FOREWORD

One of the important functions assigned to Ganga Flood Control Commission is to advise the Ganga river basin States to follow certain guidelines in respect of quality control, material specifications and maintenance in order to ensure the implementation of works and maintenance thereof, to proper standards. The Commission has prepared a number of guidelines from time to time on various flood related subjects in consultation with the States and numerous organizations. These guidelines were also approved in full Commission meetings in which representatives of Ganga river basin States and other organizations are part time members. These guidelines were circulated to all concerned.

During the official level meeting of 13th meeting of Ganga Flood Control Board, held under the Chairmanship of Secretary (WR), Govt. of India on 23.12.92, it was decided to bring out compendium of the guidelines in book form for reference by the users. Accordingly a volume containing eleven guidelines was prepared by Ganga Flood Control Commission and circulated to Co-basin States and concerned Organizations in 1995.

In view of the revisions in the codes (brought out by Bureau of Indian Standards) changes in the practices and in the State- of- the art in regard to flood control/flood management works, updating of the guidelines is a continuous process. The guidelines have been updated by incorporating the revisions in the relevant Bureau of Indian Standards codes and the –State -of – art practices presently prevailing. For the benefit of users a list of important references has been added at the end. The officers and staff associated with the updating of the "Compendium of Guidelines" deserve appreciation for their sincere efforts and hard work.

It is hoped that the "Compendium of Guidelines" would be useful in the formulation and execution of flood management schemes towards ensuring quality control and material specifications to proper standards.

PATNA
JANUARY, 2004

(C.B.VASHISHTA)
CHAIRMAN

PREFACE

Ganga Flood Control Commission is advising the concerned States to follow certain guidelines in respect of quality control, materials specifications and maintenance in order to ensure the implementation of works and maintenance thereof to proper standards. Accordingly the Commission has prepared a number of guidelines from time to time on various flood related subjects in consultation with concerned States and organizations. These guidelines were also approved in full Commission meetings. In which representatives of Ganga basin States and other organizations are part time members. These guidelines have already been circulated to all concerned.

As decided during the official level meeting 13th meeting of Ganga Flood Control Board, held under the Chairmanship of Secretary(WR) , Govt. of India on 23.12.92, accordingly a compendium containing eleven guidelines was prepared by Ganga Flood Control Commission and circulated to Co-basin States and concerned organizations in 1995.

Updating of the guidelines is an ongoing process, keeping in view the state-of – the art, revisions in the codes (brought out by Bureau of Indian Standards) and changes in the practices in regard to flood management works. The updating of guidelines was also discussed during 14th meeting of Ganga Flood Control Board held on 16th June 2000 at New Delhi. The guidelines have been updated by incorporating the revisions in the relevant Bureau of Indian Standards codes and the state-of-art. A list of important references has added at the end.

Sincere efforts and hard works put in by the officers and staff in updating of the "Compendium of Guidelines" is appreciated and acknowledge.

Any suggestions/comments for further improvement of the "Compendium of the Guidelines" would be highly appreciated.

PATNA
JANUARY, 2004

(R.N.P.SINGH)
MEMBER (PLANNIG)

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CHAPTER-I

DESIGN CRITERIA FOR FLOOD PROTECTION EMBANKMENTS

CHAPTER-I

DESIGN CRITERIA FOR FLOOD PROTECTION EMBANKMENTS

In order to ensure uniformity in preparation and processing of schemes for flood protection embankments, the following design criteria is being laid down. The design criteria have been updated based on the Indian Standard Guidelines for planning and Design of river embankment (Levees)- (First Revised 120:2000). These criteria do not apply to embankments on tidal rivers.

(1) Spacing of Embankment

" The spacing of embankments and their alignment need careful consideration with respect to their vulnerability to the river and the rise of high flood levels on account of reduction in flow area and also increase in peak discharge due to reduction in flood plain storage by construction of the embankment. Finalisation of the alignment and the spacing with due consideration to the above factors and at the same time optimizing the benefit from the proposed embankment would need considerable experience of the river behavior and studies of the effects of the embankments along different alignments. In view of the widely varying nature of the rivers, no general recommendation about spacing of embankment can substitute the need for the above studies. The following general guide lines about the minimum spacing etc. are however given, mainly with an idea to check the tendency of excessive encroachment of the natural flood plain of the river."

In case of embankments on both banks of the river, the spacing between the embankments should not be less than 3 times Lacey wetted perimeter for the design flood discharge. In case of embankment on only one bank the embankment should not be less than a distance equal to 1.5 times Lacey's wetted perimeter from the midstream of the river.

(2) Design High Flood Level

Subject to availability of observed hydrological data, the design H.F.L may be fixed on the basis of flood frequency analysis. Embankment schemes should be prepared for a flood of 25 years frequency in case of predominantly agricultural area and if the embankments concerned are to protect townships, industrial areas or other places of strategic and vital importance, the design H.F.L. shall generally correspond to 100 year return period.

In the case of embankments on both sides of the river, the design H.F.L. shall be determined keeping in view the anticipated rise in the H.F.L. on account of jacketing of the river.

N.B:- Design criteria circulated by GFCC/2/73/191-208 DATED 15.4.80 modified on the line of R.B.A. recommendations in respect of paras on Design High Flood Level and Treatment on top of embankments.

(3) **Free –Board**

As a guideline, minimum free board of 1.5 m over design HFL including the backwater effect, if any should be provided for the rivers carrying design discharge upto 3000 cumecs., for higher discharge or for aggrading flashy rivers a minimum free board of 1.8 meters over the design H.F.L. shall be provided. This should be checked also for ensuring a minimum of about 1.0 meter free board over the design H.F.L corresponding to 100 year return period.

(4) **Top Width**

Generally the top width of the embankment should be of 5.0 m. The turning platforms 15 to 30 m long and 3 m wide with side slope of 1:3 shall be provided along the countryside of the embankment every kilometer.

(5) Hydraulic Gradient

Hydraulic Gradient line should be determined on the basis of the analysis of the soils, which are to be used in the construction of embankments. However, the following guidelines are recommended.

Type of fill	Hydraulic Gradient
Clayey Soil	1 in 4
Clayey sand	1 in 5
Sandy Soil	1 in 6

(6) Side Slope

(i) River side slope

The river side slope should be flatter than the under water angle of repose of the material used in the fill upto an embankments height of 4.5 meter slope should not be steeper than 1 in 2 and in case of higher embankments slope should not be steeper than 1:3 when the soil is good and to be used in the most favourable condition of saturation and draw down. In case, the higher embankments are protected by rip-rap, the river side slope of earthen embankments upto 6 meters high may be 1 in 2 or 1 in 2.5 depending upon the type of slope protection.

In embankments constructed of sandy materials, the riverside slope should be protected with cover of 0.6 m thick good soil.

It is usually preferable to have more or less free draining material on riverside to take care of sudden draw down. In case of high and important embankment stone rip-rap either dry dumped or hand placed and concrete pavements/concrete blocks with open joints are adopted to protect the

embankments against draw down and/or erosive action of the river; in less important embankments where rip-rap is costly willow mattress can be used.

(ii) Country side slope

A minimum cover of 0.6 m over the hydraulic gradient line should be provided. For embankment upto 4.5 m height, the country side slope should be 1 in 2 from the top of embankment upto the point where the cover over hydraulic gradient line is 0.6 m after which a berm of suitable width with the country side slope of 1:2 from the end of the berm upto the ground level should be provided. For the embankments above 4.5 m and below 6 m heights, the corresponding slope should be 1:3. Normally berms should be of 1.5 m width. For embankments above 6 m height detailed design may be furnished in the project estimate.

