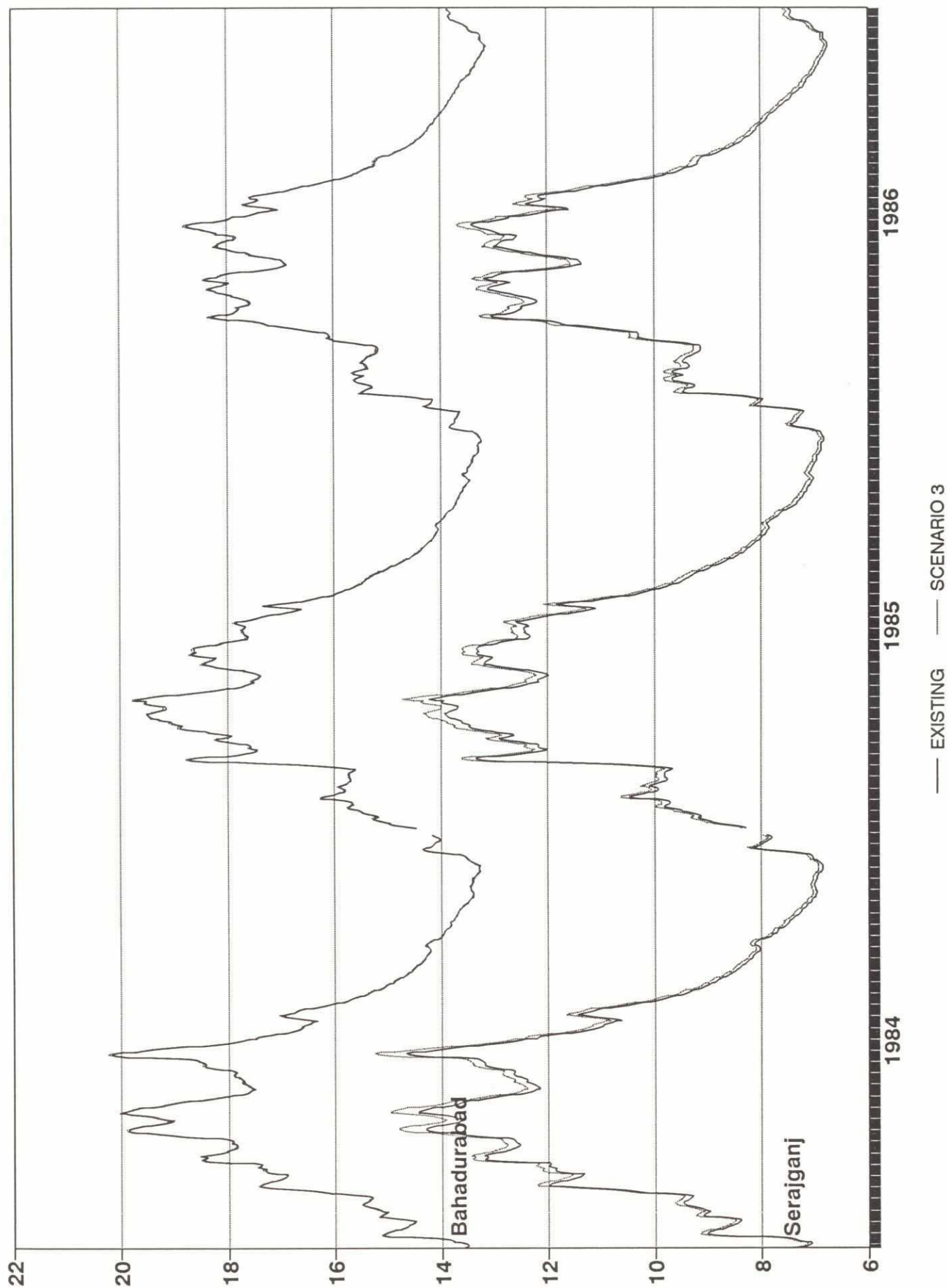
264





268





