



Government of West Bengal  
Irrigation and Waterways Department

Final Report  
of  
The West Bengal Flood Enquiry  
Committee, 1959

Volume I  
(Report)

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Irrigation and Waterways Department

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## **Nota Bene:**

**Datum—Unless otherwise stated, all levels mentioned in this Report refer to Public Works Department datum.**

## Glossary of Local Terms used in the Report

"Ailes or Aile bund"	...	Dwarf embankments around paddyfields to hold up water and demarcate same.
"Beel" and "Jala"		A tract of low wet land, Marsh or Swamp.
"Boro"	... ..	Winter variety of paddy.
"Bund"	... ..	Embankment.
"Bunded"	... ..	Embanked.
"Ring bunds" and "Gher bunds"	... ..	Circuit embankments.
"Daha"	... ..	A low long depression formed by abandoned course of a river.
"Hanas"	... ..	Breaches on bank of rivers through which water flows during floods in the river.
"Khals"	... ..	Channels.
"Nullah"	... ..	Channel, drain.
"Nikashi"	... ..	Main outlet drain.

No. 2132C.I.(F)

FROM SARDAR MAN SINGH, I.S.E. (retired), CHAIRMAN, WEST BENGAL  
FLOOD ENQUIRY COMMITTEE, 1959,

TO THE SECRETARY, WEST BENGAL FLOOD CONTROL BOARD, GOVERN-  
MENT OF WEST BENGAL.

*Calcutta, the 30th May 1962.*

DEAR SIR,

In continuation of Member-Secretary's letter No. 617, dated 27th June 1960, with which the Preliminary Report of the Committee was submitted to you in June 1960, I beg to submit herewith the Final Report of the Committee. The Report was scheduled to be submitted at the end of 1960, but has had to be delayed for reasons explained in Chapter 1.

2. The terms of reference to the Committee were—

- (a) to enquire into and determine the causes of the 1959 floods in the districts of (i) Midnapore, (ii) Howrah, (iii) Hooghly, (iv) Burdwan, (v) Birbhūm, (vi) Bankura, (vii) Purulia, (viii) Nadia, (ix) Murshidabad and (x) 24-Parganas ;
- (b) to make an assessment of the effects of these floods ;
- (c) to ascertain if the intensity of the floods in the river valley areas could have been reduced by proper regulation of releases from the dams ;
- (d) to suggest remedial measures for the purpose of preventing recurrence of such floods in future ;
- (e) to indicate broadly in order of priority schemes for flood control and flood protection-river-wise, basin-wise, or area-wise as the case may be.

Terms (a), (b) and (c) were dealt with in the Preliminary Report. This Final Report deals in detail with terms (d) and (e).

3. Unlike the Preliminary Report, this report is not a unanimous one. Two members have added minutes of dissent which appear at the end of the report. Both members are nominees from the State of Bihar. There appear to be no valid technical reasons for the minutes as will be clear from the comments in the following paragraphs :

4. Shri D. Mookerjea has merely expressed his dissension with the views of the rest of the Committee in para. 9.4.3. in Chapter 9 in para. 11.5 in Chapter 11 and sub-para. 26 of para. 16.6.1 in Chapter 16 without giving any reasons. In a note on one of the draft Chapters of the report towards the concluding stages of the Committee's work Shri Mookerjea had suggested an alternative with regard to the recommendation in para. 9.4.3 of Chapter 9 in which the Committee have recommended investigations for a storage and detention reservoir in the upper catchment of the Ajoy river. The suggestion was that the river Mayurakshi be diverted into the Ajoy and the combined streams of the Mayurakshi and the Ajoy diverted through a cut from near about Pandaveswar to the Damodar somewhere near Durgapur. (All these works to be within the State of West Bengal.) He said that such a diversion would ease the situation in the Bhagirathi as well as improve the condition of the lower Damodar. All the data for examining the suggestion in detail were not available but from the intimate local knowledge possessed by some of the members it was felt that the proposition was not a feasible one. In the first place rain storms in the Damodar, Ajoy and Mayurakshi valleys almost always synchronise so that the

diversion of the latter two into the Damodar will considerably worsen conditions in the lower Damodar and there will be disastrous floods in Trans-Damodar area almost every year. The area between the Ajoy and the Damodar is strewn with collieries and is very undulating. Diversion channel through this area will entail a large number of technical difficulties. Besides, with the Steel Plant and Power Station being put up at Durgapur the area all round is getting rapidly industrialised so that it would not only be physically but also economically a difficult project to undertake. If such a diversion were possible into the Maithon reservoir above, some good could accrue as, perhaps the water shortage being felt at present in the reservoir for the purposes of generation of power and supply of flushing doses for the lower Damodar could be got over. But this again would need investigation and even if found feasible would have the same drawback to counter which the suggestion was made, that is, a suitable site for a detention reservoir would still be necessary on the Ajoy in the State of Bihar.

5. In the Preliminary Report in Paragraph 5.14.1 (ii) in Chapter 5 almost similar recommendation was made. Shri D. Mookerjee subscribed to that recommendation. Curiously enough he is unable now to recommend an investigation and survey for a suitable site!

6. His two other objections relate to the same recommendations—the one in Chapter 16 is a repetition of what has been said in Chapter 11. Shri Mookerjee subscribed to the designed flood reserve in the two reservoirs in the Damodar Valley being kept inviolate. His objection is only to specification of levels in the relevant paragraphs. This again is curious. Only reserving a quantum of volume in the reservoirs without regard to their actual position cannot yield the result desired from the reserve. The reserve is always calculated on the basis of what the undersluices and spill-ways can discharge. Unless therefore the reserve is available between certain specific levels it cannot obviously serve the purpose for which it is meant. It would not be out of place to mention that while these reserves were agreed to by the technical representatives of the three participating Governments in 1951, the specific levels up to which the spill-way crests and the dam crests were to be constructed must also have been agreed upon. The dams have been constructed accordingly. Unless therefore the lands on the periphery of the reservoirs are acquired up to the designed levels the habitations there will be unnecessarily exposed to the danger of submergence or the expenditure incurred in construction of the dams would be infructuous and the main purpose of flood control impossible to achieve. D.V.C. are understood to be fully alive to the necessity and are already pursuing the matter. The objection of Shri Mookerjee becomes, therefore, more difficult to understand.

7. Mr. Prasad's note of dissent was actually sent and subscribed by Shri B. L. Singh who continued to be a Member of the Committee from 23rd September 1960 to 21st May 1962. Of the 10 meetings held during this period Shri Singh attended 6 meetings and took part in discussing the various matters which came up before the Committee. The 2nd sentence of the first paragraph therefore becomes rather difficult to understand. On 22nd May this officer was transferred to another assignment in Bihar and Mr. Prasad who had taken over from him as Chief Engineer, Irrigation, North Bihar, on 6th March 1962 took over the charge of this office also. Mr. Prasad therefore attended only the last two meetings of the Committee and although he may have gone through the minutes of the previous meetings had not had the opportunity of discussing any of the problems referred to in the Committee meetings. He has merely substituted his name in place of Shri B. L. Singh. However, his objections are to the same two recommendations as Shri Mookerjee's, although he proceeds to give some reasons for his dissent.

8. He suggests that the flood problem of the Ajoy can be solved by embanking it as is being done in the case of so many rivers in Bihar. In the case of the Ajoy the problem is not merely of floods but also that of sand brought down by it as well their effect on the Bhagirathi-Hooghly whose capacity of the outfall is very limited. The suggestion of obtaining relief by construction of embankments has been fully examined and the views of the Committee have been expressed in para 9.4.3.1 to which Shri Prasad has given no answer. In para. 3.3 he and his predecessors have subscribed to the view that the embankments as a measure of protection from flood are not desirable in deltaic Bengal and yet where the Ajoy is concerned he suggests taking recourse to embankments! Remedies which may be good enough for conditions in Bihar may not be so in lower areas of Bengal and in the case of the Ajoy, they certainly are not.

9. It is true enough that the irrigation projects in contemplation in the upper valley of the Ajoy together with the soil conservation measures will be useful in reducing the silt load in the river but owing to the very small sizes of reservoirs proposed and comparatively very small catchments which will be intercepted, the effect of the proposed irrigation schemes in reducing the silt charge and the discharge in the river lower down will be negligible. A sizable reservoir lower down in the valley is a necessity. But at any rate investigations and surveys for its location should do no harm to any interest.

10. The arguments against acquisition of lands on the upper periphery of the reservoir at Panchet and Maithon have been dealt with in paragraph 6 above. Shri Prasad has brought in the additional argument of human problem involved which in view of what has happened in the case of these two projects would appear to be outdated. If anything, the human problem has been aggravated by vacillating attitudes adopted in the case of these reservoirs. Besides, no project, however small, in which land acquisition becomes necessary, would be devoid of the human problems of the variety referred to by Shri Prasad. In deciding whether such projects should go through or not, the fact as to whether the works are going to be of benefit to a larger number than the number likely to be adversely affected has always to be given its due weight.

11. The reasons for the minutes of dissent have therefore to be looked for elsewhere. You would recollect that I made a reference to you in my D.O. No. 82 of 7th March 1960, in which I gave my view that the Government of West Bengal had selected various Members of this Committee in order to obtain their technical appreciation of the problems confronting the State and their solutions. This view was confirmed by the Chief Minister and he very kindly wrote to the then Chief Minister of the State of Bihar requesting him to let nominees of that State give their unfettered technical views on the various problems which the Committee would have to deal with. The late Chief Minister of Bihar unfortunately did not agree but advanced his own reasons for the nominations from Bihar. According to him the nominees from that State to be useful had to put before the Committee the likely human problems and the likely reactions of Bihar Government to any proposals which might be made. If this were not so, Govt. of West Bengal would very well replace these Chief Engineers by others from some other States. To my mind nomination of Engineers from Bihar was more to take advantage of their knowledge and experience of conditions in the contiguous State of Bihar than just expert knowledge to deal with flood problems only for which experts from other States or other countries could indeed have been selected. This appears to be obvious as the Officer of India Meteorological Department and Engineers from Railway etc., were also nominated from the local regions rather than top men



[iv]

from other regions. With this background it is suggested that the nominees from Bihar could not but add the minutes of dissent, may be under the misconception that they were doing so in the interest of the State of Bihar.

Yours faithfully,  
MAN SINGH,  
*Chairman.*

# FINAL REPORT OF THE WEST BENGAL FLOOD ENQUIRY COMMITTEE, 1959

## CHAPTER 1

### Introductory

#### 1.1. Scope of the Report :

1.1.1. In this Final Report, it has not been considered necessary to go over the ground already covered in the Preliminary Report. Nothing is being added to what was said on the terms of reference (a), (b) and (c), viz. to enquire into and determine the causes of the 1959 floods in the districts of—

- (i) Midnapore,
- (ii) Howrah,
- (iii) Hooghly,
- (iv) Burdwan,
- (v) Birbhum,
- (vi) Bankura,
- (vii) Purulia,
- (viii) Nadia,
- (ix) Murshidabad, and
- (x) 24-Parganas.

to make an assessment of the effects of the floods, and to ascertain if the intensity of the flood in the river valley areas could have been reduced by proper regulation of releases from the dams. The terms (d) and (e), i.e., remedial measures for the purpose of preventing recurrence of such floods in future and broad outline of the scheme for flood control and flood protection with their priorities were also dealt with in Chapters V and VI of that Report. There were besides certain general recommendations rough indications as to what measures were to be adopted. This report deals with these latter aspects of the enquiry more fully and recommends undertaking of schemes which will prevent or at any rate considerably reduce the chances of recurrence of floods of the intensity experienced in 1959.

1.1.2 Where complete hydrological and topographical data necessary for working out the projects are available, complete schemes in outline have been drawn up.

Their costs, based on present-day prices, have also been worked out and the estimates are appended to the Report (Appendices 6 to 44 and 46 to 65). These tasks have been accomplished with the assistance of the Flood Control Circle guided by the Chief Engineer, Floods and Flood Control, Irrigation and Waterways Directorate, which the Government of West Bengal set up in the beginning of 1960. There are certain cases where the Committee felt that before adopting the suggested solution, they should be tried in models, recommendations to that effect are accordingly being made. In certain other cases where sufficient data are not yet available and detailed schemes cannot, therefore, be prepared at this stage it will be necessary to await the completion of the necessary surveys and investigations before the preparation of suitable projects can be undertaken. In both such cases it is recommended that ad-hoc committees be set up if necessary to vet the proposals which might finally emerge before sanctioning the execution of works.

1.1.3. In paragraph 6.3 of Chapter 6 of the Preliminary Report only certain general principles were enunciated for fixation of priorities. This, the Committee felt, was not adequate. With the projects more or less clearly visualised in Chapters of that Report it was considered more appropriate to indicate priorities scheme-wise. This was done in the seventh meeting of the Committee in the month of October 1960, and the inter-se priorities were indicated to the Secretary, West Bengal State Flood Control Board in the Member-Secretary's No. 3121-C.I.F., dated 4th November 1960. In view, now, of a clearer overall picture of the problem, the recommendations in regard to the priorities have been further elaborated. In determining them now, cost-benefit ratios, overall programme of works in addition to factors like distress experienced and district-wise distribution of relief measures have all been taken into account.

Detailed recommendations will be found in Chapter 15:

### 1.2. Meetings held :

Subsequent to the submission of the Preliminary Report, on the 29th June 1960, eleven meetings of the Committee have been held. In these meetings general directions were given to the departmental officers regarding the provisions to be made in, and the manner in which the projects were to be prepared and estimated. The plans and estimates thus prepared were at first vetted by a small Sub-Committee appointed for the purpose and then discussed and finalised in the following plenary meetings :

### 1.3. Personnel of the Committee :

1.3.1. Changes which took place up to the end of June 1960 were detailed in Chapter I of the Preliminary Report. Following further changes took place up to the signing of this—the Final Report.

#### Member-Secretary

After the retirement of Shri S. Gupta, I.S.E., on 30th June 1960, Shri R. D. Singh, I.S.E., Chief Engineer, Floods and Flood Control. Government of West Bengal, Irrigation and Waterways Directorate, took over the the Member-Secretaryship. On 1st October 1960 he became the Chief Engineer, Irrigation and Waterways Directorate, and the Member-Secretaryship went over to Shri R. B. Chakravorty, W.B.S.S.E. From 21st August 1961, the date on which Shri R. B. Chakravorty went on deputation to the Government of India as Chief Engineer, Farakka Barrage, Shri D. G. Mukherjee, W.B.S.S.E., has been the Member-Secretary.

#### Members

##### (1) Chief Engineer, Irrigation and Waterways Directorate

Shri R. D. Singh, I.S.E., when he became the Chief Engineer, Irrigation and Waterways Directorate, on 1st October 1960, replaced as member, Shri A. L. Das, I.S.E., who went on leave preparatory to retirement.

##### (2) Chief Engineer, Eastern Railway

Three changes in the personnel of this Membership have taken place within this period. Shri U. G. K. Rao was replaced by Shri H. S. Hart on 30th November 1960 and Shri N. S. Tyabji replaced Shri H. S. Hart on 26th June 1961.

(3) *Chief Engineer, South-Eastern Railway*

Four changes in the personnel of this Membership also have taken place. Shri D. N. Chopra ceased to be a member on 20th September 1960 on his becoming Additional Member (Works), Railway Board. Shri A. E. Young took over this membership with effect from 21st September 1960 and continued until he was replaced by Shri M. N. Bery on 24th August 1961. Shri S. S. Mukherjee took over charge from Shri Bery on 15th May 1962 on his proceeding on leave.

(4) *Chief Engineer, Irrigation, Bihar*

Three changes took place in this case. Shri P. R. Guha who took over from Shri H. K. Nivas, I.S.E., on his retirement and continued to be a member, until he was succeeded by Shri B. L. Singh, Chief Engineer, Irrigation, South, with effect from 23rd September 1960. Shri B. L. Singh was transferred to another assignment on 22nd March 1962 and his place was taken over by Shri A. P. Prasad in addition to his charge of North Bihar.

(5) *Chief Engineer, Irrigation, North Bihar*

Shri P. R. Guha was replaced by Shri C. D. Mitra on 2nd September 1960. Shri B. L. Singh replaced him on his retirement with effect from 28th April 1961. Shri A. P. Prasad became a Member with effect from 6th March 1962 on his taking over charge from Shri B. L. Singh.

(6) *Chief Engineer, Roads Development Department, Govt. of West Bengal*

Shri P. B. Sarkar was replaced by Shri S. N. Gupta on 24th September 1960. Shri Gupta continued to be a Member until 11th October 1961 when Shri Sarkar again became a Member and remained so until 31st March 1962 when Shri S. K. Ghosh took over from him.

(7) *Chief Engineer, Calcutta Corporation*

Shri A. K. Sen remained a Member until he retired on 2nd February 1962 and ceased to be a Member. Thereafter, Shri S. K. Mitra attended the meetings.

**1.4. Extension of time for submission of the Final Report :**

The Committee in its meeting of 24th-25th October, 1960 came to the unanimous conclusion that it was impossible to submit the Final Report giving ameliorative schemes for flood prevention in outline within the short period left upto 31st December 1960, the date by which the Final Report had to be submitted, according to Government Resolution No. 37-I of 26th December 1959. It was, therefore, decided to ask for an extension of the life of the Committee by another year. Government in their Resolution No. 1-I, dated 4th January 1961 (Appendix 1) agreed to this. The main work of the Committee was almost completed by about the end of October 1961, but owing to frequent changes in the personnel of the Member-Secretary, it was found impossible to complete the report within the extended period. A further extension of three months was sanctioned by the Government in their Resolution No. 1-I, dated 2nd January 1962 (Appendix 2). Government extended the tenure of the Committee further for two months up to 31st May 1962 vide their Resolution No. 15-I, dated 11th April 1962 (Appendix 3).

**1.5. Schemes and surveys and investigations already recommended for sanction and execution to the Government of West Bengal :**

As per terms of its appointment the Committee recommended to the Secretary, State Flood Control Board, various estimates of schemes and surveys and investigations which they considered urgent in advance of submission of the Final Report. These were forwarded by the Secretary of the Committee for sanction and implementation. This was necessary to facilitate Government's taking up certain works without delay while the Committee was still in session. A list of such estimates is given below :

Serial No.	Name of Scheme	Estimated cost in Rupees
1	Tollygunge-Panchannagram Drainage scheme	29,15,000
2	Hydrological observation in South and South-West Bengal	7,03,325
3	Aerial Contour Survey in parts of Murshidabad, Hooghly, Howrah and Midnapore districts.	7,98,500
4	Scheme for Improvement of Deb and Kanta Khals	25,00,000
5	Surveying the rivers and tributaries and Khals in Kandi area, district Murshidabad.	24,852
6	Investigation for improvement of Palaspai Khal, etc, in the district of Midnapore.	4,012
7	Sealdahgong Basin Drainage Scheme.	1,11,90,000
8	Model experiment in connection with Kandi Flood Protection Scheme	1,37,000
9	Survey of Kangsabati river	19,800
10	Surveying the rivers in Trans-Damodar area	26,143
11	Surveying the river Ajoy from Railway bridge at Pandabeswar to its outfall at Katwa	11,550
12	Bamunia-Daudpur Drainage Scheme	1,49,432
13	Hydrological observations and river survey in connection with improvement of river Rupnarayan.	1,86,000
14	Survey and investigation for improvement of Kaliaghye and Rasulpur rivers.	1,52,000
15	Model experiments for study of flood problems in Trans-Damodar area	4,62,250
16	Model experiments for improvement of the Rupnarayan	3,42,400
17	Model experiments for study of flood problems in the Kaliaghye Basin	3,11,000
18	Scheme for survey and Hydrological observation in the Khari river	28,610
19	Survey and Hydrological observation on the River Darakeswar in connection with the proposed construction of dam or small check dams across the said river.	1,52,000
20	Survey and Hydrological Observations in connection with the Pagla-Bansloi Drainage Scheme.	48,000
21	Survey and investigation in Dubda Basin	23,000

## CHAPTER 2

## Drainage Indices for Design of Disposal Works

2.1. In order that the drainage works function efficiently they have to be designed for the correct quantity of water they have to dispose off. This is done by adopting a suitable depth of water over the whole of the area which must be drained off during 24 hours. This depth is known as drainage index. No formula for its accurate calculation has yet been evolved. Several empirical formulae are in use, one in common use in Bengal is Dicken's which gives the peak quantity of water to be drained as equal to  $C.A. \frac{3}{4}$ , where C is a variable constant and A is the area in square miles. The choice of value of C is very wide and depends on a number of factors all of which cannot be correctly evaluated. Experience, therefore, plays an important role in the choice of the figure. In the part of West Bengal under review, Dicken's or similar formulae are being used for the steeper areas. But in some areas even there and in the coastal areas, the structures have been designed for discharges based on drainage indices ranging from  $\frac{1}{4}$ " to  $\frac{3}{4}$ " less 25 per cent. in some cases while in some others  $\frac{3}{4}$ " to 1" had been adopted. The Committee, therefore, considered it necessary to go into this question in detail and recommend figures based on integration of the factors which govern the indices. These, in main, are —

- (a) The size of the area to be drained.
- (b) Soil cover and the nature of the soil of the area.
- (c) The topography of the area.
- (d) Rainfall and rainfall patterns over the area.

2.1.1. As regards (a) it is obvious that greater the area the smaller the index need be. For smaller areas a larger index is necessary in order to provide for its quicker drainage.

2.1.2. The effects of (b) will be variable. If the area has a vegetative cover, the run-off will be less and gradual. But if the soil is bare the precipitation after wetting the surface would tend to flow comparatively quickly along the slope of the ground and if this is steep erosion of soil would also take place.

2.1.3. Vegetative cover can be of various kinds. From the data which is available from the Forest Department it appears that within the area under review, broadly speaking, there are forests of two distinct types, namely, tidal forests and dry sal forests. The tidal forests are mostly located in the Sundarbans area of the 24-Parganas district and are managed as reserve forests. The second type of forests are to be found in the western part of the area in Purulia district and parts of Birbhum, Bankura and Midnapore districts. These forests have recently been acquired by Government and are in a bad state of denudation. The forests in the Sundarban area are reserve forests while practically all the forests in the western area are protected State forests. A large portion of the remaining area, comprising cultivated area, homestead, villages, towns, tanks and fallow lands gets inundated during floods and suffers damages. To minimise this damage efficient drainage works are necessary. The drainage index therefore, so far as this particular factor is concerned would need no change in such areas.

2.1.4. A study of the soil map of the area under review, as furnished by the Agriculture Directorate, reveals that the following types of soil groups and series occur :—

- (i) Coastal saline, and saline alkali. non-saline and degraded alkali soils.

- (ii) Ganga riverine soil including lowlands, flatlands and uplands.
- (iii) Damodar-Cossye riverine, flatlands and uplands of Vindhya group.
- (iv) Laterite and Red soil.

Types (i) and (ii) would tend to absorb some of the precipitation and the run-off will commence only after the soil gets saturated. In the cases of (iii) and (iv) there will be a little loss to begin with on account of evaporation but then the entire precipitation would tend to run-off.

2.1.5. Topography will have similar effect on the run-off. Steep slopes would tend to speed up the flow while flatter slopes will delay the process although it will be prolonged.

2.1.6. From a study of the topo-sheets it is seen that the ground levels in the area under review vary from a few feet above mean sea level in the costal area in the south to the elevation 70 feet in northern Murshidabad district near the Ganges on the north, and to elevation 2,000 feet in Purulia on the west. So that rates of run-off will be different and will depend on the location of the area.

2.1.7. The whole area under review can be divided into different ranges as below :

- (1) Flat area with practically no slope.
- (2) Areas having an average slope of 2' per mile.
- (3) Areas having an average slope of 4' per mile.
- (4) Areas having an average slope of 6' per mile.
- (5) Areas having an average slope of 10' per mile.
- (6) Areas having an average slope of 15' per mile.
- (7) Areas having an average slope of 20' per mile and above.

These are shown in the index map (Appendix 4).

2.1.8. In general terms, therefore, the area, to be dealt with are of two classes—the flat tract of Deltaic land and the rest of the area.

2.1.9. The southern parts of the district of 24-Parganas, Howrah and also the eastern part of the Midnapore district come within the first block (flat tract of deltaic land). This tract of land built up by the tides has no steady slope in any particular direction although there are shallow pockets here and there. Practically the whole of this area is embanked. The cultivated area in this tract is normally bunded (ails) and the run-off is usually arrested on the particular land concerned unless drained by drainage channels and/or sluices. Except in a few cases these lands do not get much water from upland areas which normally drain through the main streams or rivers which have marginal embankments on their banks.

2.1.10. In the rest of the area, the slope varies from a couple of feet per mile to well over 20' per mile and above even excluding the hilly zones where the slope of the ground is very much more. Hence, the basin effect is absent in all such areas.

2.1.11. As regards rainfall, its intensity, distribution and duration will all have different and cumulative effects on drainage of the precipitation on any given area.

2.1.12, Exhaustive and voluminous data in this respect available with the Meteorological Department at Calcutta were studied and were of great assistance in the consideration of the problem. The general rainfall distribution, intensity, duration over the different districts of Gangetic West Bengal in association with the passage of cyclonic storm and depressions were brought out and considered in this context. From a study of the distribution of the rainfall over different districts of Gangetic West Bengal in association with a few major storms and also taking into account the general climatology of the area, the ten districts under reference could be grouped into three different zones, namely :—

Zone I : Coastal area comprising of 24-Parganas, Midnapore, Howrah and Hooghly districts.

Zone II : Districts of Murshidabad, Birbhum, Bankura, Burdwan and Nadia.

Zone III : Extreme western district of Purulia adjoining the Chhotanagpur plateau.

### 2.1.13. Average rainfall during June to October :

The major portion of the run-off in the area occurs during 5 months of the year from June to October during which the South-West monsoon is predominant. The district average rainfall during June to October based on 60 years' data in the ten districts of West Bengal are given in Table below :

TABLE

*Statement showing district average rainfall in Gangetic West Bengal during June to October*

Zone.	District.	Average rainfall in inches.					Total (inches).
		June.	July.	August.	Septem- ber.	October	
I.	24-Parganas ...	11.49	13.72	13.13	9.40	4.98	52.72
	Midnapur ...	10.43	12.94	12.65	8.23	4.97	49.22
	Howrah ...	11.83	13.50	12.97	8.58	4.99	51.27
	Hooghly ...	9.28	11.57	12.36	8.54	3.78	46.13
II.	Murshidabad ...	9.65	10.75	10.78	8.70	3.52	43.40
	Birbhum ...	8.92	11.29	11.03	7.75	3.8	42.17
	Bankura ...	8.84	12.23	12.31	7.02	3.09	43.49
	Burdwan ...	9.94	11.43	11.40	7.78	3.51	44.06
	Nadia ...	9.74	10.20	10.36	7.91	3.83	42.04
III.	Purulia	8.51	12.17	12.54	7.80	3.17	44.19

2.1.14 It would be seen from the above that the total normal rainfall during this period in Zone I ranges from 46" to 53" while that in Zone II and Zone III, i. e., in the interior, it is slightly less, ranging from 42" to 44".



### 2.1.15. Pattern of rainfall associated with Storms and Depressions .

The heavy rainfall over the Gangetic West Bengal which leads to flood conditions is generally associated with passage of storms or depressions from the Bay of Bengal into the interior of the country during the monsoon and post-monsoon months (June to November). The depressions during the monsoon season, which form in the North Bay of Bengal, cross North Orissa-West Bengal coast and move West North Westwards. The areas on both sides of depression track receive precipitation with comparatively heavier rainfall occurring in the south-west sector of the depression. The storms or depressions tend to weaken after they cross the coast and move inland. The coastal districts of 24-Parganas, Midnapore, Howrah and Hooghly, which lie fairly close to storm tracks, are therefore, liable to receive more rainfall than the interior districts. In the post-monsoon season (October and November), however, the storms and depressions originate in the Central and South Bay of Bengal and move in different directions. A few of these post-monsoon storms approach the Gangetic West Bengal and cause heavy precipitation in the area.

2.1.16. As regards the sequence of occurrence of rainfall, it may be said that storm rainfall begins earlier in Zone I, and extends later in Zone II and Zone III. The extension of heavy rain from the coastal area into the interior districts sometimes involves a time of one day or so. However, it depends on the rate of movement of the storm or depression and its other characteristics. It may be mentioned in this connection that cyclones or depressions from Bay of Bengal which affect Gangetic West Bengal, almost invariably cause heavy rains in the coastal belt (24-Parganas, Midnapore, Howrah and Hooghly), whereas among the interior districts, some districts get heavy rains from individual storms or depressions while other districts get lesser rainfall depending on track of the storm or depression and its other characteristics.

2.1.17. It has been seen that on many storm occasions, the comparatively flat low lying areas of the coastal districts of West Bengal get submerged by the local rainfall with the first incidence of storm precipitation. This flooding is followed and accentuated by the run-off from the higher areas. The flooding is further accentuated due to progressive deterioration of the drainage channels and/or breach in the marginal embankments. This, therefore, constitutes an additional factor to be borne in mind about the coastal areas in the fixation of drainage index.

### 2.1.18. Duration of heavy rain and total rainfall associated with Storms and Depressions :

Analysis of rainfall during a few major storms followed by floods show that rainfall exceeding 1" a day generally occurs on 3 or 4 consecutive days and only in a few cases on 5 days. Of these rain-storm periods more concentrated rainfall generally occurs in the middle of the spell. A study of the storm and rainfall indicates that total rainfall in Zones I and II is of the order of 7" or 8" in 3-day storm period and about 9" to 10" in 4-day storm period with extreme maximum of 15". In Zone III (Purulia district) the total rainfall is about 4" for 3-day storm and 6" for 4-day storm with extreme maximum of 7".

### 2.1.19. Maximum rainfall in 24 hours during Storm Period :

The maximum district average of rainfall that occurred in 24 hours in cases of a few storms studied indicates that in both Zones I and II the average exceeded 4" in three out of eight cases with extreme maximum of 8" to 10". In Zone III, however, only in 1 out of eight cases 24-hour maximum rainfall exceeded 4", while on remaining 7 occasions the maximum was less than 3".

2.1.20. It is also evident that Zone I and Zone II are vulnerable to equally heavy rains associated with storms and depressions from the Bay of Bengal during the monsoon and post-monsoon seasons, the frequency of occurrence of such heavy rains is likely to be slightly more in Zone I (coastal belt) than in Zone II (interior districts) and that on certain occasions the total amount of rain may be somewhat heavier in Zone I than in Zone II. In Zone III (Purulia district) frequency of heavy rains associated with storms or depressions and total amount of such heavy rains appear to be appreciably less than in Zone I and Zone II.

2.1.21. Thus if the factor of rainfall pattern only is considered the drainage index would have to be so fixed that for Zone I it is slightly higher than in Zone II while Zone III would require the lowest index of the three. But even so the variation will not be very material.

## 2.2. Fixation of Drainage Index :

2.2.1. After consideration of all the factors mentioned above and discussion of the points connected with the drainage and run-off from different types of catchments it has been finally concluded that, for the area within the purview of the Committee, the only important factors which would affect drainage and run-off are, the extent of the area and the slope of the country.

2.2.2. In flat areas normally the water does not flow from field to field appreciably and since the crop (paddy) can stand a depth of 10" or 12" a storm rainfall of that magnitude (which is usually a very high figure) does not cause any harm to the crops. It is, however, necessary that the accumulation of rainfall from a heavy storm precipitation is drained ahead of the next expected heavy rainfall of smaller magnitude. Taking the reasonable period before any such heavy storm precipitation may come to be two weeks or so, it would be sufficient if accumulation of 10" or 12" rainfall could be drained during the said intervening period. This may be possible if a drainage index of  $\frac{3}{4}$  in 24 hours is adopted. Accordingly the Committee recommends adoption of this figure of run-off as a general rule in the deltaic rural areas of West Bengal. Of course there may be special case where the rainfall may be abnormally higher in which case the drainage index may have to be increased after special study. For conditions experienced in 1959 floods when the outfall levels ruled much higher than the average high and low water levels, drainage index even now recommended will not be sufficient, but adoption of a higher index to provide for such conditions which occur only once in a while, is not necessary as the works in that case will become costly and uneconomical.

2.2.3. For steep zones the precipitation cannot be retained on the field except for a few inches (specially where fields are not terraced) as the same would flow down to the lower valley in due course, depending mainly on the slope of the country. It is felt that it would be reasonably sufficient if the drainage indices are fixed in this zone in consideration of the slope.

2.2.4. For such areas the usual practice in West Bengal is to adopt Dicken's formula or such other similar enveloping curves for assessing the run-off. It has, however, been found that such formulae give absurd results for very small areas data for which were obviously not taken into consideration in the establishment of the formulae. Suitable modification is, therefore, necessary in respect of small area.

2.2.5. For very small catchments (of the order of a few acres) the precipitation may come down very quickly to the drainage line owing to the short distance to be travelled. For these, the run-off may, therefore, be taken as proportional to the catchment area for the same intensity of precipitation. Where the ground is steep the run-off from the precipitation comes fairly

quickly to the drainage line and also as heavy rain may continue for hours together a time may come when the run-off from such small areas in such steep zones is almost equal to the precipitation itself.

2.2.6. On this basis a maximum run-off of 1" per hour is reasonable in such cases considering that a rainfall of about 3" or so may take place within a period of three hours or so. This figure of 3" in 3 hours has been assumed as a reasonable approximation for heavy rain. Where actual observations justify or conditions warrant, a higher figure of intensity may be adopted. Of course in flatter tract the absorption factor on the land itself being higher, the peak run-off will be less than that in steeper zones. Thus a lower run-off should be adopted for flatter areas. After studying these factors different run-off varying from 1" to 0.3" per hour have been fixed for such areas. It was considered desirable that Dicken's formula be applied with suitable coefficients ranging from 100 to 1,800 depending on different slopes in the catchments measuring from 200 sq. miles and above. For intermediate areas the Committee recommends adoption of curves joining the fixed run-off arrived at from the above, with those obtained from Dicken's curve (using suitable coefficient corresponding to such areas). These are reproduced and appended at the end of this Chapter. It is not claimed, however, that these curves are the final answer. They are a good modification of the Dicken's curves for assessment of the run-off in respect of smaller areas and should give a better guidance to the designers. It is recommended that the results be checked with observations and suitable modifications introduced as a result of actual experience. It was brought out during discussion that in some cases in the D. V. C. area the discharges observed were higher than those obtained from the curves. In such cases higher figures based on actual observations should obviously be used and their application extended to other areas answering to like patterns. It has also been pointed out that other formulae in use in different parts of the country give much bigger figures of discharge than those obtained from the curves. This is true but these figures do not appear to have been verified by actual observations.