(iii) Slope Protection Works

Generally the side slopes and 0.6 m wide in top from the edges of the embankments should be turfed with grass sods. In embankments which are in imminent danger of erosion, necessity of protective measures such as slope protection by rip-rap and / or river training works should be examined separately following I.S. Code no.14262-1995.

(iv) Treatment on Top of Embankment

An embankment should be provided with suitable soling over filter for proper drainage. For embankments protecting towns industrial area and places of strategic importance the necessity of providing all weather road surfaces of 3 to 3.5 m width should be examined to ensure maintenance works for reaches which are not easily accessible.

In order to provide communication from one side of embankment to other, ramps at suitable places should be provided as per requirement to obviate subsequent interference.

(v) Land Acquisition

To ensure uniformity in respect of land acquisition for flood embankments, it is suggested that the provision for land acquisition should include at least 1.5 meters additional width beyond the toe of the embankments on the river side and width of 3 meters beyond the toe of embankment on the country side.

(7) Borrow Areas

Generally the borrow area will be on the river side of the embankments. However, in unavoidable circumstances, when the earth is to be borrowed from the country side the borrow pits shall not be closer than 10 m from the country side toe of the embankments. In certain cases when the depth of the

borrow pit is limited to 0.3 meters the borrow pit may be closer to the embankment but in no case the distance between the toe of the embankment and the edge of the borrow pit shall be less than 5 meters. In order to obviate development of flow parallel to the embankment, 5 to 6 metre wide cross bars spaced at 50 to 60 meters center to center shall be left in the borrow pits.

Salient features of BIS codes relevant to Planning, Design and construction of Flood Management and Anti-Erosion Works

1. **Planning & Design of River Embankment (IS 12094-2000**)

This standard covers planning and design of river embankments (levees) on dry land.
The salient features/main design aspects covered in this code are described in the following paragraphs:-

(i) Spacing of embankment

3 times of Lacey wetted perimeters of embankment on both bank of river

(ii) Design High Flood Level

Protection of agriculture land-25 year flood frequency
Protection of township, Industrial area-100 year flood frequency

(iii) Free Board

1.5 meters over design HFL (for Q<3000 cumecs)
1.8 m over design HFL (for Q≥ 3000 cumecs)

(iv) Top width - 5.0 meter

(v) Hydraulic gradient

Clayey soil – 1 in 4
Clayey sand- 1 in 5
Sandy soil – 1 in 6

River side slope: 1:2 to 1:3
Country side slope: 1:2 to 1:3 and
0.6 m cover over H.G.L.

2. Planning & Design of Revetment (IS 14262:1995)

This standard lays down the guidelines for planning and design of revetment used for embankment and bank protection works in case of alluvial rivers and canals.

The salient features/main design aspects covered in the code are described in the following paragraphs:-

Data required

(i) Design discharge corresponding to 50/100 year floods.

(ii) Design velocity at Bank
(iii) Silt factor (f)
(iv) L.W.L.
(v) HFL- 25/100 years return period.
(vi) Design discharge intensity
(vii) Bank slope
(viii) Size of stone for pitching
(ix) Wt. Of stone/boulder in Kg.

$W = (0.02323 \times Ss \times V^6) / [(K \times (Ss-1)^3]$

Where $K = [1-(\text{Sin}^2 \theta / \text{Sin}^2 \phi)]^{1/2}$
Ss = Specific gravity of stone
ϕ = Angle of repose of material of protection works
θ = Angle of sloping bank
V = Velocity at bank
Thickness of protection layer

$T = V^2 / [2g \times (Ss-1)]$

Where V= Velocity in m/sec.
g = acceleration due to gravity in m/s
Ss= Specific gravity of stone

3. Planning and Design of Groynes/Spur (IS 8408-1994)

This standard covers the planning and design of Groynes (Spurs) in alluvial rivers.

The salient features/main design aspects covered in the code are described in the following paragraphs:-

(i) **Design discharge**: should be equal to that for which any structure in close proximity is designed or 50 year flood whichever is higher.

(ii) **Length of spur**:- Normally effective length should not exceed $1/5^{th}$ of width of flow. Spacing of spur is normally 2 to 2.5 time of effective length.

(iii) **Top level**:- Depends on the type namely submerged, partially submerged or non-submerged and will be best decided by model experiment.

(iv) **Top width**: 3 to 6 meters as per requirements

(v) **Free board** :- 1 to 1.5 meter above design flood level

(vi) **Side slope**: Between 2:1 and 3:1

(vii) **Size of stone for pitching**:-

Wt of Stone/Boulder in Kg. = W
$W = (0.02323 \times Ss \times V^6) / [(K \times (Ss-1)^3]$

Where $K = [1-(\sin^2 \theta / \sin^2 \phi)]^{1/2}$
Ss = Specific gravity of stone
ϕ = Angle of repose of material of protection works
θ = Angle of sloping bank
V = Velocity at bank
Thickness of protection layer

(viii) **Thickness of pitching**

$T = V^2 / [2g \times (Ss-1)]$

Where V= Velocity in m/sec.
g = acceleration due to gravity in m/s
Ss= Specific gravity of stone

(ix) Launching apron

(a) Size of stone (same as adopted in pitching)
(b) Scour depth
$D= 0.473 (Q/f)^{1/3}$
Where Q= discharge in m^3 /s
F= silt factor= $1.76\sqrt{d}$
d=mean dia of river bed material in mm.

(x) **Width of Launching apron** = 1.5 D max
D max :Depths of maximum scour below designed apron level.

4. Planning Design of Guide Bank (IS: 10751-1994)

This standard covers the planning and design of guide bank, used for the various engineering structures constructed on alluvial rivers.

The salient features/main design aspects cover in the code are described in the following paragraphs.

(i) **Alignment**-Best decided by model studies.

(ii) **Length of guide Banks**

Upstream = 1.0 L to 1.5 L
Downstream= 0.2 L to 0.4 L
Where L= Length of structure between abutments

(iii) **Radius of curve**

Head – 0.45 L
Tail –0.0 to 0.5 time the radius of covered head.

(iv) **Top Width**: 6 to 9 m

(v) **Free board** : 1 to 2 m

(vi) **Side slope** : 2:1 to 3:1

(vii) **Toe protection**

(viii) **Size of stone**

$W = (0.02323 \times Ss \times V^6) / [(K \times (Ss-1)^3]$

Where $K = [1- (\sin^2 \theta / \sin^2 \phi)]^{1/2}$

Ss = Specific gravity of stone
ϕ = Angle of repose of material of protection works
θ = Angle of sloping bank
V = Velocity at bank
Thickness of protection layer

(ix) **Thickness of Launching apron**

$T = V^2 / [2g \times (Ss-1)]$

Where V= Velocity in m/sec.
g = acceleration due to gravity in m/s
Ss= Specific gravity of stone

5. **Planning and Design of Surface Drain (IS 8835-1978)**

This standard lays down broad guidelines and principles for the planning and design of surface drains for uniform application throughout the country. This standard is applicable only for surface drains in agricultural/rural area.

The salient features/main design aspects covered in the code are described in the following paragraphs.

Alignment of drains: The alignment of drain should be such that the full supply level is below the natural surface level.
Intensity of rainfall- A storm rainfall of 3 days duration
Design frequency: Three days rainfall of 5 year frequency.

Period of disposal: The following periods of disposal are recommended.
Paddy – 7 to 10 days
Maize, Bajra and other similar crops- 3 days

Sugarcane and Banana- 7 days
Cotton- 3 days
Vegetables- 1 day

Run-off: Run-off co-efficient depends on the type of soil, vegetation, general topography like land slope etc. In plain areas the run-off co-efficient is generally of the order of 0.15 to 0.20

6. **Guidelines for Construction of River Embankments (Levees) (IS 11532-1985)**

This standard covers the construction of river embankments (levees) on dry land.