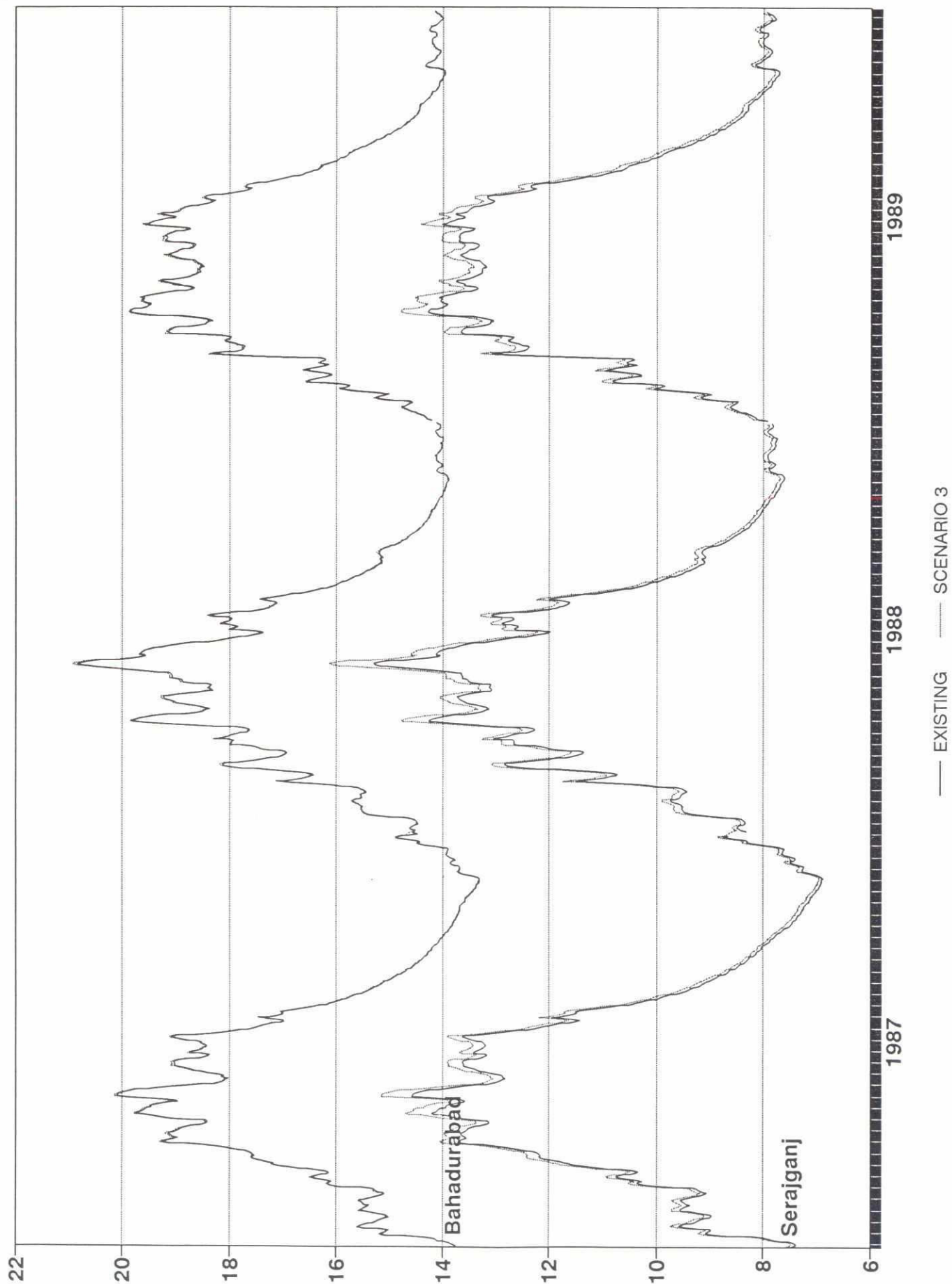
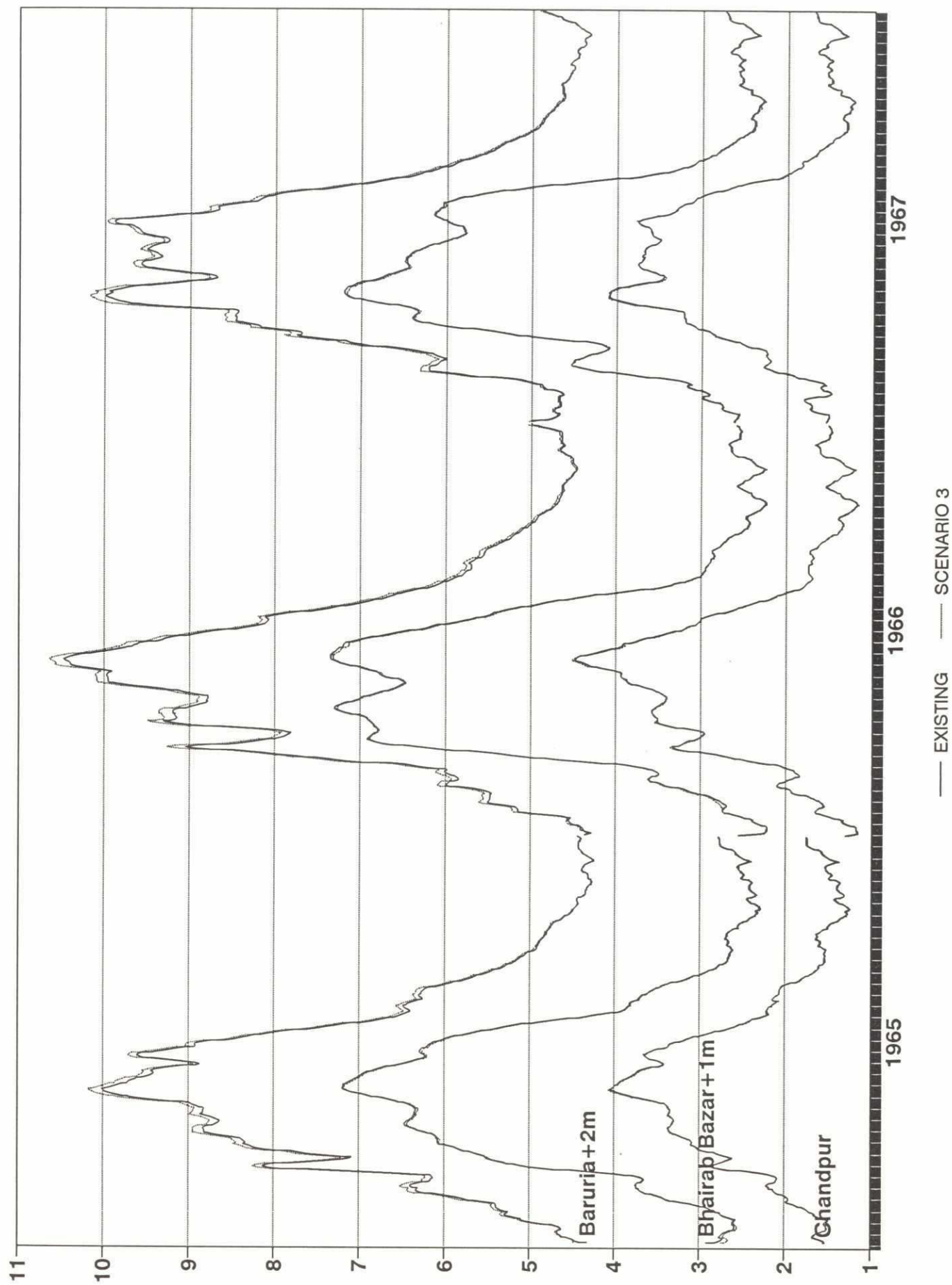