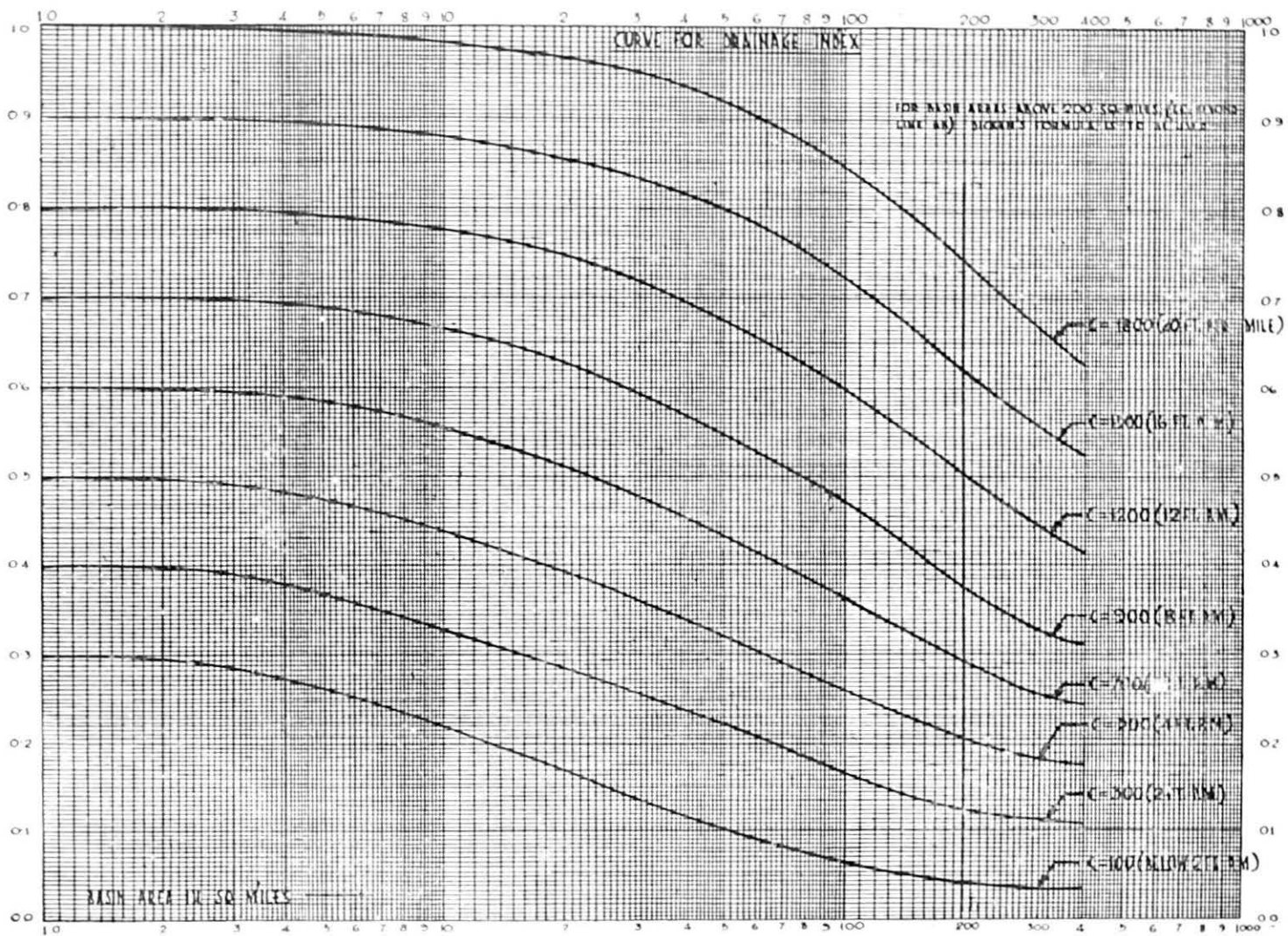
2.2.7. The foregoing recommendations are for design of channels. But in regard to the design of drainage structures in the flat deltaic tract of country as in 24 Parganas district and in the south and eastern part of Midnapore district and more particularly for areas likely to be developed, run-off as arrived at by calculation on the basis of  $\frac{3}{4}$ " in 24 hours as recommended to be adopted above, may be increased by about 25 per cent. i.e., to 1" in 24 hours. In regard to the rest of the area the Committee feels that it would be sufficient to increase the calculated discharge arrived at on the basis of aforesaid curves by 20 per cent. to 10 per cent. depending upon the slope of the country.

#### 2.2.8. Drainage index for Urban and Semi-urban Areas :

In the urban areas the run-off is greater due to built up spaces, pavements and roads, etc. The Committee taking these factors into consideration recommends that for urban area the fixation of drainage index should be decided upon in each case on its own merits. For semi-urban areas a minimum run-off of  $1\frac{1}{2}$ " in 24 hours is recommended.

2.2.9. The Committee has adopted run-off varying from 3" to  $4\frac{1}{2}$ " in 24 hours in the preparation of schemes for areas which include suburban and revenue municipalities and towns other than the metropolis. In regard to the city of Calcutta, some other factors come into play so that adoption of a run-off of 6" in 24 hours instead of existing 4" in 24 hours for South Calcutta, 6" in 24 hours for North Calcutta as has been adopted for the existing system, and 4" in 24 hours for Maniktala, Cossipur-Chitpur and Tangra areas are recommended.

RUNOFF IN INCHES/HOUR



RUNOFF IN INCHES/HOUR

## CHAPTER 3

# Remedial Measures and Schemes for Flood Prevention

3.1. In Chapter V of the Preliminary Report the area affected by the floods of 1959 was dealt with region-wise. The regions are shown in the table below where the total area, the area affected by floods, etc., are all given :—

Region No.	Description of region.	Total area in sq. miles.	1959 flooded area in sq miles	Sub-regions	Area in sq. miles.	Flood-affected area in sq. miles.
1	2	3	4	5	6	7
I	East of Bhagirathi river	8,327	1727·31	(A) Murshidabad district (Part). (B) Nadia district (part) (C) 24-Parganas district. (D) Calcutta Municipal area and Panchannagram-Boinchtala areas).	1,150 1,500 5,629 48	476 309 941 10·31 (in unsewered areas only.)
II	West of Bhagirathi river. Area on the north of Ajoy Basin	2,350	702	(A) Bagmari-Bansloi-Pagla Basin. (B) Mayurakshi Basin including Kandi area.	250 2,100	72 630
III	Burdwan area excluding Trans-Damodar area, but including a portion of Birbhum district within Ajoy Basin.	2,505	600	(A) Katwa-Purbathali-Kalna area. (B) Banka-Khari Basin. (C) Behula-Gangur Basin. (D) Ajoy-Kumar Basin	100 955 270 1,180	70 280 70 180
IV	Howrah - Hooghly area excluding Trans-Damodar area,	1,107	440	(A) Ghea-Kunti Basin. (B) Rest of the district.	470 637	49 391
V	Damodar Basin (excluding Region VI).	1,172		The river and parts of Burdwan-Bankura and Purulia districts.	1,172	
VI	Trans-Damodar area	965	625	(A) Upper Trans-Damodar area (Raina-Khandaghosh area).	300	150
VII	Midnapore district	5,253	274	(B) Lower-Trans-Damodar area  (A) Daspur area (B) Rest of Midnapore district.	665  120 5,33	475  40 234
VIII	The upper areas in the Purulia and Bankura districts.	4,100		Upper areas in Purulia and Bankura districts.	4,100	

3.2. The flood ameliorative measures have to have for their aim either reduction of the run-off or proper and speedy disposal of the run-off or both. For such disposals it is necessary that the drainage channels be maintained in an efficient condition. In most cases where unnatural interference in their regime does not take place little or no work is required to maintain the channels in good condition. This unfortunately is not the case with channels in the area in West Bengal under the purview of the Committee. To some extent this is due to natural causes but the greatest damage has been done by human neglect. Denudation of forest cover and unscientific land uses in the catchment of the rivers have resulted in greater run-off and heavy loads of detritus. Owing to pressure of population, there has been considerable encroachment in the flood plains both for habitation as well as for agriculture so that when the floods occur damages to both life and property are great. Demands for protection result in construction of marginal and circuit embankments which by reducing the capacity of the channels make matters worse. The remedial measures have therefore obviously to aim at eliminating or at any rate lessening of these evils. In paragraph 5.3 of the Preliminary Report it was recommended that the laws controlling construction of embankments along and across the channels be re-examined and altered if necessary to ensure their proper observance. The Committee recommends that this action brooks no delay and should be taken up as early as possible. Similarly maintenance and upkeep of drainage channels, sluices in embankments should be the responsibility of the expert agency of the State Government, i.e., the Irrigation and Waterways Directorate instead of being divided amongst various departments as is the case now.

3.3. It is understood that the question of retention or otherwise of some of the ex-zamindari embankments along the channels was referred to the Revenue Department but no decision in the matter has yet been intimated. It is suggested that this question be entrusted to the Irrigation and Waterways Directorate urgently with the direction that as a matter of principle embankments along rivers and channels in lower Bengal are harmful and should be discouraged wherever possible. They should only be retained where indispensably required.

3.4. The next long-term ameliorative measures common to all regions are that of providing vegetative cover in the upper catchments which are at present denuded, and introduction of more scientific land uses in the middle and lower areas. In the case of upper catchments co-operation of Government of bordering States will be urgently and indispensably necessary as almost all the rivers in the area originate and flow through those States before they enter the State of West Bengal. From the estimates for these works prepared for the portions of the areas lying within the State of West Bengal it is quite clear that the expenditure to be incurred in these work will be remunerative. The Committee therefore are sure that the Government of bordering States would be willing to co-operate in this matter. The necessity and importance of maintaining adequate forest cover and adopting proper measures for soil conservation works can hardly be over-emphasised.

3.5. For portions in West Bengal brief descriptions of the works and outlay contemplated will appear under the schemes in the respective regions being dealt with in the following chapters. The soil conservation measures envisage treatment of sheet eroded areas and gullies. In the sheet eroded areas, the digging of cattle proof trenches followed by intensive afforestation and in the gully areas the construction of extensive number of check-dams and diversion channels, gully plugging, easing of slopes, supplemented by chutes, drops, inlet and catch water drains and planting of soil binders are being provided. These measures would lead to reduction in silt charges of the various river systems and reduction of run-off from the upper catchments as well as prevention of washing away of the fertile top soil.

3.6. Initiation of soil conservation work on waste and agricultural lands under private ownership is not possible without the consent of the owners. Moreover, even if such works are undertaken with their consent the effort will not produce the desired results unless follow-up is ensured. As the work is of importance for the benefit of the community as a whole including the owners, it is desirable to have necessary powers for enforcing the conservation measures. For this purpose, the Committee recommends enactment of necessary legislation as early as possible. It is understood that this is being sought to be done in the neighbouring States.

3.7. The Committee is aware of an apprehension that soil conservation work in the upper catchments would prevent or at any rate considerably reduce the flow of sand in the river bed in adequate quantities for stowing in the mines. The coal mines at present are dependent on this material for the purpose. In a discussion held at Calcutta on 20th March 1962 where the Chairman, West Bengal Flood Enquiry Committee, 1959, and the representatives of the C.W. and P.C., Geological Survey of India, Indian Bureau of Mines, National Coal Development Corporation, Damodar Valley Corporation, Forests, Irrigation and Revenue Departments of Government of Bihar and Directorates of Forests and Irrigation (Flood Control), Government of West Bengal, were present (vide proceedings given in Appendix 5) it emerged that the requirement of stowing material for the coal mines according to the present planned production will be very many times more than the availability of river sand even under the present conditions of abnormal soil erosion. The existing stocks in the various regions of the rivers in the mining areas together with future yields are not likely to last many years and the mining industry will have to look for alternative source of sand and/or alternative material for stowing purposes. Consequently it was felt that soil conservation measures recommended to be undertaken will not alter the position of supply of stowing material for the mining industry materially. Besides the time required to complete the conservation works in the entire area and the resulting effect of the reducing the production and flow of sand will be fairly long so that the mining industry will not be adversely affected in the near future and will have ample time within which to plan and execute alternatives.

3.8. The Committee understands that the work of soil conservation is being done in the State of West Bengal under three different Directorates, namely, Forests, Agriculture and Irrigation and Waterways (Flood Control Wing). The result is that the works are being done without proper co-ordination and planning. The line of approach to the solution of the problem by the different Directorates might differ to some extent, with the result that due to lack of expert guidance and trained personnel, the desired objective is not attained within a reasonable time and available and allotted funds are not fully and adequately utilised. The Committee, therefore, recommends that it is indispensably necessary to establish a separate Soil Conservation Organisation, preferably a Soil Conservation Directorate immediately under the proposed Soil Conservation Board setting up of which is understood to be under contemplation. This Soil Conservation Directorate should comprise of officers from the three aforementioned Departments and be given charge of execution of all Soil Conservation works in the State and thus ensure unified and at the same time co-ordinated effort.

3.9. Remedial measures for the deteriorated rivers and channels which have to dispose of run-off from the upper catchment and precipitation from the locality, speedily and efficiently, in order to prevent congestion of water, or in other words, floods in the area can take various forms. By resectioning some channels including remodelling structures on and along them, silt clearance by dredging and by river training works their discharging capacities can be enlarged and restored. The latter requires to be very carefully planned and in important

cases, tried in models before they can be adopted in proto-types as such works are generally expensive and the expenditure can be infructuous unless all possible factors have been taken into account while designing. The only method of checking this by trying the ideas in models which in recent years have been so well perfected that almost correct results become obtainable. But naturally for construction of such models accurate data such as detailed sections and bank lines of the channels, topography of the areas abounding them as well as hydrological data along them are necessary. Unfortunately these in the cases of such important rivers and channels as the Bhagirathi, the Babla, the Ajoy, the Tolly's Nullah, the Rupnarayan, the Kangsabati, the Kaliaghye, etc., are not available. They have also to be available over fairly long periods in order to be of use for preparing ameliorative schemes and also to prove the models before they can be utilised for the purpose of predicting results from projected designs.

3.10. For the above mentioned reason the Committee approved an estimate for 'Hydrological Observations in flood affected parts of South and South-West Bengal' amounting to Rs. 7.03 lakh (vide Appendix 6). The estimate provides for gauge, silt and discharge observations for varying periods at 23 sites where such data were wanting. It also provides for taking cross-sections of rivers at certain observation sites. This was sent to the Secretary, State Flood Control Board and was sanctioned and the necessary work is in hand.

3.11. Similarly aerial survey in the flood affected areas of parts of Howrah, Hooghly, Midnapore and Murshidabad districts were considered necessary as up to date maps showing the general configuration of the country and contours were not available, and in the case of Kandi area, those that were available were very old and did not indicate the changes of river courses and effects of siltations of the rivers "beels" and low-lying areas and putting up of embankments and "gher" bunds. The Committee therefore decided that aerial photography and survey of this area should be got done through Survey of India authorities to have the latest factual and pictorial representation of the area affected by floods of 1959. The Committee approved an estimate of "Aerial Survey in flood affected areas of the districts of Murshidabad, Midnapore, Hooghly, Howrah, etc. of West Bengal" amounting to Rs. 7.98 lakhs (vide Appendix 7). This estimate provides for—

- (i) aerial photograph on 2" to one mile scale and making enlargements therefrom for preparation of 4" scale photo mosaics which would enable easier identification of the rivers, important drainage channels, beels low-lying areas and other important objects,
- (ii) running level lines covering the area on grid system at fixed intervals and superimposing the spot levels so obtained on the photo mosaics,
- (iii) ground survey and interpolated contouring as necessary.

This estimate was sent to the Secretary, State Flood Control Board, and sanctioned and the necessary work is now in progress.

3.12. Estimates for collections of other hydrological and topographical data and for model experiments were recommended in the various intermediary recommendations made from time to time to the Secretary, Flood Control Board, Government of West Bengal. While it is satisfactory that at least some of the estimates covering the collection of these have been sanctioned and hydrological observations and surveys have been taken up, the Committee stresses that the other estimates recommended by it should soon be likewise administratively approved so that there is no avoidable delay in starting observations and surveys in the channels concerned and taking up model studies. It should be realised that the later they are started, the later will be possible solution available. The other methods of improving the condition of the channels in each region have been worked out in sufficient detail. All that will be required will be to prepare detailed working estimates when it is decided to take up the particular project.



3.13. Another common catastrophe which afflicts the lower districts is the submergence of a large number of villages. Those affected in the districts of Midnapore, Howrah, Hooghly, Burdwan and Nadia totalled 97 in 1959. The number and names of such villages together with other particulars in the districts of 24-Parganas and Murshidabad were not received from the District Magistrates concerned though requested for. In normal years no damage is generally experienced, but during heavy floods heavy toll is taken in loss of cattle, crop and houses and at times in human life. There can be no remedy against submergence of low-lying cultivated areas except putting ring bunds round them. This will create a lot of complications making the remedy worse than the trouble itself. For that purpose the villages have been divided into three categories, namely, small villages where there are no pucca buildings, comparatively larger villages with some pucca buildings, and very large villages providing more amenities for community life. The Committee recommends that in the case of the first category the whole village should be raised 1' 6" above the highest flood level. The earth for raising the site should be dug out of land to be acquired from public funds but reconstruction and remodelling of huts and houses on raised site should be done by the villagers themselves. It might be necessary to legislate for powers to raise the existing holdings to the desired level.

3.14. In the case of the second variety, a raised earthen platform of sufficient dimensions with the top 3' above the highest flood level, should be provided which ordinarily should be utilised for some community purpose such as School, dispensary or place of congregations, etc. But during times of heavy floods this should be available for shifting the village populace as well as the cattle. Type designs and rough estimates for both have been worked out. These are appended at Appedix 8. The total cost of dealing with the 97 villages will be approximately Rs. 86.50 lakhs.

3.15. In the case of very large villages, however, no hard and fast types can be evolved. Each case will have to be dealt with on its merits. In certain cases it might be necessary to permit ring bunds round the populated areas with pumping arrangements to drain out the precipitation within the bunded area.

3. 16. The Committee also recommends that where new public buildings are planned to be constructed in the villages in future, they should be built with plinths well above the high flood level so that in emergency such buildings could be used as shelters by the villagers.

## Region I, East of the Bhagirathi—Murshidabad and Nadia Districts

### 4.1. Area:

The area east of River Bhagirathi-Hooghy in Murshidabad and Nadia districts measuring 2,650 sq. miles is bounded by the river Bhagirathi on the west, by the Ganges on the north, by the rivers Mathabhanga and Ichhamati on the east and the northern district boundary of 24-Paraganas on the south.

### 4.2. Rivers and Drainage Channels:

The main drainage outfall is the Bhagirathi. The Jalangi, the Bhairab, the Churni, the Mathabhanga and the Ichhamati are the important rivers traversing the area and are fed by the Ganga spill during floods. There are also a few local drainage channels such as the Gobra Nala, the Suti Nadi, the Khana Khal, etc.

### 4.3. Problem:

4.3.1. The problem of Nadia and Murshidabad districts are more or less similar. Before the avulsion of the Ganga into the Padma, there were several active rivers in this region like the Bhagirathi, the Bhairab, etc., which used to flow south-easterly and were the main delta builders. The rivers and the adjoining tract of the land used to be frequently flushed by flood spills. The Bhairab was one of the most active delta builders and had quite a number of spill channels. After the avulsion of the Ganga into the Padma resulting in reduction and almost cutting off of headwater supplies, the lower reaches of these rivers got silted up by tidal action. New water courses like the Jalangi the Mathabhanga and the Churni later developed flowing in a south-westerly direction. These also have deteriorated. All old river courses have turned into moribund rivers and the low depressions have formed into "beel" areas.

4.3.2. The water levels in the main drainage carrier channels, i.e., the Bhagirathi, the Jalangi, etc., rule higher than the adjoining country-side during floods and thus such areas remain submerged due to accumulation of rain water and/or spill from rivers. Further due to deteriorated condition of the inner drainage channels and main rivers, the post-monsoon drainage is also very slow. A detailed description of the conditions ruling in these important rivers immediately preceding and during 1959 floods has been given in para. 3.6 of the Preliminary Report.

### 4.4. Proposed Remedial Measures:

#### 4.4.1. Improvement of the Bhagirathi:

4.4.1.1. The first and foremost remedial measure proposed for this region is the improvement of the Bhagirathi which is the main drainage artery of this area. This river devoid of perennial headwater supplies has been deteriorating rapidly and its carrying capacity has also become very much limited with the result that drainage congestion has increased. The river can be improved only by restoring headwater supplies which is envisaged in the Ganga Barrage Project. The Committee therefore recommended this scheme as one of vital importance not only for this region but also for the conservancy of the river Hooghy in its lower reaches.

#### 4.4.1.2. Ganga Barrage Project :

The scheme consists of a barrage across the Ganga at Farakka and another one on the Bhagirathi at Jangipur and a feeder canal from Farakka to Jangipur with the object of restoring head water supplies to the Bhagirathi-Hooghly. The Committee notes with great satisfaction that the execution of the project has since commenced and is expected to be pushed on with vigour.

#### 4.4.1.3. River Training and Protection of Bhagirathi-Hooghly :

Along with the construction of the barrages and control of head water supply as envisaged under above mentioned project, the Committee recommends that suitable resectioning of the river Bhagirathi along with necessary training and protection works should be undertaken so that these may link up with the construction of the Ganga Barrage Project.

#### 4.4.1.4. Control of Floods in the Western Tributaries of the Bhagirathi :

The western tributaries of the Bhagirathi bring in considerable volumes of sand and water adversely affecting the regime of the river. So the Committee recommends control of floods in these tributaries ; specially the Ajoy, which has no retention basins is urgently called for.

#### 4.1.1.5. Soil Conservation and Afforestation in the Catchments of the Western Tributaries :

The Committee further recommends immediate implementation of soil conservation and afforestation schemes in the catchments of western tributaries of the Bhagirathi so that silt entry into the Bhagirathi may be reduced as far as possible. This will also help in reducing run-off to some extent and thus intensity of flood will be lessened.

#### 4.4.2. Improvement of Drainage Congestion in Nadia and Murshidabad districts :

##### 4.4.2.1. Kalantar, Pagla Chandi Daha and other Beel Areas :

A few depressions or low pockets exist on the right bank of the Jalangi locally known as Kalantar area and Salmari Beels in Murshidabad district and Pagla Chandi Daha, Beel Kumari, etc., in Nadia district. Similar depressions exist between the Jalangi and the Churni and the Ganga-Jamuna. All these low pockets remain water-logged or submerged during the monsoon when the levels on the outfall rivers rule higher. Most of the beels are disconnected from the local drainage channels in the area. The existing drainage channels are also partially silted up. The Committee recommends the resectioning of the existing important drainage channels of this area and excavation of some new cuts, where feasible, connecting the low beel areas to suitable points of the drainage channels.

##### 4.4.2.2. Re-excavation of Khana and Nutan Khals :

The drainage congestion in the basin area of about 120 sq. miles in police-stations Kaligunj and Nakashipara in Nadia district may be reduced by re-excavation of the Khana Khal from Pagla Chandi Daha to river Jalangi as well as of the Nutan Khal. The drainage congestion in the low depression extending right from Kaligunj near Plassey up to the Jalangi via Pagla Chandi Daha, Khana Khal, etc., and several other isolated beels may be attributed to (a) spill from the Jalangi, (b) accumulation of rain water in the depressions due to high level ruling in Jalangi, (c) very slow drainage owing to deteriorated condition of the local drainage channels, (d) spill from Bhagirathi during high

floods. The approach to the solution of this problems would be the re-excavation of the Khana Khal and the Nutan Khal with sluices at outfall if necessary and excavation of new cuts to connect the beels for drainage. The Bhagirathi spill may have to be excluded by strengthening and raising the embankments there. Since sufficient data are not available survey and hydrological observations in this area are required to be done. The preparation of the detailed scheme will be possible only after collection of necessary data.

#### 4.4.3. Flood Flushing Scheme between the Bhagirathi and the Jalangi :

4.4.3.1. In the Murshidabad and Nadia districts above the confluence of the river Jalangi with the Bhagirathi a number of channels have lost their head water supplies. Improvement of these channels will go a long way in solving the flood problems of this area. The solution of the problem may lie in the flushing of the channels from the Bhagirathi.

4.4.3.2. The Chhoto Bhairab, Suti and the Bhandar Daha Nadi which are now serving as drainage carriers were originally spill channels. They have lost their head-water supply being cut-off from the main Ganges river and their outfall into Jalangi has become practically silted up due to back water effect of Jalangi spill. So the drainage through them is very slow. Consequently, the area is dotted with water-logged pockets in the shape of beels which do not have proper drainage outlet as they are cut-off from the main drainage channels.

#### 4.4.3.3. The scheme envisages—

- (a) restoration of head-water supply to Suti-Bhandar Daha river, Chhoto Bhairab, and
- (b) resectioning and desilting of the existing channels and excavation of new cuts as necessary.

The total basin area that would be served by these drainage channels is about 373 sq. miles. Resectioning of the existing drainage channels and excavation of new cuts with provision of sluices at outfalls for improvement of drainage of the basin is essential in any case. The Committee therefore recommended that since the ruling levels in the Bhagirathi are likely to change under the post Ganga Barrage conditions, the flushing-cum-drainage scheme in the area should be drawn up in consultation with the Ganga Barrage authorities. In case the flushing from the Bhagirathi is not possible the improvement of channels for the purpose of drainage must be carried out.

## CHAPTER 5

# Region I, East of the Bhagirathi— 24-Parganas District

**5.1. Area :**

The 24-Parganas district measuring 5,629 sq. miles is bounded on the south by the Bay of Bengal, on the West by the Hooghly, on the east by the rivers Ichhamati-Kalindi-Raimongal and on the north by the southern boundary of Nadia district. The area can be broadly divided into two parts, the northern part of the district measuring about 2,540 sq. miles traversed by a number of moribund rivers which previously used to be the spill channels of the Bhagirathi and the southernmost part of the district of 24-Parganas south of the Dampier-Hodges line running from Kulpi on the Hooghly to Haroa on the Kultigong and Hasnabad on the Ichhamati, is popularly known as the Sunderbans area. The Sunderbans comprise a total area of 3,089 sq. miles out of which about 1,460 sq. miles have been reclaimed by constructing nearly 2,200 miles embankments along the innumerable tidal creeks, channels and rivers criss-crossing the area. Within this area approximately 1,000 sq. miles are under cultivation and 190 sq. miles are under fisheries ; the rest comprises foreshore land, vegetation and wastes.

**5.2. Rivers and Drainage Channels :**

**5.2.1.** The main rivers of this area the Hooghly, the Haroa-Kultigong, the Matla and the Ichhamati-Kalindi. At the sea-face near the head of the Bay of Bengal the estuary is formed by the rivers Hooghly, Bartala, Saptamukhi Thakuran, Matla, Gosaba and Raimongal. All these rivers cut across the Sunderbans area. Other important drainage channels traversing this area are the Bidyadhari-Peali, the Nowi, the Sunti, the Nona-gong and the Sealdah-gong.

**5.2.2. The River Hooghly :**

The most important river in the area is the Hooghly which is the lower reach of the Bhagirathi. The Bhagirathi which once constituted the main channel of the Ganga, takes off from the parent stream at a point near Nurpur in Murshidabad district. From Nabadwip downwards the channel takes the name of the Hooghly. It is joined from the west by the rivers Damodar, the Rupnarain, the Haldi and the Rasulpur which bring in drainage from an area of about 16,000 sq. miles. On the left bank besides part of the Sunderbans area, a belt measuring about 562 sq. miles hugging this bank in the 24-Parganas district, drains directly into the river. This area along the Hooghly on the north of Calcutta is divided into a number of basins like Khardah, Ichhapur, Bagherkhal and adjoining Municipal areas while south of Calcutta it is divided into other basins like Monikhali, Keorapur, Churial, Roypur, Kantakhali, Falta-Khola-khali, Mograhat, Hara-Hatugunge and Kulpi.

**5.2.3. The Bidyadhari-Peali-Matla :**

Near Tribeni about 35 miles above Calcutta, the old river Ganga splits into three streams, namely, the Hooghly, the Jamuna and the Saraswati. With the avulsion of the Ganga eastwards the Jamuna as well as the Saraswati began to deteriorate and ultimately died. The Bidyadhari was an important spill channel of the river Jamuna and used to receive from it considerable upland supplies. The Peali takes off from the Bidyadhari and falls into the Matla at Kultali. The Bidyadhari itself also joins the Matla above Port Canning. The

factors responsible for the death of the Bidyadhari have also left their influence on the Peali, the upper reaches of which are already dead and the lower reach is fast deteriorating. The Matla similarly used to receive its upland supplies through the Bidyadhari, the Peali, the Karatia and the Athrabanki but due to their deterioration has in time become a purely tidal river and is deteriorating. This system of rivers drains an area of about 278 sq. miles, which is divided into four drainage basins, i.e., Sonarpur-Arapanch-Matla, Nagartala, Karatia and Lower Peali.

#### 5.2.4. The Haroa-Kultigong :

Another important river of this area is the Haroa Kultigong. It is formed by the joining of the Nowi and the Sunti which were the spill channels of the now defunct Jamuna. The river flows down into the Raimongal estuary taking on its way the drainage from a number of basins through drainage channels, principal among which are the Nona-gong and the Sealdah-gong. The Kultigong serves also as the outfall of the storm water drainage and sewage from the urban area of Calcutta through the Calcutta Corporation Storm-water and Dry-weather Flow Channels. The area drained by the Haroa-Kultigong river measures about 950 sq. miles. This area has been sub-divided into smaller basins like Nowi, Sunti, Pashkhally, Nona-gong, Sealdah-gong, Haroa-gong, Bagjola-Ghuni-Jatragachhi, Calcutta city and suburbs, Tollygunge-Panchannagram, Northern Salt-Lakes area, rural areas adjoining the Storm-Water channels and Sankda basin.

#### 5.2.5. The Ichhamati-Kalindi :

The easternmost river in this region is the Ichhamati-Kalindi which drains into the sea through the Raimongal estuary. The Ichhamati-Kalindi drains about 625 sq. miles of area including Beel-Pakuria and the Dantbhanga Basins.

#### 5.3. Problem :

5.3.1. The problem of the entire area is the difficulty in drainage created by various factors, the principal ones being—

- (a) Diminution in the upland supply into the Bhagirathi due to its off-take remaining cut-off from the Ganga during the major portion of the year resulting in the deterioration of the entire river system and the drainage channels.
- (b) Effect of tidal action on drainage carriers which worsens the condition further in most cases.
- (c) Premature reclamation of spill areas by putting up of marginal embankments along the rivers and drainage channels resulting in the rise in the levels of the beds and in flood levels affecting drainage capacity.
- (d) The general configuration of the greater part of the area is such that it is only slightly higher than the mean sea-level, so that rivers can serve the purpose of drainage only during the low tide periods.
- (e) In some cases bed levels in the outfall channels having become higher, drainage by gravity is not always possible.
- (f) The area being situated at the head of the Bay of Bengal is liable to be affected by the first onslaught of the depressions/storm from the Bay. (Moreover, fluctuations in tide levels is also more than other coastal areas.)
- (g) During severe cyclonic storms, tide lockage increases due to water-levels in outfall channels ruling higher and inland areas behind the embankments remain submerged for longer periods.

5.3.2. In the case of the Sunderbans area other additional factors come into play. They are—

- (a) Premature reclamation of land stopping the raising of land during the process of delta formation.
- (b) Breaches in weak embankments and their inability to withstand the saline action and wave wash.
- (c) Insufficient number and capacity of existing drainage sluices in the embankments.

#### 5.4. Conditions ruling in main outfall rivers during 1959 floods :

5.4.1. During abnormal floods of 1959, there was extraordinary heavy rainfall in all the river basins drained by the Bhagirathi-Hooghly synchronising with the spring-tides. This naturally resulted in acute drainage congestion and the Hooghly level ruled high for a number of days submerging large parts of 24 Parganas which lie along the lowest reach of the Hooghly. The ground level at certain places in this district being lower than the H.W.L. of Hooghly, they were affected for days together, the internal drainage due to local heavy rainfall being tide-locked for a long period. The gauge at Chitpur reached R.L. 18.60 against the previous record of R.L. 18.00. The average low water-level during this period was also far above than in other years.

5.4.2. The water-level near Diamond Harbour sluice also ruled correspondingly higher and submerged the vast tracts of low pockets in the Mograhat Basin to depths ranging from 4' to 9'. The maximum water-level in 1959 near the outfall of Rajapur Khal was R.L. 16.17 which was much higher than the average H.W.L. assumed for drainage of the basins on the eastern bank of the Hooghly. Similarly the high water and low water-levels at Kulti on the Kultigong were R.L. +12.4 and R.L. -0.6 against an average of R.L. +9.4 and R.L. -2.3. This caused severe drainage congestion in the Calcutta Municipal as well as the vast rural areas draining through the Haroa-Kultigong. The Calcutta-Hasnabad-Taki Road was under 5' water and remained submerged for more than 20 days causing severe damage.

5.4.3. The Ichhamati level at Basirhat exceeded R.L. 11.51 and the average low water-level in the corresponding week was R.L. +1.69 against a maximum of R.L. +10.70 and average low water-level of R.L. -1.09 during 1956 floods. These water-levels show that not only the average high water-level in 1959 was very high in all the rivers but the average low water-level in 1959 during this period was also much higher than the average low water-level in other years and it also synchronised with an exceptionally heavy rainfall in a wide area. The design F.S.L. for drainage of all the adjoining basins had been fixed on average tide curves which is much lower than the water-levels attained in 1959 in all the rivers. This naturally increased the tide lockage assumed and caused severe and prolonged drainage congestion.

#### 5.5. Measures recommended for improving the drainage capacity of the Hooghly :

5.5.1. The conservancy of the river Hooghly, the most important river of the area, is of vital importance. The remedial measures in respect of the Bhagirathi have been recommended under para 4.4 in the foregoing Chapter 4.

5.5.2. In the Port limits the use of the river as a navigable channel is only possible now by heavy dredging of shoals and bars which reform continuously. Dredging is being carried out in the river Hooghly by the Commissioners for the Port of Calcutta but the spoil is dumped within the river channel. In order to improve the regime of the Hooghly and its capacity as

drainage carrier the Committee recommends that the materials obtained from dredging of shoals and bars should as far as possible be deposited outside the river section.

5.5.3. A lot of encroachment in the form of cultivation and reclamation of the foreshore and berm lands in the river section has taken place and is still going on. This is very harmful. The Committee recommends that effective steps should be taken by the Government to stop this.

5.5.4. In the lower reaches on either bank for certain distance upstream and downstream of Calcutta, encroachments in the shape of protruding jetties, construction of other structures and disposal of Industrial waste are taking place. The Committee strongly recommends that such encroachments should be totally stopped and the solid industrial waste should not be allowed to be dumped into the river while the liquid industrial waste should be properly treated before it is discharged into the river.