The salient features, which are covered in the code, are described in the following paragraphs.
Investigation of borrow areas, their location and depth of excavation, foundation preparation, earthwork, compaction, moisture control and slope protection are the important aspects to be carefully attended during construction.

The recommended distance and the depth of borrow pits are as under: -

Distance of Borrow pits (m)	Maximum depth of Borrow pit (m)	
	River side	Countryside
25 upto 50	1.0	0.6
Over 50 upto 75	1.5	0.6
Over 75 upto 100	2.0	0.6

7. **Construction and Maintenance of Guide Banks (IS 12926:1995)**

This standard lays down guidelines for construction and maintenance of guide banks in alluvial rivers. The main aspects to be considered for construction/ maintenance of guide banks are described in the following paragraph:

(i) **General Considerations**:-The lay out of guide bank should be based on hydraulic consideration to streamline the river flow. The height of the bank should be determined from the highest flood level and free board requirement. The slope of the bank should be designed considering the engineering properties of construction materials and using conventional slip analysis.

(ii) **Earthwork for guide bank**: It is preferable to take earth for construction of guide bank from the river side. Borrow pits should be at a safe distance of about 3 H from the toe of launching apron, where H is the height of guide bank.

Construction of guide bank should be taken in hand alongwith abutments. Afflux bund should be tied to high ground to prevent outflanking of structure.

(iii) **Maintenance**:-Post monsoon and past flood inspection should be carried out regularly to ascertain the health of structure and repaired works. Regular patrolling of guide bank should be done during floods to monitor the behaviour of structure and to take protection measures.

Annual inspection of under water protection work should be carried out after the flood season to asses scour and launching of the apron in the vicinity of the structure.

CHAPTER-II

CHECK LIST FOR EXAMINATION OF FLOOD CONTROL PROJECTS

CHAPTER-II

CHECK LIST FOR EXAMINATION OF FLOOD CONTROL PROJECTS IN GFCC

Preliminary Examination

1. Have the requisite number of copies been received?
2. Have the recommendations of Flood Control Board and its TAC been enclosed.
3. Is the nature of flood management of the scheme clear?
   (Control/protection works: measures for abatement of floods: modifying the susceptibility to flood damage; mollifying the loss burden):
4. Is category of the project indicated? (Flood control/ power/ Irrigation/ multipurpose).
5. Are the following reports contained?
   - (a) General report of the Chief Engineer.
   - (b) Report of the Superintending Engineer.
   - (c) Detailed report of the Executive Engineer.
6. Is an index map enclosed?
7. Is the present status of the scheme given?
8. Is it an inter- State scheme? If so, has the interstate aspect been discussed in the project?
9. Are the B.C Ratio calculations enclosed?.
10. Is the basis of benefits enclosed?
11. Is General Abstract of Cost enclosed?
12. Is there a mention regarding basis of rates adopted?
13. Have the details of quantities been enclosed?
14. Are the drawings to support the quantities included?
15. Is there a map showing area affected and the proposals of the Project?
16. Are calculations for design flood enclosed?
17. Are flood routing calculations/backwater level calculations attached?
18. Is a longitudinal section enclosed?
19. Are detailed cross sections enclosed?
20. Has a contour map of the area been enclosed?
21. Has a plan showing bank lines in various years been enclosed?
22. Has the period of completion been mentioned?
23. Has a programme of execution been enclosed?
24. Are the drawings signed by the Executive Engineer?
25. Have certificate of checking arithmetical calculations been recorded?

DETAILED EXAMINATION

1. Has the scheme been prepared in accordance with the recommendations of the State TAC and approval of the State Flood Control Board ?
2. Does the report of the Chief Engineer contain the following aspects?
   - a. Broad description of the problem
   - b. General discussion of viable alternatives.
   - c. Inspection details of the area to be benefited and the project site.

d. Regarding the preparation of the Master Plan for overall development of the river basin and the stages of basin and the stages of basin development and mention about the scheme fitting into the Master Plan for Flood Control and its priority.

e. Recommendations.

2. Does the report of the Superintending Engineer contain the following Aspects?

(a) A description of the present problem with mention about the period since it has existed and the past approach towards its alleviation.
(b) Justification of adopting the proposal out of the viable alternatives.
(c) Inspection details of the area to be benefited and of the alignment/site of the proposed scheme.
(d) The rates adopted in the estimate of cost of the scheme and the leads indicated for construction material.
(e) The rates adopted in working out benefits from the scheme.
(f) Is the scheme proposed to be executed in stages? If so, have the various stages been discussed? The programme of construction and period of completion of the scheme.
(g) The staff required for execution of the scheme.
(h) How does this scheme fit with the Master Plan for flood control if such a Plan exists? Else can this scheme become a part of the Master Plan later on? Are there any features, which are not likely to fit in the overall development of the basin? Have the other Departments concerned with the development been informed?
(i) Recommendation.

3. Does the report of the Executive Engineer contain the following aspects?

(a) Detailed description of the problem as at present.
(b) History of the problem with details of past works executed or approach taken. In case of chronic problem, reasons of the problem remaining unattended and in case of recent problem, the cause of the problem.
(c) Inspection details regarding the area to be benefited and of alignment/site of the proposed scheme and schemes in the vicinity.
(d) Availability of suitable construction materials in adequate quantities and their leads.
(e) Discussion on the provisions under various subheads.
(f) Basis of rates adopted for estimate of cost of work and benefits.
(g) Description of design features.
(h) Surveys conducted in formulation of the scheme.
(i) Construction programme and completion period.
(j) Recommendations.

4. Have the various flood control components of the multipurpose project been indicated

5. Examine the general Index map of the State. Is the scheme properly located?

6. Does the basin plan indicate river system with gauge/discharge sites, rain gauges and catchment area with contours.
7. Have the damage areas been identified and flood intensities worked out at each of the damage center(s), which get affected?
8. Examine whether the given hydrological meteorological and other data is adequate?
9. Have the following aspects been discussed?
   (a) Flood cushion in the reservoir.
   (b) Maximum moderated flood flows over the spillway etc. and its frequency.
   (c) Safe carrying capacities of the channel below the dam, existing and after construction of flood embankment, channel improvement , river diversion etc.
   (d) Synchronized moderated peak flows due to release(s) from the dam upstream and un-intercepted catchment upto the damage centers.
   (e) Average annual expenditure incurred on flood relief works.
   (f) Area and population affected/likely to be affected before/after the project.
   (g) Estimated saving to annual loss of life, cattle, crops etc (evaluated in terms of money) due to flood control.
10. Have the following aspects of drainage been discussed?
   (a) Surface and subsurface drainage problems of the command area with details of studies on subsoil water table.
   (b) Maximum intensity of 1, 2, & 3 day rainfall
   (c) Deficiencies in farm drains
   (d) Deficiencies in existing natural drains
   (e) Proposals for improvement of drainage/water logging of the area with criteria.
   (f) Identification of the area in Command which will get benefited due to execution of drainage net work and benefits thereof in terms of relief from crop damage, increased yields etc.

11. Examine whether the proposal has got any inter-state/international implication. If so, has the concurrence of the concerned parties been enclosed?
12. Examine the alternative proposals, if any and find out the alternative adopted is the best solution as per economic and technical aspects.
13. Is the B.C ratio worked out on prescribed standard and annual loss supported by documents from the Revenue Department of the State? Is the average annual damage computed on the basis of at least last 10 years data? B.C Ratio calculation for flood control component of the project is suggested as under:
   (i) Average Annual damage computed (on the basis of at least last 10 years data)
   (ii) Average Annual damage anticipated after the execution of the project.
   (iii) Saving in Annual Damage (Item- i, Item –ii)
   (iv) Annual cost of flood control component.
      (a) 12% of allocated cost of dam
      (b) 16% of allocated cost of embankment
      (c) Total annual cost (a & b)
   (v) B.C. ratio= Item no.(iii)/Item no.(iv)
14. Flood relief provided at the damage center and examine viability of the proposal.