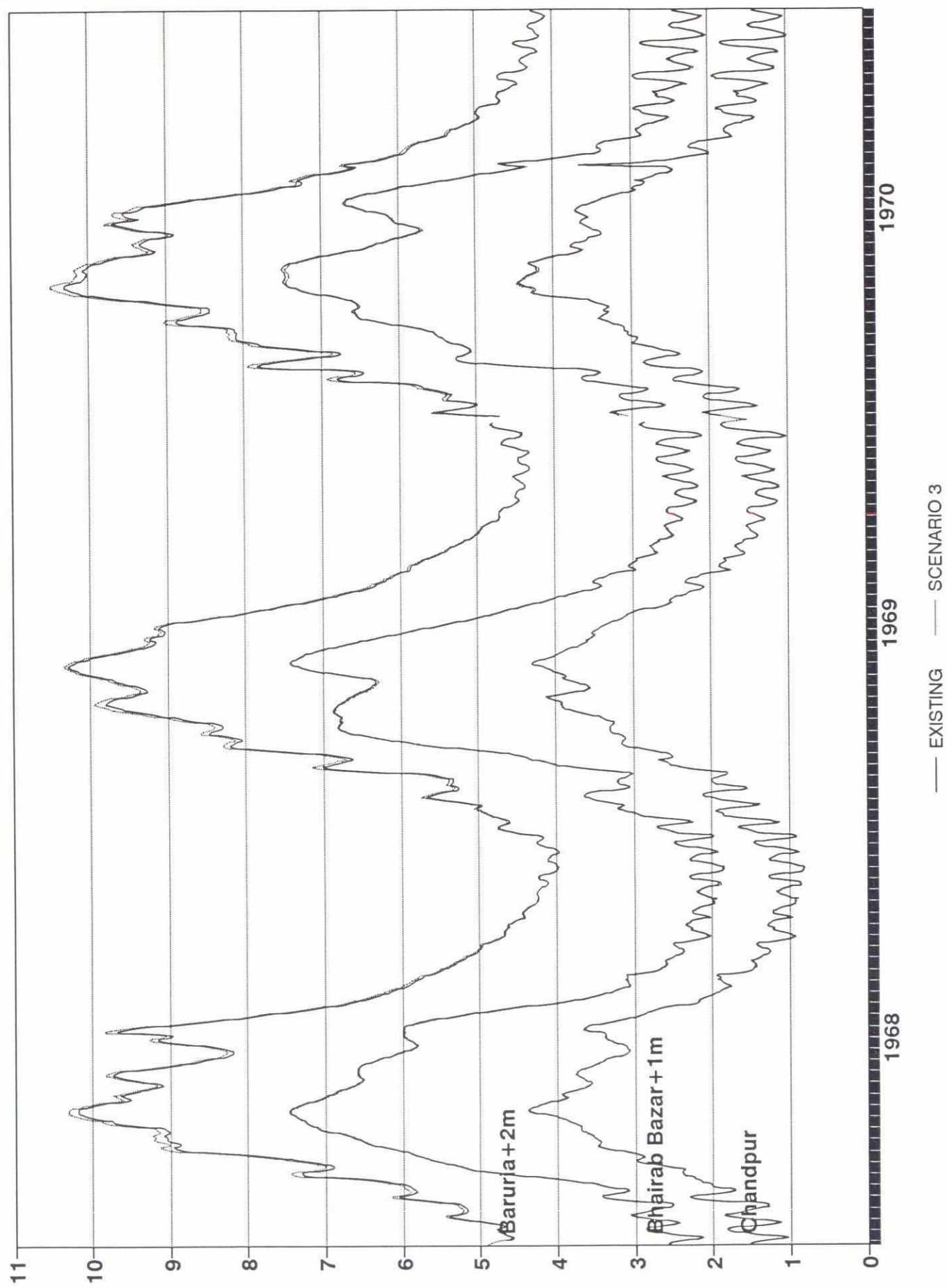
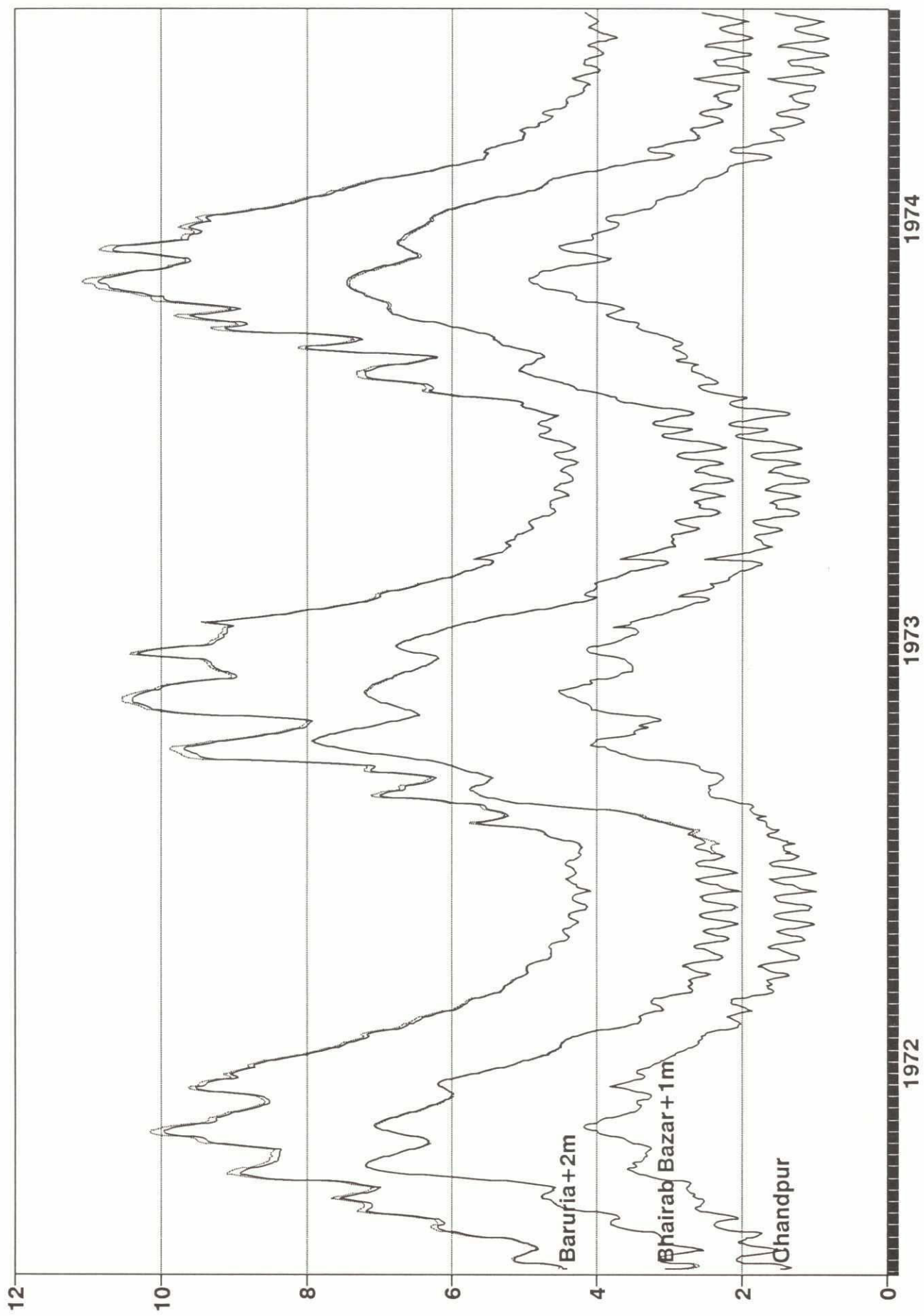