5.5.5. The proper conservancy of the river at present is entirely dependent upon the maintenance of the present tidal influx. The Committee recommends that no new schemes which may result in reduction of this should be permitted or undertaken.

5.5.6. The river Rupnarayan, and the southern branch of the Kangsabati which combine with the Kaliaghye and form the river Haldi fall into the Hooghly. They have also shown signs of deterioration. The Committee is of the view that suitable redistribution or regulation of the discharge coming down from these principal tributaries with inter-connected basins may go a long way in the improvement of the river Hooghly. How best this can be done can only be ascertained by model studies. Collection of the necessary data should be undertaken immediately in order that these studies can be commenced early.

## 5.6. The Khardah-Basin Drainage Scheme :

### 5.6.1. Area : -

This basin extends over an area of about 12.32 sq. miles out of which about 8.25 sq. miles which is urban in character falls within the Barrackpore (South), Titagarh, Khardah and Panihati Municipalities and the remaining 4.07 sq. miles rural in character lies close to those municipal areas. The area is bounded on the north by the Ichapore basin, on the west practically by the river Hooghly, on the east by the Nowi basin and on the south partly by the Bagiola-Ghuni-Jatragachi basin and partly by the Nowi Basin. The basin is served by two channels, namely the Khardah Khal and the Talpukur Khal and the areas drained by each are 5.99 sq. miles urban, 2.65 sq. miles rural and 2.26 sq. miles urban, 1.42 sq. miles rural, respectively.

The general level of the area varies between R.L. 22.00 and R.L. 8.00. The urban area is, however, comparatively high and lies between R.L. 22.00 and R.L. 14.00.

### 5.6.2. Problem :

This basin used to be drained through the Sonai Khal or the Swarnabati Nadi and two drainage channels, i.e., the Khardah and the Talpukur Khals. The latter starts from the Dankuni beel, and falls into the river Hooghly near Titagarh and while the Khardah Khal takes off from the Kebla beel and falls into river Hooghly near Khardah. The Sonai Khal is completely dead and it is difficult to trace out its course in the field. The two channels have also been badly silted up and their sections have been considerably encroached at places due to rapid urbanisation near their banks. Moreover, these channels are open to tides.



### 5.6.3. The Scheme :

A scheme was originally drawn up with provision for drainage of the entire area through the Khardah Khal with four branch channels draining into it. During a recent survey it was noticed, however, that due to too many encroachments excavation of one of these branch channels was not possible. As such the scheme had to be modified. A part of this basin is now proposed to be drained through the other existing channel known as the Talpukur Khal. Provision has thus been made in this scheme for resectioning of both these outfall channels, i. e., the Khardah Khal and the Talpukur Khal to lengths of about 3.64 miles and 1.22 miles respectively. As there is not enough space for earthen channels of requisite sections specially in the urban areas, the narrower sections in these lengths will be lined in order to increase their capacities. Provision has also been made for excavating three new branch channels all with outfall into the Khardah Khal. Two of these channels will run along two sides of the Barrackpore Trunk Road and the other one along the eastern sides of the Eastern Railway main line. The channels along the two sides of the B. T. Road are also proposed to be lined due to the width of land available being restricted. The total lengths of channels to be lined will be about 6.4 miles. At the outfall of the main channels sluices will be provided in order to prevent ingress of tidal water into the basin. The design has been based on available data in regard to average tide curve at the outfall. In case of abnormal floods as happened in 1956 and 1959 reasonable drainage facilities will be available to the urban area by running the channel at a level higher than the design F.S.L. But in order to prevent worsening the conditions in the low rural areas an additional regulator is being provided across the Khardah Khal at a point about 1.5 miles above its outfall into the Hooghly. The F.S.L. of the main channels have been fixed in reference to average ground levels at their off-take points and water-level at their outfalls. Necessary provisions have also been made for construction of new bridges and remodelling of existing bridges across the main channels and proposed new branch channels.

This project does not provide for drainage of a narrow strip which is lying along the river Hooghly. Topography of this strip was not available so that the Committee approved a small survey being carried out. If as a result of this survey it is found out that the strip cannot drain directly into the river as it is very likely suitable schemes will be necessary to be drawn up.

A drainage index of  $\frac{3}{4}$ " per day has been assumed for the rural area. The urban area within this basin being very thickly built up a drainage index of 4.5" per day has been adopted.

The F.S.L. of the Khardah Khal has been fixed assuming 2.00 ft. depth of water to be standing in the low area at the off-take of the khal where the average ground level is at R.L. 8.36. So far as Talpukur Khal is concerned the average ground level near its off-take is about R.L. 12.00. In this case the outfall condition being favourable, complete drainage has been assumed in fixing the F.S.L.

### 5.6.4. Benefits :

The non-agricultural tract within the municipal areas measuring 8.25 sq-miles will be greatly benefited due to better drainage facilities and improved sanitary conditions. Due to improvement of drainage condition in the agricultural area of 4.07 sq. miles, an increased yield of foodgrains will be secured.

5.6.5. The estimated cost of the scheme is Rs. 44.50 lakhs, as given in the abstract of estimate (vide Appendix 9). The Committee recommends the sanctioning of the scheme and its early implementation.

### 5.7. The Nowi Basin Drainage Scheme :

#### 5.7.1. Area :

The Nowi Basin covers an area of 82 sq. miles of which 7 sq. miles are urban and the rest rural. The area falls within Barrackpore and Barasat subdivisions of the district of 24-Parganas and is bounded on the north by the Bagher Khal Basin, on the east by the Sunti Basin, on the south by the Bagjola-Ghuni-Jatragachi Basin and on the west by Khardah-Ichhapur Basins. The general level of the area varies from R.L. 8 to R.L. 30. There are a few very small pockets below R.L. 8. The area is drained into the Haroagong through the Nowi Khal and its branch channels.

#### 5.7.2. Problem :

At the off-take of the Nowi Khal there is a low-lying area locally known as the Barti Beel measuring about 9 sq. miles which acts as the receptacle of drainage from major part of this and the adjoining basins. This Beel area gets submerged every year whenever there is heavy rainfall and the area adjoining Barti is thus affected due to want of proper drainage outlet. The existing section of the Nowi Khal is narrow and is badly silted up and cannot drain the basin efficiently resulting in prolonged submersion of a large number of low pockets in the area causing considerable damage to standing crops. Partial drainage of this basin is effected through the Ichhapur Khal but the capacity of that khal is also limited at its outfall.

#### 5.7.3. The Scheme :

The scheme provides for resectioning of the whole of the Nowi Khal 18.4 miles in length from the Barti Beel to the Haroagong and excavation of a number of new branch channels connecting the low pockets with the Nowi Khal. Sluices have been provided at the out-falls of the branch channels but the Nowi Khal has been designed as an open tidal channel taking into account the tide lockage. The scheme will have to be executed in suitable phases. The section of the channel will in the beginning have a capacity of 1,000 cusecs (excluding the effect of tide lockage). This will be gradually increased to the ultimate capacity of 2,100 cusecs or 3,835 cuasecs with tide lockage. This has been gathered from the model studies. Provision has also been made for construction of necessary road and railway bridges across the main and branch channels.

The channels have been designed assuming a run-off of 3" per day for the urban area and  $\frac{3}{4}$ " per day for the rural area and the effect of the tide lockage has been considered.

#### 5.7.4. Benefits :

Out of the total area of about 82 sq. miles about 20.2 sq. miles of agricultural land will be saved from annual inundation and a further area of about 4.5 sq. miles will be brought under cultivation. Lastly, it will help to a considerable extent towards the conservancy of the river Haroa-Kultigong by increasing the drainage discharge and its capacity.

5.7.5. It has already been recommended in the Preliminary Report that Nowi should be resuscitated to accommodate the design discharge of 2.10 cusecs for proper conservancy of the river Haroa-Kultigong. The Committee recommends early implementation of this scheme which is estimated to cost

Rs. 1 crore (vide Appendix 10) and is expected to remove the drainage congestion of a vast area ; in addition it will improve the Haroa-Kultigong river system. This is a ready scheme prepared by the Greater Calcutta Master Plan Technical Committee. The Committee has only reviewed the drainage index and introduced the modification necessitated by the change.

### 5.8. The Sunti Basin Drainage Scheme :

#### 5.8.1. Area :

The basin covers an area of 89 sq. miles in Barasat, Naihati, Amdanga and Habra police-stations of the 24-Parganas district and is bounded on the north by the Bagher Khal Basin, on the east by the Nonagong and Panskhali basins, on the west by the Nowi Basin and on the south by the Nowi and Panskhali basins. The basin is mainly rural in character except about 3 sq. miles of urban area near Barasat town. The ground levels vary from R.L. 26 to R.L. 5.

#### 5.8.2. Problem :

The basin at present drains partly through the Nowi basin and partly through the river Sunti within the basin itself.

The Barti Beel proper and other low pockets in the Sunti Basin get submerged in case of heavy and sudden rainfall by run-off from higher areas of the basin overburdening the drainage channels of adjoining basins, namely the Nowi and the Ichhapur basins.

#### 5.8.3. The Scheme :

This scheme has already been prepared in detail by the Irrigation and Waterways Directorate of the Government. The Committee have, however, had the estimate recast on account of the change in drainage index from  $\frac{3}{4}$ " less 25 per cent. per day to  $\frac{5}{8}$ " per day and in the tide lockage. The modified estimate amounts to Rs. 150.00 lakhs (vide Appendix 11). The Committee recommends that this be sanctioned and the scheme be taken up for execution as early as possible. The scheme will have to be executed in phases. The channel will have a capacity of 1,000 cusecs at the beginning and will be gradually increased to 2,300 cusecs, or the Nowi Basin scheme can be taken up in entirety and this scheme may be taken up after studying the effects of that scheme on the Haroa-Kultigong.

### 5.9. The Sealdah-gong Basin Drainage Scheme :

#### 5.9.1. Area :

This basin covers an area of 169 sq. miles and is bounded on the north by the Eastern Railway line between Habra and Maslandapur Railway Stations, on the east by the road running from Maslandapur to Basirhat-Chaital, on the west by the loop of Padma Nadi in the upper reaches and the Seal-dahgong lower down and on the south by a line starting from the confluence of the Sealdahgong and the Kultigong and running towards due east for about 4 miles. The entire area is rural in character with average elevation, ranging from R.L. 5 to R.L. 24 and is full of various Beels, namely, the Nangla, the Padma, the Kakur, the Baykar, the Bhebla, the Dhever, the Kazirhati Nadi, etc. The present scheme covers an area of 129 sq. miles of the basin. For the remaining area of 40 sq. miles a separate scheme is understood to have been prepared and approved by the Government,

### 5.9.2. Problem :

This area, which is full of Beels, suffers from acute drainage congestion due to want of proper outlets and deterioration of the existing drainage channels. Originally the northern area, which is encircled by the Padma Nadi, used to drain into the Ichhamati river through the Padma and the Jamuna. But with the deterioration of these, the drainage of the northern area cannot now be effected through the Padma. The southern area is drained by the Sealdahgong, locally known as the Metia Khal which takes off from the low-lying areas near the north of Albelia Railway Station. The upper reach of Sealdahgong is badly silted up but the lower reach is in somewhat better condition. Since the low areas have not got proper outlets, they are submerged whenever there is heavy rainfall and remain water-logged almost for the entire monsoon period.

### 5.9.3. The Scheme :

This scheme has already been prepared in detail by the Irrigation and Waterways Directorate of the Government. The estimate amounts to Rs. 112 lakhs (vide Appendix 12). The Committee recommends that this be sanctioned and the scheme be taken up for construction.

## 5.10. The Manikhali Basin Drainage Scheme :

### 5.10.1. Area :

This basin covers an area of 22 sq. miles of land of which about 3.31 sq. miles lie within the jurisdiction of the Calcutta Corporation and remaining 18.69 sq. miles within the police-stations of Metiabruz, Garden Reach, Behala and Mahestala of 24-Parganas district. It incorporates the whole of the Garden Reach Municipal area and a portion of the South Suburban Municipal area west of Diamond Harbour Road. The basin is bounded on the north and west by the river Hooghly, on the south partly by the Budge Budge Railway line and partly by Nungi-Ramnagar Road and Biren Roy Road and on the east partly by the Diamond Harbour Road and partly by the Boat Canal and the old Kidderpore Docks. The basin area of 22 sq. miles can be classified into three categories, i.e.—

		Sq. miles.
(i) Urban area	... ..	9.46
(ii) Semi-urban	... ..	2.30
(iii) Rural area	... ..	10.24
Total	... ..	<u>22.00</u>

Under the first category are included 3.31 sq. miles of Calcutta Corporation, 3.35 sq. miles of Garden Reach Municipality and 2.80 sq. miles of South Suburban Municipality. The general levels of the area vary from R.L. 6.00 to R.L. 18.00, of which the major portion is at R.L. 12.00 and above.

### 5.10.2. Problem :

The Manikhali Khal Basin used to be drained previously by the old Manikhali and Hayatpur Khals. Later a new channel named Manikhali Khal (new) was excavated. With the passage of years portions of the basin have been highly developed and are also getting rapidly urbanised. But the Khals of the area have deteriorated and therefore drainage congestion has resulted necessitating the undertaking of this drainage scheme.

### 5.10.3. The Scheme :

The scheme provides for resectioning of the new Monikhali Khal, the old Manikhali Khal and the Hayatpur Khal totalling a length of about 10 miles, excavation of two new branch channels with regulators at their outfall ends, provision of an additional 5 vented sluice and remodelling of existing sluices at the outfall of the new Monikhali Khal, provision of a single vented sluice at the outfall end of the old Manikhali Khal and strengthening and repairing of the existing sluices on Hayatpur Khal, remodelling and reconstructing the Railway and road bridges and other ancillary work.

### 5.10.4. Run-off :

The area immediately bordering the river Hooghly within the area of Calcutta Corporation and Garden Reach Municipality have some direct escape facilities into the river, hence only 70 per cent. of the net discharge from this area has been considered as falling into the channel which is being remodelled, the rest 30 per cent. is expected to drain directly into the Hooghly. For the purpose of calculation of drainage discharge, the following drainage indices have been assumed :—

- (a) 4" per day for urban area of 3.31 sq. miles of the Calcutta Corporation including the area under the Port Commissioners.
- (b) 3" per day for an area of 6.15 sq. miles under Garden Reach, South Suburban or Behala Municipality.
- (c) 2½" per day for an area of 2.30 sq. miles in the Metiaburuz police-station.
- (d) ½" per day for rural area of 10.24 sq. miles.

### 5.10.5. Benefits :

Out of total basin area of 22 sq. miles 18 sq. miles are non-agricultural and the remaining 4 sq. miles are agricultural in nature out of which 1 sq. mile will be fully benefited and 3 sq. miles will be partly benefited. The removal of drainage congestion in the urban and semi-urban areas will be a boon from the point of view of sanitation and would help in industrial growth.

5.10.6. The cost of the scheme amounts to Rs. 30 lakh as given in the abstract of estimate (vide Appendix 13). The Committee approves of this scheme and recommends its early implementation. It may be relevant to mention here that this scheme was also one of the schemes formulated and recommended by the Greater Calcutta Master Plan Technical Committee set up by the Government in 1947. The provisions in the estimate prepared by that Committee have been revised based on the present-day prices of labour and materials and the drainage indices now recommended as well as certain modification which were considered necessary.

## 5.11. The Keorapukur Basin Scheme including desilting of the Tolly's Nullah :

### 5.11.1. Area :

This basin extends over an area of about 16.6 sq. miles lying within Tollygunge, Sonarpur, Behala and Bishnupur police-stations in the district of 24.Parganas. This area is bounded on the south by the Mograhat Basin, on the west by the Keorapukur Khal, on the east by Garia-Baruipur Road, and on

the north by the Netaji Subhas Chandra Road in Tollygunge area. The total basin area can broadly be classified into the following types :—

	Sq. miles.
(i) Urban area	1.60
(ii) Semi-urban area (including 3 sq. miles of potentially urban area)	9.00
(iii) Rural area	6.00

The whole of the urban area of 1.60 sq. miles is within jurisdictions of Calcutta Corporation. Out of the 9 sq. miles of semi-urban area part, namely, 6 sq. miles falls within Garia and Rajpur Municipalities. The ground levels within this basin vary from R.L. 7.00 to R.L. 22.00. Average level within the area of Calcutta Corporation is about R.L. 20.00 and that of Garia and Rajpur Municipalities vary between R.L. 12.00 to 18.00. The rural area is comparatively low and the ground levels vary between R.L. 7.00 and R.L. 12.00.

#### 5.11.2. Problem :

This area used to be drained formally through the Adiganga which is now dead. At present partial drainage of this area is effected through the Tolly's Nullah which has also been badly silted up. For this reason it suffers badly due to want of proper drainage outlet. Nowadays the discharge from a part of this basin on its such spills over to the Mograhat basin at times, thereby aggravating trouble in that basin where the problem is already acute. Moreover the rural area within this basin being low proper drainage by gravity is not possible as the average tide level in Tolly's Nullah runs comparatively high.

#### 5.11.3. The Scheme :

This scheme provides for desilting of the Tolly's Nullah to required section from Garia Road Bridge up to its outfall to serve as the main drainage outlet for the basin. For the western or the rural portion of the basin which is comparatively low, provision has been made for installation of pumps near the bank of the Tolly's Nullah including excavation of a leading channel connecting the pump house with the low pocket. The remaining portion of basin being comparatively high gravity drainage is possible and as such a separate drainage channel with a regulator near the outfall in Tolly's Nullah has been proposed. Within this zone land having an average level up to R.L. 12.00 has been included for gravity drainage. The area within Calcutta Corporation will drain direct into the Tolly's Nullah. Provision has also been made for construction of necessary bridges,

#### 5.11.4. The drainage indices adopted are as follows :

	Per day.
(i) Urban area	4.5"
(ii) Semi-urban area	1.5"
(iii) Rural area	$\frac{3}{2}$ "

#### 5.11.5. Benefits :

Out of total basin area of 16.6 sq. miles, 10.6 sq. miles is urban and semi-urban in nature and this will be benefited by improved sanitation and drainage. The remaining 6 sq. miles is rural which will also be benefited due to improved drainage facilities. An increased yield of crops will be secured,

5.11.6. The cost of the scheme amounts to Rs. 40.00 lakhs as given in the abstract of estimate (vide Appendix 14). This scheme is approved by the Committee and early implementation of the same is recommended.

#### 5.12 Improvement of the Tolly's Nullah :

5.12.1 The scheme in the foregoing paragraph envisages resectioning the channel to accommodate drainage from the small areas proposed to be drained through it. The improvement of the main channel, however, is a crying need of the locality and a solution aiming at permanent resuscitation is very necessary. Not only drainage of a large and important area is dependent upon the efficient functioning of this channel but its improvement will incidentally gratify the public sentiment on account of several sacred places situated on its banks. NEDECO were invited to examine the problem in 1953. Their scheme along with the final documents submitted by them recently were passed on to the Committee in March 1962 for their views.

#### 5.12.2. Scheme :

The scheme envisages resectioning the channel from Hastings to Garia Railway Bridge to certain sections and excavation of tidal basin above Garia. The calculation of sections in different reaches and the size of the basin are based on studies in a mathematical model developed from surveys and observations made in 1954. Certain discrepancies have been noticed between the observed and the figures computed from the above model. The divergence in some cases is rather high. This is admitted by NEDECO and no satisfactory explanation has been found for it. This may be due to either the data collected not having been sufficient, or the model not being absolutely correct, so that in either case it was not possible to prove the model to the required satisfaction. Hydraulic model studies were also carried out by the River Research Institute in a proved model in the year 1950-51. The results were communicated to the NEDECO Engineers. The studies, however, were based on a cadastral survey of 1929 as corrected by a local survey of 1945-46. The results obtained are very different from those obtained by NEDECO. The sections of the channel are shallower and narrower but the basin is larger in area although shallower. The indications thus are that although in principle the NEDECO scheme is sound, their designs and estimates can only be accepted as preliminary ones. They have got to be again checked up by further studies in a fresh hydraulic model based on the latest surveys and hydraulic data. It will be useful to compare the results of the hydraulic model studies with those obtained by computations.

5.12.3. The estimate based on NEDECO designs amounts to Rs. 297.5 lakhs. This does not provide for land required for deposit of silt to be removed annually from the tidal basin. Besides, certain encroachments and building operations have taken place in the area originally contemplated for deposit of spoil and silt necessitating longer pipe lines than provided. A reconnaissance survey by the Special Engineer, Salt Lakes and Allied Schemes, has revealed that low area in the Tollygunge-Panchannagram Basin is available for the purpose which will be sufficient for a period of about 25 years. This area will have to be acquired forthwith in order to prevent further encroachments and also inflation in prices. As the raised area should be fit for building purposes, it should fetch handsome prices on sale. Adding the cost of such acquisition and necessary development and interest charges the estimate will aggregate to about Rs. 1,575 lakhs. The rough estimate is attached as Appendix 15. The cost, however, is likely to increase further if the ultimate sections of the channel are to be as envisaged in the present scheme of NEDECO because excavation to low levels will be costly and steep side slopes in some portions will need protection. Alternatively some length of the resectioned channel might have to be lined.

5.12.4. The Committee recommends that this scheme be taken up for execution as soon as the studies suggested above have been completed and the final designs and estimates worked out. Pending finalisation of the details of this scheme resectioning of the Tolly's Nullah included in the scheme for the drainage of Keorapukur Basin, recommended in Para. 5.11 above, should be taken up.

5.12.5. It is apparent that the scheme does not offer a permanent solution of the problem. For this purpose it is recommended that an investigation be undertaken at an early date to find out the possibility of diverting sufficient upland supplies to maintain the resectioned channel in regime.

### 5.13. The Churial Basin Drainage Scheme :

#### 5.13.1. Area and Boundary of the Basin :

The basin covers an area of 63.70 sq. miles of which about 6.53 sq. miles lie within the Behala Municipality and 2.48 sq. miles within Budge Budge Municipal area. The rest measuring 54.69 sq. miles is rural. The basin is bounded on the north by Biren Roy Road and Nungi-Budge Budge Road, on the east by Keorapukur Khal and Diamond Harbour Road, on the south by the northern boundary of Mograhat Basin between Keorapukur Khal and Diamond Harbour Road and Amtala-Bakrahat-Churial Road and on the west by the river Hooghly. The general levels of the area vary from R.L. 6 to R.L. 14. There are some small isolated areas where elevation is a little above R.L. 14.00.

#### 5.13.2. Problem :

Parts of the basin area are low and suffer from drainage congestion due to inadequate water-way of the existing Churial Khal which has become partially silted up and also due to insufficiency of the ventage of the existing sluice at the outfall end. Also a part of the basin at the head end beyond the Diamond Harbour Road used to drain formerly into the Tolly's Nullah through the Keorapukur Khal, but due to gradual deterioration of the Tolly's Nullah this drainage is not effected now through that channel. Some of the low pockets of this basin have no connecting links at present with the Churial Khal and as such remain water-logged.

#### 5.13.3. The Scheme :

It is proposed to drain the area into the river Hooghly through the Churial Khal. The scheme provides for resectioning of the entire length of existing Churial Khal with its side channels, extension of the main channel beyond Diamond Harbour Road by excavation of a new cut commencing from the low pocket of Purba-Barisha south of Biren Roy Road, excavation of some new branch channels, construction of new foot-bridges and remodelling of the existing bridges on main and branch channels. It also provides for remodelling of the existing Eastern Railway bridge on the Churial Khal near its outfall, construction of an additional sluice at the outfall across a diversion channel to be newly excavated.

5.13.4. The drainage indices assumed for design purpose are as follows :

- (a) Behala and Budge Budge Municipal area 3" per day,
- (b) Rural area  $\frac{3}{2}$ " per day,

#### 5.13.5 Benefits :

Out of the total basin area of 63.70 sq. miles 6 sq. miles of agricultural land will be benefited fully. In addition an area measuring 30.5 sq. miles will also be partly benefited.



5.13.6. The cost of the scheme amounts to Rs. 85.00 lakh as given in the abstract of estimate (vide Appendix 16). The Committee approves of the scheme and its early implementation.

**5.14. The Balarampur Khal Drainage Scheme :**

**5.14.1. Area :**

This scheme provides for drainage of an area of 36 sq. miles in the catchment of the Balarampur Khal which forms part of the Falta Basin in police-stations Falta and Diamond Harbour in the district of 24-parganas and is bounded on the north by the Katakhal Khal, on the east by Calcutta-Diamond Harbour Road, on the south by Sarisha-Nurpur Road and on the west by some small local drainage channels of this basin. The average ground levels vary from R.L. 7.5 to R.L. 10.5 and are rural in character.

**5.14.2. Problem :**

During heavy rainfall large portions of the basin get submerged due to drainage congestion resulting from heavy siltation of the upper reach of the Balarampur Khal. Even in normal years large areas of this basin remain water-logged for a prolonged period causing considerable damage to the standing crops. The upper reach of the Balarampur Khal has been silted up due to meeting of tides through this Khal and Katakhal Khal.

**5.14.3. The Scheme :**

The Committee understands that a scheme for improving the drainage of this basin is already under execution.

**5.15. Remodelling of the Mograhat Basin Drainage Scheme :**

**5.15.1. Area :**

This basin is comparatively big and extends over an area of about 297 sq. miles, which is rural in character and falls within Diamond Harbour subdivision in the district of 24-Parganas. It is bounded on the north by the Keorapukur and the Churial Basins, on the east by the dead Piali river, on the west by Calcutta-Diamond Harbour Road and on the south by the Hara-Hatuganj Basin. The general topography of this basin is very flat and the average ground levels vary between R.L. 6.00 and R.L. 15.00. There are a network of channels within this basin numbering about twenty-three with only one outfall, namely, the Diamond Harbour Creek.

**5.15.2. Problem :**

The drainage congestion in this basin is very acute. This is mainly due to the sections of existing channels being inadequate for the discharges they have to carry from their respective basins. This is partly due to their having got silted up and partly due to their original designed sections not having been adequate. The channels were originally designed assuming a drainage index of  $\frac{1}{2}$ " per day under the presumption that in addition to discharge through the channels there will be considerable surface flow over the fields up to the outfall sluice. The drainage congestion has further been accentuated to a great extent due to the death of the river Piali as a result of which considerable area which used to drain formerly into that river is now draining through the Diamond Harbour Sluice.

**5.15.3. The Scheme :**

The scheme provides for resectioning of all the inner channels measuring approximately 101 miles in length to full section required for disposal of the run-off at the rate  $\frac{3}{4}$ " per day. Provision had to be made for construction of an additional sluice including excavation of a by-pass channel at the outfall for

accommodating discharge to be disposed off over and above to that for which the old Diamond Harbour sluice was designed. A Regulator has also been provided near the outfall of Nazar Khal in order to enable the low areas within the Mograhat basin during high floods to drain by regulating the drainage from the higher areas. In addition other ancillary works have also been provided for.

#### 5.15.4. Benefits :

Out of total basin area of 297 sq. miles which is mostly agricultural in character, about 150 sq. miles suffered from drainage congestion during abnormal floods of 1956 and 1959. In years of normal floods also quite a considerable area within this basin suffers from drainage congestion. Major portion of this area will be benefited by this scheme.

5.15.5. The cost of the scheme as per rough estimate is Rs. 155 lakhs as given in the Appendix 17.

This scheme as drawn up is approved by the Committee which recommends early implementation of the same.

#### 5.16. The Sankdah Khal Scheme :

##### 5.16.1. Area :

The basin covers an area of 25 sq. miles of land within police-stations Sandeshkhali and Haroa of 24-Paraganas district and is bounded on the north as well as on the east by the river Bidyadhari, on the south by the Karatia Basin and on the west partly by the river Bidyadhari and partly by the Karatia Basin. The ground levels vary from R.L. 5.00 to R.L. 11.00.

##### 5.16.2. Problem :

The main drainage channel, i.e. the Sankdah Khal has been badly silted up and the low pockets in some places are not connected with the outfall channel. As such, an area of 9 sq. miles within this basin suffers every year from drainage congestion.

##### 5.16.3. The Scheme :

A scheme providing for desilting of the Sankdah Khal and excavation of the branch channels including construction of a new sluice and ancillary works has been approved in principle by the Committee. The drainage index should, however, be raised to  $\frac{3}{4}$ " per day. The modified estimate amounts to Rs. 16.50 lakhs (vide Appendix 18). The Committee recommends its early sanction and the scheme should be taken up for construction as early as possible.

#### 5.17. The Beel Pakuria Scheme :

##### 5.17.1. Area :

The basin covers an area of about 38.5 sq. miles in Beel Pakuria, Jamberia Abad, etc., in police-stations Basirhat and Hashnabad and is bounded on the north and east by the road from Basirhat-Hararpur-Sankchura-Hasnabad Road, on the south by Sankchura-Chandpur Road and on the west more or less by Uttardebipur, Khordao-Sadarpur Road.

##### 5.17.2. Problem :

An area of 38.5 sq. miles including Beel Pakuria and Jamberia Abad in the basin suffers badly from drainage congestion due to want of proper outlet. The existing Beel Pakuria Khal which is the main drainage channel of this basin has deteriorated and silted up and cannot effectively drain the basin. Whenever there is heavy rainfall large areas are submerged causing damage to cultivated lands.

### 5. 17. 3. The Scheme :

The scheme providing for resectioning and remodelling of the Beel Pakuria Khal up to its outfall on the Kanta Khali Nadi along with a branch channel from Karerabad with sluices in the Beel Pakuria Khal and marginal embankments has been approved in principle by the Committee. The drainage index should, however, be raised to  $\frac{3}{4}$ " per day. The modified estimate amounts to Rs. 9.50 lakhs (vide Appendix 19). The Committee recommends that this be sanctioned and the scheme taken up for construction as early as possible.

### 5. 18. The Dantbhanga Beel Scheme :

The scheme has been kept in abeyance for the present.

### 5. 19. Scheme for remodelling of Sundarban Embankments and Sluices :

There are about 2,200 miles of embankments in the Sundarbans to protect an area of 1,460 sq. miles out of which about 1,000 sq. miles are under cultivation. A large part of the area has been prematurely reclaimed and it is generally lower than the high water level. Sluices have, therefore, been provided in the embankments. The embankments are however of weak sections. On exposure to tidal action and wave attacks, these are liable to breach causing saline inundation and damage to the standing crops. The sluices are not everywhere of adequate capacity. There is, therefore, the problem of drainage disposal also. With a view to solving these, it is necessary to remodel the existing earthen embankments providing adequate protective measures where necessary, such as revetments, retired alignments, forest cover, etc., at the same time afford adequate drainage facilities by constructing requisite number of sluices. The cost of such a scheme is roughly estimated to be Rs. 736.64 lakhs (vide Appendix 20). The Committee recommends that preparation of detailed scheme be undertaken so that the works can be taken up at an early date.

5.20. There is another aspect of the problem of the Sundarbans. Sundarban Delta has been built up by the silt brought down by the Bhagirathi-Hooghly and other spill channels of the Ganga. The process has been assisted by silt pushed up by the tide from the Bay. With the reduction and total stoppage in some areas of head water-supplies on the spill channels, land formation at present is dependent entirely on tides. Most of the Sundarbans area has, however, as already stated, been reclaimed prematurely, that is before the natural action of silt deposition by tides, had raised the land to a sufficient height. A remedy to the evil may be sought by throwing open the land to the action of tides. The Committee recommends that the work may be undertaken to study the possibilities of this method by taking up small areas. The study will include the examination of the possibilities of rehabilitating people of the area keeping in view that it would be unwise to reduce the present spill areas or reclaim existing forest land subject to spill for the purpose.

5. 20. 1. In this context it may be mentioned that certain investigations are in progress which envisage closure of some of the estuaries. In the event of any such scheme materialising, the recommendations made in the above two paragraphs will need a fresh review.

## CHAPTER 6

## Region I, Calcutta Municipal Area and its Immediate Surroundings

### 6.1. Area :

6.1. This region of about 48 sq. miles comprises Calcutta Municipal area of nearly 37 sq. miles and Tollygunj-Panchannagram-Boincheetola area of about 11 sq. miles. It is bounded on the west by the river Hooghly and partly by the Port Commissioners' Boat canal from Majerhat to the river Hooghly, on the north by the limits of Calcutta Corporation following a road from the Hooghly to the Sealdah-Naihati Railway line, on the east partly by the aforesaid Railway line and partly by the New Cut Canal up to Dhapa and then along the Central Lake Channel from Dhapa to Bantala and the Panchannagram embankment from Chowbhaga to Jadavpur and then by the Railway line between Jadavpur and Garia, on the south by the Tolly's Nullah between Garia Railway Station and Chetla and thence partly by the northern boundary line of Behala Municipality. Out of the aforesaid Calcutta Municipal area 3.31 sq. miles of Port area has been included in the Monikhali Drainage Basin Scheme and 1.6 sq miles immediately adjoining the Tolly's Nullah in Tollygunj area under the Keorapukur Basin Drainage Scheme which have been dealt with in Chapter 5.

6.1.2. The Calcutta Municipal area includes the city proper with Port area Cossipur, Manicktola and Tollygunj. The city proper with Port area measures 22.62 sq. miles, out of which 2.53 sq. miles in the former and about 1.40 sq. miles in the latter are unsewered. About 1 sq. mile out of 3.14 sq. miles of Manicktola has been sewered by the Calcutta Improvement Trust. The Cossipore area of 3.30 sq. miles and Tollygunj area of 7.44 sq. miles are also unsewered. Thus the unsewered areas total about 17 sq. miles which work out to 46 per cent. of the whole area.

### 6.2. Brief description of existing Drainage System :

#### 6.2.1. Sewered Areas :

(1) North Calcutta up to Lower Circular Road on the south and east—75 sq. miles of area are served by Palmer's Bridge Drainage Pumping Station and its subsidiary station on the Raja Dinendra Street.

(2) South Calcutta up to Budge Budge Railway line—12.5 sq. miles including the sewered areas on the west of Tolly's Nullah (Kidderpore-Alipore-New Alipore and portion of Dock areas) are served by the Ballygunge Drainage and its subsidiary pumping stations at Mominpore Road, Nimak Mahal Road and Chetla Road all situated on the west of Tolly's Nullah.

#### 6.2.1.1. Disposal of Dry Weather Flow :

The dry weather flow is pumped from Palmer Bridge Pumping Station through two high level sewers, one 8' in diameter and the other 9' in diameter and from Ballygunge Pumping Station through two other high level sewers, one 5' in diameter and the other 8' in diameter to Topsis commonly known as Point A. From this point it is carried by a high level pucca channel about 20,000' in length to the Sedimentation tanks at Bantola where it undergoes primary settlement and the effluent is then disposed of into the river Kulti through the dry weather flow sluice about 17 miles from Bantola. But, as the available capacities of pumps and sewers to Point A, are inadequate to deal with the maximum dry weather flow, the other pumps meant to discharge into the Storm Water Channel have to be used,

### 6.2.1.2. Disposal of Storm Water.

Storm water is pumped from Palmer's Bridge Pumping Station and is conveyed by an open storm water channel from the station up to Makhalpota and thence along the Central Lake Channel up to Bantola where a similar channel from Ballygunge Pumping Station meets it and the combined channel known as the storm water channel flows into the Kultigong at Kulti. Before Bantola the channel also receives drainage from the adjoining areas of Dhapa, Tollygunge and Panchannagram.