15. Have the various departments of the State agreed to the sharing of the above allocated cost?
16. Is the B.C. Ratio for Flood Control Projects acceptable or otherwise justified?
17. Do you agree with the type of protection work suggested including the flood space provided in the reservoir on the basis of analysis of data? If not what are your findings?
18. Have all the details of the proposed protection works, including reservoir routing studies given? If not what are the shortcomings?
19. Have the relevant standards and specifications been correctly followed, if not what are the shortcomings?
20. Examine the design calculations including routing studies and point out mistakes, if any.
21. Examine the drawings, have all the design aspects been taken into the drawings?
22. If the proposals are for embankment, is the spacing all right? Has adequate provision for drainage for country side been provided?
23. Does the L-section and X-section indicate G.L formation level design HFL, Hydraulic gradient and type of soil and Flood gradient
24. Examine the estimate, point out deficiencies. Check the quantities of various items for their correctness.
25. Is the year of which the rates are adopted in the estimate indicated?
26. Have the analysis of rates for various major items of work for the major components of the project furnished, with basis for analysis?
27. Has the planning of the colony /building been done keeping in view the ultimate use for optimum utilization of the investment?
28. Are the permanent buildings being constructed required for maintenance of the project only?
29. Have the proposals for disposal of temporary building been discussed?
30. Are the major components of work proposed to be done departmentally or through contractor?
31. Have the various alternatives for construction programme studied and proper justification furnished for the final programme adopted ?
32. Examine details of project cost charged to flood control and its correctness.
33. Has the proposed construction programme been prepared and matched for timely completion of each of the major components?
34. Is the scheme included in the Plan? If not what is the present position regarding its inclusion in the Plan?
35. Whether any model studies have been carried out for the structures at crucial points enroute if any and if so, what results/conclusions have been arrived at? If not, are any model studies called for?

CHAPTER-III

BROAD GUIDELINES FOR PREPARATION OF PROJECT ESTIMATES

CHAPTER-III

BROAD GUIDELINES FOR PREPARATION OF PROJECT ESTIMATES

1. Requirement under Different Heads

1.1 **A- Preliminary**: It has been the experience that the overall provision under this sub-head could amount to 1% or more of the total cost of I work. In case of big projects costing more than 30 crores, the outlay could be as much as 5% of the anticipated cost of works.

1.2 **B-land**: This head covers the following items of works

(a) Acquisition of Land: - Certificate for land rates from competent authority should be appended.
(b) Cost of other properties like houses, wells, trees, etc. plinth area rate of building and present actual cost of wells.
(c) Cost of standing crops: Provision should be based on the rate of yield per hectare on 25% to 50% of the agricultural land being required.
(d) Rent for use of land.
(e) Interest charges on the amount of award for the period between taking over possession of the land and the date of award.
(f) Solatium charges for compulsory acquisition : 1% of the land cost
(g) Legal charges.
(h) Relocation of communication like roads, railways etc.
(i) Rehabilitation: Detail should be given in the report.
(j) L.A. Establishment charges: 6.25% of cost of land.

1.3 C-work

(a) Where some schedule of rates is used or adopted reference to the year to which the scheduled rates pertain, should invariably be mentioned.
(b) Lump sum provisions should as far possible be minimized
(c) Provisions for contingencies and W.C establishment may be considered @ 3% and 2% of the works cost. These percentage provisions should not be considered on Lump sum provisions.

1.4 For D- Regulators, E-Falls, F-Cross drainage works, G- Bridges, H– Escapes, Lump sum provisions should be discouraged.

1.5 **K- Buildings**

The usual practices are to make the provision under this head on the basis of plinth area rates for different types of buildings (Rehabilitation, non residential, Permanent and Temporary). It is observed that the total cost of buildings in a project generally amounts to 3% to 5% of the cost of I-Works. Provision exceeding 5% of I- Works cost is considered excessive and open to objection. Provision less than 3% is likely to be adequate only

in case where the project is located near Urban area or some existing projects where other buildings could be obtained for use.
In addition to the cost of buildings, provision for following items is also required under this head:

(a) Land Development (b) Colony roads (c) Fencing (d) Service connection such as water supply, sanitation and electrification.

1.6 L - Earth work

The provision shall be based on detailed surveys. The analysis of rates shall also be furnished indicating lead and lift involved and their detailed calculation

1.7 M- Plantation

In the estimate for head works this is generally made on Lump sum basis and in estimate for canals, this is given as cost per km. The basis for adopting a certain km rate should be indicated.

1.8 **O- Miscellaneous**

The total provision under this head is generally of the order of 4% of I works. It is however not unusual to have provisions working out to more than 4% also.

1.9 P- Maintenance

The usual norms is 1% of the cost of I-works, less A – preliminary, B-land and Q-Special T & P and covers maintenance of all works during construction period.

1.10 O – Special T & P

The provision under this head may be made as under

Capital cost of machinery……P
Depreciation chargeable to works……Q
Residual value of equipment (net amount booked under
Q special T & P)……(P-Q) = Z
Credit due to resale or transfer of equipment……. about 75% of Z
(To be shown under the head receipt R & R on capital a/c).

Note: For any economically planned project, 75% of the life of machinery can be considered to have been used in the work in the project. Out of the residual value about 75% of the cost may be considered as recoverable by resale or transfer of equipment (For inspection vehicle, no amount is taken as chargeable to works and about 20% of capital cost taken as resale

value). The loss to the project is not expected to be more than 10% of the capital cost of the machinery.

1.11 R- Communications

The cost should be based on the basis of actual requirement and may be indicated per metre for bridges and per kilometer for roads and railways. For railways it should be the cost as indicated by the railway authorities.

1.12 Losses in stock

This generally provided at 0.25% of the cost of I works, less A-Preliminary, B- Land and Q – Special T & P.

1.13 II - Establishment

In case of works let out on contract, the provision for establishment including leave and pensionary charges is generally of the order of 8 to 10% for the concentrated works and 10 to 12% for scattered works like canals.

For works to be executed departmentally the provisions could be higher than those given above say upto 15%.

Since the land acquisition staff is separately provided for under B-Land, the percentage provision for II – Establishment has to be considered on the cost of I-works less B-land.

1.14 III- T & P

It is meant to cover survey instruments, camp equipment, office equipment and other small tools. It is generally provided at 1% of the cost of I -Works.

1.15 IV Suspense

The net provision under this minor head will be " Nil" as all the outstanding suspense are expected to be cleared by adjustment to appropriate heads at completion of the project.

1.16 V-Receipts and Recoveries on Capital a/c

(i) 15% of the cost of temporary building: higher rate may be adopted for tubular construction etc.
(ii) Resale value of Spl T & P

1.17 Indirect charges

(i) Audit and Accounts Charges 1.0% of the cost of I – works
(ii) Abatement of land revenue :- 5% of land cost or 20 times the annual revenue lost.

CHAPTER-IV
DEFINITION OF VARIOUS TERMS USED IN FLOOD REPORTS

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DEFINITION OF VARIOUS TERMS USED IN FLOOD REPORTS.

(i) **Low flood**: - Level of the river depicting predominant monsoon flow in the river higher than usual in other seasons of the year and has following limits.