Figure 3.12 b) (8 Pages)
Water Level Hydrographs Compared to Existing
Situation at Baruria, Bhairab Bazar and Chandpur



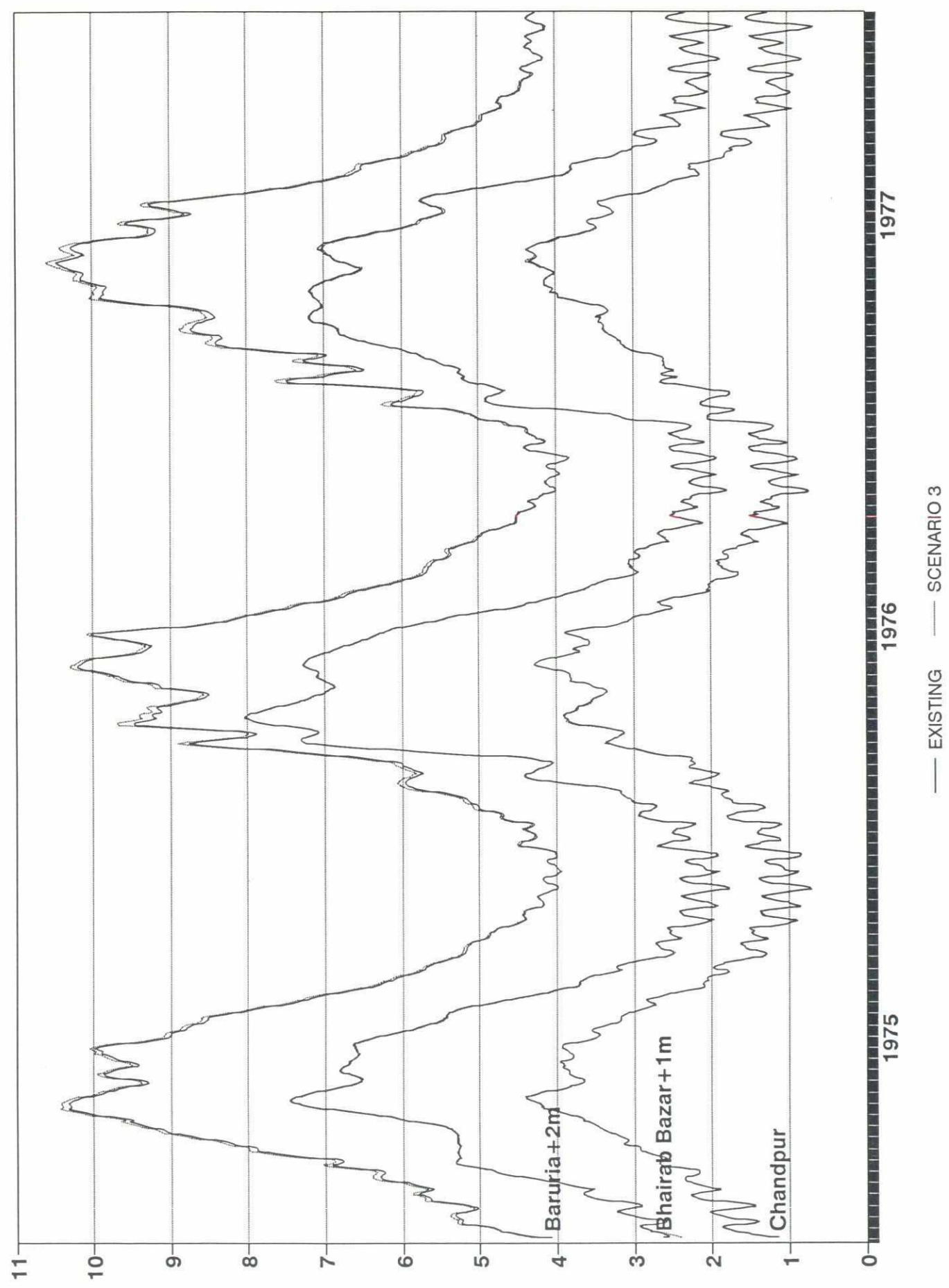
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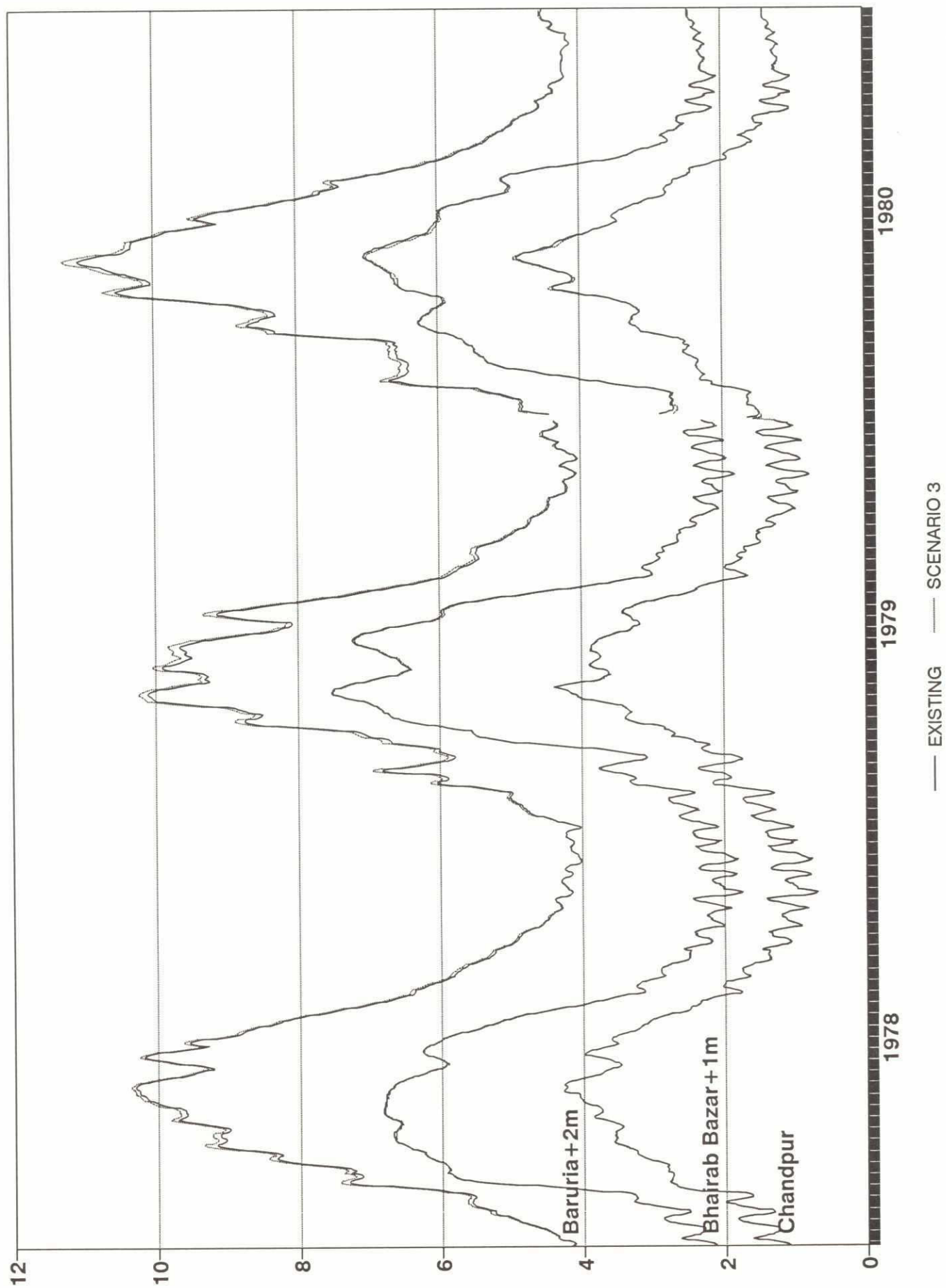