## 6.2.2. Unsewered and partly sewerred areas :

### 6.2.2.1. Cossipore area :

The Cossipore area measuring 3.30 sq. miles is unsewered and at present drained by surface drains. It includes amongst others a part of the area enclosed by Jessore Road, Barrackpore Trunk Road and Dum Dum-Nager Bazar Road which contains the Belgachia and Birpara pockets. A portion of the area immediately adjoining the river Hooghly drains directly into the same through existing drains debouching on the river. The drainage of the major portion of the remaining parts of this area excepting the Belgachia pocket finds its way to the Birpara pumping station. The drainage from the Belgachia pocket is led to the existing Bagjola Pumping Station of the Calcutta Corporation from where the discharge is conveyed through a syphon under the Kistopore Canal and disposed of into the Northern Salt Lake. As the Northern Salt Lake city extension scheme has been taken up for execution, it has become necessary to divert this pumped discharge. A sewage treatment plant at Bagjola for treatment and disposal of sewage up to a limit of 34 cusecs, the total installed capacity of the existing pumps at the Bagjola is already under construction. The effluent after treatment will be drained into the Bagjola main drainage channel. It may be mentioned here that at times of heavy rainfall the storm water discharge from some adjoining areas of Belgachia also find access into the channel leading to the pumping station. But in view of the limited capacity of the existing pumps it stagnates there. At the site of the Bagjola sewage treatment plant, space has been kept for augmenting the capacity, should it become necessary.

At Birpara, gravitational arrangement for draining the flow into a "Nikasi" leading into the Bagjola Khal has, a few years ago, been supplemented by a pumping arrangement at the time when the khal was being resectioned in connection with Bagjola-Ghuni-Jatragachi Drainage Scheme. But the Bagjola-Ghuni-Jatragachi Drainage Scheme as executed does not provide for taking in the drainage from the Cossipore area. Discharge of untreated sullage from this area into the Bagjola Khal is unsatisfactory. There is, however, a scheme for disposal of drainage and sewage of this area into the Dhapa lock pumping station, drawn up by the Calcutta Improvement Trust. This scheme envisages the discharge being led to the Dhapa lock pumping station through a syphon to be constructed under the Circular Canal at Ultadanga, where a pumping station will be located. Ultimately the discharge from Dhapa will be led to Bantola and thence to Kulti. The Committee recommends early implementation of the scheme. However, till the scheme is taken up and completed, the Committee is of opinion that the effluent at Birpara should be treated being led into the Bagjola Khal. Resectioning, if necessary, of the Bagjola-Ghuni-Jatragachi main drainage channel should be done.

### 6.2.2.2. Manicktola area :

Out of 3.14 sq. miles, only one sq. mile has been sewerred. The drainage from the areas not sewerred is at present pumped through four syphon pumping stations situated on the west bank of New Cut Canal. The discharge

from the pumping stations is passed through syphons under the New Cut Canal and disposed of into the Northern Salt Lake Area. Drainage from the existing sewerage portion gravitates to the newly constructed Dhapa Lock Pumping Station which has begun functioning since March 1959. The discharge from the Dhapa Lock Pumping Station is carried through the recently excavated channel to Bantola for ultimate disposal into the Kultigong.

#### 6.2.2.3. Topsia :

Surface drainage from about 1.5 sq. miles is dealt with by one pumping station at Topsia which discharges into the high level D. W. F. Channel, at point A.

#### 6.2.2.4. Tangra area :

Surface drainage is disposed of by a small pumping station into the storm water channel from Palmer's Bridge Pumping Station.

#### 6.2.2.5. Chingrighata area :

A portion of the Chingrighata area is served by a small pumping station situated on Pagladanga Road. Pumped surface drainage is discharged into the storm water Channel from Palmer's Bridge Pumping Station.

#### 6.2.2.6. Tollygunj area :

The Tollygunj Municipal area of 7.44 sq. miles was amalgamated with the Calcutta Municipal area in 1952. The major portion of surface drainage of Tollygunj area is drained through five main surface drains into the low Panchannagram area. There is a network of smaller surface drains connected with the main drains. The small area (on the fringe) abutting on Tolly's Nullah gets drained into the Nullah. The drainage from Tollygunj-Panchannagram basin is carried through a channel by the side of the Panchannagram Takavi embankment leading to Chowbhaga, situated on the right bank of the storm water channel, from Ballygunj Pumping Station to Bantola. At Chowbhaga it discharges into the storm water channel through a sluice whenever water levels in the channel permit gravitational drainage.

### 6.3. Problem :

6.3.1. During the months of September-October 1959, the city of Calcutta and its immediate adjoining areas experienced flooding of a magnitude and duration which had hardly been experienced before. The amount of flooding in unsewered area has been estimated by the Chief Engineer, Calcutta Corporation, to be as follows :

	Total area in sq. miles.	Area flooded in sq. miles,	Percentage of flooding.
1. Tollygunge	7.44	5.58	75
2. Manicktola	3.14	1.57	50
5. Cossipore	3.50	1.98	60
4. Topsia	1.50	1.18	75
		10.31	

6.3.2. The city of Calcutta is situated on the eastern bank of the Hooghly and the land generally slopes away from the high river bank in a south-easterly direction. The city is also cut across on the north and east by Calcutta canal system comprising the Circular Canal, the Beliaghata Canal, the New Cut Canal, the Town Head Cut, the Suburban Head Cut and on the south and west by the Tolly's Nullah and Chetla Boat Canal which have high banks. The city has, therefore, become like a saucer-shaped basin interspersed with low lying pockets.

6.3.3. The drainage difficulties arise due to unfavourable topographical features coupled with the following factors :—

- (i) Heavy concentrated rains submerging the low pockets as the internal sewer system is not designed for such heavy precipitation. The sewerage system, constructed about 100 years ago, has inverted to invert connection, and suffers from lack of adequate hydraulic gradient in places, silt burden from unfiltered water flushing and Khatal refuse and additional load due to increased population of the city. Heavy silting up of the same takes place thus reducing the effective area of the sewers.
- (ii) Existing inadequate pumping capacity of the storm water drainage pumping stations.
- (iii) Increase of tide lockage during widespread rains such as occurred in 1956, 1959, due to the outfall rivers, mainly the Kultigong and partly the Hooghly ruling high.
- (iv) Construction of unauthorised huts and buildings in the low-lying areas sometimes on the actual lines of drainage, particularly after the influx of population resulting from partition of the country and the industrial development.
- (v) Inadequate capacity of the storm water channel from Bantola to Kulti.
- (vi) The elevation of some portions adjoining the river Hooghly and Tolly's Nullah being lower than the high water level and their getting submerged by over-topping during extraordinary high tides in 1959.
- (vii) Inadequate capacity of two existing sedimentation tanks for treatment of dry weather flow necessitating the diversion of untreated sewage directly into the storm water channel resulting in deposit of silt into it.
- (viii) Deterioration of the Haroa-Kultigong.

6.4. The remedial measures proposed can be broadly subdivided into the following categories :—

- (1) Improvement of the existing internal drainage system of sewered areas and proper maintenance and regular desilting of the existing sewers.
- (2) Prevention of heavy silt entry into the sewers from Khatal flushing, unfiltered water, etc.

- (3) Increasing the pumping capacity in the Drainage Pumping Stations.
- (4) Providing adequate drainage facility for the disposal of storm water in the existing unsewered areas as well as extending sewerage in such areas.
- (5) Increasing the capacity of the existing sedimentation tanks at Bantola.
- (6) Remodelling the storm water channel from Bantola to Kulti, increasing its capacity to deal with the urban as well as the rural drainage including augmenting the capacity of the sluice at its outfall.
- (7) Improvement of the river Haroa-Kultigong.

#### 6.5. Improvement of the Drainage capacity of existing Sewers:

6.5.1. The underground sewers of Calcutta city were designed for a run-off of  $\frac{1}{2}$ " per hour which is much less than the storm rainfall which may even exceed 6" in 3 hours. As such the low-lying areas are frequently inundated causing inconvenience to pedestrians and interruption of vehicular traffic. Accumulation of water over several streets varies from 1' to 2' in depth and the duration of such inundation is governed by the intensity of rainfall occurring. Since the capacity and character of existing sewers cannot be increased or changed, the Committee recommends that adequate steps should be taken for ensuring proper and regular desilting of sewers so that the full section is available for effecting drainage. There has been a considerable time-lag in this work for various reasons. Suitable mechanical appliances should be introduced in addition to manual methods to clean them as quickly as possible. The cost of clearing the accumulated silt in the sewers has been roughly estimated by the Chief Engineer, Calcutta Corporation, to be Rs. 12 lakhs (vide Appendix 21). The Committee recommends early undertaking and completion of this work.

6.5.2. The portion of the city, 7.1 sq. miles in area, on west of Tolly's Nullah, comprising Chetla, Alipore, New Alipore, Kidderpore, Mominpore and Port Commissioners' area at present drains to Ballygunge Drainage Pumping Station through a syphon under Tolly's Nullah, near the Kalighat bridge. Apart from the drainage difficulties experienced in this area, present arrangement overloads the southern drainage system and, therefore, relief can be had if a separate drainage outfall can be provided for this part of this area. The Committee recommends investigation of the possibility of forming a separate drainage entity for this area with a separate outfall into the Hooghly after proper and full treatment of effluents.

#### 6.6. Increasing the Pumping capacity:

There is an urgent need for further augmentation of the capacities of the drainage pumping stations. The capacity of the station for South Calcutta should be increased from the existing 4" to 6" per day, and for Tangra and Cossipore and Maniktala areas from 3" to 4" per day. A scheme has been prepared and is under execution for augmenting the pumping capacities of the Palmer Bridge and/or the Ballygaunge Pumping Stations. The estimated cost of the scheme for the purpose for Ballygunge and Palmer Bridge Pumping Stations prepared by the Calcutta Corporation is Rs. 31 lakhs and that for Topsia Pumping Station is Rs. 5.5 lakhs (vide Appendix 22). The Committee recommends that the work be pushed on as expeditiously as possible.



### 6.7. Sewering of the Cossipore area :

The Cossipore area measuring 3.30 sq. miles is unsewered. There is a scheme by the Calcutta Improvement Trust for sewerage. On implementation of the sewerage scheme, drainage from the area will be led to Dhapa Lock Pumping Station through a syphon across the Circular Canal, both sewage and storm water being lifted at a pumping station to be constructed at Ultadanga. Probable cost of disposal of storm water of Cossipore area as envisaged above has been roughly estimated and reported by the Chief Engineer, Calcutta Corporation, to be Rs. 3.68 crores (vide Appendix 23). The Committee recommends that work on this scheme should be taken in hand and completion expedited as early as possible.

### 6.8. Disposal of storm water of unsewered portion of Maniktala area :

Out of 3.14 sq. miles area of Maniktala about 1 sq. mile has been sewered by the Calcutta Improvement Trust. The rest of the area will also be sewered by them. The Dhapa Lock Pumping Station would take care of the disposal of storm water from the Maniktala area as well. The cost of this scheme roughly estimated by the Chief Engineer, Calcutta Corporation, is Rs. 2.97 crores (vide Appendix 24). The Committee recommends that the sewerage should be extended to the remaining portion as early as possible.

### 6.9. Sewering and Disposal of storm water of unsewered pockets in Topsia-Tangra.

The area is at present unsewered and all the drains are surface drains which are in a very bad condition. The sewerage of Tangra area up to Kankurghachi Railway line has been provided in the Calcutta Corporation scheme at an estimated cost of Rs. 39.70 lakhs. A portion of Tangra area on the other side of the Railway line about 141 acres is proposed to be developed by the Calcutta Improvement Trust. The Trunk-sewer to serve both these areas has been approximately estimated to cost Rs. 32.40 lakhs. The two estimates total Rs. 72.10 lakhs (vide Appendix 25) and the Committee recommends that sewerage should be extended to this area.

### 6.10. Sewering of Tollygunge area :

The whole of Tollygunge Municipal area of 7.44 sq. miles is unsewered. This large area is a chronic sufferer from drainage congestion and flooding for want of a suitable outfall. The State Government has taken up for execution the Tollygunge-Panchannagram Drainage Scheme at an estimated cost of Rs. 29.15 lakhs. On the implementation of this scheme the surface drainage is likely to improve if the internal drainage system is properly prepared and linked up to the outfall channel of the Tollygunge-Panchannagram Drainage Scheme and additional pumps to cope with the full discharge including sewage effluent after proper treatment is provided in the proposed Auxiliary Pumping Station to be installed at Chowbhaga under the Tollygunge-Panchannagram Drainage Scheme. The Calcutta Corporation has prepared a scheme in which the area has been divided and treated as two separate drainage entities, portion of Tollygunge between Tolly's Nuliah and Sarat Ghosh Garden Street measuring about 5.05 sq. miles has been treated as a separate unit in consideration of topographical features and for facility of quick drainage disposal. The remaining portion measuring about 2.40 sq. miles is proposed to be served by the Ballygunge Drainage Pumping Station. The cost of providing sewers for the entire area of 7.44 sq. miles has been estimated by the Calcutta Corporation to be Rs. 8.98 crores (vide Appendix 26). This is very essential and should be taken up early. The Committee understands that this estimate

does not include necessary provision for additional pumps at the Chowbhaga outfall. This is a necessity and should be provided for, as the Tollygunge-Panchannagram Drainage Scheme, as now designed by the Irrigation and Waterways Department, has provided for an auxiliary pumping station for disposal of drainage from a part of the area when the water level in the storm channel runs high and gravitational drainage through the sluice is not possible. As a short-term, interim measure the Committee recommends that the existing surface drains in the Tollygunge area be improved and linked up with the outfall channel of the Government scheme and that an auxiliary channel for drainage of the Baishnabghat area suitably aligned and provided to give relief to a fairly large tract within the basin.

#### 6.11. Increasing the capacity of the Sedimentation tanks at Bantala :

The existing two "Pruss" type sedimentation tanks at Bantala for pre-settling the sewage has a total capacity of 120 million gallons per day, which is inadequate. They do not function properly and fully throughout the year for attaining the objective of removal of the suspended solids and B. O. D. as originally envisaged when they were constructed about twenty years ago. Two additional sedimentation tanks are necessary taking into consideration the increased sewage from the augmented water-supply and the need of having a stand-by for periodic repairs and cleansing. The existing sedimentation tanks also need thorough repairs and replacement of certain parts. The estimated cost of repairing of sedimentation tanks and other structures at Bantala have been worked out to Rs. 1.89 lakhs. The estimated cost of constructing two additional sedimentation tanks with ancillary works has been worked out roughly to be Rs. 50 lakhs (vide Appendix 27).

#### 6.12. Remodelling and increasing the drainage capacity of Storm Water Channel from Bantala to Kulti :

##### 6.12.1. Description and boundary of the basin :

The scheme covers an area of about 119.71 sq. miles in the police-stations Tollygunge, Sonarpore, Bhangar, Haroa and Canning in the district of 24-Parganas, including the city of Calcutta and its adjoining urban and rural areas. The area is bounded on the south by Tolly's Nullah and Sonarpur-Arapanch basin, on the north by Krishnapur Canal and storm water channel, on the east by a ridge line starting from Kulti proceeding towards south for about 3 miles and on the west by the river Hooghly. The basin can be broadly classified as urban area measuring 43.21 sq. miles and rural area of 76.50 sq. miles. The first category includes area under Corporation of the city of Calcutta and proposed urban area in the Northern Salt Lakes.

##### 6.12.2. Problem :

The storm water channel from Bantala to Kulti, a length of about 17 miles, was excavated by the Corporation of Calcutta in the year 1937-39 for providing an outfall for draining the storm water from the city of Calcutta and its adjoining urban and rural areas after the river Bidyadhari was silted up. Recently a scheme has been taken up for desilting the storm water channel, but no remodelling of the channel was envisaged. This is now considered necessary. Owing to rapid urbanisation and increase in population the drainage indices originally adopted are no longer considered sufficient. Northern Salt Lake is proposed to be reclaimed. Pumping capacity in certain areas of Calcutta Corporation is also proposed to be considerably increased. There will also be increased run-off due to implementation of some new scheme. Unless the capacity of the storm water channel is increased it will not be possible to accommodate the additional discharge from these. The previous

drainage indices and the revised drainage indices now adopted are shown in the following statement :—

Sl. No.	Name of basin,	Area in sq. miles.	Previous drainage Index.	Revised drainage index.	Revised discharge in cusecs.	Less gravita- tional dis- charge into other channel.	Net dis- charge in cusecs.	Remarks
1	2	3	4	5	6	7	8	9
1.	South Calcutta,	10 sq. miles.	4"	6"	1,620	145 to Tolly's Nullah,	1,475	Pumped.
2.	Tollygunge-Panchanna-gram-Bainchitala—							
	(a) Urban area,	12.8	3"	4"	1,382	...	450	Pumped and rest gravita- tional.
	(b) Rural area.	4.2	9/16"	3/4"	85	...	85	...
3.	Tangra area	1.57	3"	4"	170	...	170	Pumped discharge.
4.	North Calcutta	7.5	6"	6"	1,215	751 to Hooghly.	464	Do.
5.	Maniktola a. ca	3.44	3"	4"	372	...	372	Do.
6.	Cossipore-Chitpore area.	3.9	3"	4"	421	...	421	Do.
7.	North Salt Lake—							
	(a) Propo- sed urban.	4	9/16	6"	648	...	648	Do.
	(b) Polder area.	14	9/16	1½"	567	...	567	Do.
8.	Rural area served by the storm water channel.	58.3	9/16"	3/4"	1,191	...	1,181	Gravitational.

### 6.12.3. Scheme :

The scheme provides for widening and deepening of the storm water channel from Bantola to Kulti to accommodate the design discharge after revision of drainage indices as mentioned in above Table. It also provides for remodelling of the outfall sluice, a detritus apparatus and two additional sedi- mentation tanks at Bantola for dealing with the pumped discharge from the areas which are getting reclaimed or urbanised, remodelling of a few minor sluices and culverts to drain the adjoining rural areas into the channel and other ancillary works. Since drainage of the rural area can be delayed for a day or two it is proposed that the pumped discharge from the city should get preference over the rural gravitational discharge whenever the two exceed capacity of the channel. In order to do this sluices at the outfall of internal channels will have to be properly worked and controlled. The storm water channel has been designed for a total discharge of 75 per cent of pumped discharge and 10 per cent. of gravitational discharge from rural areas as it might be impossible to shut out discharge from the latter altogether. The peak pumped discharge has not been adopted as maximum pumping from all stations will not synchronise. The capacity of the sluice at the outfall will be

25 per cent. higher than that of the remodelled channel. It will have to be ensured that the channel is not overloaded with discharge from any additional area.

#### 6.12.4. Benefit :

The scheme will benefit both urban and rural areas. It may be noted that unless the storm water channel is remodelled, the drainage from the Northern Salt Lake area and Tollygunge-Panchannagram Basin cannot be effected properly and also no purpose will be served by increasing the capacity of the pumps in the pumping stations of the Calcutta Corporation.

#### 6.12.5. Cost :

The cost of the scheme prepared in broad outline amounts to Rs. 151 lakhs as given in the abstract of estimate (vide Appendix 28). The Committee approves the scheme and recommends its early implementation.

### 6.13. Tollygunge-Panchannagram Basin Drainage Scheme :

#### 6.13.1. Description and Boundary of the Basin :

The basin covers an area of 12.82 sq. miles of which about 6.25 sq. miles is within the limits of the Calcutta Corporation. Out of the remaining 6.57 sq. miles 2.47 sq. miles are urban and 4.10 sq. miles rural in character. The basin is bounded in the north by the Calcutta Corporation storm water channel, on the west by Russa Road, on the south by Tolly's Nullah and on the east by Eastern Railway line to Sonarpur and Panchannagram embankment.

#### 6.13.2. Problem :

With the death of the river Bidyadhari and gradual deterioration of Tolly's Nullah the area, particularly the lower rural portions, came to suffer from serious water-logging. Later, the Calcutta Corporation storm water channel to Kulti was constructed which is now the only outlet of drainage for the area.

Drainage from the higher portions of the basin, viz., Tollygunge area finds its way by gravity through several culverts and roadside channels into the lower Panchannagram area which virtually acts as a receptacle of storm water from the adjoining higher lands. With the advance of the rainy season this gets filled up, with the result that during latter part of the monsoon, it cannot take in any more and higher areas also suffer.

The storm water channel being primarily meant to serve as the carrier channel of the pumped drainage discharge from Calcutta city, the extent of drainage relief of the area under consideration is limited by the levels that rule in the channel particularly at the time of rains of heavy intensity within the city. Another limiting factor is the vantage of the existing Chowbhaga sluice which is inadequate.

#### 6.13.3. The Scheme :

The scheme provides for excavation of a main channel and necessary branch channels. The main channel 4 miles in length starts from a Railway culvert near Jadavpur Railway Station and ends at Chowbhaga where a new four-vented outfall sluice is proposed to be constructed. The channel will have its outfall in the storm water channel of the Calcutta Corporation. It provides also for an auxiliary pumping station at Chowbhaga for tackling part of the discharge amounting to 450 cusecs from the basin at the time when the storm water channel is ruling high.

6.13.4. The detailed scheme has already been prepared at an estimated cost of Rs. 29.15 lakhs (vide Appendix 29) by Irrigation and Waterways Directorate of the Government and is under implementation. The Committee strongly recommends early completion of this scheme.

#### 6.14. Drainage of Bainchitala area :

This area of 4.2 sq. miles requires to be provided with adequate drainage facilities. The scheme envisages excavation of necessary drainage channels with a sluice at the outfall into the storm water channel. The estimated cost of this, prepared in broad outline, is about Rs. 5 lakhs (vide Appendix 30).

#### 6.15. Improvement of Haroa-Kultigong.

The measures for the conservancy of the Kultigong are vitally important for effective drainage of the city and its environs. Extensive hydrological observations and river surveys spread over a prolonged period have been carried out and model studies made with a view to determining the measures necessary for the conservancy of the Haroa-Kultigong which has shown signs of deterioration. These have been dealt with in the previous Chapter. The Committee recommends the immediate implementation of the measures suggested for the improvement of the Kultigong.

## CHAPTER 7

# Region II, West of the Bhagirathi—The Bagmari-Bansloi-Pagla Basins and the Mayurakshi Basin including Kandi Area

### 7.1. Area :

Region II is the triangular tract in West Bengal bounded on the east by the Ganga-Bhagirathi, on the south by the Ajoy Basin and on the west by the boundary of the State of Bihar. It may be subdivided into (a) the Bagmari-Bansloi-Pagla Basin area and (b) the Mayurakshi Basin including Kandi area.

### 7.2. Rivers and Drainage Channels :

7.2.1. The main rivers and drainage channels traversing this area are—

- (1) The Bagmari, the Bansloi and the Pagla.
- (2) The Mayurakshi-Babla system with its tributaries, the Dwaraka, the Brahmani and the Kuia (Kopai-Bakreswar).

7.2.2. All these rivers excepting the Bagmari ultimately drain into the Bhagirathi. The river courses are short with steep gradient in their upper reaches and very flat in lower reaches as they pass through depressions into the Bhagirathi.

### 7.3. Problem of the area :

7.3.1. The problem of these river basins is more or less similar. A low depression separated by the high bank from the Bhagirathi extends along the west bank of the Bhagirathi all along to Katwa. Ground-levels of this depression are generally lower than the corresponding water-levels ruling in the

Bhagirathi during August and September. Quite a number of Beels exist in these pockets. As such large areas remain submerged during the flood season causing acute drainage congestion. This becomes very acute when heavy rainfall in the two basins synchronises with the high flood levels in the Bhagirathi. Additional areas get submerged thereby causing damage to standing crops, communications and habitations as the Bhagirathi with its present deteriorated condition is unable to take the run-off from these tributaries. During very heavy rain storms the run-off from even these two basins is enough to cause high floods in the Bhagirathi.

7.3.2. The direction of flow from or into these low depressions gets reversed depending upon the relative flood levels in these tributaries and the Bhagirathi. The outfall channel being not in a healthy condition it takes considerable time before the flooded areas get drained out even after the flood level in the Bhagirathi subsides.

#### 7.4. Measures recommended :

##### 7.4.1. Improvement of the Bhagirathi :

Since the capacity of the Bhagirathi is much less than the cumulative effect of the flood discharges from its western tributaries, it is difficult to give protection to these areas until the Bhagirathi is improved. For this purpose, the speedy implementation of the Ganga Barrage Project and necessary resectioning of the Bhagirathi along with the requisite river training and protection works are the measures that cannot be over-emphasized as already suggested in Chapter 4.

##### 7.4.2. Afforestation and soil conservation works in the catchment of the Mayurakshi and its tributaries :

7.4.2.1. The Mayurakshi originates in the Santhal Parganas and the upper catchment of the Mayurakshi river system in the State of Bihar covers about 1,590 sq. miles. The catchments are in a bad state of deforestation and denudation. Contour bundings have been initiated in the smaller catchments of the tributaries. Complete survey of the entire catchment to ascertain the requirement of treatment for the purpose of soil conservation has not been made yet. It is understood that the Bihar Forest Department in consultation with the Agriculture Department have prepared a five-year scheme for treating 16,000 acres of land in the upper catchment of the Mayurakshi for soil conservation and afforestation purposes at a cost of Rs. 25 lakhs. This scheme has been undertaken as a Centrally sponsored one for soil conservation in the upper catchments of river valley system.

7.4.2.2. The catchment in the Birbhum district is 1,266 sq. miles which includes about 10,000 acres of forest land and nearly 4,000 acres of waste land. The forest land is in a bad state of degradation and the waste land, resulting from gradual denudation, is now lying barren. The water absorbing capacity of the soil under both the categories is very poor and they are in the advance stage of erosion. As proper conservation measures and a well managed forest will reduce sediment load and intensity of discharge to a large extent, the Committee approves and recommends an estimate for soil conservation measure in the Birbhum district at a cost of Rs. 16.50 lakhs based on a scheme prepared by the Chief Conservator of Forests, West Bengal (vide Appendix 31).

##### 7.4.3. Bagmari, Bansloi and Pagla Basins :

7.4.3.1. About 72 sq. miles were flooded in the year 1959 when the average depth of submergence was 8". The area being generally much lower than the ruling flood level of the Ganga-Bhagirathi from about the middle of August, drainage congestion is almost an annual feature.

7.4.3.2. In the Preliminary Report it was stated that these rivers being situated some distance below the selected site of the Barrage across the Ganga and the fact that the feeder canal was to cross these streams, provision for disposal of floods and drainage from these rivers was expected to be made under the Ganga Barrage Project. It has now been ascertained that the location of the Barrage across the Bhagirathi has been shifted and the feeder canal will have its outfall above the confluence of the Bansloi-Pagla and the Bhagirathi. Under the circumstances a separate scheme will have to be formulated for dealing with the problems of the area although spilling from the Ganga-Bhagirathi in this portion of the low flat country to the east of the Sahibgunge Loop line will be considerably reduced after the construction of the Barrage at Farakka.

7.4.3.3. The Committee is of opinion that the problem in this basin can possibly be effectively tackled after the completion of the Farakka Barrage Project when water-level in the Bhagirathi will be controlled. A possible line of approach to the solution may then be to divert the Pagla-Bansloi directly into the Bhagirathi along a suitable alignment by-passing the low pockets below the river Pagla by putting up embankments along the right bank of Pagla. This scheme, if feasible, will benefit an area of about 15 sq. miles which is very low and full of beels and remains water-logged for a major part of the Monsoon period.

7.4.3.4. Since the requisite hydrological and other data are not available to establish beyond doubt the feasibility of such a scheme, the Committee considers that collection of these data is necessary and for this purpose approves an estimate amounting to Rs. 48,000 (vide Appendix 32). The estimate provides for gauge and discharge observations. It also provides for survey of rivers and channels and taking cross-sections half a mile apart.

#### 7.4.4. Flood Protection Measures for Kandi area :

7.4.4.1. Kandi area comprises broadly 1,080 sq. miles of low area bounded by Sahibgunge Loop line on the west, Naihati-Azimgunge Railway line on the north, Katwa-Azimgunge Railway line on the east and Ahmedpur-Katwa Railway line on the south. About 400 sq. miles of this area were flooded in 1959 and a similar area was also flooded in 1956. The lowest portion of this area known as "Hijol beel" area suffers almost every year due to prolonged submersion.

7.4.4.2. This area is mainly traversed by the Mayurakshi system of rivers which has a total catchment area of 3,600 sq. miles consisting of the four main rivers, namely—

- (i) the Mayurakshi.
- (ii) the Kuia (Kopai and Bakreswar).
- (iii) the Dwaraka and
- (iv) the Brahmani.

The Monikornika, the Kana Mor and the Gambhira are more or less the spill channels of the above rivers. All these rivers flow into "Hijol Beel" whence the river Babla originates ultimately drainage into the river Bhagirathi. The flood level in "Hijol Beel" area is influenced by the level ruling in the Bhagirathi. The level of the Bhagirathi is again dependent on flood discharge from the Ganga and the floods in other tributaries like the Pagla, the Bansloi and the Ajoy. As such the flooding in "Hijol Beel" is affected by a combination of several factors apart from the floods in the Mayurakshi system.

7.4.4.3. The bankful capacity of the Bhagirathi is about 90,000 cusecs at the outfall of the Babla. With the discharge coming down the river, this capacity is not adequate to take in much additional flow from the Mayurakshi

system. Therefore, a considerable volume of flood inflow gets blocked as valley storage and a large portion of Kandi area remains submerged.

#### 7.4.4.4. Problem of Kandi area :

The catchments of the rivers referred to in the foregoing paragraph are in a bad state of deforestation and denudation. The courses of these rivers are short, gradients steep and effects of heavy precipitation immediate and severe. The rivers being shallow spilling starts even during moderate floods. The flood problem of Kandi area is due to one or a combination of the following factors :—

- (a) A large portion of the Beel area is lower than the H. F. L. of the Bhagirathi resulting in drainage congestion.
- (b) The capacity of the outfall channel of the Mayurakshi system is not adequate to drain away the floods.
- (c) Inadequate capacity of the Bhagirathi.
- (d) Local heavy rainfall.
- (e) Backing up effect of the Ajoy flood.
- (f) Breaches in embankments.

7.4.4.5. The Kandi area may be broadly divided into two zones depending upon the nature of the problem :

Zone I—Sloping area with ground-level fairly above the H. F. L. of the Bhagirathi.

Zone II—Low Beel areas, i.e., where the country is flat and ground level is lower than the H. F. L. of the Bhagirathi.

7.4.4.6. The problem of Zone I is mainly due to the deteriorated condition of the rivers which are shallow and begin to spill, even at low stages. For instance, the bankful capacity of the Mayurakshi is only 30,000 cusecs or so, while a discharge of 2,00,000 cusecs in the Mayurakshi is not uncommon. The rivers have, therefore, been mostly embanked along both banks. but the embankments are not of adequate section. The capacity of the rivers is also restricted at many places on account of irregular and faulty location of embankments so much so that they invariably breach during high floods affecting large areas.

7.4.4.7. As normal slope of the country is not always towards the rivers, the spill water does not come back to the river but flows across the country along some depressions and old spill channels, and ultimately collects in Hijol Beel. The rivers Manikornika and Kana Mor are two such important spill channels which remain practically dry during low floods. During high floods, however, a large volume of spill water flows through these channels and creates additional problems on the left bank of the Mayurakshi. In fact, the whole of the area between the Manikornika-Kana Mor and the Mayurakshi gets flooded. As the Mayurakshi flood spills into the Manikornika from above the Railway line, the existing embankments on the left bank of the Mayurakshi below the Railway line cannot give the desired protection to the area which is flooded by the Manikornika spill. The Manikornika which later joins with the Kana Mor floods large areas all along. It is also responsible for breaches in the embankments along the Kana Mor which falls into the Dwaraka near Ranagram.

7.4.4.8. The river Dwaraka also starts spilling from the Railway line and near Sankarghat it meets the Brahmani. The combined catchment of the Dwaraka and the Brahmani is slightly less than of the Mayurakshi river. From Sankarghat the area becomes low and flat. The peak discharge in these rivers is, however, much less than that of the Mayurakshi.



7.4.4.9. But for a few places, e.g., Beel Langolhat, Beel Panchthopi and a low area near the Manikornika Zone I area does not suffer from acute drainage congestion. The area is high and sloping and above H. F. L. of the Bhagirathi and as such flooding is not so prolonged as in the lower zone. The problem is mainly of general flooding on the left bank during high floods. The right bank is also flooded at many places. Acute drainage congestion, however, occurs only near "Beel" Langolhat and this is caused by spill however from the mayurakshi. Drainage from this "Beel" is very slow. The problem of this zone can be briefly summarised as follows :

- (1) Flooding on left bank of the Mayurakshi due to spills from the Mayurakshi, the Manikornika and the Kana Mor.
- (2) Flooding on the right bank of the Mayurakshi and drainage congestion in Langolhat area due to the Mayurakshi and the Kuia floods.
- (3) Spilling on both banks of the Dwaraka and the Brahmani due to floods in these rivers.
- (4) Faulty location of embankments and inadequate sections.

Evidently some relief could be given to this area, if embankments of adequate section, were located at appropriate places.

#### 7.4.4.10. Zone II :

All the rivers of the Mayurakshi system flow into Zone II, which is virtually flat and form the river Babla, the main outfall channel into the Bhagirathi. Apart from the Babla, there are a number of other outfall channels of which Jhum-Jhum Khali and Uttarasan are important. The latter two channels during floods in the Bhagirathi flow in the reverse direction into the "Hijol Beel." Here all the river channels are very much reduced in the section and almost the whole area remains submerged. The "Beel" areas serve as detention basin,

7.4.4.11. This zone which is full of "Beels", starts from Kandi-Bharatpur Road along the Mayurakshi and the Kuia rivers and extends right up to Sankarghat along the Dwaraka. Another low depression extends along the Jibanti Khal, a small drainage channel to Beel Telkar, and goes almost up to Azimgunge. The ground level of this area is mostly lower than the H.F.L. of the Bhagirathi and water level is primarily governed by the flood level ruling in the Bhagirathi. Originally these low areas were not cultivated and used to remain submerged. Now, due to influx of population, the low areas have gradually been reclaimed by numerous "gher bunds". These bunds can give protection only during low floods but invariably breach during high floods and vast areas get submerged. This is an annual feature here. Since inflow from the Mayurakshi system of rivers is much greater than the capacity of the Bhagirathi and "Hijol Beel" level is primarily dependent on the level ruling in the Bhagirathi, the whole of the low area which is much below H.F.L. of the Bhagirathi cannot be effectively protected against floods in the Mayurakshi which, in most cases, synchronise with floods in the Ajoy.