(a) It results in over flowing of bank once in every two years.
(b) It submerges the adjoining fields but generally does not prevent flow of drainage of fields.
(c) It also does not create drainage congestion in the nearby populated areas.
(d) Water Level always remains at least one metre below plinth level of township as fixed by the Civil Authorities for Civil Construction of Industrial Complex and Residential areas.

(ii) **Medium flood**: - Level of the river where crops in the adjoining areas come under submergence and populated areas are encircled with flood waters but the flood waters remain below the following limits.

(a) It results in overflowing of bank with flood frequency of once in 10 years
(b) It submerges agriculture areas and enters in the residential areas blocking drainage systems for not more than 6 hours.
(c) Flood water in the Residential areas and Industrial complexes remain just below the plinth level as fixed by Civil authorities.

(iii) **High flood**: - Any flood level of the river, which is higher than danger level and corresponds to return period of more than 10 years.

(iv) **Danger Level**: A level of the river depicting the stage of the river which if crossed by the flood water will start damaging crops and property and will affect the daily life of population. This level is to be taken as medium flood level or 0.3 m below plinth level which ever is less.

(v) **Warning Level**:- A flood level 0.6 to 1.0 meter below danger level depending upon the lead time available.

(vi) **Highest Flood Level** :- The highest flood level of the river ever recorded at the place.

(vii) **Very high flood**:- Any flood which exceeds 1 in 100 years frequency.

(viii) **Flood Plain**:-Land adjoining the channel which is inundated only during floods.

(**Note**:-All levels should pertain to G.T.S. bench Marks and should be in metric units.)

(ix) **Alluvial river**:- A river which flows through deposits created by itself and is constantly building its flood plain by over flowing. The sediment that it carries is similar to that in its bed and bank.

(x) **Bank**: Elevation of land which confine water of a stream to their natural channel in normal course of flow; banks are called right and left, as viewed facing downstream, along a curve are called concave or convex depending on whether the center of curvature is towards or away from the channel.

(xi) **Braided river**:- A river with an extremely wide and shallow channel, within which the normal river flow passes through a number of smaller interlaced. channel separated by bars of shoals. In such river there is often little tendency for the channel as a whole to meander, though local meandering in the minor channel generally occurs.

(xii) Delta Stage of river: The reach of a river when it approaches the sea with very gentle slope and velocity, drops down the sediment and divides into channel on either side of the deposits resulting in the formation of delta.

(xiii) **Meander**: Deviations in the channel of stream maintaining, however, a general deviation of the channel on the whole.

CHAPTER-V

GUIDELINES FOR PREPARATION OF COMPREHENSIVE PLAN FOR FLOOD MANAGEMENT

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GUIDELINES FOR PREPARATION OF COMPREHENSIVE PLAN FOR FLOOD MANAGEMENT

1.0 INTRODUCTION

The Comprehensive Plan for Flood Management related to fixed base year may be prepared/updated under the following seven broad Chapters and the details of items mentioned therein are as follows:-

1.01 General

General introduction of the river system viz. location-Country, State and Districts covered by the river system, limiting Latitude and Longitude of the catchment , adjacent basins , any special feature of the river system etc. Location to be shown on the map also.

1.02 The River Course

Description of the river course from origin to outfall by dividing it into appropriate segments if needed, viz their location, length, direction of river flow, meandering if any, slope, tributaries joining it, general condition of the river whether section well developed or interlaced or wide or salient features of river line forming boundary between States, District etc., catchment area of the river and its various salient features etc. Similar description of important tributaries. Districtwise breakup of catchment (It is to be indicated on index map of the river system.)

1.03 Topography

Description of the ground level and pattern of ground slope in the catchment narration of the direction of flow/drainage pattern of flood water in tune with the topography (contour map to be attached). Dividing river length/catchment in different zones depending upon the slope of the area, if any.

1.04 Drainage Arteries/Tributaries

Description of the tributaries, dead and redundant river courses, details of the chaurs/detention basins/beel area etc., their length, catchment area, drainage capacity etc. to be described in tabular form.

1.05 Climate/Rainfall/Temperature:

Nature and extent of climate, rainfall and the temperature variation over the catchment in its various portions. List of various observatories in the catchment by different agencies.

1.06 Geology

Description of the geological details of the area in the catchment, type and extent of rock they are made of, orographic units of the area, the volcanic character of the area, location of faults/joints in the catchment, details of past earthquakes etc.(existence of faults/joint is important in making decision for the selection of reservoir sites), Division of area based on lithological sedimentational and tectonic history, Chronological description of geological process shaping the pattern of the river courses etc.

1.07 Hydrology and Ground Water Occurrence

Hydrology of the basin, the status of ground water in the region- ground water potential, the level of exploitation of ground water, number of State tube wells and private tube wells and their state of functioning- the groundwater table at various points, fluctuations in groundwater table, size of ground water aquifer.

1.08 Land Use Pattern

Percentage of district area under various use type of crops grown, agro climatic zones assigned to the area, area covered by individual crops in the past for as many years as possible, trend of the fluctuation in the extent of area covered by individual crops, yields of the crops.

1.09 Forest

Area under forest, location of forest blockwise, the type of forest, general health of the forest, etc.

1.10 Soil

Districtwise soil types, PH values of the soil, general properties of the soils in the region- the origin of the soil, depth of the various soil strata. Districtwise soil in different parts of the catchment to be shown in the map

1.11 Agriculture & Irrigation

Various type of crops grown, their productivity, marketing etc., sources of irrigation and their dependability impact or irrigation on productivity.

1.12 Population & Socio-Economic Condition

Population in the catchment area, urban and rural population, rate of growth of population- SC & ST population, population dependent on agriculture, number of agricultural labourers & their income level, the average size of land holding and land per person, impact of population on productivity etc., impact of flood on living condition of the population and on the development of area.

1.13 Mineral

Mineral deposits in the catchment, types and extent of mine area, their level of exploitation etc.

1.14 Industries

Major & medium industries, cottage industries source of raw materials, marketing the products

1.15 Communication & Transport

Description of the roads, railways, aerodromes, post & telegraph lines etc. in the catchment, Inland waterways, means of transport i.e. automobiles, bullock carts etc.

2. HYDROLOGY

2.01 General

Definition of hydrology, description of general hydrological phenomenon and the catchment characteristic leading to floods.

2.02 Catchment

Shape, size, maximum and average width, length and other features of the catchment like hilly, plain etc. affecting the hydrology. Catchment area at various points along the river, catchment area of the tributaries etc.

2.03 Meteorological Observations

2.03.1 Rain Gauge Station

Status of Meteorological observations being done in the catchment by the IMD, CWC, State Government etc. List of the rain gauge stations, their location in the catchment and date of commencement of observation. The adequacy of rain gauge stations using the criteria of IMD, WMO, ISI etc. in the hilly and plain parts of the catchment. Deficiency in them, if any. The possible suitable location of any proposed rain gauge station.

2.03.2 Rainfall

Annual and monsoon rainfall in different parts of the catchment, period of monsoon in different parts of the catchment for very big catchments. Listing of annual maximum ever rainfall, annual average rainfall and annual monsoon average rainfall for all the rain gauge stations, say in a Table – 2.1. Mention of rainfall of high intensities with magnitude and duration causing severe floods in the catchment. Stating 24 hrs. rainfall of return period of 5,10,15,25,50 years and one- day , 2- day, 3- day, 4- day and 5- days rainfall

of 25, 50 and 100 years return period at as many raingauge stations as available in tabular form (These values to be analysed from daily rainfall data or to be obtained from the IMD , if available, or to be read from Isopluvial line of IMD/CWC, if brought out).