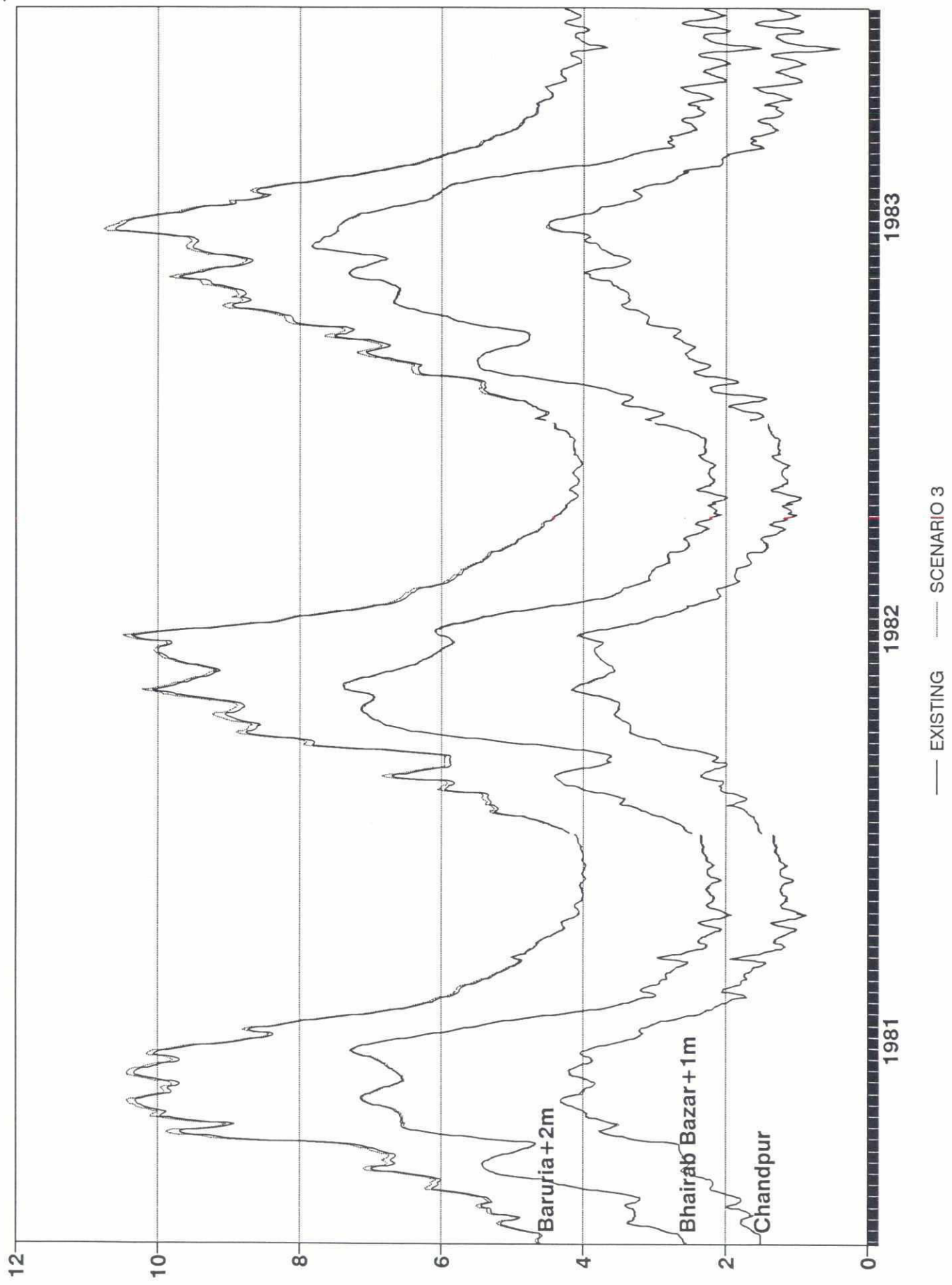
— EXISTING - - - SCENARIO 3

25A

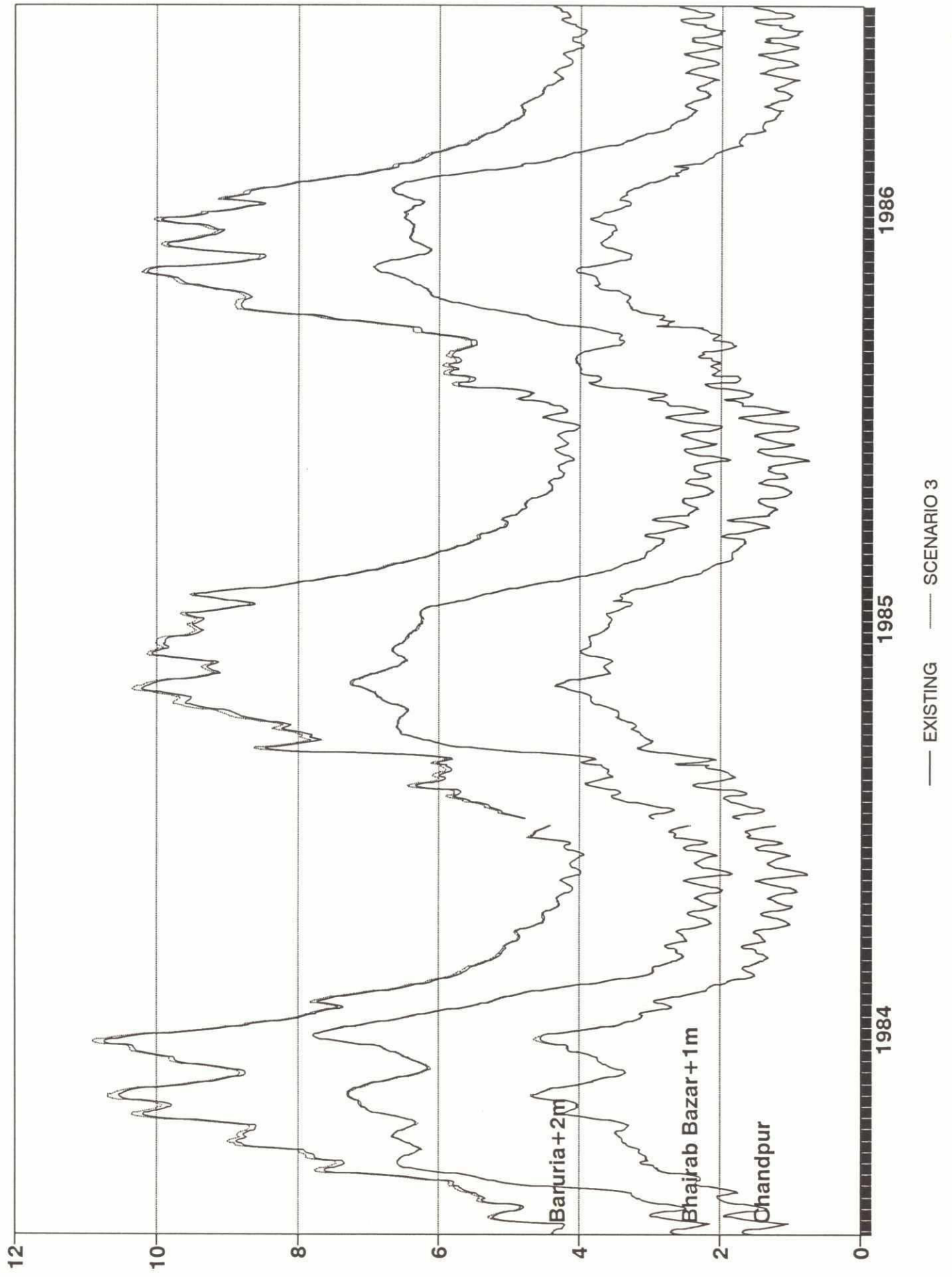


283

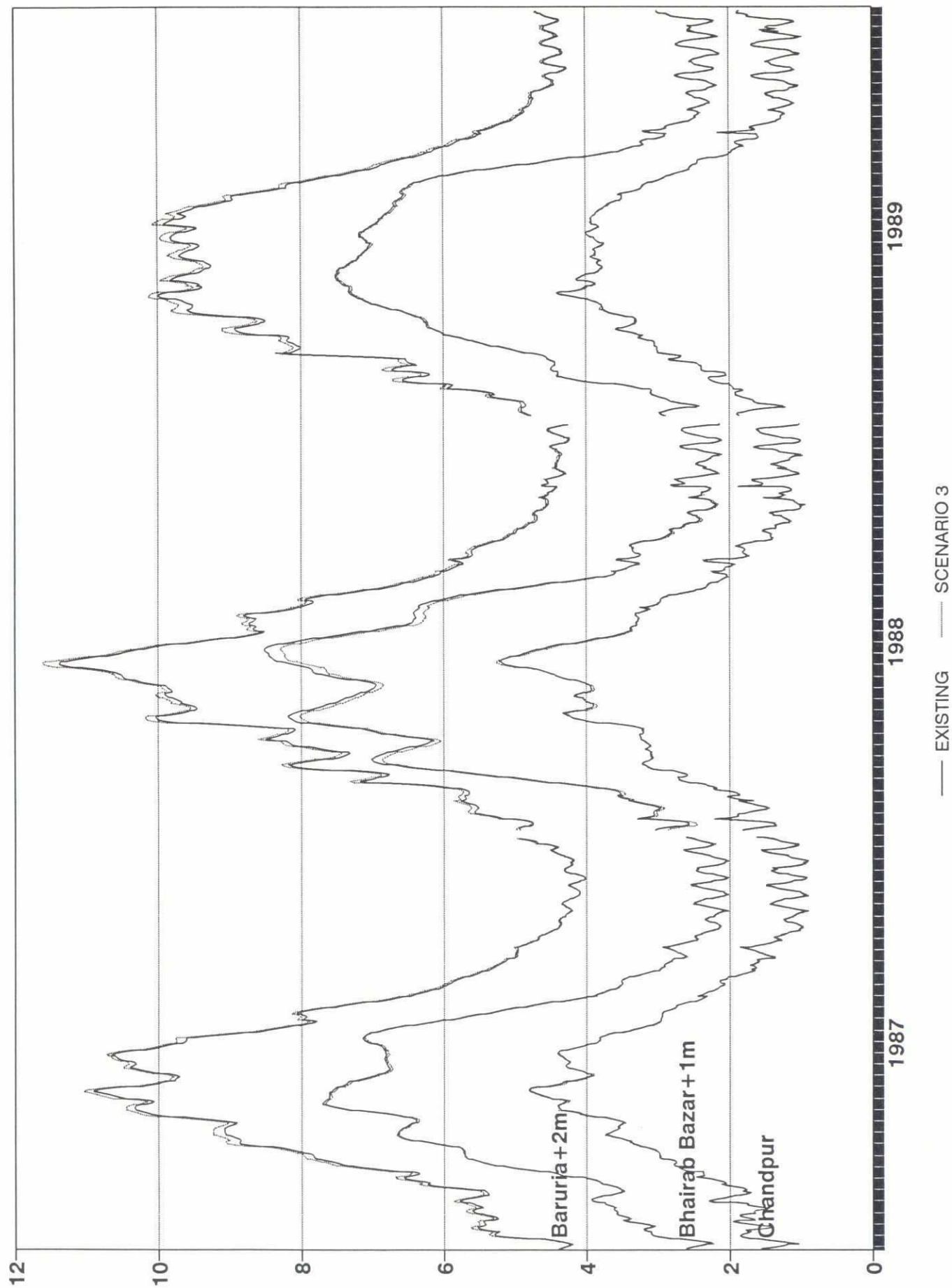