7.4.4.12. Partial relief to this area can be given only in moderate floods by retiring some "gher bunds" and increasing the capacity of the Babla with one or two additional drainage cuts. It may be noted that extraordinary high floods occur only once in five or six years and in the rest of the years large portion of this area is likely to be protected. During abnormally high floods some breaches in the "gher bunds" and inundation in this area cannot be prevented. However, the measures suggested in the succeeding paras will improve drainage of this area both during flood and post-flood periods.

7.4.4.13. The ideal solution of the flood problem of this area would be to throw open the low-lying areas to inundation. But since a large part of this area has already been reclaimed for cultivation, it may not be possible to do so. It should, however, be seen that no further encroachment or obstruction takes place and no new embankments are permitted to be constructed. The Committee recommends the following remedial measures :

(a) Long-term measures—

- (i) Soil conservation measures in the upper catchments.
- (ii) Flood control reservoir in the Ajoy. This has been dealt with in Chapter 9.
- (iii) Construction of the Ganga Barrage. The execution of this project is under way.

(b) Short-term measures—

- (i) Thorough examination of all the embankments for the purpose of deciding which of them are to be retained.
- (ii) Improving the existing outfall channels.
- (iii) Provision of additional drainage outlets.
- (iv) Provision of additional waterways in this section of the Bandel-Barhawa Loop.
- (v) Removing or retiring some of the "gher bunds" and constructing escapes or sluices in all the "gher bunds" decided to be retained.

7.4.4.14. The Committee considered in detail a comprehensive scheme prepared covering all the short-term measures suggested above. The scheme consisted broadly of retaining and strengthening the embankment on left bank of the Mayurakshi from the Sahibgunge Railway line to about Kandi-Bharatpur Road. Embankment on the right bank of the Mayurakshi was also proposed to be retained for a certain length from the railway bridges to relieve the drainage congestion in the Langolhat area. In addition to these, embankments on the right bank of the Dwaraka from Sankarghat to Ranagram and embankments on the right bank of Kana Mor up to Ranagram were also proposed to be retained and strengthened. All the embankments were to be retired at places wherever necessary. The scheme also provided for resectioning of the Babla and a few other outfall channels and two new drainage cuts one from Talgram and the other from Ghatla to drain directly into the Bhagirathi. Sluices were also provided at required places. The estimated cost of the scheme worked out to nearly Rs. 3.5 crores.

7.4.4.15. The Committee after considering the scheme came to the conclusion that since the problem was very complicated and flood levels depended on so many factors inter-related to one another, it was almost impossible to find out the best solution by theoretical calculations and to decide which embankments or combination of embankments would afford the best protection to the area and give the maximum benefit. It was neither possible to ascertain what would be the optimum discharge through the proposed new cuts and for what discharge the outfall channels should be designed and what would be the overall effect of all these measures on flood levels in Hijol Beel and in the Bhagirathi under varying conditions and volume of run-off. It was also not possible to say what would be the effect of separating the Dwaraka Basin from the Mayurakshi Basin. Considering all these factors and the cost involved, the Committee recommends that the problem should be studied in a model with various combination of embankments and capacity of existing outfall channels and new cuts to find out the best possible solution of the problem for the long-term measure. The model experiment should also find out the maximum amount of

spill area that may be cut out by embankments without increasing the "Hijol Beel" and the Bhagirathi flood levels and the maximum likely outflow into the Bhagirathi under these conditions. The effects of other tributaries of the Bhagirathi and that of Ganga Barrage should also be taken into account. The Committee approves an estimate amounting to Rs. 1.37 lakhs for the purpose (vide Appendix 33).

7.4.4.16. To have adequate data for the construction of the model and its studies the Committee thought it necessary and recommended taking up of—

- (a) Aerial Photograph of the area with spot heights at intervals marked thereon showing ground levels from which contour lines could be drawn.
- (b) Hydrological observations (gauge, discharge and silt) on the various rivers in the area.
- (c) Ground survey for obtaining cross-sections half a mile apart of rivers, tributaries, khals and embankments in the area.

7.4.4.17. The work involved in (a) above was incorporated in the overall estimate amounting to Rs. 7.98 lakhs prepared for aerial contour survey of South and South-west Bengal. The work involved in (b) above is included in the overall estimate for such observations in South and South-West Bengal amounting to Rs. 7.03 lakh. The Committee approved both of these estimates and recommended for immediate commencement. The Committee approved also an estimate amounting to about Rs. 25,000 framed to meet the probable cost for survey mentioned in (c) above and this would cover taking cross-sections of the river Dwaraka from Morgram Road to its outfall in the Bhagirathi, of the Mayurakshi from Tilpara Barrage to Talgram, i.e., up to the junction of the Kuia and the Mayurakshi and of the Kuia river from the junction of the Kopai and the Bakreswar to "Hijol Beel". This estimate provides also for such survey of all the other small rivers and important khals in this area including the Kana Mor, the Bele, the Manikornika, the Brahmani, the Gambhira, the Jibanti-Banki, the Jhum Jhum Khali and the Uttarasan. These estimates are at Appendices 6,7 and 34.

#### 7.4.5. Interim Scheme recommended for Kandi area :

7.4.5.1. The model experiments referred to in para 7.4.4.15. would require considerable number of years to arrive at a solution. As an interim measure, the Committee recommends Phase I of the scheme, which envisages strengthening of some of the embankments which are apparently necessary as well as resectioning of the river Babla to accommodate moderate flood of the Mayurakshi system of rivers so as to give relief to the low areas in most of the years. A scheme prepared in broad outlines on these lines is estimated to cost Rs. 75 lakh. The effect of the embankment on the right bank of the Mayurakshi and its effect on Hijol Beel also have been considered as far as possible by theoretical calculations. The Committee approves this scheme and recommends its immediate execution.

7.4.5.2. The object of the scheme briefly stated is to protect the area between the Manikarnika and the river Mayurakshi from flooding during extraordinary floods without causing any adverse effect on Hijol Beel area. In years of moderate flooding, the Hijol Beel area is also expected to get some relief. The scheme comprises the following works :—

- (i) Retention and strengthening the existing embankments on the left bank of the Mayurakshi, retiring it where necessary and its extension along the left bank of the Manikarnika up to the railway line, including closing of all breaches.

- (ii) Retiring some gher bunds as necessary on the Mayurakshi and the Kuia in Hijol Beel area.
- (iii) Construction of necessary sluices in the embankment for drainage.
- (iv) Diversion of the Manikaranika into the river Mayurakshi below the Railway line.
- (v) Resectioning of the Babla to accommodate the additional discharge due to strengthening of the left bank embankment on the Mayurakshi.

7.4.5.3. The area on the left bank of the Mayurakshi is lower than that on the right bank ; as such this area is more susceptible to flooding. Large quantity of water is also spilled into the Monikarnika from above the Railway line which causes more flooding. The important roads, villages including the town of Kandi, are all located on this side. The existing ex-zamindary embankment on the left bank of the Mayurakshi is also one of the oldest embankments. Considering all these factors, the ex-zamindary embankment on the left bank of the Mayurakshi is proposed to be retained up to Kandi-Bharatpur Road. The embankment is not, however, of adequate section and will have to be strengthened and raised. In many places it will have to be retired to accommodate the designed flood. The embankment is proposed to be extended from a point near Satpalsa along the left bank of the Monikarnika, so that the area does not get spilled from that river. The discharge of the river Manikaranika above Satpalsa will be led into the Mayurakshi. Thus the present embankment will completely exclude the area behind it from the Mayurakshi or the Monikarnika spill even during the highest flood. In other words, the whole of the area east of the Railway line bounded by the Mayurakshi on the south up to Kandi-Bharatpur Road will be protected against the highest flood.

7.4.5.4. The probable flood level after strengthening this embankment has been calculated and it appears that some areas will continue to be flooded on the right bank. But this area will be very small, and after results of model experiment are available, it may be possible to give relief to this area also.

7.4.5.5. The effect of strengthening the left embankment of the Mayurakshi on "Hijol Beel" area has also been considered. The peak discharge in the Mayurakshi will now increase but as large amount of surface flow of spill water will be cut off the peak inflow into "Hijol Beel" area will not materially change.

7.4.5.6. At some places along the Kuia river and the Bele river (Mayurakshi) the embankments have encroached upon the river sections. As such the embankments breach even during moderate floods. It is proposed to retire the embankments at such places, which will benefit the Hijol Beel area also.

#### 7.4.5.7. Benefits :

With the implementation of 1st phase of the scheme (interim measure) it is expected that about 69 sq. miles on the left bank will be benefited. Due to retiring of certain gher bunds the "Hijol Beel" area will be protected against flood in most of the years.

#### 7.4.5.8. Estimated Cost :

The estimated cost of Phase I of the Scheme comes to Rs. 75 lakh (vide Appendix 35) and the Committee approves the same. It may be noted that the present scheme is only a part of a bigger scheme. Separate estimate will be prepared for other portions of the bigger schemes when results of model experiment are known.

## CHAPTER 8

## Region III, East of the Bhagirathi-Burdwan Area excluding the Ajoy Basin and Trans-Damodar Area

### 8.1. Area :

Region III comprises an area measuring 2,505 sq. miles of Burdwan district south of the river Ajoy between the Bhagirathi on the east and the Damodar on the west. Leaving out the Ajoy-Kunur Basin which is being separately dealt with in Chapter 9, the remaining area may be roughly subdivided into :—

- (i) Katwa-Purbasthali-Kalna area (strip along the west bank of the Bhagirathi).
- (ii) Banka and Khari River Basin.
- (iii) Behula-Gangur River Basin.

There is a network of D. V. C. irrigation canals within this region excepting the strip along the Bhagirathi which lies in sub-area (i).

### 8.2. Rivers and Drainage Channels :

The main outfall rivers of this area are the Bhagirathi and the Ajoy, and major drainage channels traversing the area are the Kunur, the Khari, the Banka and the lower reach of the Gangur and the Behula. The upper reaches of the latter two rivers used to drain some area during very high floods but now, in the D. V. C. system their sections have been reduced by embanking and converting them into irrigation channels. The river Khari has its outfall in the Bhagirathi while the river Banka meets the Khari a few miles above the confluence of the latter with the Bhagirathi.

### 8.3. Katwa-Purbasthali-Kalna area :

8.3.1. This area extends along the west bank of the Bhagirathi from Katwa to Kalna and is affected by the Ajoy and the Bhagirathi floods and also by local heavy run-off from the catchment of Banka, Khari and other rivers. The flood level in this area is mainly governed by the water-level ruling in the Bhagirathi. As such whenever heavy rainfall synchronises with high flood level in the Bhagirathi, it gets submerged.

### 8.3.2. Measures recommended :

The problem of this area can be tackled by—

- (a) improvement of the Bhagirathi for which steps have already been recommended in Chapter 4,
- (b) regulation of the Ajoy floods and improvement of the river. This has been dealt with in Chapter 9,
- (c) maintenance of the local drainage channels serving the area by silt clearance and resectioning as necessary so that drainage is not delayed after the flood subsides. This measure should be taken up immediately without waiting for the implementation of the long term measures (a) and (b) above. It is expected to afford some relief in the low-lying Purbasthali area.

### 8.4. Scheme for Flood Protection Works of Nabadwip Town :

#### 8.4.1. Area :

Nabadwip town covering an area of approximately 3.5 sq. miles situated on the right bank of the Bhagirathi near the confluence of Jalangi is the most

important town in the strip of area along the river Bhagirathi in this region. The old town which was much smaller is located on high lands and was rarely flooded. As a result of influx of refugees after partition of Bengal, the town has expanded vastly extending to low lands and the distress due to flooding has now become acute.

#### 8.4.2. Problem :

In 1959 a major portion of the town was heavily flooded, water reaching up to the first floor of several houses in the town. Inundation of the town starts as soon as the flood level in the Bhagirathi is higher than R.L. 30.00. The gauge readings of the last few years indicate that in almost every year this was exceeded. In 1956 and 1959, the highest flood levels were R.L. 36.41 and R.L. 35.84 respectively. The whole town except 0.167 sq. mile was submerged to a depth of 3' to 6' completely paralysing the normal life of the town, its water-supply, conservancy and other essential works.

#### 8.4.3. The Scheme :

8.4.3.1. The Railway line on the west side of the town runs on an embankment with a number of open culverts. On the Bhagirathi side on the east there is no embankment but there is the foreshore road which is slightly above ground level but below the H. F.L. On the western side of the Railway line there is the Muriganga which is a dead loop of the Bhagirathi. At present the drainage of the town is effected both through the culverts in the Railway embankment into the Muriganga and through open drains directly into the Bhagirathi on the east. During high floods it was found that the Bhagirathi water spilled into the town both through the Railway culverts on the west and by over-topping the bank of the river on the east. The river bank near Ranighat is being scoured badly and protection works have been taken up by the Irrigation and Waterways Department.

8.4.3.2. The present scheme envisages enclosing the town by a circuit embankment, the Railway embankment on the western side forming a part of the circuit. All the culverts in the Railway embankments and other drains of the town with outfall into the Bhagirathi will be sluiced so that the normal drainage arrangement of the town will not be disturbed in any way. The sluices will be closed only when the flood level is higher than the town level and drainage will then be effected by pumping.

8.4.3.3. The embankment on the eastern and northern sides of the town will have to be constructed in full while the Railway embankment on the west will have to be strengthened at places and the countryside crest raised slightly to give necessary free board. A pumping station has been provided at the lowest part of the town. It is found that some of the existing drains will have to be remodelled and extended so that storm water from all parts of the town flow to the pump house. A part of the extension will have to be in underground sewers. Pumps will come into operation during high floods only. The possibility of installation of an additional pump in future due to possible expansion of the town, has been kept in view.

8.4.3.4. The drainage index assumed for the purpose of arriving at the total discharge to be pumped is  $4\frac{1}{2}$  for the congested area and 50 per cent. of this for less congested area which is full of low pockets. For gravitational discharge through sluices in normal times, a run-off of 6" and 3" in 24 hours has been assumed for the respective areas. The Chief Engineer, Public Health Directorate of the State Government, was consulted in the matter.

8.4.3.5. The effect of circuit embankment on the Bhagirathi was considered. Since the embankment runs over the bank level and set back from the bank line it will have little effect on the Bhagirathi in most of the years. During high floods, however, large areas are spilled over by the Bhagirathi and reduction of the spill area by 3.5 sq. miles will not have any appreciable effect on the river.

8.4.3.6. The alignment of the proposed embankment has been so fixed as to enclose not only the existing town but some additional space as well to provide for future extension of the town. The embankment runs along the river bank where protection work is in progress. At other places the embankment has been set back as far as possible. While fixing the alignment the existing foreshore road has been utilised as far as possible.

8.4.3.7. The Railway embankment will have to be strengthened wherever the cover over assumed percolation gradient is not adequate. It is found that the crest of the Railway embankment will have to be raised slightly to give the required free board of 3'. Provision has been made in the estimate for this.

8.4.3.8. All the culverts in the Railway embankment forming the circuit will be sluiced. The open drains into the Bhagirathi will also be sluiced so that the existing drainage arrangement is not disturbed and the required pumping is kept to the minimum. During high flood the sluices will have to be kept closed and drainage will have to be effected by pumping. A pumping station has been provided in the scheme and is proposed to be provisionally located near Ranighat. The maximum quantity of water to be pumped is 283 cusecs assuming 14½" run-off for 1.38 sq. miles and 2½" run-off for 1.90 sq. miles. But as this includes an area of 0.50 sq. mile which is not yet occupied as an urban area, the number of pumps proposed to be installed initially are as follows:

	Cusecs.
(i) 2 Nos. pumps of 75 cusecs each	150
(ii) 1 No. pump of 40 cusecs	40
(iii) 1 No. pump of 25 cusecs	25
<b>Total installed capacity</b>	<b>215</b>

The smaller pumps have been provided for lower run-off. A space for an additional pump of 75 cusecs has been kept in the pump house.

8.4.3.9. All the outfalls of the Municipal drains excepting the Monipur Ghat outfall is proposed to be connected to the pumping station by remodelling the existing kacha drain. The Monipur Ghat outfall will be connected to this drain by means of a covered sewer as an open drain is not possible to be taken through the congested area.

8.4.4. **Benefits:**

The total estimated cost is Rs. 30 lakh. (vide Appendix 36). The annual cost of the maintenance and operation of pumps is anticipated to be Rs. 30,000 approximately. The annual cost of maintenance of the embankments and other allied works is estimated to be Rs. 25,000 approximately. Thus the total recurring expenditure is likely to be Rs. 55,000. The value of flood damages in 1959 was Rs. 3.63 lakh and amount spent on relief was Rs. 2.52 lakh. The 1956 figures are not available. Considering the fact that it gives protection to the life and properties of nearly a lakh of people living in the historic town of Nabadwip, the Committee recommends the taking up of the scheme.

### 8.5. Scheme for resectioning the Banka including drainage of Bhuri-Shyamsundarpur Beel areas :

8.5.1. The basin area of this scheme measuring about 198 sq. miles is bounded on the south by the Damodar left embankment and watershed line up to the Gangur and the Behula rivers, on the west by the Damodar Main Canal and Jagulipara Silla Road, on the north by a ridge line almost parallel to the G. T. Road and the Damodar Valley Corporation Left Bank Main Canal and on the east practically by Memari-Manteswar Road. The area includes towns like Burdwan, Galsi and Saktighar. Except these and a few other townships measuring 7.46 sq. miles the area is primarily rural in character. The river Banka is the main storm water drainage channel in the area. It takes off from a point within police-station Galsi, passes through the thickly populated areas including the municipal town of Burdwan and flows into the river Khari. The combined flow of the Banka and the Khari (known as Khari river) then flows for about 6 miles, before ultimately falling into the river Bhagirathi.

#### 8.5.2. Problem :

8.5.2.1. Within the basin of the Banka (up to Burdwan town) there are three low pockets, namely, (i) Bhuri-Pursura Beel, (ii) Shyamsundarpur Jala and (iii) Isufabad Jala. Formerly, the condition of the river Banka was satisfactory and its capacity adequate to take the run-off without causing any drainage congestion in the area. In the distant past, it was even used for navigation purposes. But with the passage of time, there has been heavy accretion of silt on its bed. The deterioration was accentuated further with the introduction of silt laden water from the Damodar into the Banka through the Jujuty and Jhapur sluices, for supplying irrigation water to the Eden Canal system and also for supply of water to the Burdwan Municipality and the Eastern Railways. All these have resulted in heavy silt deposits on the bed of the Banka for about ten miles upstream of the Kanchannagar Headworks comprising a weir, an undersluice and Head-sluice about 6 miles upstream of Burdwan. As a sequel, the problem of disposal of storm water discharge from the Banka catchment above Kanchannagar, has assumed a serious proportion, as will be evident from the fact that the inundation of the low pockets, viz., Bhuri-Pursura Beel, Shyamsundar Jala and the Isufabad Jala, has become a matter of annual occurrence.

8.5.2.2. There is drainage congestion in the area downstream of the Kanchannagar Headworks also in years of heavy rainfall, as the drainage capacity of the river Banka is insufficient in certain lengths. Some areas get submerged thereby causing damage to crops and distress to people. Besides, drainage of some of the Municipal towns is also affected for days together. During the 1955 and 1959 floods, part of the Grand Trunk Road was under knee-deep water and road traffic remained dislocated for a considerable period. Saktigarh town also felt drainage difficulties during these periods. To sum up, the problem is one of acute drainage congestion due to (i) the silted up and raised bed of the Banka upstream of Kanchannagar Headworks and (ii) the inadequate carrying capacity of the Banka downstream of Kanchannagar. On account of this drainage congestion, the cultivation in the low-lying areas especially in the three low pockets mentioned above suffers every year.

#### 8.5.3. The Scheme :

The scheme envisages efficient and quick disposal of drainage water from the basin including removal of the congestion from the three low pockets, mentioned above by resectioning the existing channels and excavating a few new cuts joining the low pockets to the main drainage artery. The Banka is proposed to be re-excavated and silt cleared from the junction of the two



streams forming the Banka near the village Ghosh Kamalpur up to near about Saktigarh in the first instance ; this being the reach comparatively more deteriorated. Silt clearance of the two natural streams upstream of their confluence at Ghosh Kamalpur is also proposed for giving drainage facilities to Bhuri-Pursura Beel area. A new branch channel is proposed to be excavated from the Shyamsundarpur Jala to the Banka to drain out the jala. The silt clearance of the remaining portion of the Banka up to a point one mile downstream of the bridge crossing for Memari-Manteswar Road near village Ganguria is proposed to be taken up in the second phase. A drainage index of  $1\frac{1}{4}$ " per day has been assumed for working out the discharges up to Kanchannagar weir and beyond that Dicken's formula has been used taking value of  $C=120$ .

#### 8.5.4. Benefits :

The following benefits will accrue on execution of the scheme :—

- (a) Vast areas within 198 sq. miles now suffering from drainage congestion almost every year, will receive the requisite drainage facilities and will be able to grow both Khariff and Rabi crops in most of the years.
- (b) The risk of submergence of towns like Burdwan, Saktigarh, Galsi and Palsit will be eliminated saving thereby large sums at present expended on flood relief. Internal drainage and sanitation of Burdwan Municipality will also improve.
- (c) The traffic on G. T. Road, etc., will not be dislocated.
- (d) The perennial source of malaria from the water-logged Beel areas will be removed and sanitary conditions will improve.

8.5.5. The estimated cost of the scheme works out to Rs. 58 lakh. As already stated above, the work is capable of being executed in two phases. Hence the estimate has been prepared accordingly. The estimated cost of Phase I of the scheme (Bhuri-Shyamsundarpur drainage scheme and resectioning of the Banka up to 482 chains below Kanchannagar weir) works out to Rs. 32.00 lakh (vide Appendix 37) and for Phase II of the scheme (resectioning of the lower reach of the Banka) Rs. 26.00 lakh (vide Appendix 38). The Committee recommended early implementation of the scheme.

#### 8.6. Resectioning of the Khari :

The requisite data for resectioning the Khari is not available. As such the scheme could not be prepared. The Committee, however, approves an estimate amounting to Rs. 28,600 for surveys and collection of the required hydrological and field data (vide Appendix 39). Detailed scheme if feasible may be prepared after collection of necessary data. The Committee recommends that necessary surveys and hydrological observation should be started early and meanwhile the outfall reaches of the Banka-Khari should be maintained properly by occasional silt-clearance as necessary.

#### 8.7. The Behula-Gangur River Basin :

8.7.1. The Behula and the Gangur are more or less moribund rivers in the upper and middle reaches and normally do not serve as drainage channels except in the lower reaches where water-level is more or less governed by flood level ruling in the Bhagirathi. During heavy rainfalls, however, when the depth of submergence increases, these channels could function for drainage also. But they have been converted into irrigation channels under the D.V.C. system and the sections have been reduced by putting up embankments in the original bed of the river. There is a small escape and a syphon in the tail-end of the Behula and the Gengur. The Committee is of opinion that as drainage channels have been converted into irrigation canals alternative drainage facilities should be provided. Detailed investigations should be taken up to see how best the position

could be improved and schemes for relieving the drainage congestion in the area prepared.

### 8.8. D.V.C. Canals-problem and measures recommended for improvement :

8.8.1. A net-work of irrigation channels has been constructed in this area as well in Trans-Damodar and Howrah-Hooghly areas. During 1959 floods a number of canal structures with inlets were damaged. Certain structures on some drainage channels were not found adequate for carrying the discharges they were subjected to. The number and capacity of escapes were found inadequate. A number of breaches occurred and some cuts were made in the D.V.C. canals during the critical period in 1959 creating additional problems. Flooding in the low areas was accentuated by these factors. Under these circumstances the situation may become serious when a canal crosses a railway line or a road and the waterway is not designed to carry additional discharge that might come through breaches and cuts and thereby endangers the Railway line or the road. The capacity of certain structures in drainage channels now converted into irrigation canals has also been found to be inadequate.

### 8.8.2. Measures recommended for Improvement of Drainage Facilities in D.V.C. System :

8.8.2.1. The Committee recommends that—

- (a) the canal structures should be examined for waterway and those found deficient should be remodelled to provide for additional ventage for efficient drainage.
- (b) additional escapes should be provided to dispose of all the discharge coming into the channels from the inlets,
- (c) the drainage indices recommended by the Committee (vide Chapter 2) may be considered for adoption, with advantage subject to the limitations mentioned therein.
- (d) the canal embankments should be strengthened with adequate free board.
- (e) it may be examined whether any of the canals which have been extended in the spill areas of the Damodar on the right bank is obstructing the natural flow of spill water or drainage of the country and, if so, necessary measures should be taken for affording proper drainage facilities,,
- (f) an investigation should be made to ascertain whether new drainage cuts and/or additional cross-drainage works are required in areas drained by the Kousiki, the Kana Nadi, the Kana Damodar, etc., which have been converted into irrigation canals.

8.8.2.2. Some of the drainage channels have now to accommodate the tail discharge from the irrigation canals also. These channels which were hardly adequate for draining the local basins are causing increased drainage congestion as they are subjected to additional loads. For improving the situation, the Committee recommends that steps should be taken for resectioning the drainage channels such as the Purana, Rajapur, Dankuni Khal, etc., or alternative channels provided, where necessary, for disposing of the tail discharges.

8.8.3. The Committee recommends that investigation works which will take some time should be taken up immediately and necessary schemes should be drawn up and implemented as soon as possible. It is understood that there is a provision of Rs. 2.5 crores for extension and improvement of these canals out of which Rs. 25 lakhs only are earmarked for new cross-drainage works. This is not considered adequate. However, until detailed investigations are made no idea of the additional works that are necessary and the cost thereof, can be given at this stage.

## Region III, Ajoy-Kunur Basin in Burdwan Area

9.1. The Ajoy originates in Bihar in the Chhotanagpore Hills and above Siktia takes in two important streams, namely, the Pathro and the Jainti Nadis. It enters West Bengal near Chittaranjan and falls into the Bhagirathi at Katwa. In West Bengal it has two important tributaries, namely, the Hinglow on the left and the river Kunur on the right. The Ajoy catchment measuring about 2,420 sq. miles is a long and narrow one, lying between those of the Damodar and the Mayurakshi river system.

### 9.2. Problem.

9.2.1. The flood slope of Ajoy in Bihar portion is comparatively steep and there is no spilling in that area. The spilling starts on the right bank of Ajoy near its confluence with Hinglow, a few miles downstream of Pandabeswar. From near about Beta in the district of Burdwan the country becomes flatter. On the right bank starting from near Beta there is more or less a continuous Schedule 'D' embankment up to Purucha while beyond that the embankments are ex-zamindary. Flooding on both banks below Purucha is almost an annual feature. The Schedule 'D' embankment is of adequate section and maintained properly while the ex-zamindary embankments are of less than standard section. Area protected by Schedule 'D' embankments is 54 sq. miles while that expected to be protected by ex-zamindary embankments is 89 sq. miles. On the left bank of the Ajoy there exists a number of embankments mostly detached. The embankments on this bank are all ex-zamindary except for one of small length. These embankments often breach and repairs are carried out by various agencies which are often not very effective. Due to the existence of Schedule 'D' embankments on the right bank, the pressure on the left bank has been marked. The river channel has deteriorated due to deposition of sand. The total area liable to be flooded during high floods on the left bank is about 115 sq. miles.

9.2.2. On the right bank of the Ajoy lies the irrigable commanded area of the Durgapur branch of the D. V. C. canal system while on the left lies the irrigation commanded area of Mayurakshi canals system. In times of high floods both the areas get affected to some extent.

9.2.3. In the lower reaches high floods cause extensive damages to areas which have been occurring frequently and those which occurred in 1916, 1942, 1946, 1956 and 1959 were abnormally high. The highest flood discharge in 1956 through the railway bridge over the river in between Bhedia and Bolpur was estimated to be of the order of 3,00,000 cusecs. The capacity of the Bhagirathi at Katwa being 1,27,000 cusecs up to its danger level, the inflow at this place from the Ajoy of 3,00,000 cusecs created an extremely disastrous situation resulting in flooding of vast areas. In the 1959 flood, which was of the order of 2,50,000 cusecs, considerable amount of damages were again caused along both the banks of the Ajoy and the left bank of the Bhagirathi. The area inundated during 1959 on the right bank of the Ajoy was about 80 sq. miles.

9.2.4. Floods in the river Ajoy rise very rapidly and very high. Frequently they breach ex-zamindary embankments which were put up to protect fertile lands in the lower reaches of the river. Further, as the flood waters of the Ajoy flow into the Bhagirathi at Katwa extensive flooding takes place on the left bank of the Bhagirathi also. As the contribution of some of the western tributaries, specially the Ajoy, often exceeds considerably the main Bhagirathi flow at Katwa, some form of control of this inflow and entry of sand into the Bhagirathi is necessary.

### 9.3. Area affected by Kunur floods :

9.3.1. The river Kunur is a local drainage channel. It runs more or less parallel to the river Ajoy originating from a little east of Ondal-Saithia branch of the Eastern Railway and meets the Ajoy near Mongalkote. Its total length is about 70 miles with a catchment of about 298 sq. miles. It crosses the Eastern Railway Loop line near Guskara railway station about 22 miles upstream of its junction with the river Ajoy.

9.3.2. Several areas of land in the lower catchment of the river Kunur comprising about 14 sq. miles remain water-logged during the rainy season and as a result the lands remain unfit for cultivation. The water-logging of this area is due to the following reasons :—

- (a) The waterways of the river Kunur is too narrow and inadequate for the discharge it is expected to carry.
- (b) Due to steep slope of the upper reach of the Kunur water rushes down rapidly whenever there is a heavy precipitation in its catchment. The slope in the lower reach (between Guskara and Mongalkote) is flat being about a foot per mile. Thus it takes a fairly long time to drain out the surplus water.
- (c) Some portions are very low pockets, drainage of which is not practicable.
- (d) The flood in the river Ajoy occasionally synchronises with the local rainfall in the catchment of the Kunur. As a result drainage through the Kunur is held up and besides, due to the back water effect of the Ajoy flood, the drainage is delayed and the difficulty augmented.
- (e) When the Ajoy is in very high floods, the flood spill enters through the gaps of the poorly maintained marginal ex-zamindary embankments on the right bank (lying more or less between the Eastern Railway Loop Line and the junction of the Kunur river with the Ajoy). This flood spill is mostly drained out through the Kunur into the Ajoy and causes further holding up of the Kunur drainage.

9.3.3. Area on right bank of the Ajoy is affected due to—

- (a) breaches in Ajoy right embankment and ex-zamindary embankments, and
- (b) flooding from the Kunur.

The public demand is for remodelling of ex-zamindary embankments to standard section on both banks. The effect of such an embankment system would be—

- (a) Increase in flood levels ;
- (b) Extending the flood wave further downstream ;
- (c) Holding back of flood water of the Kunur longer.

Besides, in case of breaches during abnormal floods, these will cause heavier damage than if the embankments were not there.

### 9.4. Long-term measures recommended :

9.4.1. The solution of the harmful flooding from the Ajoy lies in control of silt by soil conservation measures as well as afforestation of waste land and also control of floods by construction of storage and detention reservoirs,

#### 9.4.2. Afforestation and Soil Conservation measures :

9.4.2.1. Out of a total catchment of 2,420 sq. miles, about 1,020 sq. miles lie in West Bengal. The Committee recommends as first step towards flood moderation and improvement of the river, afforestation and soil conservation measures in its upper catchment and the undertaking of scientific land uses in the middle catchment. From information furnished by the Government of Bihar so far it appears that out of 1,400 sq. miles in the upper catchment in Bihar, schemes for soil conservation measures covering an area of 6 sq. miles have been carried out in the Second Plan and in the Third Plan it is proposed to carry out such schemes covering 41 sq. miles. Such afforestation and soil conservation works in West Bengal (in Burdwan and Birbhum districts) are roughly 113 sq. miles. Out of this 6.2 sq. miles have already been afforested.

9.4.2.2. A scheme for soil conservation measures in the catchment area in West Bengal prepared in broad outlines by the Chief Conservator of Forests at an estimated cost of Rs. 61,21 lakh (vide Appendix 40), envisages treatment of sheet eroded areas and gullies. In the sheet eroded areas, digging of 6' wide cattle-proof trenches is provided as nothing can be achieved until grazing is eliminated. There will be contour trenches inside at suitable intervals. These will be followed by intensive afforestation with suitable spurs. In the gully areas it is proposed to have extensive number of check-dams and gully plugging. These will be supplemented by chutes, drops, inlets and catch-water drains. The catch-water drains will be for diversion of head water flow where the gradient is appreciably high. Bamboos, grasses, etc., will be put on the check-dams and even raised in 'thalis' to reinforce them, as well as to cover waste lands. 'Ipomea cornea' is proposed to be used extensively to consolidate the check-dams. The average expenditure would approximately be Rs. 61,200 per sq. mile and would fetch an average yearly return of Rs. 5,265 which shows that the investment will pay adequate dividends. The estimate provides for necessary expenditure on administrative set-up and personnel. The Committee recommends that this scheme be taken in hand for implementation as early as possible.

9.4.2.3. The Committee likewise strongly recommends that comprehensive schemes of soil conservation and afforestation in the Ajoy catchment within Bihar should also be undertaken simultaneously on an extensive scale. For this purpose the Government of West Bengal should take up the matter with the Government of Bihar.

#### 9.4.3. Storage and detention reservoirs in the upper catchment :

9.4.3.1. As the capacity of the Bhagirathi in its present deteriorated condition is limited large inflow from its tributaries gets blocked up resulting in large-scale spilling of the tributaries and makes the Bhagirathi itself overflow its banks, adversely affecting the drainage of areas upstream of Ajoy out-fall including the "Hijol Beel". If all the areas, subject to inundation by the Ajoy spill, were to be protected by embankments only, the discharge would have to be confined between the embankments on both banks and ultimately led to Bhagirathi. This would accentuate the flooding and increase the silt charge in that river and would adversely affect its regime. Therefore, if the lower valley is to be protected from flooding, the provision of embankments alone will not solve the problem. The Ajoy floods must, therefore, be regulated by storage and detention reservoirs.

9.4.3.2. The Committee, therefore, recommends that investigation should be taken up immediately for storage and detention reservoirs in the upper catchment and express the view that such a project is essential not only for improving the Ajoy river itself but also for improving the Bhagirathi. In

this connection, the Committee would draw the attention of Government to the Committee's recommendation made in paragraph 5.14.1 (ii) of the Preliminary Report. It is since understood that the Government of Bihar is considering the construction of six reservoirs on the Ajoy and its tributaries for irrigation purposes only. Investigations for suitable detention reservoirs are essential and should be taken up. In larger interests, a unified scheme for the Ajoy valley is desirable.