2.04 Hydrological Observation

2.04.1 Stream Gauging Network

Status of gauge, discharge and silt data being observed at various sites in the river system by the CWC or State Government. List with particulars of the hydrological observation sites namely Latitude and Longitude of the location, type of data observed, period of observation etc. in tabular form (Table 2.2) . The adequacy of the hydrological observation sites as per criteria of WMO, New Hydrological sites recommended and type of data to be observed specified.

2.04.2 Recording maximum observed annual discharges and gauges for all the hydrological observation sites for all the years, observation with date of occurrence of the peak value (Table 2.3), analysis of these data. Observing any pattern in the annual peak gauge/discharge data series over the years or on the different sites along the river/tributaries. Hydrologic observational sites attaining extreme gauge /discharge at the same time which might be intercepting catchment having similar climatic and hydrologic characteristics etc.

2.04.3 Gauge and Discharge Relationship

Development of gauge and discharge relationship curve (also called the rating curve) with a purpose to compute discharges for peak gauges having no corresponding discharges measured due to practical difficulties or to compute river stages corresponding to adopted design discharge of return period of various years discussed subsequently. Least square technique may be utilized to draw the average curve and to develop mathematical equation of the rating curve. Cross –section of the site to be properly reflected in the rating curve i.e. sudden changes in its shape of cross-section, zero bed level. Attaching the rating curve in graphical form and also the river cross- section.

2.05 Flood Frequency Analysis

2.05.1 General

Historical background of design discharge in vogue, while designing flood management in the past, need to evaluate future probability of occurrence of river stage and discharges in a scientific manner. Philosophy behind designing structures (embankment, reservoirs, drains etc.) for discharge with particular level of risk of failure. Criteria set out by the Rastriya Barh Ayog and other bodies for design discharge to be adopted for flood protection works

to protect different category of areas viz agricultural field, urban or industrial area etc.

2.05.2 Data Availability and Analysis

Description of type and length of stream data available particularly with respect to adequacy to fit them into various statistical distributions for evaluating gauges and discharges of various return periods. Decision to use partial duration series or annual extreme value series for computing the design gauge/discharges. Testing Normal, Log Normal Pearson Type-III, Log Pearson Type –III, Gumbel etc. distribution for goodness of fit the extreme value data either graphically or analytically say by Chi-square test. Deleting outliers or zero values with proper engineering skill. A table to show the list of distributions fitting over the various hydrological observations sites. Computing flood discharges from these distribution from these distributions for return period of 10, 20, 25, 50and 100 years and presenting them in a table separately for gauges and discharges. Period of data utilized and ever maximum observed gauges/discharges to be mentioned in the table.

Computation of design flood discharges from unit hydrograph techniques also for medium size catchment, Derivation of unit hydrograph from plot of rainfall and corresponding flood hydrograph. Synthetic unit hydrograph to be established for ungauged catchment. Establishing rainfall run-off relation and showing it in graphical form. Computing rainfall excess of return period of 10,20,25,50 and 100 years of return period of one- day, two- day….. five- day duration. Arranging rainfall excess in critical sequence as per the ordinate of the unit hydrograph to obtain the design discharge of above return periods.

Discussions of design discharges obtained from the unit hydrograph technique or from frequency analysis of discharges. The reasons of increasing/decreasing design discharges along the course of the river or tributaries. If the design discharges are lower in lower reaches, proper and exhaustive investigation for it.

2.06 Sediment Load

Factors affecting the sediment load in the river system. Presenting in tabular form monthly or annual sediment load for all the silt observation sites. Percentage of coarse, medium and fine silt load component passing through each of sites also to be given. Analysis of the data, Pattern of silt loads whether increasing or decreasing at a site over time and also along the river from upstream to downstream reach. Amount of deposition of the silt load in the river bed if principal type of silt (coarse or medium or fine silt) deposited in various reaches.

3.0 RIVER MORPHOLOGY AND RIVER BEHAVIOUR

3.01 General

Importance of study of river morphology in context of floods, bank erosion and lateral shifting of the rivers etc. Need to carry out morphological study of various river sub-system, viz. the existing erratic behavior of these rivers manifested in frequent changes in the river course, lateral migration of these river courses to a large distance, heavy over bank spilling due to inadequate channel capacity, frequent carving of secondary or new channels, rising of the river beds, frequent attack on river bank and embankments etc. all summed as the problem of "floods". Usefulness of study of the flood pattern of these rivers erosion and deposition process leading to formation of shoal and bars etc. in more rational and scientific manner in better planning and management of various aspects of floods. Need to verify Lacey's regime formula in these rivers.

3.02 Morphological Characteristics

Followings may be the list of morphological characteristics of a river which will throw light on river morphology, behaviour of river and problems of floods, erosion lateral shifting etc.

(i) Channel Characteristics

(a) Cross-section study for variation in area, deepest bed movement (lateral and vertical), description of secondary channels with reference to erosion problem, if any.
(b) Bankful width, mean depth, width-depth ratio etc. Inter relationship between different parameters.
(c) Regime status: Whether it conforms to Lacey's regime.
(d) Lateral slope of river bed- from observed cross-sections of different years. Describe slope of flood plains.

(ii) Aggradations/Degradation of bed

(a) By cross-section study: Detailed study of river cross-section taken at fixed suitable intervals in different years. Superimposing these plans and computing and comparing area of the cross-section below a reference datum line may show aggradation/degradation. The cross-sections along with corresponding longitudinal section and river regime plans before and after floods etc to be acquired and cubature study performed to ascertain aggradation/degradation.
(b) By G-D curve study: By noticing shift in upward/downward direction of G-D curves of different years.
(c) By sediment balance study: By comparing sediment load passing through two river cross-sections may indicate scouring/deposition of sediment between these two cross sections (Refer para 2.06)

(iii) Sediment Transport

Relation between sediment transport and different flow parameters including stream power – viz developing relation like.

$Q = a*x^b$ …….(2.1)

Where
Q = Sediment load
x= a chosen parameter as discharge, velocity stream power.
A&b = Constants to be determined.

(ix) Flow Characteristic

Relationship between different flow parameters with reference to mean velocity and critical velocity.

Relations may be of the type.

$B= a*Q^b$ ……(2.2)
$D= c* Q^d$ ……(2.3)
$V= e* Q^f$ ……(2.4)

Where B= width
D= Mean Depth
V= Mean velocity
Q= Discharge
a, b, c, d, e and f = constants to be determined from actual data.
and b+ d+ f = 1
For low flows critical velocity V* may be correlated with depth to get an equation of the form of Kennedy equation $V* = 0.84 D^{0.64}$

(v) Plain Forms

(a) Meander or braiding characteristics of the main river. For meandering reaches establish relation between:-

1. Meander length and bankful width.
2. Meander width and bankful width
3. Radius of curvature and bankful width

Give tortuosity and sinuosity of the rivers.

(b) Changes in Thalweg (This should include meander geometry, tortuosity, sinuosity etc.)

(vi) **Bed Forms**

(a) Bars and shoals- identify point bars, middle bars and alternate bars at vulnerable sites.
(b) Analysis of bed forms with reference to flow characteristics.

A study of bed forms may be conducted on values of C and F

'Mannings 'n' and Froude Number 'F' to be calculated every day at the sites having bed bars. If Froude Number is less than 2 and C is less than 15, it can be inferred that the plain bed is unstable, that is, the bed gets deformed leading to ripples and dune patterns. Such information about bed forms may be very important consideration in designing anti-erosion works diversion channels etc.

(vii) Analysis of bed slope, water surface slope and energy slope with respect to valley slope.
(viii) Channel Migration

Shifting of deepest channel with reference to the channel pattern like bankful width, maximum width etc. Establishing whether channel migration is dependent upon variation in discharges from season to season. Establish relation between the ratio of maximum discharge to bankful discharge on one hand and lateral channel shifting on the other.