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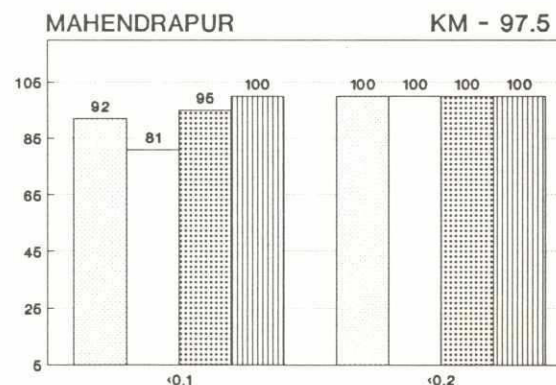
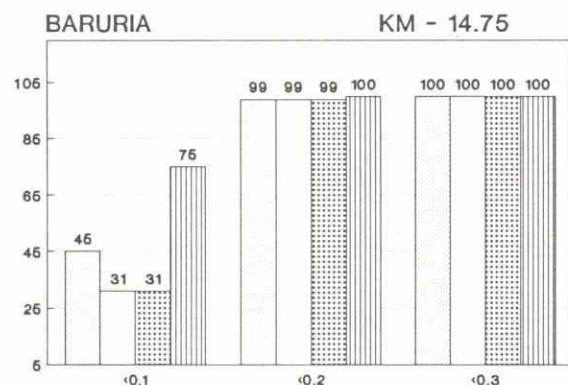
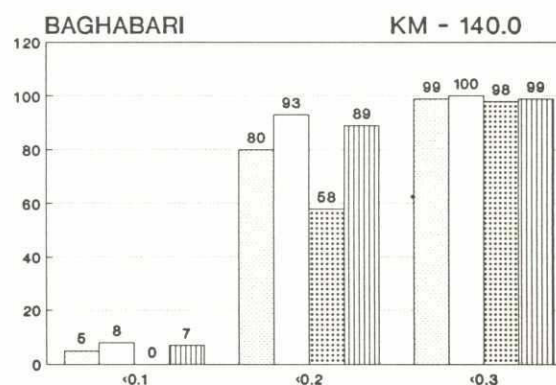