#### 9.5. Protection to irrigated areas :

9.5.1. Notwithstanding the measures suggested in the foregoing paragraphs, the Committee is of the opinion that some special measures are necessary, in cases where irrigation facilities have been provided but the areas are subjected to occasional flooding, to mitigate as far as possible the distress in the area. On the right bank during high floods spill from the Ajoy encroaches into the commanded area of the D. V. C. canals. About 20,000 acres are normally affected by the Ajoy-Kunur spill. In years of abnormal floods and heavy local rainfall when breaches on the embankments also take place, a much larger area is affected. On the left bank, the irrigated area from Mayurakshi canal system has not been extended too deep into the spill area of the Ajoy and in most years it was not affected by normal Ajoy flood.

9.5.2. After careful consideration of factors the Committee recommended that where irrigation has already been provided, the area should be protected from flooding by either strengthening and/or retiring the embankments or putting up new ones as the situation demands.

While giving effect to this recommendation the effect of cutting off of the spills of the Ajoy on the Bhagirathi-Hooghly may be investigated.

9.5.3. The details of the existing embankments and cross-section of Ajoy being not available, it is not possible to recommend the specific embankments to be strengthened, retained and/or retired. The Committee, therefore, recommends the sanction of an investigation scheme estimated to cost Rs. 11,700 for survey of the river Ajoy including the Kunur for a total length of 160 miles in West Bengal from Katwa upwards to Pandabeswar (vide Appendix 41). This scheme provides for taking cross-sections of the rivers and embankments where existing at half mile intervals, the level lines along the cross-section extending 500 ft. on either side of the country-side toe of the embankments. Survey will also be done to locate correctly the exact position and length of the existing embankments.

#### 9.6. Measures recommended for Kunur Basin :

9.6.1. The Kunur river being a tributary of the Ajoy investigation for improvement of the Kunur and drainage congestion in its basin should also be taken up along with the investigation for the Ajoy. Until the Ajoy floods are controlled normal silt clearance of the Kunur will not be effective.

9.6.2. The waste lands in the catchment of the river should be afforested and effective soil conservation measures should be adopted to cover all forms of land uses.

9.6.3. The adequacy of waterways in Sahibgunge loop line of the Eastern Railway near D. V. C. Canal crossing just above Bhedia has been examined. The area is mainly flooded from Ajoy and the Kunur spills and the openings are on the low side. But as depth of inundation both upstream and downstream of the bridge over the Kunur is considerable and since the improvement of the Kunur is not possible without the improvement of the Ajoy, the Committee recommends that the scheme for increasing the bridge openings should await till some suitable scheme is drawn up for the Ajoy.

## Region IV, Howrah-Hooghly Area

### 10.1. Area :

10.1.1. This area measuring 1,107 sq. miles is bounded on the north by the southern district boundary of Burdwan, on the east and south by the river Hooghly and on the west by the river Damodar. This region which is protected in parts by embankments may be broadly subdivided into two zones, viz.—

Zone I—The Ghea-Kunti basin of the area north of Sheoraphuli-Tarakeswar Railway line bounded by the Kana Nadi on the west and the Hooghly on the east.

Zone II—Area south of Tarakeswar line bounded by the Damodar on the west and the Kana Nadi and the Hooghly on the east.

10.1.2. Zone I comprising 470 sq. miles is moderately sloping up to Chinsurah-Dhaniakhali Road, but more or less flat below. The D. V. C. irrigation canals have been extended into the area above the Dhaniakhali Road. The drainage channels have now to accommodate the discharge from the irrigation system in addition to the local run-off.

10.1.3. The total area of Zone II is 637 sq. miles almost whole of which is drained into the Hooghly except for a small area now draining into the Damodar through the Madaria Khal. This zone consists of the following basins :—

- (a) Madaria Khal Basin which originally measured about 126 sq. miles now drains only about 12 sq. miles into the Damodar.
- (b) Purana Khal Basin measuring 54 sq. miles drains into the Hooghly.
- (c) Rajapur Basin measuring originally about 184 sq. miles traversed by the Kana-Damodar, the Dakatia Khal, the Kousiki Khal, the Metia Khal, etc., drains into the Hooghly through the Rajapur Channel. Owing to deterioration of the Damodar, an additional area of 140 sq. miles formerly part of the Madaria Khal and other basins also drains through the Rajapur Basin.
- (d) Saraswati Basin measuring 31.64 sq. miles drains into the Hooghly through the river Saraswati.
- (e) Dankuni Basin measuring 56 sq. miles drains into the Hooghly through the Dankuni Khal.
- (f) Basin drained by Howrah Drainage Channel measuring 37 sq. miles.

### 10.2. Rivers and Drainage Channels :

The main rivers of this area are the Damodar and the Hooghly. The Ghea, the Ilura, the Kedarmati, the Saraswati and the Kunti Nadi are the internal drainage channels having their out falls into the Hooghly. In addition there are other local drainage channels like the Rajapur Khal, the Purana Khal, the Dankuni Khal, the Madaria Khal, the Howrah drainage channel, the Barjola channel, the Gujarpur Khal, the Kousiki Khal, the Metia Khal and

the Dakatia Khal. The Ghea-Ilsura basins drain partly through the Kunti and the upper Saraswati river and partly through the New Cut from the Kunti excavated by the D. V. C. The discharging capacities of these rivers and drainage channels are limited and cannot accommodate the run-off during heavy precipitation. The problem is sometimes further aggravated by tide-levels ruling high in the Hooghly.

### 10.3 Problem :

#### 10.3.1 Zone I :

The area gets frequently flooded whenever there is heavy rainfall due to limited capacity of the channels. In 1959, breaches in the embankments and tide lockage due to high-water level ruling in the Hooghly, were additional causes for heavy flooding. As there was no scope for widening the out fall rivers, i.e., the Kunti and the Saraswati, a new channel known as the Kunti-cut was excavated by the D. V. C. to improve drainage.

10.3.2. The problem of Zone II may primarily be attributed to the deterioration of the Damodar in its lower-most reach. The rivers, namely, the Damodar, the Kana Damodar and the Kana Nadi flow over low ridges and are, therefore, incapable of functioning as efficient drainage channels. Drainage at low stage of floods is effected mostly through the channels in the intermediate valleys between the old rivers, such as, the Rajapur and the Purana Khals. The Rajapur channel was originally designed for a basin area of 184 sq. miles with a drainage index of  $\frac{1}{3}$ " per day. The diversion of drainage into this system from about 76 per cent. of additional area causes serious congestion reducing the effective index. As the ground-levels in this additional areas which used to drain into the Damodar vary between R.L. 30 and R.L. 16, the drainage index for this area is actually higher than even  $\frac{3}{4}$ ".

10.3.3. The Purana Khal was designed with a drainage index of  $\frac{3}{4}$ " less 25 per cent. This has also proved to be inadequate.

### 10.4. Measures recommended :

10.4.1. The drainage congestion in this region cannot be fully removed unless the main out-fall river, the Hooghly, is improved. The measures recommended for improving the Hooghly have been dealt with in Chapter 5. The internal drainage channels of this region including the Damodar which is proposed to be canalised from Amta downwards are also proposed to be resectioned where necessary so that the drainage may be effected as quickly as possible whenever the out-fall levels permit.

10.4.2. There are a large number of embankments in the Ghea-Kunti area which have been put up to protect the low flat areas. These embankments need be property aligned and strengthened to give effective protection. The run-off from the area above the Dhahiakhali Road may have to be diverted directly into the Kedarmati or the Ghea in order to reduce congestion in the low pockets below. Since requisite data are not available the Committee recommends an estimate amounting to Rs. 16,100 (vide Appendix 42) for collection of hydrological and survey data required for preparation of the necessary scheme. The estimate provides for gauge and discharge observations and survey of the existing embankments and river channels in the Ghea-Kunti area.



## 10.5. The Ghea-Kunti Basin Scheme :

### 10.5.1. Description and Boundary of the Basin :

This basin covers an area of 285 sq. miles which is mainly rural in nature. It is bounded on the west and south by the Kana Nadi and on the north and east by the G. T. Road and the basin boundary of the Kunti Nadi. The ground-levels of the area vary from R. L. 70 to as low as R. L. 18. The area above Chinsurah-Dhaniakhali Road is fairly sloping while below that road, it is practically flat and a large number of embankments have been built in this area.

### 10.5.2. Problem :

This basin used to drain through Kunti Nadi and the upper and lower Saraswati Nadi into the Hooghly. All these rivers have now been practically silted up and encroached upon. The outfall levels are also generally high. Consequently, the drainage of this basin is very slow. Moreover, the capacity of the internal drainage channels the Ghea, the Ilsura is also inadequate. The low areas of this basin cannot be protected effectively by embankments along the banks of the river as these are likely to be submerged by the surface run-off from behind. Recently a new cut from the Kunti was excavated by the D. V. C. to improve the drainage of the area. It was observed during 1959 floods that the section of the cut was not adequate for the disposal of the run-off from the basin. Breaches occurred in the marginal embankments along the cut causing large-scale inundation in the areas below the off-take of the cut.

### 10.5.3. The Scheme :

Since widening of the Kunti and the Saraswati Nadi is not feasible, the scheme provides for widening the existing Kunti cut to accommodate the additional discharge necessitated by revision of the basin area and the drainage index. The scheme also provides for resectioning of the lower reaches of the Ghea, the Ilsura and the Kedarmati rivers so that they may carry the full discharges. Since it will be costly and difficult to widen the existing Railway Bridge over the Kunti-cut, it is tentatively proposed to flume the Railway bridge and also utilise the existing adjacent Railway bridge with a small bypass Channel meeting the Kunti-cut again on the down-stream side of the Railway line. If this is not found feasible then the question of increasing the waterway under the Railway track will become essential. The scheme also provides for remodelling the syphon on the Dankuni Khal, the head and tail regulators at the off-take and out-fall ends of the cut and the G. T. Road bridge and other ancillary works.

10.5.4. Originally a uniform drainage index of  $\frac{3}{4}$ " per day was assumed while designing the cut. The Kedarmati Basin also appears to have been omitted while working out the run-off. The latter basin has now been included in the scheme and since the area is fairly sloping in the upper reach and flat in the lower reaches Dicken's formula assuming the value of coefficient "C" = 140 has been used in calculating the design discharge. This corresponds to a run-off of  $1\frac{1}{2}$ " per day for the sloping area and  $\frac{3}{4}$ " per day for the flat area. The discharge has also been verified from figures available during 1959. The design discharge now comes to 9.720 cusecs against the present capacity of 5.100 cusecs of the outfall channels, viz., the Saraswati (700 cusecs), the Kunti (2,000 cusecs) and Cut from Kunti (2,400 cusecs). Therefore, the balance discharge of 4,620 cusecs will have to be passed through the Kunti-cut proposed to be widened.

### 10.5.5. Benefits :

About 40 sq. miles of this basin are submerged during extraordinary heavy rainfall. It is expected that after implementation of the scheme about 25 sq.

miles of the submerged area will be fully benefited. In normal years there is drainage congestion in areas varying between 5 to 10 sq. miles which will now be saved from annual inundation.

10.5.6. The cost of the scheme amounts to Rs. 73 lakh as given in the abstract of estimate (vide Appendix 43). The Committee approves the scheme and recommends its early implementation. The area is very near to Calcutta and as it is likely to develop further, it may be difficult to implement the scheme if delayed.

## 10.6. Scheme for canalisation of Damodar and improvement of Internal Drainage Channels :

### 10.6.1. Area :

This is a triangular area measuring about 500 sq. miles and is bounded on the east by the Kana Nadi and the western basin boundary of the Saraswati, on the south by the river Hooghly, on the west by the river Damodar and its proposed diversion into the Bakshi Khal and then along the ridge between the Rupnarayan and the Damodar. The Damodar and the Hooghly are the main outfall rivers of this area while the Madaria Khal, the Dakatia Khal, the Rajapur Khal, the Purana Khal, the Gujarpur Khal and the Barjola Khal are the internal drainage channels on the left bank of the Damodar and the Ghesopati Khal, the Bainam Khal and the Dewantala Khal are the local drainage channels on the right bank of the Damodar. Practically all the drainage channels on the left bank of the Damodar except the Madaria Khal drain directly into the Hooghly.

### 1.6.2. Problem :

The bed and the mouth of the Amta channel of the Damodar have considerably silted up and an area on the left bank which used to drain to the Damodar through the Madaria Khal is now draining into the Rajapur Basin causing acute congestion there. The banks of the Rajapur Khal near its outfall into the Hooghly are heavily built up so that there is no scope for its widening.

### 10.6.3. The Scheme :

10.6.3.1. Since the Rajapur channel cannot be remodelled and widened the only remedy for removing the drainage congestion in the area is by canalising the Amta channel of the river Damodar so that the same may serve as a drainage channel. This is not possible as long as the uncontrolled spill from the Damodar is allowed to enter into the Amta channel during high floods when the drainage of the local basins is needed the most. Therefore, a scheme was prepared designed to divert the entire discharge entering into the Amta channel to the Mundeswari by closing the mouth of the Channel near the Beguahana. The Amta channel was proposed to be resectioned to carry the drainage of the local area only both on the right and left bank of the channel. Since diversion of the Damodar from Beguahana into the Nundeswari would increase the flood problem in the Trans-Damodar area the present scheme has been prepared to divert the flood discharge entering into the Amta channel from a point about 5 miles above Amta to the Rupnarayan direct. An area of 277 sq. miles will then drain through the canalised lower Damodar.

10.6.3.2. The scheme provides for a cross regulator in the Damodar about 5 miles above Amta and a diversion channel into the Rupnarayan along the Maja Damodar and the Bakshi Khal. The channel will be embanked on both banks and designed for a capacity of 25,000 cusecs which is about the present maximum capacity of the Amta channel. The lower reach of the Damodar below the cross regulator will also be resectioned to take drainage from an area of 277 sq. miles. Near the outfall end, the channel will be diverted direct into the Hooghly and a sluice provided. This diversion is necessary to obtain better foundation for the outfall sluice.

10.6.3.3. The discharge from Dakatia Khal is proposed to be diverted into the Damodar through the Madaria Khal by re-aligning the Madaria Khal embankment and extending the same along left bank of the Kausiki Khal. Thus the congestion in the Rajapur Basin will be considerably reduced.

10.6.3.4. Provision has also been made in the estimate for resectioning all the local drainage channels of the area, e g., the Dakatia Khal, the Madaria, the Ghesopati Khal, the Bainam Khal and the Dewantala Khal including excavation of two new channels to accommodate the full run-off from the basin. The Rajapur channel and the Purana Khal will be just sufficient to drain the basin area now left. Provision has, however, been made for necessary silt-clearance of the channels.

10.6.3.5. Drainage index has been assumed at  $1\frac{1}{4}$ " per day for steeper areas above the Amta. For areas below the Amta the drainage index has been assumed as  $\frac{3}{4}$ " per day.

#### 10.6.4. Benefit :

Drainage congestion in an area of about 277 sq. miles of the basin will be removed by canalisation of the Damodar. Over and above this, it will also give relief to Rajapur and Purana Khal basins.

#### 10.6.5. Cost :

The cost of scheme amounts to Rs. 2 crore as given in the abstract of the estimate appended (vide Appendix 44). The original scheme referred to in paragraph 10.6.3 provided for diverting the entire discharge of 25,000 cusecs into the Mundeswari at Beguahana. It did not provide for resectioning of the Mundeswari channel to accommodate this additional discharge and it was apprehended that this might result in worsening the flood conditions along this channel or the Trans-Damodar area. The scheme, however has the advantage of being more economical than the one worked out now. It has not been possible to examine whether resectioning of the Mundeswari and providing embankments along it would be feasible in order to prevent greater damages from floods in that area. It should also be investigated as to whether the entire discharge of 25,000 cusecs now entering the Amta Channel at high flood stage need be diverted into the Mundeswari or the new channel proposed. In case, it is found feasible to let a part of this discharge continue to flow along the Amta channel. Further economies might be possible. The Committee suggests that these aspects of the problem be thoroughly examined before one of the two schemes is finally accepted for execution.

## CHAPTER II

## Region V, the Damodar Basin

## 11.1. Area :

11.1.1. The Damodar Basin in West Bengal covers a total area of 2,137 sq. miles including the area known as Trans-Damodar area measuring about 965 sq. miles. The latter has been classified as Region VI and dealt with separately in the following chapter because of its special problems. This chapter deals with the rest of the area measuring 1,172 sq. miles, which is triangular in shape and is bounded on the north and east more or less by the Grand Trunk Road and the State boundary of Bihar and on the west by the Darakeswar Basin up to Khandaghosh.

11.1.2. The flood problems in a number of southern districts of West Bengal, namely, Burdwan, Hooghly and Howrah are primarily associated with the floods in the river Damodar which is shallow, wide, flashy and frequently spills over its right bank from near about Silna below the Anderson weir at Rondia. The entire left bank of the river below Silna is embanked up to its outfall into the Hooghly to protect the area on this side which contains important towns and vital means of communication between Calcutta and rest of India. The right bank was also embanked but as it became difficult to maintain embankments on both sides parts of the right bank embankment were abandoned. The part below Begua Hana still remains. In addition to these embankments there are innumerable small ex-zamindary embankments in the whole of the Trans-Damodar area. The region north of the Pursura-Arambagh Road is broadly known as the upper Trans-Damodar while below that it is known as the lower Trans-Damodar area.

## 11.2. The Damodar River, its tributaries and branches :

11.2.1. The Damodar River originates from the Chotanagpur hills and has a catchment area of 6,664 sq. miles up to Panchet-Maithon, 7,550 sq. miles at Durgapur and 8,500 sq. miles at the head of the Rupnarayan. The Barakar and the Konar are the important tributaries of the river in Bihar, while the Sali is the only important tributary in West Bengal.

11.2.2. Near Begua 'hana' the Damodar bifurcates into two channels. viz., the Damodar channel and the Kanke-Mundeswari channel. The Damodar channel is silted up and now carries discharge during high floods only. The main flow passes through lower Trans-Damodar area along the Kanke Mundeswari river which in turn further branches into two loops known as the Harinakhal and the Kabla nala which meet the main channel lower down. Ultimately the river discharges into the river Rupnarayan via the Hurhura, the Chaubisbigha, and the Aurora Khals. During high floods vast area is inundated and the flow then does not remain confined to channels only. A large volume of flood also spills over the upper Trans-Damodar area through eleven large 'hanas' on the right bank between Rondia and Sure-Kalna. The discharge through the 'hanas' depends on the flood-level in the river Damodar and the bed levels and widths of the 'hanas' or openings. Spilling through the 'hanas' starts when the discharge in the river reaches about 1,00,000 cusecs. The Mulkati Khal begins to draw at this stage and flow into the lower Trans-Damodar area. During very high floods the Damodar spill spreads further across and passes into the next valleys of the Deb and Kanta Khals, which are more or less parallel to the Mulkati Khal.

## 11.3. Problem :

The left bank area is protected by an embankment of adequate section. The right bank alone is subject to floods. The upper Trans-Damodar area has

a fair gradient and as such the drainage is quick. The extent of area covered by the spill and depth of inundation depends solely upon the peak discharge and the period over which the Damodar River is above the bankful stage. The acuteness of inundation is relieved as soon as the flood level in the Damodar subsides below the bank level. Sand is sometimes deposited over the fields during high floods and renders the land uncultivable. The bankful capacity of the river from Silna to Sure-Kalna is between 1,75,000 to 2,00,000 cusecs. A discharge of 2,50,000 cusecs at Durgapur, however, does no harm as the spilling then corresponds to about 6" over the right bank in the upper Trans-Damodar area. The rise in flood level thereafter is comparatively slow and the spilling over the right bank begins. The spill water travels downwards as surface runoff and also through the Mulkati, the Deb and the Kanta Khals creating problems in the lower Trans-Damodar area. It also deposits sand in the internal drainage channels and aggravates the local drainage problems. The main flow of the Damodar through the lower Trans-Damodar area is carried by the Kanke-Mundeswari channel whose bankful capacity at Harinkhola is only about 70,000 cusecs. In the lower areas near the Rupnarayan the capacity of the drainage channels is still less. The high flood levels at Harinkhola in recent years were as under—

Year				R.L.
1957	...	...	...	44.96
1958	...	...	...	46.21
1959	...	...	...	46.31
1960	...	...	...	45.72
1961	...	...	...	45.79

The peak discharge in 1961 at R.L. 45.79 was 80,000 cusecs. It is evident that flood levels in Harinkhola were more or less the same in different years but the extent of spilling was widely varying. In 1961 there was spilling for a period of about 48 hours submerging an area of 40 sq. miles while in 1959 the spilling was for about 216 hours submerging an area about 500 sq. miles though there was not much difference in the high flood levels. Of course in the year 1959 there were other contributing factors such as the Darakeswar spill, synchronising of the Rupnarayan floods and the spring tides from the Bay which retarded the drainage thereby increasing the flooded areas. The present drainage capacity of the Rupnarayan-Hooghly being limited, also contributed to the holding up of the drainage from the area.

From a study of a few floods it is seen that problems become very acute only when there is heavy precipitation simultaneously in the lower and upper valleys. This has been amply illustrated during 1961 when in spite of a very heavy storm precipitation in the upper valley there was hardly any drainage congestion in the lower valley. All these studies indicate that—

- (i) a discharge of the order of 2,50,000 cusecs for a short duration at Durgapur is not so harmful for the Trans-Damodar area.
- (ii) The problem is less acute when the precipitation in the upper Damodar valley does not synchronise with that in the lower valley.

Before the construction of the D.V.C. dams, the flood peaks were high but the duration was small. The construction of the dams has moderated the peaks but increased the duration of floods. This increase in duration has enhanced the chances of synchronisation of floods from the upper and lower valleys as also from the adjoining river basins.

11.4. The worst storm on record that ever occurred over the Damodar basin up to Ranigunge had a mean rainfall of 11.9 inches in 5 consecutive days in August 1913, the highest mean rainfall in a day being 4.9" in August 1935.

11.5. The characteristics of some of the past high floods as furnished by the D.V.C. are given in the table below—

Year of flood	Total run off in the monsoon period (June to October) I,000 acre ft.	Flood period.	Peak flow I 000 cusecs.	Volume of flood.			
				During the period when flow was more than 50,000 cusecs I,000 acre ft.	Maximum in 24 hours I,000 acre ft.	Maximum in 48 hours I,000 acre ft.	Maximum in 72 hours I,000 acre ft
1	2	3	4	5	6	7	8
1963	...	August 6-12	650	3,238	1,210	2,058	2,563
1935	5,010	August 11-15	640	1,560	934	1,264	1,512
1939	9,440	July 31 to August 7-12	282	1,751	520	1,127	1,433
1941	8,900	October 9-13	634	1,351	780	1,080	1,176
1942	12,020	August 7-13	382	1,731	624	1,076	1,358
1943	8,880	August 3-11	296	2,245	508	904	1,360
1946	8,420	September 16-21	323	1,448	560	952	1,230
1950	8,190	July 10-22	338	2,199	560	864	1,048
1951	4,540	September 10-14	381	1,395	664	996	1,216
1956	5,081	September 25-30	420	983	648	918	...
1958	3,900	September 14-19	665	1,306	881	1,160	1,306
1959	8,900	September 30 to October 3	810	2,105	1,270	1,802	1,950
1961	...	September 30 to October 4	562	1,448	824	1,140	1,865

11.5.1 The peak flow figure of 1913 was computed from data collected at Raniganj and the rest up to 1956 (pre-dam period) are observed figures at Rhondia or Durgapur, while those of 1958-59 and 1961 are derived from the sum of calculated inflow into the reservoirs and the calculated discharge from the uncontrolled catchment below the dams up to Durgapur. As regards the peak flow figure for 1959, the West Bengal authorities have computed lower figures. This, however, is not very material as it is the total volume of the floods which rules the operation of the reservoirs. The 1959 flood although fairly high was not the highest, the highest on record being that of 1913 which had about 50 per cent. greater volume. The designed flood having a much greater volume was adopted for planning the ultimate Damodar Valley Scheme. But until the other contemplated storage reservoirs were built, the Committee is of opinion that the flood reserve in the existing reservoirs should be so provided as to enable the 1913 flood to be routed to 2,50,000 cusecs at Durgapur.

11.5.2. Studies (vide Appendix 45) in this connection made in the River Research Institute, West Bengal, show that this could be achieved with a flood reserve of 1.321 million acre ft. at Maithon and Panchet Hill reservoirs. The Committee recommends that this reserve should remain inviolate and should be available for flood control from 15th June to the 15th October. For this purpose necessary acquisition of land up to R.L. 500 (G.T.S.) in the case of Maithon and R.L. 445 (G.T.S.) in the case of Panchet Hill reservoirs should be made.

11.5.3. As some smaller floods have occurred between the 15th and 31st October, in the past, it will be desirable to examine the extent of flood reserve necessary during that period to take care of such floods.

11.5.4. A suitable method of regulation of the reservoirs will have to be evolved by trials with the assistance of the Flood Forecasting Unit and with particular reference to the problems of the lower valley.

#### 11.6. Conservancy of the river channels :

11.6.1. After construction of dams, the floods will be moderated in most of the years and it would increase the chances of further encroachment in the flood plain of the Damodar-Mundeswari. This may increase distress to a great extent during extraordinary floods when there will be very little moderation of discharge so far as the lower Trans-Damodar area is concerned. Damages caused after further encroachment will, therefore, be higher. At present there is a practice to obstruct the river bed itself for boro irrigation. These obstructions cause untold damages to the river channels and the Committee recommends immediate stoppage of this practice. Wherever necessary alternative irrigation arrangements should be provided, if possible, to stop unauthorised or ill-advised obstructions.

11.6.2. The Committee appreciates that it may not be altogether possible due to pressing economic needs and the increase of population to stop encroachment in the flood plains. When such encroachments are made and allowed by the Government the party encroaching should be told that the area is subject to flooding and no flood protection scheme will be provided. However, in such areas the crop pattern and method of land use should be changed as far as possible so that during flood season no damages to crops occur. By changing the crop pattern, the damage due to floods can be reduced substantially in most cases.

11.6.3. Due to decrease in flood spill and frequency of high floods in the Trans-Damodar areas, the Mundeswari and other drainage channels will tend to shrink. Flushing doses may be helpful if they are of adequate volume and duration under favourable conditions.

11.6.4. The Committee recommends that channels in the Trans-Damodar area should be kept under careful watch by taking cross-sections and collecting silt and discharge data regularly at suitable points. As the problem in this area is complicated model studies for improvement of rivers are considered necessary. After the results of model experiments are available it would be possible to state what would be the optimum discharge and duration necessary for maintaining and improving the regime of the rivers and channels in this area. Till this is known, it may be worth-while for the authorities making releases of flushing doses to watch the behaviour of these rivers every year vis-a-vis the releases made.

#### 11.7. Soil Conservation :

11.7.1. Except a small portion in the Purulia district, the upper catchment of the Damodar River lies in the State of Bihar. A comprehensive survey of the entire catchment to find out the needed extent of Soil Conservation and afforestation work is necessary. The Committee notes with gratification that the importance and urgency of integrated Soil Conservation works in the upper Catchment of the River Valley Projects have been accepted by the Planning Commission and the Government of India are giving liberal financial assistance for undertaking necessary works. A Centrally-sponsored integrated scheme is under execution in the 3rd Plan under which 56,000 acres of land will be treated with Soil Conservation measures and afforestation and 12,000 acres of

agricultural land will be covered by Soil Conservation measures by the Bihar Govt. at a cost of Rs. 1.63 crore. It is also understood that the Soil Conservation organisation of the D.V.C. has also certain schemes for afforestation of 10,000 acres at a cost of 19.65 lakhs during the period in Bihar and 6,000 acres at a cost of Rs. 12 lakh in the Purulia district of West Bengal. Although the upper catchment of the Damodar River lies in the State of Bihar, the discharge and silt load during the flood season from the lower catchment are not insignificant. The lower catchment extends over about 1,900 sq. miles covering the districts of Purulia, Bankura and Burdwan. The major foci of erosion are concentrated over derelict forest area measuring about 122 sq. miles and barren lands covering about 35 sq. miles. The erosion in the agricultural land does not pose any serious problem as most of them are terraced and bounded for paddy cultivation. Some of the waste lands, however, are still cultivated periodically in a primitive fashion as a result of which the top soil is getting thinner day by day. Gullies, both big and small, are also formed frequently due to this faulty cultivation. These waste lands are the remnants of a well stocked forest that was cleared in the days of permanent settlement when agriculture was looked upon as the only means of livelihood for the village people. The forests, too, suffered from the effects of maltreatment that was the rule in the days of private management. Erosion and run-off in the forest area are as was in the barren lands because of the absence of dense undergrowth and adequate ground cover. The Committee recommends that afforestation and soil conservation work should be taken up in the forest and waste lands covering 122 and 35 sq. miles respectively as an emergency measure. For this purpose the Committee also recommends an estimate of Rs. 1.25 crore (vide Appendix 46). There may be some variations in this estimate depending on the accurate data that will be available after a proper survey which will precede the actual execution of the work. Similar Soil Conservation measures in areas outside the State of West Bengal should also be undertaken.

## CHAPTER 12

### Region VI, Trans-Damodar Area

#### 12.1. Area :

Region VI is the tract of country measuring 956 sq. miles on the right bank of the Damodar, bounded on the north and east by the river Damodar and on the west and south partly by the eastern boundary of the Bankura district and partly by the eastern boundary of the Midnapore district and the Rupnarayan. It may be broadly subdivided into two blocks, namely—

- (a) Upper Trans-Damodar area comprising Raina-Khandokosh area ; and
- (b) the lower Trans-Damodar area comprising the rest of the Trans-Damodar area below the Pursura-Arambagh Road.

The ground levels of the upper Trans-Damodar vary between R.L. 135 and R.L. 45 while those of the lower Trans-Damodar area vary between R.L. 45 and R.L. 14.

#### 12.2. Rivers and drainage channels :

The Damodar-Kanke-Mundeswari, the Rupnarayan and the Darakeswar are the main rivers in this area while there are a number of internal drainage channel such as the Mulkati Khal, the Deb, the Kanta and the Harinkhola



Khals. The Kanke-Mundeswari which takes off from the Damodar from Beguahana branches into a number of channels in the lower Trans-Damodar area, the principal amongst which are the Hurhura, the Chaubbisbigha, and the Aurora Khals.

#### 12.2.1. The Mulkati Khal :

This is more or less a spill channel of the Damodar with which it is inter-connected at a number of places through 'hanas'. The Khal has its off-take near Kumirkhola and runs along a depression parallel to the Damodar and meets it again below Beguahana. When the discharge in the Damodar exceeds 1,00,000 cusecs, the river begins to spill over the right bank through the 'hanas' into the Mulkati Khal. During very high floods the Damodar spill also reaches the next valleys of the Deb and the Kanta Khals.

#### 12.2.2. The Deb Khal :

There are two channels in the area just south of the Mulkati khal and more or less parallel to it. They are both known as Deb khals and serve the internal drainage of the area.

#### 12.2.3. The Kanta Khal :

This Khal is also parallel to the Deb khals and serves the internal drainage of the area south of the Deb khals.

#### 12.2.4. The Kanke-Mundeswari :

The Kanke-Mundeswari takes-off from the Begua-hana and about 90 per cent. of the discharge of the Damodar at this place now passes through this channel, the rest flowing along the lower Damodar into the Amda channel. It has a bankful capacity of nearly 70,000 cusecs at Harinkhola thirteen miles below the off-take. Lower down the capacity reduces.

#### 12.2.5. The Darakeswar :

The river Darakeswar originates in the Purulia district and after flowing through steep country meets the Silabati near Ghatal and flows as the river Rupnarayan. The river Darakeswar carries a lot of sand and discharge is very flashy. It begins to spill over both the banks from near about Arambagh. The lower Trans-Damodar area is thus affected both by the Damodar and the Darakeswar spills.

#### 12.2.6. The Rupnarayan :

The whole of the Trans-Damodar area is ultimately drained through the Rupnarayan. In addition, the Rupnarayan drains the Darakeswar and the Silabati basins as also a large portion of the Kangsabati basin. The river Rupnarayan joins the Hooghly at Geonkhali. Tidal influence extends into the Silabati up to Gadghat. When all the rivers are simultaneously in flood, the inflow far exceeds the capacity of the Rupnarayan and it spills over large areas on the left bank. The problem of drainage is aggravated when spring tides synchronise with high floods. The ground level in the strip along the banks of the Rupnarayan being much lower than the high water-level, marginal embankments have been put up along the right bank.

#### 12.3. Problem :

The problems of the Trans-Damodar area have been described in Chapter 11 dealing with the Damodar Basin. The drainage problem in the upper Trans-Damodar area results mainly from the spill from the Damodar. This is

accentuated by heavy precipitation in the area. There are about eleven large 'hanas' on the right bank of the Damodar through which water spills over whenever the discharge in the river exceeds 1,00,000 cusecs. During very high floods sand is deposited on the fields and in the beds of the local drainage channels causing damage to the standing crops and drainage difficulties. The flooding in the area is not, however, prolonged and relief is obtained as soon as the water-level in the Damodar subsides. In the lower Trans-Damodar area, however, it is due to spill from both the Damodar and the Darakeswar and unfavourable conditions arising from the inadequate drainage capacity of the Rupnarayan, which has in addition to take in the discharges from the Darakeswar, the Silabati and the Kangsabati. The flooding on the lower Trans-Damodar area is prolonged as drainage is governed by the outfall conditions in the Rupnarayan. During extraordinary high floods, the water-level in the Rupnarayan runs high for days together and drainage is very slow. There are also some man-made obstructions such as circuit embankments, embanked roads and bunds for 'boro' cultivation which worsen the condition further.

#### 12.4. Measures recommended :

The measures recommended for Trans-Damodar area may be classified under four categories—

- (i) Regulation of the discharge from the dams.
- (ii) Improvement of the main rivers such as the Rupnarayan, the Munde-swari and the Darakeswar.
- (iii) Resectioning of the silted up inner channels for efficient drainage.
- (iv) Providing regulators across some of the 'hanas'.

12.4.1. (i) Regulation of discharge from the dams has been fully dealt with in Chapter II.