4.0 THE FLOOD AND DRAINAGE PROBLEM

4.01 General

Definition of floods, Causes of flooding in general, Interaction of man's activity, flood plains and flood damage. To highlight accentuation of flood problem despite flood protective measures due to the increasing pressure of man's activity over the flood plains in pursuit of all round development and consequent alterations in the ecological balance. Sediment load, river regime and the flood plains. Stable/unstable nature of the river regime Role of sediment in inducing instability to the river regime-instability caused by interruption to the flow following reduction in lean water supply to flush the river and maintain the river cross section – reduction in spill area due to increased human activity in the catchment, details of premature reclamation of deltaic region of river Ganga downstream of Farakka for rivers belonging to this region. Problems associated with sedimentation of coarse sand over flood plains.

4.02 History of past Flood

4.02.1 General

Mention of area affected by flood in the river system. Degree of severity of the flood problem in its various zones.

4.02.2 Frequency of Floods

Table giving names of districts and the years of flooding in each district thus broadly indicating the nature of occurrence of floods in each districts. Flood prone areas of different frequency to be shown on map. Area affected every year to those only once in ten years to be shown in different colours. Depth of flooding at various points in the area, Table showing number of days the water level flowed over danger level at each hydrological observation sites every year in the past.

History of flooding i.e. yearwise, description of flooding with damages. Such history may include period of occurrence of floods, locality/area affected, details of damages to embankments, canals, roads, railways, industrial towns. Rainfall during the storm, synchronisation or otherwise of flooding in various part of the catchment. Sites of bank erosion, changes in river courses etc.

4.03 Nature of Flood and Drainage Problem

The nature of flood damages in different parts of river system. Causative factors behind the damages in various zones of the catchment viz. due to over flow of banks, flow of sheet water from upper catchment, accumulation of flood water in depressed area, lack of proper drainages, transfer of flood water from adjacent catchments, inadequate channel capacity to drain off water. Spilling reaches of the main river and the tributaries with depth spilling. Other topographical, physiographical and meteorological peculiarities behind the floods, Problem of bank erosion, shifting of river course and carving out of new channels, meandering tendency of rivers. Problems compounded by any past flood management work like embankment, channel diversion etc. Flood problem of Khadir and Diara area with seriousness of problem duly documented.

General drainage problem, places of drainage congestion, with likely causes, Extent of area affected by salinity/water-logging, Normal duration of the drainage congestion, Means of drainage i.e. through channels or from field to field. Sluices and their functioning-objectives, design, operation difficulties, past pattern of operation, design of gates including lifting arrangement, seals, lifting effort etc. Proposed pattern of operation for future to achieve the objective. Inadequacy of waterways under rail, road and canals. Efforts of removal of drainage congestion

4.04 Flood Damages

4.04.1 General

Direct and indirect type of flood damages with explanation of the terms. System of collecting and reporting flood damages by the State Government at the present time. Need to collect river systemwise flood damage data instead only the districtwise only as at present.

Recommendations of RBA in this regard. Method adopted by the GFCC to compute river systemwise flood damage data from the districtwise damage data i.e. by allocating a percentage of district data to the river system under consideration in proportion to the area of the district coming in the river basin.

4.04.2 Analysis of Flood Damage Data

Year of commencement of collection of comprehensive flood damage data by the State Government. Flood damages having components like population affected, total area affected, crop area affected, damages to crops, human and cattle lives lost, damages to public property etc. in the river system each year (to be attached in a tabular form). In case only districtwise damage data area reported by the State Government, computation of basinwise damage value in proportion to the area of the district coming in the river system. Reporting the value of damages at the current year price level as well as at constant price level of year of preparation of the comprehensive plan. The price of agricultural commodities published by Directorate of Economics & Statistics to be used for this conversion as an approximation, as damages to agricultural commodities by flood are over 60 percent to total damages. Above details of damages in protected and unprotected area to be given separately.

4.04.3 Trend of Flood Damages

Computation of average damage over blocks of five years. Discussion of trends in each component of damages i.e. whether area affected, crops affected, damage to crops etc. area is increasing, decreasing, stationary or random, reasons for such trends to be investigated.

4.05 Other Suggested Studies

4.05.1 Important control structures like dams, weirs, barrages, bridges etc. and their effect on river morphology and causation of floods, construction of levees and their effect on river characteristics and their behaviour.

4.05.2 Aspects of various river training works carried out yearwise in the entire length of the river, their necessity and subsequent impact of these works, especially on the suitability or otherwise of the anti-erosion works to achieve the desired objectives the identification of the most vulnerable reaches and reasons there of.

4.05.3 In places of erosion, apparent mode of erosion i.e. by sloughing /toe cutting /wave action etc. to be recorded and correlated with the morphological characteristics of the river morphology.

4.05.4 Any other study if done on the particular river should be brought out.

4.06 Conclusions

5.0 PAST EFFORTS OF FLOOD MANAGEMENTS, ACHIEVEMENT AND FUTURE APPROACH

5.1 General

Description of evidence of flood protection works in antiquity over different civilization. Mention of flood management works adopted in different parts of the country from ancient period to recent period. Prevalent flood management works in pre-independence period in India with description of controversy in North India over use of embankment as flood management works particularly in West Bengal (refer Bengal embankment Act 1873), Orissa, Assam, U.P and Bihar. Brief description of National Flood Policy, 1954, the suggested outline of phased programme by the Committee. Spurt of activity following this policy and action taken by the State Governments and the Central Government.

5.2 Recommendations of Past Committees

Brief mention of all past committees set up either by State or Central Govt. particularly after 1954 to suggest flood management works in the river system in particular, or on flood problem in general like the Rashtriya Barh Ayog etc. their proposals/recommendations.

5.3 Works Executed/on-going/proposed.

Details of various works viz. reservoir, embankment, drainage improvement, anti erosion, town protection works done in the river system. Table 4.1 to show already executed schemes with details like name of the scheme, State and district involved, bank of the river, date of start and of completion, length of embankment, estimated cost, area benefited and other relevant details, if any. Description of ongoing schemes, Table 5.2 to show details similar to that of executed schemes with additional information of benefit so far achieved, expenditure already incurred and proposed future outlay. Description of proposed schemes, Critical review of them with comments on suitability or otherwise, completeness or incompleteness of the measures, from point of view of broader perspective, Supplementary measures suggested to the proposed schemes. Table 5.3 to list all the proposed schemes with details as in table 5.1 and 5.2. Table 5.4 to summarise Table 5.1, 5.2 & 5.3 showing total length of embankment constructed total area benefited and total cost ; similar details for ongoing schemes and for improvement of existing schemes; similar details for balance works separately for new embankments, improvement in existing embankments and road-dowels etc.

5.4 Future Approach

5.4.1 General

Philosophy of planning of flood management works in brief steps to be followed for the planning as suggested by the RBA may be (i) Assessment to the problem (ii) Identification of the goal (iii) Alternative measures possible (iv) Consideration of criteria to be adopted (v) Evaluation of the alternatives (vi) Decision of single or combination of alternatives and (vii) Fixing priorities of the schemes. Need to take the river system as a unit in formulating the plan. Comprehensive approach to river basin planning. The multidisciplinary nature of planning involving technical and administration departments. Need to review and up-date the plan at appropriate time interval as planning is a dynamic process.

Accordingly, future planning may be done as per following steps:

Step-1 Identification of the problem.

Step-2 Possible alternatives, solutions and alternative recommended for adoption with justifications. Care to be taken to incorporate works executed or under progress as far as practicable.