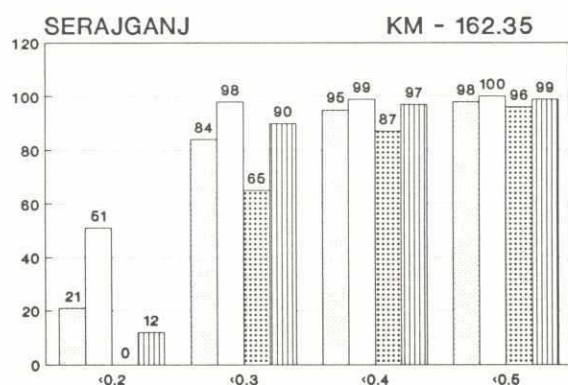
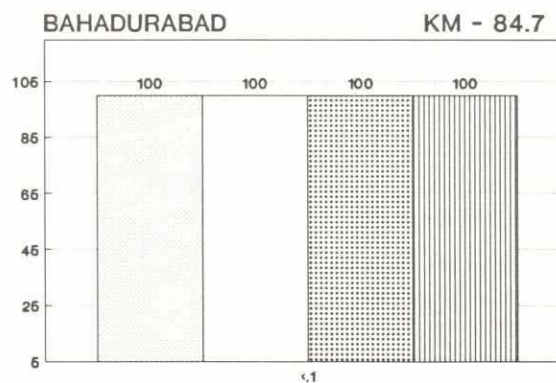
SCENARIO 3 - 25 YEARS : DISTRIBUTION OF CHANGES IN WATER LEVEL