#### 12.4.2. (ii) Improvement of the river Rupnarayan :

12.4.2.1. The Rupnarayan as already described, is inter-connected with several other rivers. Its hydrolic conditions are, therefore, complicated. As such the measures required for a solution of the problem can only be devised after hydrological and topographical data are collected over a series of years for all the connected rivers and their basins. Unfortunately, these are not available. Collection of these has recently been taken up. It has since been found that certain observation and survey of the Rupnarayan were not covered by those two estimates. A fresh estimate amounting to another Rs. 1.86 lakh (vide Appendix 47) has, therefore, been approved and submitted to the Government for sanction. This estimate provides for taking cross-sections every half a mile apart along the river from Bandar to Geonkhali and also along the spill channels. It also provides for taking gauge, discharge and silt observations at 3 sites and gauge observations at 7 sites for one year. The data thus collected will enable a model being set up at a further cost of Rs. 3.42 lakh (vide Appendix 48), where various proposals for the improvement of the river will be studied. It provides for the construction of a model from Bandar to Geonkhali a distance of about 50 miles. The spill channels are also proposed to be incorporated in the model. The ultimate aim of any work should be to enlarge the capacity of the river. The most straightforward method of dredging it to the requisite section not being possible owing to the cost involved as well as the lack of space for dumping the dredged material, recourse will have to be taken to constructing training works like spurs, groynes and levees and perhaps dredging some reaches. The effect of such training works in the Rupnarayan on the Hooghly will have to be kept in mind while making studies as any works affecting that river adversely will have to be avoided.

The most suitable and economical solution will emerge from experiments and studies in the model.

#### 12.4.2.2. Improvement of the Mundeswari and its spill channels :

The improvement of the Mundeswari and its spill channels by sending down flushing doses has often been recommended, but neither the size of doses nor duration has ever been specified. These should be determined by specific studies in the prototype.

12.4.2.2.1 The Committee has recommended an estimate amounting to Rs. 4,62,000 (vide Appendix 49) for construction and operation of the necessary models for devising flood control measures in the Trans-Damodar area. The estimate provides for a necessary model of the Trans-Damodar area incorporating all the river channels within the area. The Committee has approved an estimate amounting to Rs 26,143 (vide Appendix 50) for survey of all the rivers and channels in the Trans-Damodar area and collection of hydrological data at 5 additional sites, found necessary for the model experiments proposed to be carried out. These data are also necessary for preparation of Flood Control Schemes for the area.

#### 12.4.2.3. (ii) Improvement of the Darakeswar :

12.4.2.3.1 The Darakeswar catchment is in the worst condition in that part which lies in the districts of Bankura and Purulia. The river rises in the district of Purulia close to its border with Bankura and then passes through the latter covering a very large watershed. A small part of the eroding catchment lies in the district of Midnapore also. The total catchment area of the Darakeswar stands at 1,692 sq. miles of which 180 sq. miles are covered by degraded forests and 51 sq. miles by waste lands. Most of the waste lands have developed as a result of unplanned usage in the days of permanent settlement when agriculture was looked upon as the principal means of livelihood for people depending on the use of lands. These waste lands are being cultivated periodically without taking necessary precautionary measures for whatever produce these are capable of yielding. The inevitable consequences follow and the fertile top soil reaches vanishing point in no time. The history of the degraded forests is in no way different from that of the rest. Unregulated felling, burning and grazing over a long period of private management have brought the forests to such a state of degradation that their beneficial role in preventing floods, moderating climate and preserving the soil and moisture has almost come to an end. Soil erosion and surface run-off is nearly as severe here as in barren lands. The West Bengal Forest Committee, 1938, which had thoroughly studied the problem of destruction of forests in this region observed in their final report that breaking up of land for cultivation was encouraged by the land tenure system prevailing in those days. Moreover, in the rural areas the only economy that was known to people was what centered round agriculture. The configuration of this region being undulating, agriculture on sloping land is not of uncommon occurrence. But such cultivation is done without the safeguards for soil conservation. These areas should also come within the purview of control measures proposed to be recommended by this Committee. The major foci of erosion, however, occur in the extensive tract covered by degraded forests and waste lands. The necessity of adopting soil conservation measures is so urgent that immediate attention is to be paid to these major foci. The Committee, therefore, recommends treatment of the degraded forests and waste lands in the first phase of the work in this basin. For this purpose the Committee recommends an estimate amounting to Rs. 1.82 crore for afforestation and soil conservation over 231 sq. miles out of the total basin area of 1.692 sq. miles (vide Appendix 51). The estimate provides for small check dams, contour trenches, gully plugging, etc.

12.4.2.3.2. The Committee also recommends investigation to be undertaken in regard to construction of a dam at Suknibasa or any other suitable place for checking movement of sand and supply of required flushing doses in the channel of the river below. Since construction of a dam for this purpose only would be uneconomical, the Committee is of opinion that irrigation and flood control aspects should also be combined if possible in the project. As requisite data for preparation of such a scheme are not available, the Committee recommends an estimate amounting to Rs. 1.52,000 (vide Appendix 52) for hydrological observations at the possible dam sites and collection of gauge, discharge and silt data in a number of tributaries to find out the foci of erosion. These investigations will also cover reconnaissance survey for location of sites of check-dams wherever necessary in some of these tributaries as an alternative to the multipurpose reservoir.

12.4.2.3.3. The Committee in its Preliminary Report recommended that sufficient waterways in the Pursura-Arambgh-Khanakul Road should be provided so that the spills of the Damodar and the Darakeswar were not obstructed. The waterways in the said road have now been checked up and it has been found that though they are sufficient for the local run-off they cannot accommodate large volume of flood spill from the Damodar and the Darakeswar. The Committee suggests that instead of constructing additional culverts and bridges and raising the road level suitable causeways may be provided near the sites where breaches occurred in 1959. This will not materially affect the traffic which might only be dislocated for a couple of days during high floods.

12.4.3. (iii) Resectioning of the silted up inner channels—Improvement of the Deb and the Kanta Khal in police-station Raina :

12.4.3.1. Description and boundary of the basin :

The basin traversed by the inner channels Mulkati, Deb and Kanta khals measures 265 sq. miles and lies in police-stations Raina and Khandaghosh of the district of Burdwan and is bounded on the north and east by the river Damodar and on the west and south by the right bank main canal and distributary No. 16 of the D. V. C. canal system. The country is fairly sloping with ground levels varying from R.L. 126 to R.L. 65 in a distance of about 45 miles.

12.4.3.2. Problem :

The problem of the area has already been described. Submergence of the basin is occasioned by the flood spill of the river Damodar and/or the local heavy rainfall. Though the area inundated by the flood spill is considerable, the depth of a submergence in the upper part hardly exceeds 2 ft. and does not cause much damage to crops. But drainage congestion occurs almost every year in the lower area of about 19 sq. miles due to inadequate capacity of the drainage channels as well as inability to drain out when the level at the outfall rises high. The water gradually accumulates in this area and causes extensive damage to crops.

12.4.3.3. The Scheme :

The scheme envisages removal of drainage congestion by resectioning the lower portions of the Mulkati, the Deb and the Kanta khals to accommodate requisite discharges. Length of the Mulkati khal proposed to be resectioned is about 7 miles while those of the Deb khal and the Kanta khal are 12 and 11.5 miles respectively. The drainage index assumed in the estimate submitted to the Government was  $\frac{3}{4}$ " per day. This will need revision.

#### 12.4.3.4. Benefit :

The area affected each year is about 19 sq. miles. After implementation of the scheme the inundated area is likely to be reduced to only about six sq. miles.

12.4.3.5. The cost of the scheme amounts to Rs. 25 lakh as per the abstract of the estimate (vide Appendix 53). The Committee recommends its early implementation.

#### 12.4.4. (iv) Closing of banas on the right bank of the Damodar, :

There cannot be any general principle for closing the 'banas.' Each case should be decided on its own merit after detailed survey and investigation.

## CHAPTER 13

### Region VII, Midnapore District

#### 13.1. Area :

Region VII comprises the whole of Midnapore district measuring 5,253 sq. miles and is bounded on the north by the boundaries of the districts of Bankura and Hooghly, on the east by the Rupnarayan and the Hooghly, on the south by the Bay of Bengal and on the west by the eastern boundary of the State of Orissa. It has been broadly subdivided into two blocks, namely, (a) the Daspur area, and (b) the rest of the Midnapore district. Daspur area measuring about 120 sq. miles is enclosed by the rivers: Rupnarayan, the Silabati, the Palaspai and the Durbachatty Khals.

#### 13.2. Rivers and drainage channels :

The rivers Darakeswar, the Silabati and the Rupnarayan, the Palaspai and the Durbachatty Khals are the major drainage channels of the Daspur area while the Kangsabati, the Rupnarayan, the Kaliaghye, the Rasulpore, the Hooghly and the Subarnarekha are the main channels for the rest of the district. Large portions of this region being lower than the high-water levels ruling in the rivers during monsoons, have been enclosed by innumerable circuit embankments which are served by internal drainage channels with sluices at the outfall ends.

##### 13.2.1. The Kangsabati River :

The Kangsabati river begins to spill over both its banks from a few miles below the Midnapore anicut. The area on the right bank is irrigated, and it is protected by embankments. At Kapastikri the Kangsabati bifurcates into two branches. One flows towards the south and meets the Kaliaghye river near Raikhali forming the river Haldi which falls into the Hooghly. This branch of the Kangsabati is embanked on both the banks. The other branch flows eastwards after bifurcating further into two channels and taking the name of the Palaspai and the Durbachatty Khals into the Rupnarayan. There is also another spill channel from this branch of the Kangsabati meeting the river Silabati near the abandoned Panna circuit.

##### 13.2.2. The Rupnarayan River :

The rivers Darakeswar and the Silabati join near Ghatal and flow as the river Rupnarayan. Owing to deterioration of the Damodar about 90 per cent. of the flow from that river is now diverted into the Rupnarayan through the

Kanke-Mundeswari. In addition, large volume of water from the Kangsabati basin also flows into this river. It is embanked on both banks below the outfall on the Gaighata Khal at Bakshi while on the right bank the embankment runs up to Ghatal. The river has become very shallow and wide in a number of places and hence its drainage capacity has been considerably reduced.

### 13.2.3. The Kaliaghye River :

The Kaliaghye river originates in the undulating areas of the Midnapore district and after flowing through steep country enters comparatively flatter and lower tract of the district near Sabong. Below this point, the river spills over both the banks. It has a number of important tributaries, namely, the Baghai Khal, the Kapaleswari, etc., before it meets the Kangsabati River at Raikhali and flows as the river Haldi. A very large area in the lower reach of the Kaliaghye is affected every year by floods in this river. The right bank is protected all along by Schedule 'D' or Taccavi embankments while series of detached circuit embankments exist in the left.

### 13.2.4. The Rasulpore River :

The Rasulpore river has got comparatively small catchment of about 470 sq. miles and it originates from a low pocket south of the Kaliaghye river and falls into the Hooghly.

### 13.2.5. The River Subarnarekha :

This river flows almost along the border of the district and a very small area of West Bengal is drained into it and as such hardly any area is normally affected by floods in this river.

### 13.3. Problem :

13.3.1. About 72 sq. miles of Daspur area are protected by the Chetua Circuit Embankment which is surrounded by the Rupnarayan, the Silabati and the Palaspai. There were several other circuit embankments in this area, namely, the Narajola, the Panna and the Ghatal which were subsequently abandoned throwing open the embanked areas to floods from the Kangsabati, the Silabati and the Darakeswar. The problems of the Chetua Circuit are—

- (1) The ground levels of some portions within the circuit are lower than the high water-level in the outfall rivers. As such drainage by gravity through sluices is not always possible.
- (2) The capacities of the sluices are also inadequate, so that drainage is very slow even when the outfall level is favourable. Therefore, occasional cuts are made in the embankments after a heavy precipitation to drain out the accumulated rain-water quickly.

13.3.2. The problem of the rest of the area is complicated as it is interconnected with many river basins and the deteriorated condition of the Rupnarayan in which the tidal conditions exist has further aggravated it.

13.3.3. The low pockets of the rest of the Midnapore district are also protected by a large number of circuit embankments. The major rivers have more or less continuous embankments on both the banks. The outfall levels are high and occasionally it becomes difficult to drain the run-off from the area enclosed within the embankments. The problem is further aggravated by the floods and rainfall occurring simultaneously during spring tides when the drainage gets tide-locked for a number of days. While the embankments are generally strong enough to withstand floods in the main rivers those at places along the left bank of the Kaliaghye need some strengthening.

### 13.4 Remedial measures :

#### 13.4.1. The remedial measures are—

- (1) Improvement of the main rivers, namely—the Silabati, the Darakeswar, the Rupnarayan, the Kangsabati, the Kaliaghye and the Rasulpur.
- (2) Afforestation and soil conservation measures in the catchments of the rivers.
- (3) Remodelling the internal drainage channels behind the embankments with provision of adequate sluices.
- (4) Strengthening of the existing embankments where necessary.
- (5) Removal of encroachments and obstruction in the river sections to provide sufficient waterways for flood discharges.

#### 13.5. Improvement of the Kangsabati—the Palaspai Khal and the Kaliaghye :

13.5.1. The improvement of the Rupnarayan and the Darakeswar has been dealt with in the previous chapter. Construction of regulators to distribute the discharge of the Kangsabati into the different channels with a view to improving them and/or silt clearing them will have to be studied in a model as also the alignments of existing and new embankment. The flood control reservoir on the Kangsabati will reduce the flood problem in this area to some extent. The problem of the Kaliaghye river can only be solved by suitably locating the embankments with some training works and dredging at suitable places. All these should be studied and the overall effects of the different alternative measures assessed in a model. The Committee, therefore, recommends an estimate amounting to Rs. 3,11,000 (vide Appendix 54) for construction and operation of models for improvement of the Kangsabati-Kaliaghye river system and flood moderation in the area.

13.5.2. Since complete hydrological and survey data are not available for the construction and operation of the models, the Committee recommended two estimates one amounting to Rs. 1,52,000 (vide Appendix 55) to meet the probable cost of survey and hydrological observation at 17 sites of the Kaliaghye and Rasulpur rivers and the other amounting to Rs. 19,800 (vide Appendix 56) for survey only of the river Kangsabati and its branches. Hydrological observations for the Kangsabati river have already been provided for in the comprehensive estimate amounting to Rs. 7.03 lakh.

#### 13.6. Afforestation and soil conservation :

Of the rivers that form the major drainage channels as stated in para. 13.2 above, the upper catchment of only the Kaliaghye lies in the district of Midnapore. Out of the total catchment area of 800 sq. miles, the degraded forests and waste lands constitute about 31.6 sq. miles and 4.4 sq. miles, respectively. The major portion of the catchment area is comprised of undulating tract with a covering of sandy and hard soil that has very little capacity for retention of moisture. The waste lands of today were covered with forests in the past. Their gradual denudation was caused mainly for meeting the requirement of agricultural crops of the local people. In those days agriculture was looked upon as the only means of livelihood. This feeling was more strong as the value of forests as source of perpetual benefit was not at all realised. The extension of agriculture was also encouraged by permanent settlement prevailing then. The West Bengal Forest Committee, 1938, have elaborated on these points as page 31 of their printed preliminary report. Whatever little forests stood against this drive of extending agriculture was unfortunately left in the hands of zamindars who did not manage the forests on scientific lines. The result was severe form of maltreatment over a very long period. These

forests that have now come in the possession of Government have practically lost the most important properties that are usually associated with well-managed forests, viz., conservation of soil and moisture inside the forests in the adjoining areas, and moderating the climate particularly reduction of the desiccating effects of hot wind. The waste lands at present are subjected to periodic cultivation amounting almost to shifting cultivation although the level of production is very much below the economic limit. This type of cultivation is done without providing for the necessary safeguards for undulating tracts with the result that the valuable top soil is gradually washed away in the form of sheet erosion. The cultivators move to another piece of waste land when the top soil in the previous one gets very thin. Besides the denuded forests and the waste lands there are some sloping lands which are under some form of permanent agriculture. These areas too are subjected to soil erosion for the lack of proper conservation measure. In 1954 an integrated scheme estimated at Rs. 53-84 lakh was prepared for the entire catchment area but only Rs. 4.87 lakh was sanctioned and spent in three years ending in 1957-58 under a pilot project. The scheme was not implemented subsequently. Under the circumstances the Committee recommends that only the major foci of erosion should be tackled in the beginning as an emergency measure. A study of Kaliaghye catchment shows that the major foci of erosion are concentrated in the denuded forests and waste lands. Taking these points into consideration, the Committee recommends an estimate amounting to Rs. 21,45,000 for afforestation and soil conservation measures in the Kaliaghye basin (vide Appendix 57). The area proposed to be covered by this estimate is about 36 sq. miles. The treatment will follow the standard pattern, viz., contour trenching, gully plugging, erecting brushwood dams and afforestation of barren land.

### 13.7. Remodelling of the inner channels of Chetua Circuit :

13.7.1. There are two main channels in this area, namely, the Chandreswar and the Kalmijole Khals. It is understood that a scheme for improvement of Chandreswar Khal having a basin of 30 sq. miles has been drawn up by the Irrigation and Waterways Directorate. One for the Kalmijole Khal, south of the Chandreswar Khal basin, serving an area of 19 sq. miles has been prepared.

### 13.7.2. The Problem :

The Kalmijole Khal is badly silted up and the outfall sluice at Mahesghata is inadequate. Since the drainage period is very limited owing to water-level ruling high at the outfall for a prolonged period, the lower part of the basin remains submerged whenever there is heavy rainfall. Sometimes cuts are made in the embankments to drain out the accumulated water quickly. This practice is dangerous as flood may occur in the outfall river before the artificial cut can be closed as happened in 1959.

### 13.7.3. The Scheme :

The scheme provides for resectioning of the Kalmijole Khal to accommodate a run-off of  $\frac{3}{4}$ " per day while the sluice at Mahesghata is proposed to be remodelled for a run-off of 1" per day. There are a number of sluices already existing in this area which drain about 8 sq. miles. The Mahesghata sluice is, therefore, proposed to be remodelled to accommodate the remaining area of 11 sq. miles.

### 13.7.4. Benefit :

Out of the 19 sq. miles of the basin area about 8 sq. miles is very low which suffers frequently from drainage congestion due to inadequate capacity of the drainage channel and the sluice. The drainage congestion in this area



will be removed with the execution of the scheme. The estimated cost of the scheme is Rs. 7.12 lakh as in the abstract at Appendix 58. The Committee recommends its early implementation.

### 13.8. Dubda Basin Scheme—Description and Boundary of the basin :

This basin extends over an area of 180 sq. miles. It is bounded on the north by the Baghai river and on the east by Belda-Contai Road and Tajpur embankment, on the south by the Orissa Coast Canal and on the west by the Jokee embankment. The Kudi and the Negua Khals are the two important internal drainage channels of the basin and fall into the Orissa Coast Canal. Drainage is then passed partly through the Peechabani Khal, partly into the Rasulpur river and partly into the Subarnarekha river. A small part of the basin is also drained by the Baliaghye Drain.

#### 13.8.1. Problem :

An area of about 40 sq. miles known as Dubda Swamp having an average ground-level of R.F. 6 gets submerged by the run-off from the Negua and the Kudi Khals flowing through a sloping country in their upper catchments measuring about 130 sq. miles. The rate of run-off from the sloping area is very high and the low pockets get submerged almost every year. The area remains water-logged until the floods in the Kudi and Negua Khals subside. Drainage congestion in the adjacent basins like Sarpai and Contai are also consequently caused.

#### 13.8.2. The Scheme :

The scheme provides for—

- (a) diversion of a portion of the drainage of the basin coming down the Kudi Khal to the Baliaghye Drain and thence to the Rasulpur river,
- (b) disposal of the drainage of another part of the basin through the Negua Khal by a new channel along Kudi-Parul Road connecting on the Orissa Coast Canal,
- (c) provision of a lock at the 12th mile regulator dividing Orissa Coast Canal into a high and low-level canal on two sides of the lock during monsoon months,
- (d) the discharge from the Negua Basin will be passed through the high level portion of the Orissa Coast Canal and drained into the Peechabani Khal which is proposed to be resectioned and the sluice at its outfall remodelled,
- (e) draining the Dubda Swamp through the low-level Orissa Coast Canal into the Rasulpur through the Sarpai sluice.

13.8.3. Thus the discharge of a considerable portion of the basin (Nagua and Kudi Basins) will be disposed off by-passing the low pocket, viz., Dubda Swamp. The run-off assumed is  $\frac{3}{4}$ " per day for the Dubda Swamp while for the Negua Khal and Kudi Khal basins which have got steep slopes it has been calculated taking the constant in Dicken's formula as 200.

#### 13.8.4. Benefits :

At present 40 sq. miles is submerged every year. It is expected that after implementation of the scheme this vast pocket will be saved from annual inundation.

#### 13.8.5. Cost :

The estimate cost of the scheme outlined is Rs 77 lakhs (vide Appendix 59). The Committee approves the scheme and recommends its early implementation. An estimate amounting to Rs. 23,000 (vide Appendix 60) for detailed survey and investigations in Dubda Basin has also been approved by the Committee.

### 13.9. Contai Basin Scheme—Description and boundary of the basin :

This basin covers an area of 86 sq. miles. It is bounded on the north by the Sarpai basin, on the east by the river Rasulpur, on the south by the Seadyke and on the west by Peechabani basin.

The basin comprises the following :—

	Sq. miles.
(1) North Contai Basin	... 24.06
(2) New Panipia Basin	... 12.47
(3) Old Panipia Basin	... 7.76
(4) Mirzapore-Jhowa Basin	... 16.88
(5) Daulatpur Basin	... 3.35
(6) Darsanamayee Basin	... 6.50
(7) Amirbad Basin	... 3.88
(8) Mogra Basin	... 11.14
Total :	... 86.04

An almost continuous sand dune running east to west divides the basin more or less into two blocks.

#### 13.9.1. Problem :

All the sub-basins except the north Contai Basin measuring 24.06 sq. miles have independent outlets and the drainage is fairly satisfactory but some redistribution is necessary. The existing drainage arrangements of the North Contai basin is through the Contai Nallah into the canalised Sarpai towards the north which ultimately drains into the Rasulpur river. During monsoon, water-level of the canalised Sarpai remains high due to entry of flood water from the Dubda Basin. As a result major part of North Contai Basin suffers from drainage congestion throughout the monsoon and crops fail almost every year.

#### 13.9.2. The Scheme :

The scheme provides for drainage of the North Contai Basin directly through the existing new Panipia sluice after providing necessary additional ventage. It also provides for resectioning of the Panipia Khal and the Contai Nallah which are necessary to dispose of drainage from the additional area. A lock in the Orissa Coast Canal for entry of boats into the Contai Nallah has also been provided. The scheme provides for making use of the existing old Panipia sluice by segregating an area of 7.96 sq. miles of high-lands from the new Panipia Basin and draining the same through the old sluice. The drainage of the Mirzapur-Jhowa Basin is also to be diverted through a new sluice at Dakshin-Kendua. The Mogra Basin of 11.14 sq. miles is proposed to be drained partly through a new cut into the Darshana Moyee sluice and the remaining through Amirabad sluice. The north Contai Basin has been designed with a drainage index of  $\frac{3}{4}$ " per day.

#### 13.9.3. Benefit :

About 24 sq. miles of the area will be benefited from the scheme. After implementation of the scheme it is expected that large areas will be saved from annual inundation and the annual loss will be reduced to a considerable extent.

13.9.4. The estimated cost of the scheme amounts to Rs. 50 lakhs (vide Appendix 61). The Committee recommends its early implementation.

### 13.10. Re-excavation of Bamunia-Daudpur drainage channel :

#### 13.10.1, Description of the basin :

The Bamunia-Daudpur Khals serve an area of 22 sq. miles of Sarpai Basin in police-stations Contai and Egra of the district. The Bamunia Khal originates from paddy fields near the 10th mile post of Contai-Belda Road and after flowing for a length of 7 miles falls into the Sarpai canal. Daudpur Canal originates near the second mile post of Tajpur Embankment and joins the Bamunia Khal at about one mile upstream of its outfall into the Sarpai Canal.

#### 13.10.2. Problem :

Due to heavy silting of this channel proper drainage of the area cannot be effected resulting in heavy damage to cultivation.

#### 13.10.3. The Scheme :

The Scheme provides for resectioning of the Bamunia-Daudpur Channels as necessary to accommodate a run-off of  $\frac{3}{4}$ " per day from the basin.

#### 13.10.4. Benefit :

Drainage congestion of large portion of the basin will be removed after implementation of the scheme.

#### 13.10.5. Cost :

The estimated cost of the scheme amounts to Rs. 1,49,432 (vide Appendix 62). The Committee recommends its early implementation.

## CHAPTER 14

### Region VIII, Purulia and Bankura Districts

#### 14.1. Area :

Region VIII covers an area of 4,100 sq. miles and is bounded on the north by the Damodar Basin, on the east by the western boundary of Burdwan and Hooghly districts, on the south by the Midnapore district and on the west by the State boundary of West Bengal. The country is undulating in nature and has got a steep slope, as such there is no drainage congestion in the area. The upper areas are mostly barren or covered with shrubs and denuded lands while some of the valleys are terraced for paddy cultivation.

#### 14.2. Rivers :

The Kangsabati, the Silabati and the Darakeswar are the important rivers of this area. They remain almost dry throughout the year except during the monsoon when there are occasional high discharges for short duration.

#### 14.3. Problem :

The region in particular does not suffer from inundation or drainage congestion. During very high floods the rivers may spill over the banks at a few low places, even then the submergence is only local and for a very short duration and no remedial measures are necessary on this account. But conditions in the catchments and flashy flow in the rivers create serious problem

in the regions lower down, as they adversely affect the regime of the rivers, on account of—

- (a) Rapid flow in the channels due to great difference of elevations from the sources to the mouths.
- (b) Friable bed and side material of the river channels.
- (c) Sediment load.
- (d) Great variations in discharges taken down by them.

Amongst all these factors sediment load is of paramount importance, as it would not only reduce the life of reservoirs if any were built, but comparatively heavy sediment load and low discharge affect adversely the slope, cross-section and course of the rivers in the lower flatter reaches. Sediment load in excess of what the river normally carries or can carry will disturb the river regime by depositing it in the river bed or on the spill area. In course of time river bed becomes higher than the adjoining country and flood levels in the river tend to rise causing drainage congestion. If, therefore, the regimes of the rivers below have to be properly maintained or improved sediment load brought down by the upper reaches must be reduced as far as possible.

#### 14.4 Remedial measures :

Sediment load can only be reduced by intensive soil conservation and afforestation measures in the upper catchments and scientific land uses. These will in addition result in eventual increase in production of foodgrains and fuel wood, timber, etc. Measures for such control for the Darakeswar catchment have already been dealt with in Chapter 12.

#### 14.5. Afforestation and soil conservation in the catchment of the Kangsabati and the Silabati :

Although the Kangsabati Catchment is spread over the districts of Purulia, Bankura and Midnapore, it is only in its upper part lying within the limits of Purulia district that the problem of soil erosion is most acute. The upper catchment cover an area of 8,06,000 acres of which forests and waste lands constitute 1,20,000 and 13,900 acres, respectively. The catchment area of the Silabati river is mostly in the district of Bankura and measures 3,38,500 acres with 95,000 acres under forests and 32,000 acres as waste lands. The waste lands represent the end of a harmful process that started long ago when agricultural production was looked upon as the only occupation of the rural people. The configuration of the terrain being undulating, the clearance of forests for agriculture without the usual safeguards for conservation resulted in abnormal impoverishment of soil. The fertile top soil has been gradually removed in the process of erosion and the lands are now subjected to periodic cultivation with negligible yield of crops. Surface erosion and run-off are very severe in these areas and unless put under permanent cover immediately, these are likely to be lost for ever for any kind of land use. Forests were also not an exception to this type of maltreatment of land by their users. The forests in the Kangsabati Catchment were in private possession till their acquisition by Government of Bihar sometime in the year 1947-48. Similarly, the forests of Silabati Catchment were held by private owners till 1955 when Government of West Bengal started acquiring them for direct management. Unregulated cutting, grazing and burning have opened by the tree canopy and destroyed the undergrowth, to such an extent that their value in the matter of conservation of soil and moisture has diminished at an alarming rate. The Purulia forests are also heavily burdened with rights of numerous kinds. In

the Kangsabati Catchment, agricultural lands extend over an area of 6,41,060 acres the major portion of which are under paddy for which lands are properly levelled and bunded. But the high lands measuring about 40,000 acres are under sloping cultivation. Agricultural lands in the Silabati Catchment are practically free from serious type of soil erosion because the main crop is paddy for which lands are always levelled and bunded. The major foci of erosion are found to be concentrated in 72,000 acres of degraded forests, 18,000 acres of waste lands and 40,000 acres of agricultural land in the Kangsabati Catchment and in 95,000 acres of degraded forests and 39,000 acres of waste lands in the Silabati Catchment. The Committee recommends that these badly affected areas should be taken up under integrated soil conservation schemes, and approves the estimates of Rs. 322 lakh (vide Appendix 63) and Rs. 167.35 lakh (vide Appendix 64) for Kangsabati and Silabati Catchments respectively, for afforestation and soil conservation works and recommends early implementation.

#### 14.6. Check-dams and escapes on streams in the undulating areas :

14.6.1. The works suggested in the foregoing paragraphs for soil conservation and afforestation cover denuded forest and waste lands. These will enable control of erosion from those areas only, but they form a small part of the total catchments. The rest of the areas are under cultivation most of which are terraced for growing of paddy. Since the country is fairly sloping, the level difference from one terraced field to the other is considerable. During heavy precipitation the "Ailes" of the fields in such areas breach and there is sudden flow of large volume of water held in the terraced lands supplemented by the rainfall run-off. This not only causes heavy erosion of the fields but also increases the peak discharges in the rivers below. It is also a common practice in this area to build low earthen bundhs across depressions to form small storage tanks. In most of these cases proper escapes are not provided and the bundhs breach during heavy precipitation creating additional problems. The slopes of the small streams in the hilly, undulating areas are very steep and continuous erosion in the bed and the sides of the streams goes on. Suitable measures to prevent these are also necessary. The Committee recommends that in order to prevent such happenings the local officers should be instructed to give technical advice to the farmers to construct safer 'ailes' and provide suitable escapes in the tank so that they do not breach during heavy precipitation. It is desirable that the Directorate constructs a few such works as models and proper publicity is given to the fact that advice for designing similar work is available to public free.

14.6.2. To prevent sheet erosion, gully formation and scouring near the streams the Committee recommends that measures such as diverting the head-water, plugging small gullies and constructing check-dams at suitable intervals to reduce the bed slope are necessary.

14.6.3. Since requisite data are not available for preparation of specific schemes, Committee recommends an estimate amounting to Rs. 4.98 lakh (vide Appendix 65) for investigations and surveys for preparation of schemes of check-dams and escapes in such areas. The estimate provides for a thorough reconnaissance of about 2,000 sq. miles in the four districts of Purulia, Bankura, Birbhum and Midnapore as well as survey of all the streams and channels having steep slopes for preparation of the specific schemes. It also provides for hydrological observations at about 20 stations to determine the foci of erosion. Subsequent observations at these stations will indicate the extent of benefit derived from the soil conservation measures. The estimate also provides for a field laboratory for analysis of soil as well as work-charged and regular establishments necessary for carrying out the investigations which will extend over 2 years. The work should be taken up without delay so that specific soil conservation schemes in this region can be prepared early.

## CHAPTER 15

## Overall Estimated costs of Schemes—Their Priorities and Programme

15.1. From the recommendations made in the foregoing chapters it is obvious that the task of ensuring safety against future floods is going to be arduous. Not only will it be necessary to invest large sums of money but resources in men and materials will also require to be taxed heavily. Even if there were no limitations to the availability of these, nature of works involved will need time to work out final plans and execute. In some cases, due to lack of requisite data and in others for trying out alternative solutions in models, longer time will be necessary. The Committee have, therefore, considered it necessary to recommend a planned programme for the works. The programme, while keeping in view the main objective of speedy provision of protection from ravages of future floods, must take account of the time, money, men and material required for execution of the required works.

15.2. The scheme, recommended by the Committee, falls into two categories one in which sufficient data were available and it was, therefore, possible to draw up the schemes in outlines and work out their approximate costs and the other in which due to lack of data no schemes could be drawn up. But in order to obtain a rough picture of the overall cost of remedial measures approximate figures of cost of the latter from comparable works have been adopted.

15.2.1. The schemes under the first category are—

### Category I

Serial No.	Name of scheme.	Cost In lakhs of rupees.
1	Scheme for Raising of Villages	86.50
2	Khardah Basin Drainage Scheme	44.50
3	Nowl Basin Drainage Scheme	100.00
4	Sunti Basin Drainage Scheme	150.00
5	Sealdahgong Basin Drainage Scheme	112.00
6	Manikhali Basin Scheme	30.00
7	Keorapukur Basin Scheme	40.00
8	Churia Basin Scheme	85.00
9	Remodelling the Mograhat Basin Drainage Scheme	155.00
10	Sankdah Khal Scheme	16.50
11	Beel Pakuria Scheme	9.50
12	Remodelling Sundarban Embankments including construction of necessary sluices.	736.64
13	Scheme for Improvement of the Tolly's Nullah including reclamation of 2.34 sq. miles of Tollygunge-Panchannagram basin.	1,575.00
14	Scheme for desilting of underground sewers of Calcutta city area for increasing their drainage capacity.	12.00
15	Scheme for augmenting the pumping capacity of the drainage pumping stations of Calcutta Corporation.	36.50

Serial No.	Name of scheme.	Cost lakhs of rupees.
16	Scheme for the sewerage of Cossipore area ... ..	368.00
17	Scheme for disposal of storm-water and sewerage of Maniktola area ..	297.00
18	Scheme for disposal of storm-water and sewerage of Topsia-Tangra areas ...	72.10
19	Tollygunge sewerage and drainage disposal scheme ... ..	898.00
20	Scheme for remodelling and increasing the drainage capacity of the storm-water channel from Bantola to Kulci.	151.00
21	Tollygunge-Panchannagram Basin Drainage Scheme ... ..	29.15
22	Scheme for Afforestation and Soil Conservation in the catchment of Mayurakshi within West Bengal.	16.50
23	(a) Survey of rivers and tributaries and Khals in Kandi area, district Murshidabad.	0.25
	(b) Model experiment for flood protection for Kandi area ... ..	1.37
	(c) Flood protection scheme for Kandi area (Phase I) ... ..	75.00
24	Scheme for flood protection works of Nabadwip town ... ..	30.00
25	(a) Bhuri-Shyamsundarpur Beel Drainage Scheme ... ..	32.00
	(b) Scheme for resectioning the Banka ... ..	26.00
26	Scheme for Afforestation and Soil Conservation in the catchment of the Ajoy within West Bengal.	61.21
27	Ghea-Kunti Basin Scheme including widening of the 'Kunti' Cut ...	73.00
28	Scheme for canalisation of the lower Damodar and improvement of internal drainage channels.	200.00
29	Scheme for Afforestation and Soil Conservation in the catchment of the Damodar within West Bengal.	125.00
30	Scheme for Afforestation and Soil Conservation in the catchment of the Darakeswar.	182.34
31	Scheme for improvement of Deb and Kanta Khal ... ..	25.00
32	Scheme for Afforestation and Soil Conservation in the catchment of the 'Kallaghye'.	21.45
33	(a) Investigation for resectioning of the inner channels of Chetua circuit and determining adequacy of sluice in Maheshghata.	0.04
	(b) Remodelling of the Kalmijole Khal within Chetua circuit and sluice at Maheshghata.	7.12
34	(a) Survey and investigations in Dubda Basin ... ..	0.23
	(b) Dubda Basin Scheme ... ..	77.00
35	Contal Basin Scheme ... ..	50.00
36	Scheme for re-excavation of Bamunia Daudpur Khal ... ..	1.49
37	Scheme for Afforestation and Soil Conservation in the upper catchment of the Kangsabati.	322.00
38	Scheme for Afforestation and Soil Conservation in the catchment of the Sifabati.	167.35
	Total of schemes under Category I ... ..	6,498.74

15-2-2 The probable cost of schemes of the Second Category including the cost of investigations and surveys necessary for preparation of the schemes are—

### Category II

#### A. General Investigations and Surveys

Serial No.	Name of scheme.	Cost in lakhs of rupees.
1	Hydrological observations in parts of South and South-west Bengal.	7.03
2	Aerial Survey in parts of Murshidabad, Hooghly, Howrah and Midnapore districts.	7.98
3	Surveying the rivers in Trans-Damodar Area in Howrah and Hooghly districts.	0.26
4	Survey and investigation for the improvement of the Kaliaghye and the Rasulpur rivers.	15.2
Total of schemes under Category IIA		16.79

#### B. Schemes including costs of surveys and investigations

Serial No.	Name of scheme.	Probable Cost in lakhs of rupees.
1	Scheme for re-excavation of the Khana and the Nutan Khals from Pagla Chandi Daha to the river Jalangi.	46.00
2	Flood flushing scheme between the Bhagirathi and the Jalangi	50.00
3	Remodelling of sewerage system of the city area to the West of Tolly's Nullah with separate outfall including necessary sewage treatment works.	334.00
4	Scheme for repairs to the existing sedimentation tanks and other structures at Bantala.	1.89
5	Scheme for augmenting the capacity of the existing sedimentation tanks at Bantala.	50.00
6	Scheme for Drainage of Bainchitala area	5.00
7	(a) Investigation for Pagla-Bansloi Drainage Scheme	0.48
	(b) Pagla-Bansloi Drainage Scheme	50.00
8	Flood Protection Scheme for Kandi area (Phase-II)	275.00
9	(a) Survey and hydrological observation in the river Khari	0.29
	(b) Scheme for resectioning the Khari	50.00
10	Scheme for additional escapes and cross-drainage works in D. V. C. canals, remodelling of canal structures as necessary and for disposal of tail discharge.	75.00
11	(a) Investigation for flood detention reservoir in the upper catchment of the Ajoy.	10.00
	(b) Scheme for flood detention reservoir in the upper catchment of the Ajoy	1,500.00
12	(a) Survey of the river Ajoy from Railway bridge at Pandabeswar to its outfall at Katwa.	0.12
	(b) Strengthening of the Ajoy embankments for protecting irrigated area	35.00



Serial No.	Name of Schemes.	Probable cost of lakhs of rupees.
13	Scheme for Improvement of the Kunuar river ... ..	25.00
14	(a) Survey for flood protection in Ghea-Kunti area ... ..	0.16
	(b) Scheme for improvement and/or retiring of ex-zamindary Embankments in Howrah-Hooghly area.	44.00
15	(a) Hydrological observation and river survey in connection with the improvement of the river Rupnarayan.	1.86
	(b) Surveying the river Kangsabati with its branches in the lower reaches	0.20
	(c) Model experiment and tidal computation of the river Rupnarayan	3.42
	(d) Construction and operation of models for flood moderation in Trans-Damodar area.	4.62
	(e) Construction and operation of models for study of flood problem and its moderation in the Kangsabati and the Kaliaghye system.	3.11
	(f) Scheme for improvement of the Rupnarayan, the Trans-Damodar rivers, the Kangsabati, the Kaliaghye and the Rasulpur.	2,300.00
16	(a) Survey and hydrological observations of the river Darakeswar in connection with the proposed construction of dam or small check-dams across the said river or its branches.	10.52
	(b) Construction of a dam or small check-dams across the Darakeswar	600.00
17	Scheme for construction of Causeways in Pursura-Arambagh-Khanakul Road at certain places.	4.00
18	Scheme for closing of 'hanas' by constructing suitable structure for regulating the discharge through the right bank of the river Damodar.	10.00
19	(a) Investigation and survey for preparation of schemes for provision of check-dams and escapes on streams in undulating areas of Purulia, Bankura, Birbhum and Midnapore districts.	4.98
	(b) Scheme for constructing check-dams and escapes in the stream in undulating areas in Purulia, Bankura, Birbhum and Midnapore districts.	200.00
20	Scheme for soil conservation in the upper catchment of the Mayurakshi outside West Bengal.	...
21	Scheme for Afforestation and Soil Conservation in the catchment of the Ajoy outside West Bengal.	...
22	Scheme for Afforestation and Soil conservation in the catchment of the Damodar outside West Bengal.	...
<b>Total of schemes under Category IIB excluding Soil Conservation schemes outside West Bengal.</b>		<b>5685.65</b>

15.3. The total bill of cost of the works recommended will aggregate to about Rs. 122.01 crore. Of this Rs. 22.20 crore will be required for works in the control of the Corporation of Calcutta. Thus the balance of Rs. 99.81 crore will have to be found by the State. This figure if analysed will not appear to be as high as it does at first sight. Schemes such as Soil Conservation, Reclamation of low lands, raising of villages will more than pay for themselves while in the other schemes benefit in the shape of increased agricultural yield, better sanitation and drainage, greater safety from flood damages, a general sense of security, etc., will eventually aggregate in value to more than the money recommended to be invested.

15.4. The schemes envisaged can be subdivided into—

- (1) Flood moderation schemes.
- (2) Flood protection schemes.
- (3) Drainage schemes.

15.4.1. The flood moderation schemes include schemes for soil conservation, flood detention reservoirs and those for improvement of rivers. These will cost about Rs. 73.87 crore.

15.4.2. The flood protection schemes are schemes designed to afford protection against inundation. These include schemes designed to protect townships, villages and such rural areas for which inundation is harmful. They will cost about Rs. 13.06 crore.

15.4.3. The drainage schemes are necessary where deterioration of the local drainage channels and their outfall rivers contribute to drainage congestion. These will cost about Rs. 35.08 crore.

#### 15.5. Priorities :

15.5.1. It will be noticed that in the second category there are some problem areas for which although early solutions are necessary, none can be suggested till the necessary investigations and surveys are completed. These envisage hydrological observations and topographical studies as also model experiments in cases where flow conditions are complex and theoretical analysis of the problem and its solution are almost impossible. It is obvious, therefore, that investigations and surveys in respect of such schemes should receive high priority and the works proceeded with as expeditiously as possible so that ultimate solutions of the problems and the costs thereof can be worked out early.

15.5.2. In their Preliminary Report the Committee indicated certain general principles for fixing priorities of schemes. Under the long-term remedial measures Soil Conservation in the hilly and middle catchments of rivers was recommended to be given the highest priority. With regard to the other schemes the Committee gave the highest priority to works designed to improve the regime of the rivers. In this last context the Committee considered the Ganga Barrage project to be a scheme which should be given top-ranking priority in view of its being of vital importance for improving the regime and proper conservancy of the Bhagirathi-Hooghly, the most important drainage outfall river of the Southern and South-western part of West Bengal. The Committee notes with great satisfaction that this scheme has since been taken up for execution by the Government of India.

15.5.3. Since submission of the Preliminary Report, the Committee has examined in detail the problems and requirements of different areas under its purview and approved a number of schemes to deal with them. Giving due regard to these and other relevant factors, as also the required weightage to regional considerations for benefits to reach a broadbased cross-section of people, the Committee has decided to fix inter-se priorities for the various schemes recommended. In view of a clearer overall picture it would be desirable to group the schemes under three priorities, namely, priorities I, II and III.

15.5.4. The intention, however is not to break the continuity in the execution of all the schemes but only to provide for the more important ones being taken up earlier and the rest to follow. This will provide time for preparation of schemes not yet ready for want of data and also for proper allocation of resources in money, men and materials.

15.5.5. The names of the individual schemes with their probable cost under the different priorities are given below—

### Priority I

Serial No.	Name of schemes.	Estimated Cost in lakhs of rupees.
1.	Hydrological observations in parts of South and South-west Bengal ...	7.03
2	Aerial survey in parts of Murshidabad, Hooghly, Howrah and Midnapore districts.	7.98
3	Surveying the rivers in Trans-Damodar area in Howrah and Hooghly districts.	
4	Tollygunge-Panchannagram Basin Drainage Scheme ... ..	29.15
5	(a) Survey of rivers and tributaries and Khals in Kandi areas, district Murshidabad.	0.25
	(b) Model experiment in connection with flood protection scheme for Kandi area.	1.37
	(c) Flood Protection Scheme for Kandi area, Phase I ... ..	75.00
6	Scheme for flood protection works of Nabadwip Town ... ..	30.00
7	Investigation for flood detention reservoir in the upper-catchment of the Ajoy.	10.00
8	(a) Hydrological observation and river survey in connection with the improvement of the river Rupnarayan.	1.86
	(b) Model experiment and tidal computation of the river Rupnarayan ...	3.42
9	Surveying the river Kangsabati with its branches in the lower reaches ...	0.20
10	Survey and investigation for the improvement of the Kaliaghye and Rasulpur rivers.	1.52
11	Construction and operation of models for flood moderation in Trans-Damodar area.	4.62
12	Contai Basin Scheme ... ..	50.00
13	Khardah Basin Drainage Scheme ... ..	44.50
14	Kaorapukur Basin Scheme ... ..	40.00
15	(a) Survey of the river Ajoy from Railway Bridge at Pandabeswar to its outfall at Katwa.	0.12
	(b) Scheme for strengthening of the Ajoy embankments for protecting irrigated area.	35.00
16	Scheme for improvement of Deb and Kanta Khals ... ..	25.00
17	Sealdahgong Basin Drainage Scheme ... ..	112.00
18	Nowi Basin Drainage Scheme ... ..	100.00
19	Beel Pakuria Drainage Scheme ... ..	9.50
20	Bhuri-Shyamsundarpur Beel Drainage Scheme ... ..	32.00
21	Manikhal Basin Scheme ... ..	30.00
22	Scheme for augmenting the pumping capacity of the drainage pumping stations of Calcutta Corporation.	36.50

Serial No.	Name of schemes.	Estimated cost in lakhs of rupees.
23	Scheme for desilting of underground sewers of Calcutta city area for increasing their drainage capacity.	12·00
24	Scheme for disposal of storm-water and sewerage of Manicktola area ...	297·00
25	Scheme for repairs to the existing sedimentation Tanks and other structures at Bantala.	1·89
26	Scheme for the sewerage of Cossipur area ... ..	368·00
27	Scheme for disposal of storm-water and sewerage of Topsia and Tangra areas.	72·10
28	Scheme for remodelling and increasing the drainage capacity of the storm-water channel from Bantola to Kulti.	151·00
29	Tollygunge sewerage and drainage disposal scheme ... ..	898·00
30	Scheme for re-excavation of Bamunia Daudpur Khals ... ..	1·49
31	Ghea-Kulti Basin Scheme including widening of the Kulti Cut ...	73·00
32	(a) Survey and investigation in Dubda Basin ... ..	0 23
	(b) Dubda Basin Scheme ... ..	77·00
33	Scheme for afforestation and soil conservation in the upper catchment of the Kangsabati.	322·00
34	(a) Scheme for afforestation and soil conservation in the catchment of the Ajoy within West Bengal.	61·21
	(b) Scheme for afforestation and soil conservation in the upper catchment of the Ajoy outside West Bengal.	...
35	(a) Scheme for afforestation and soil conservation in the catchment of the Mayurakshi within West Bengal.	16·50
	(b) Scheme for soil conservation in the upper catchment of the Mayurakshi outside West Bengal.	...
36	Scheme for afforestation and soil conservation in the catchment of the Silabati.	167·35
37	Scheme for afforestation and soil conservation in the catchment of the Darakeswar.	182·34
38	(a) Scheme for afforestation and soil conservation in the catchment of the Damodar within West Bengal.	125·00
	(b) Scheme for soil conservation works in the upper catchments of the Damodar Basin outside West Bengal.	...
39	Churial Basin Drainage Scheme ... ..	85·00
40	(a) Investigation for resectioning of inner channels of Chetua circuit and determining the adequacy of sluice at Maheshghata.	0·04
	(b) Scheme for remodelling of Kalmijole Khal within Chetua circuit and the sluice at Maheshghata.	7·12
41	Scheme for Raising of village ... ..	86·50
42	Scheme for improvement of the Tolly's Nullah including reclamation of 2·34 sq. miles of Tollygunge-Panchannagram Basin.	1,575·00

Serial No.	Name of schemes.	Estimated cost in lakhs of rupees.
43	Scheme for additional escapes and cross drainage works in the D. V. C. Canal, remodelling of canal structures as necessary and for disposal of tail discharge.	75 00
44	Scheme for constructing causeways in the Fursura-Arambagh-Khanakul Road at certain places.	4 00
Total of schemes under Priority I (excluding soil conservation schemes outside West Bengal).		<u>5,346.05</u>

### Priority II

Serial No.	Name of schemes.	Probable cost in lakhs of rupees.
1	Scheme for augmenting the capacity of the existing sedimentation tanks at Bantala.	50.00
2	Scheme for resectioning the River Banka ... ..	26.00
3	Scheme for canalisation of the Lower Damodar and improvement of internal drainage channels.	200.00
4	Construction and operation of models for study of flood problem and its moderation in the Kangsabati and the Kaliaghye system.	3.11
5	Scheme for flood detention reservoir in the upper catchment of the Ajoy	1,500 00
6	Flood protection scheme for Kandi area (Phase II) ... ..	275.00
7	(a) Survey for flood protection in Ghea-Kunti area ... ..	0.16
	(b) Scheme for improvement and/or retiring of ex-zamindary embankments in Howrah-Hooghly area.	44 00
8	Scheme for afforestation and soil conservation in the catchment of the Kaliaghye.	21.45
9	Scheme for improvement of the Rupnarayan, the Trans-Damodar rivers, the Kangsabati, the Kaliaghye and the Rasulpur.	2,300.00
10	Remodelling the Magrahat Basin Drainage Scheme ... ..	155 00
11	Scheme for drainage of Bainchitola area ... ..	5.00
Total of schemes under Priority II ... ..		<u>4,579.72</u>

## Priority III

Serial No.	Name of schemes.	Probable cost in lakhs of rupees.
1	Sunti Basin Drainage Scheme ... ..	150.00
2	Sankdah Khal Scheme ... ..	16.50
3	Remodelling of sewerage system of the city area to the west of Tolly's Nullah with separate outfall including necessary sewage treatment plants.	334.00
4	(a) Survey and hydrological observation in the river Khari ... ..	0.29
	(b) Scheme for resectioning of the river Khari ... ..	50.00
5	Remodelling Sundarban embankments including construction of necessary sluices.	736.64
6	Scheme for re-excavation of the Khana and the Nutan Khals from Pagla-chandi Daha to the river Jalangi.	46.00
7	(a) Survey and hydrological observation of the river Darakeswar in connection with the proposed construction of dam or small check-dams across the said river or its branches.	1.52
	(b) Scheme for construction of a dam and/or small check-dams across the Dwarakeswar.	600.00
8	Flood Flushing Scheme between the Bhagirathi and the Jalangi ...	50.00
9	Scheme for closing of 'hanas' by constructing suitable structures for regulating the discharge through right bank of the river Damodar.	10.00
10	(a) Investigation and survey for preparation of schemes for provision of check-dams and escapes on streams in undulating areas of Purulia, Bankura, Birbhum and Midnapore districts.	4.98
	(b) Scheme for constructing check-dams and escapes in streams in undulating areas of Purulia, Bankura, Birbhum and Midnapore districts.	200.00
11	Scheme for improvement of the Kunur river ... ..	25.00
12	(a) Investigation for Pagla-Bansloi Drainage Scheme ... ..	0.48
	(b) Pagla-Bansloi Drainage Scheme ... ..	50.00
Total of schemes under Priority III ... ..		2,275.41

## 15.6. Programme :

15.6.1. As already observed the Plan for dealing with the flood problems is likely to cost Rs. 122.01 crore. It would not be out of place to discuss here the ways and means position. A sum of Rs. 8.96 crore is estimated as the cost of soil conservation schemes in West Bengal. A sum of Rs. 22.20 crore is likely to be incurred on schemes for the improvement of drainage of Calcutta by the Calcutta Corporation. The former schemes, it is presumed, will be financed by the Centre while the latter will have to be found by the Calcutta Corporation. This will leave a further sum of about Rs. 90.85 crore for the remaining schemes to be found by the State Government.

15.6.2. A review of heavy floods in the State reveals that they are known to have occurred as shown below—

Damodar	Ajoy	Bhagirathi	Mayurakshi	Kaliaghye
1913	1913	1913	1913	1913
1935	1916	1925	1929	1926
1941	1942	1938	1946	1940
1956	1946	1948	1950	1942
1959	1956	1956	1956	1946
	1959	1959	1959	1952
				1958

15.6.3. It is obvious that nature does not follow any particular cycle in the matter of visitation by such heavy floods in the State. They have occurred even at very short intervals. Therefore, the programme has to be planned mainly on the basis of the availability of resources and on the hope that disastrous floods will not occur during the planned period. Obviously a gamble on a very long period cannot be taken. It has to be remembered that disastrous floods occurring in one part of the country or other almost every year. Last year the neighbouring States of Orissa and Bihar suffered heavily from the ravages. The execution of schemes, therefore, may not be spread over more than fifteen years at the most. It would definitely be desirable to execute them even earlier. The long period suggested involves a great risk as a single disastrous flood may result in enormous loss involving crores of rupees as has been the case in recent past.

15.6.4. The Committee accordingly recommends that the programme of execution of these schemes should be spread over not more than four Five-Year Plan periods with a beginning being made in the Third Five-Year Plan. Obviously, in the initial years the expenditure will per force have to be proportionately less, the expenditure gaining momentum with the increase in tempo of works in the subsequent plan periods. On this assumption the expenditure in the remaining years of the Third Five-Year Plan period may not exceed Rs. 10 crore, including about Rs. 3 crore of the Calcutta Corporation schemes and the Fourth, Fifth and Sixth plans may be of the order of Rs. 39, Rs. 44 and Rs. 29 crore respectively.

15.6.5. The provision in the present Plan programme for the schemes included in this report is only 153 crores. The State Government should, therefore, increase the provision by either reallocating funds from other sectors of the State Plan or go up to the Central Government for the necessary assistance. Such assistance will also be necessary in the subsequent plan periods. It must be remembered that in case of a visitation of a flood of the intensity of 1959 both the State and the Central Governments might have to find even larger sums of money for relief and rehabilitation of the unfortunate section of population which might be affected by such a visitation. There should, therefore, be no hesitation in making an all-out effort for securing the necessary finance to implement the recommended programme.

## CHAPTER 16

## Conclusion and Summary of Recommendations

16.1. In Chapter 3 of the Preliminary Report a factual description of the effects of the 1959 flood has been given. A gross area of 4,358 sq. miles was inundated to a greater or lesser depth. Nearly 54 lakhs people were affected and about 4 lakhs had to be rescued and given shelter. More than 100 human lives were lost. Large number of private and public buildings were destroyed and crops over nearly 1.5 million acres were totally lost. The total loss was estimated by officials of the Agriculture Department at about Rs. 39 crore. About Rs. 3 crore were spent in loans and grants for the relief of the affected populace. Thus the aggregate amount lost was nearly Rs. 42 crore. This figure does not take into account the distress of the people who were marooned and rescued, the lives that were lost and the cattle destroyed which would be impossible to evaluate in terms of money. A Welfare State cannot view such a disaster with equanimity.

16.2. One of the main causes of the flood has been the incapacity of the channels to drain away timely the heavy precipitation of rainfall and run-off from the upper areas. These channels have suffered from neglect over a very long period in the past and their condition tends to worsen every year, with the result that with every comparable future flood the disaster is greater.

16.3. As has been pointed out in the previous chapter it is very difficult with the data available and progress which the science of Meteorology has made, so far to predict occurrence of such floods. In the past, high flood years have been experienced at intervals even as short as 2 years and as long as 16 years. Fortunately none has occurred since 1959 but this can be no reason for complacency. Measures to combat the evil effects must be undertaken with the least possible delay so that even if a flood comes during the next season or so there would be some work done which would relieve the distress to some extent.

16.4. The total outlay recommended for securing a reasonable protection from floods of the nature of 1959 will amount to nearly Rs. 122 crore. Of this Rs. 8.96 crore have to be spent on soil conservation works and Rs. 22.20 crore for the city of Calcutta. There are other schemes such as the improvement of Tolly's Nullah which will more than pay for themselves. The rest of the schemes will fetch indirect dividends in the shape of increased agricultural yields, better sanitation and drainage, greater safety from flood damages and a general sense of security.

16.5. The Committee's findings on terms of its reference (a), (b) and (c) have already been summarised in para. 6.1 of the Preliminary Report. Those regarding (d) and (e) are dealt with here.

16.6. (d) Remedial measures for the purpose of preventing recurrence of such floods in future :

16.6.1. The various schemes drawn up for the purpose in outline region-wise and recommended to be executed have been listed in Chapter 15 under Category I and those for which important data were not available certain investigations and surveys have been recommended and the likely schemes emerging therefrom are listed Category II. Besides these specific works certain general precautionary procedures and measures have also been recommended which are summarised below :

1. For design of drainage channels in the deltaic rural areas of West Bengal a run-off of  $\frac{3}{4}$ " in 24 hours should be generally adopted. There may,



however, be special cases where the rainfall may be abnormally high, in which case the drainage index may have to be increased after special study. (Para. 2.2.2.)

2. For areas below 200 sq. miles run-off curves derived from Dicken's formula suitably modified on the lines indicated in para. 2.2.6. of this Report may be adopted. These curves are not the final answer, but are good modifications of the Dicken's curves for assessment of run-off in respect of smaller areas. Figures obtained from such curves should, however, whenever possible, be checked with actual observations and suitable changes introduced. (Para. 2.2.6.)

3. For design of structures the calculated run-off may be increased generally by 25 per cent. for deltaic areas. For other areas, run-off as obtained from the curves may be increased by 20 per cent. to 10 per cent. (Para 2.2.7.)

4. For semi-urban areas a minimum run-off of  $1\frac{1}{3}$ " in 24 hours is recommended. (Para. 2.2.8.)

5. Run-off varying from 3" to  $4\frac{1}{3}$ " in 24 hours for areas which include suburban and riverain municipalities and towns other than the Metropolis may be adopted. (Para. 2.2.9.)

6. For the Calcutta city run-off 6" 24 hours for the South and North Calcutta areas 4" in 24 hours for Maniktola-Cossipore and Tangra areas may be adopted. (Para. 2.2.9.)

7. Laws controlling construction of embankments along and across the channels should be re-examined and altered, if necessary, to ensure their proper observance. This action brooks no delay and should be taken as early as possible. (Para. 3.2.)

8. Maintenance and upkeep of drainage channels and sluices in embankment should be the responsibility of the Irrigation and Waterways Directorate instead of various Departments as at present. (Para. 3.2.)

9. As a matter of principle, marginal embankments along rivers and channels in lower Bengal are harmful to the regime of river and should be discouraged. They should only be retained where indispensably required. The question of deciding the issue of retention of otherwise of some of the ex-aminadry embankments along the channels should be taken up by the Irrigation and Waterways Directorate. (Para. 3.3.)

10. All embankments which are retained should be of standard and adequate section. (Para. 5.2.2. of Preliminary Report.)

11. Where irrigation facilities have been extended within flooded areas, they should be protected from flooding by either strengthening and / or retiring the embankment or putting up new embankments as the situation demands. (Para. 9.5.)

12. Necessary administrative steps should be taken for stopping the practice of putting up obstructions in the beds of rivers and channels for 'boro' irrigation and fisheries. Whatever possible, alternative irrigation arrangements should be provided, to stop unauthorised or ill-advised obstructions. (Para. 11.6.1)

13. Necessary legislation should be enacted as early as possible for having powers required for enforcing soil conservation measures on waste and agricultural lands under private ownership. (Para. 3.6.)

14. A separate Soil Conservation Organisation should be established immediately under the proposed State Soil Conservation Board which should comprise of officers of the three departments concerned, namely, Forests, Irrigation and Waterways and Agriculture. Execution of all Soil Conservation works in the State should be entrusted to his organisation to ensure unified and co-ordinated efforts. (Para. 3.8.)

15. The Government of Bihar should be moved for undertaking comprehensive schemes of Soil Conservation and Afforestation in the catchments of the Mayurakshi, the Ajoy and the Damodar within Bihar on an extensive scale. (Paras. 7.4.2, 9.4.2.3, and 11.7.)

16. For providing temporary shelter during floods, new community buildings within flood-affected villages should in future be constructed with plinths well above high flood levels. (Para. 3.16.)

17. With a view to effecting improvement of some of the dead and moribund rivers in the area within Murshidabad and Nadia districts, flood flushing of such rivers from the Bhagirathi including resectioning of the existing channels and excavating new cuts as necessary should be taken up after necessary detailed investigations. (Para. 4.4.3)

18. Effective steps should be taken by Government to stop encroachments in the form of cultivation and reclamation of the foreshore and berm lands in the river section which have taken place and continue to do so. (Para. 5.5.3.)

19. In order to improve the regime of the Hooghly and its capacity as drainage carrier, material obtained from dredging of shoals and bars should as far as possible be deposited outside the river section. (Para. 5.5.2.)

20. On either bank of the river and for certain distance above and below Calcutta, encroachments in the shape of protruding jetties, construction of other structures and disposal of industrial wastes are taking place. Government should take necessary steps for totally stopping these. (Para. 5.5.4.)

21. Disposal of solid industrial wastes into the river Hooghly should not be allowed while liquid waste should be properly and fully treated before the effluent is allowed to be discharged into the river. (Para. 5.5.4.)

22. Raising of prematurely reclaimed low areas in Sundarbans by opening them to free play of tides is recommended. Work should be taken up in small areas to study the possibilities of this method vis-a-vis the scheme for closure of estuaries already under investigation. Study should include examination of the possibilities of rehabilitating people of such areas keeping in view that it would be unwise to reduce the present spill or reclaim existing forest land subject to spill for the purposes. (Para. 5.19.)

23. No further encroachment or obstruction should take place and no new embankments should be permitted to be constructed in the Hijol beel area. (Para. 7.4.4.13.)

24. Investigation should be taken up how best the drainage difficulty of the Behula and the Gangur Basin can be solved as some parts of these two rivers have been converted into irrigation channels and alternative drainage facilities have therefore to be provided. (Para. 8.7.1.)

25. In connection with operations and flood routing in D.V.C. reservoirs:

(a) a flood forecasting unit should be set up.

(b) feasibility of reducing the ranges of rainfall in the weather forecast made by the India Meteorological Department, should be examined:

- (c) a wireless link should be set up for connecting the Meteorological Offices in Calcutta with Maithon and other key points in the upper and lower valleys for quick transmission of messages relating to weather forecast and river condition. (Para. 11.5.1 read with Para. 5.19.5 of Preliminary Report.)

26. Flood reserve of 1.321 million acre-ft. at Maithon and Panchet should remain inviolate from 15th June to 15th October and for this purpose necessary acquisition of land should be made up to R.L. 500 (G.T.S.) in the case of Maithon and R.L. 445 (G.T.S.) in the case of Panchet Hill Reservoirs. (Para. 11.5.2.)

27. Due to decrease in flood spill and frequency of high floods in the Trans-Damodar area the Mundeswari and other channels will tend to shrink. Hence flushing doses of adequate volume and duration under favourable conditions may be helpful for their maintenance. The channels in the Trans-Damodar area should be kept under careful watch by taking cross-section and collecting silt and discharge data regularly at suitable points. (Paras. 11.6.3 and 11.6.4.)

28. In the undulating areas of Purulia, Bankura, Birbhum and Midnapore districts breaching of 'ailes' in the fields and tank 'bunds' on small streams during heavy precipitation create additional problems lower down. In order to prevent such happenings local officers should be instructed to give technical advice to the farmers for construction of safer 'ailes' and provision of suitable escapes in such tanks. (Para. 14.6.1.)

#### 16.7. (e) Priorities of schemes :

16.7.1. In the Preliminary Report certain general principles for fixing the priorities were indicated. Since submission of that report problems and requirements of different areas have been examined in detail and a number of schemes have been prepared. These have been grouped under three priorities considering various relevant factors. The intention, however, is not to break the continuity in the execution of schemes as planned but to provide for the more important ones which are ready being taken up earlier and allowing time for collecting necessary data for preparation of others so that their execution and that of others can follow. The whole plan should be considered an integrated one as otherwise the overall benefits indicated may not accrue. The specific priorities for all the schemes are listed in Para. 15.5.5 of Chapter 15. (Paras. 15.5.3. and 15.5.4.)

16.7.2. The programme for execution of the schemes has been planned mainly on the basis of availability of resources. Gamble on a very long period cannot be taken, the execution of schemes should not be spread over more than fifteen years at the most. Even this period involves a great risk as a single disastrous flood may result in enormous loss. The expenditure for schemes should be of the order of Rs. 10, Rs. 39, Rs. 44 and Rs. 29 crores in the third, fourth, fifth and sixth plan periods respectively. (Para. 15.6.4.)

16.7.3. Provision of about 1.53 crores in the present plan programme is inadequate and should be increased either by reallocating funds from other sectors of the State Plan or going up to Central Government for necessary assistance. But there should be no hesitation in making an all-out effort for securing necessary finance to implement the recommendation in this regard. (Para. 15.6.5.)

**16.8. Acknowledgment :**

The Committee have had unstinted assistance from the officers and staff of the Irrigation and Waterways Directorate, especially the Flood Control Circle as well as the Directorate of Forests of the Government of West Bengal. Officers of the India Meteorological Department, the Damodar Valley Corporation and the Corporation of Calcutta have likewise extended help and co-operation whenever they were needed. To them all, the Committee express their appreciation and grateful thanks.

**P. R. AHUJA,**  
Chief Engineer (Floods), F. I.,  
Central Water and Power Commission  
**N. S. TYABJI,**  
Chief Engineer, Eastern Railway.

**MAN SINGH,**  
Chairman, West Bengal Flood  
Enquiry Committee, 1959.  
**S. S. MUKHERJEE,**  
Chief Engineer,  
South Eastern Railway.

**B. PARTHASARATHY,**  
Chief Engineer (Civil),  
Damodar Valley Corporation.

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Subject to reservation made in enclosed note—

**D. MOOKERJEA,**  
Chief Engineer,  
Kosi Project, Bihar.

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Subject to the note of dissent in the enclosed note—

**A. P. PRASAD,**  
Chief Engineer,  
Irrigation (South), Bihar.  
**S. MITRA,**  
Chief Engineer,  
Corporation of Calcutta.

**A. P. PRASAD,**  
Chief Engineer,  
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**S. N. SEN,**  
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ment of West Bengal.

**R. D. SINGH,**  
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River Research Institute,  
West Bengal.

**D. G. MUKERJEE,**  
Member-Secretary,

West Bengal Flood Enquiry Committee, 1959 and  
Chief Engineer, Floods and Flood Control.

## Notes of Dissent

**Note of dissent submitted by Shri D. Mookerjea, Chief Engineer, Kosi Project, Bihar :**

I sign the report subject to the reservation that I do not subscribe to the views expressed in para. 9.4.3. in Chapter 9, para. 11.5. in Chapter 11 and sub-para 26 of para. 16.6. 1 in Chapter 16.

**D. MOOKERJEA,**  
Chief Engineer, Kosi Project,  
Government of Bihar.

The 24th May 1962.

**Notes of dissent submitted by Shri A. P. Prasad, Chief Engineer (North and South), Irrigation, Bihar :**

On taking over charges of the Chief Engineer, Irrigation, Bihar, in March 1962, I got associated with the works of the West Bengal Flood Enquiry Committee. Before that all the local inspections of the flooded area and the problems connected therewith were held. There was no opportunity for me to attend the local inspections. I am, therefore, unable to associate myself with the recommendations made by the Committee based on the information obtained during the course of local inspections,

I would, however, invite attention to the recommendation of the West Bengal Flood Enquiry Committee, 1959, in Chapter 9 about long-term measures for flood control from the Ajoy. While I agree that afforestation and soil conservation measures in the catchment of Ajoy river are necessary for flood moderation and prevention of soil erosion, I do not agree that investigation for storage and detention reservoirs in the upper catchment is essential. The nature and the extent of flooding in the lower reaches of Ajoy as described in Chapter 9 is such as can be reasonably controlled by the construction of marginal embankments along river Ajoy as has been done in case of several rivers in North Bihar. Some of these embankments have been in existence for over two centuries and are providing protection to the areas which used to get flooded before. No serious harmful effect has been noticed by the construction of these embankments.

In the upper catchment lying in the State of Bihar some storage dams and a diversion barrage at Siktia have been planned for execution. These storage dams together with soil conservation measures will go a long way in arresting harmful silt in river Ajoy the useful effect of which will be felt in due course in the lower reaches of the Ajoy. I do not consider it necessary to undertake investigation of any other flood storage reservoir in the upper catchment of river Ajoy lying in Bihar. I, therefore, do not agree to the recommendation of the West Bengal Flood Enquiry Committee in this respect.

Regarding Chapter 11 in the Final Report it has been recommended that the entire flood reserve of 13.21 lakhs acre-ft. in Maithon and Panchet at reservoir levels of R.L. 500 and R.L. 445 respectively as envisaged while framing the project must be made available and kept inviolate for accommodation of flood.

In this connection I have to state that how the required flood reserve should be provided may be left to the Governments concerned to decide according to the priority they attach to the different purposes for which D.V.C. dams have been built. Raising the reservoir levels of Maithon and Panchet reservoirs at

this stage will create serious problem in land acquisition. It was for very compelling reasons that land and houses were acquired up to R.L. 495 in case of Maithon and in case of Panchet land and houses were acquired up to R.L. 425 and only houses were acquired up to R.L. 435. The human problem involved in the matter was so great and compelling that further acquisition of land could not be done. Since after the construction of the dams people once uprooted have anyhow settled down and more industrial interests have been built up round the periphery of the reservoirs. It will be extremely hard if the people are made to leave their hearth and home once again by acquisition of further land in the periphery of the two reservoirs. The problem of rehabilitation of displaced persons and industries will prove quite hard for solution. I do not therefore, agree to the recommendation of the further acquisition of land in the periphery of the Maithon and Panchet reservoirs. The matter may, however, be left to the discretion of the participating Governments as to what course they will adopt for providing extra flood reserve than what is available at present.

A. P. PRASAD,  
Chief Engineer (North and South Irrigation,  
Bihar.

The 24th May 1962.

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