LEGEND :

X-axis ■ Difference in Level in Meter
Y-axis ■ Non Exceedance Percentage



- May to October
- May to June
- July to August
- September to October



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Scenario 3-25 Years : Distribution of Changes in Water Level Compared to Existing Situation at Bahadurabad, Serajganj, Baghabari, Baruria and Mahendrapur

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FIGURE 3.13 a)

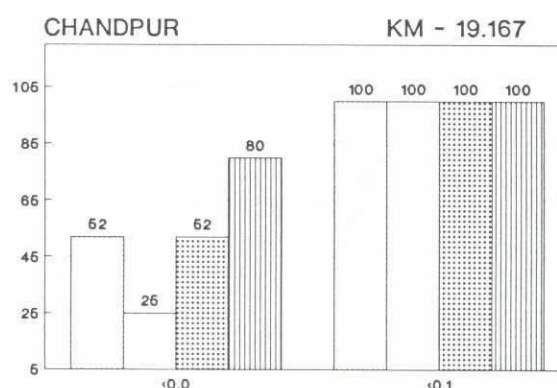
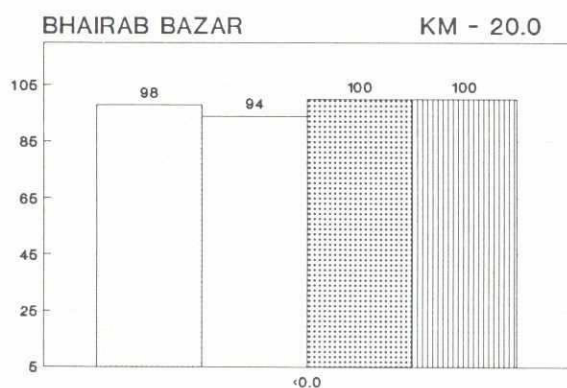
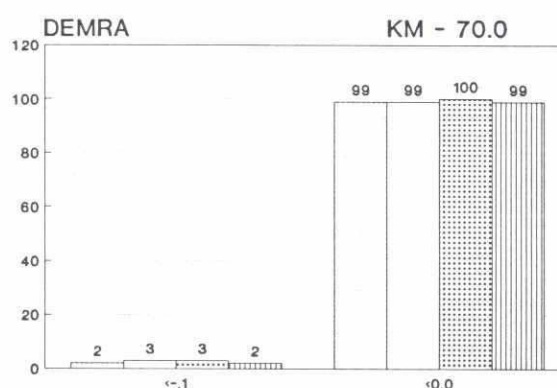
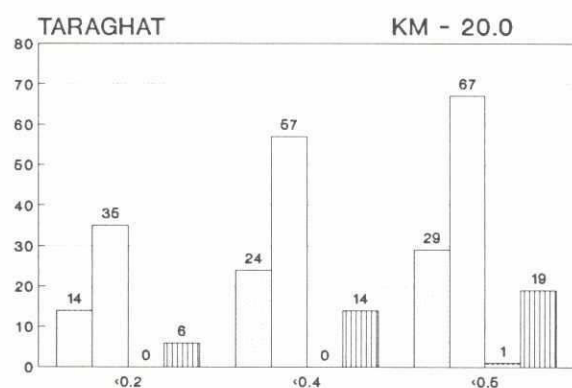
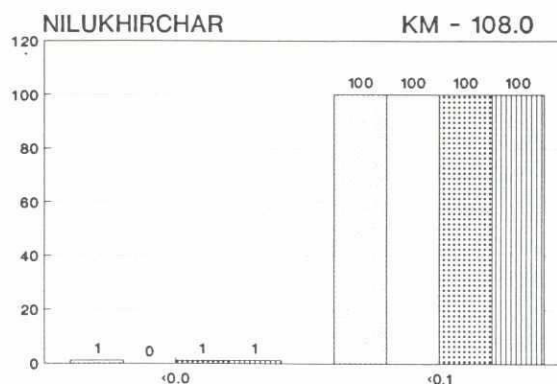
SCENARIO 3 - 25 YEARS : DISTRIBUTION OF CHANGES IN WATER LEVEL

LEGEND :

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- May to October
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FLOOD HYDROLOGY STUDY

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Scenario 3-25 Years : Distribution of Changes in Water Level Compared to Existing Situation at Nilukhirchar, Taraghat, Demra, Bhairab Bazar and Chandpur

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FIGURE 3.13 b)