Step-3 Prioritisation of works.

Step-4 Estimation of balances works to be dealt with likely annual expenditure.

Step-1: Identification of the problem with the help of para 4.01.

Step-2: Possible alternatives, solutions and alternative recommended

(a) General

The alternative solutions to be obtained from the review of strategies of flood management viz. strategies to modify flood, strategies to modify the susceptibility to flood damage, strategies to modify the loss burden and strategies to bear the loss. Strategies to modify flood includes measures in channel phase, land phase and atmospheric phase of the river system. Channel phase includes embankments including flood walls and dowel walls, reservoirs, detention basins, channel improvement, emergency floodways, river diversion, inter basin transfer, bank stabilization and anti-erosion measures, ring bunds and underground storage reservoirs etc. Flood reduction measures in land phase includes watershed management works and in atmospheric phase include weather modification; measures to modify susceptibility to flood are flood plain management, development and redevelopment policy, structural changes, flood proofing, disaster preparedness and response planning, flood forecasting and flood warning.

Measures to modify the loss burden includes evacuation, flood fighting, public health measures as emergency measures and disaster relief, tax remission, flood insurance and redistribution of losses. Bearing the loss and living with the flood. Examination of each of above measures for relevance or suitability to the river system under consideration. Some measures are detailed below.

(b) Reservoir

Study of effectiveness of reservoirs in moderating flood in lower reaches-routing, studies of flood hydrograph for each of the possible reservoir sites existing, proposed or contemplated alongwith programme for creating them. Magnitude of flood cushion in the reservoirs Preparation of regulation scheme of reservoirs with or without flood cushion to effect maximum flood moderation. Assessing reservoir sites in Nepal, chalking out minimum set of data required to be collected in that country to assess flood moderation due to reservoirs in Nepalese territory.

(c) Embankment

Suggesting embankment in suitable reaches of the main river and the tributaries with proper justification as to its effectiveness with respect to existing flood problem alongwith a time frame for its execution. Designing them to cater to the flood discharge of 25, 50 or 100 years return period as per existing guidelines according to the importance of the area to be protected, Statement of the expected rise in water level, bed level, and flood slope in post embankment condition. Estimation of extent of area likely to be benefited by proposed embankments. Examining the existing embankments and suggesting their raising and strengthening.

(d) Drainage Improvement Works

Identification of natural detention basin water logged area. Study of the measures for drainage improvement viz. Channelisation of river and the drains etc. interlinking of channels, digging new drains, providing anti flood sluices, providing adequate regulators in embankments, improving channel conditions by removing local obstructions by weed growth, cultivation etc., diversion of flood water into adjoining river system, examination of adequacy of waterways under road, railways and canals and increasing it suitably wherever required. Likely impact of drainage improvement work suggested, total benefits from them.

(e) Anti-Erosion Works

Difficulty in predicting erosion sites in a river system. Depending upon the river system the standarisation of dimension of spurs, groynes etc. Suggestion of measures like Dhar closure, diversion channel etc. to divert the river current from attacking the river bank in specific cases, examination of same for model analysis.

(f) Watershed Management Works

Identification of the extent of catchment area to be earmarked for watershed management works. Assessment of its impact on the flood moderation and stabilization of the river regime based on similar works done in the past in similar adjacent catchments. Quantitative and qualitative benefit from the measure. Possible cost of the measures.

(g) Flood Plain regulation/Zoning

Preparation of map dividing the flood plain of the river system depending upon the severity/risk of floods in different areas in a scale of 1:15000 or 10,000 or any nearer scale subject to the availability of map (state Govt. may do this work and supply the map to the GFCC). Carrying out survey works by competent authority for this purpose so that maps with a contour interval of 0.5 m on 1:15000 scale is available. Based on the flood risk maps prepared as above, the river system may be subdivided into various flood plain zones for identified human activities. Legislative enactment for the flood plain zoning by the State Govt. may be enacted to enforce implementation of the envisaged activity in the various zones.

(h) Disaster Preparedness

Working out plans and have full rehearsal of disaster preparedness in the river system.

(i) Flood forecasting and Flood Warning

Described in Chapter –VI.

(j) Flood Proofing

Suggesting suitable flood proofing measures for flood affected areas. Also flood proofing measures to be taken in advance before undertaking a particular activity in a flood plain susceptible to frequent flooding.

(k) Plan Size

Estimate of the economically viable plan size (Pre-feasibility stage) in the river system based on average damages in the river system assuming that upto 80% of affected area can be protected. The plan size may be about 5- times the value in rupees of average annual damages at current prices. The cost of future proposals to be checked against the economically viable plan size.

Step-3 Prioritisation of Work

Arranging the balance works (i.e. the recommended work excluding those already completed or under progress) suggested in the plan in order of priority with stipulated time frame.

Step-4 Estimate of Balance Works with likely annual expenditure, working out the approximate cost of balance works on pro-rata basis on the cost of similar works executed in the catchment or adjoining area/actual estimate. Likely annual expenditure on the balance works.

6.0 FLOOD FORCASTING AND FLOOD WARNING

Introduction

Concept and definition of flood forecasting utility of the forecast, parameters constituting the flood forecast, definition of warning level, definition of warning time and its importance, activities following formulation of forecast viz. dissemination of the forecast to concerned Engineering and Administrative authorities. Brief history of forecasting in India

6.01 Existing Flood Forecasting Activities in the River System

Description of agencies doing the flood forecast, List of existing forecasting stations in the river system. Details of individual forecasting station including existing ways and means of collecting data for the forecast, formulation of the forecast and dissemination to all concerned. Accuracy achieved by the forecasting stations. Proposals to improve existing forecast stations and to set up new station if any. Adequacy of the existing forecasting stations.

6.02 Recommendations and Conclusions

Description of need to correlate forecast level with extent of inundation of flood plain areas, suggesting ways and means to improve warning time by, say, using modern advanced techniques viz. installing telemetric stations for data transmission and collection, setting up computer compatible rainfall radar for more accurate and quicker assessment of aerial rainfall, utilisation of weather forecast of the super computer of the IMD at Delhi etc. Need for additional base stations, forecast stations, inflow and outflow forecast stations etc. in the river system to qualitatively improve the forecast and enhance the efficacy of the flood forecasting system as a whole.

7.0 SUMMARY OF PROPOSAL

7.1 Summary of proposal

All the proposals of flood management of the plan to be summarized in this chapter. They may be narrated serially para referred to in the plan to be

properly quoted for each of the proposals. Agencies to carry out the proposals also to be mentioned.

An executive summary of the Comprehensive Plan for flood management with an index may should be appended invariably with such plan.

CHAPTER VI

CRITERIA FOR TAKING UP UPDATING OF A COMPREHENSIVE PLAN OF FLOOD MANAGEMENT

CHAPTER VI

CRITERIA FOR TAKING UP UPDATING OF A COMPREHENSIVE PLAN OF FLOOD MANAGEMENT

Attention is invited to the item 17.2.4 of the summary record of discussions of the 17th meeting of the GFCC (circulated by this officer letter No. GFCC/C-2/86/44 p 61-94 dated 15.6.89 wherein the Members of GFCC had expressed the following broad views regarding the updating of Comprehensive Plan prepared by the GFCC of individual; river systems in the Ganga Sub-basin.

" They (the Members) were of the view that preparation of Comprehensive Plan of flood Management for river systems was a dynamic process. As such, the plans would require periodic updating say every five- years in the light of changes in the river configuration, efficacy of works already executed and other developmental activities in the catchment ……"

In addition to the above most of the earlier reports were prepared on the basis of inadequate data/information due to which various essential studies could not be carried out which could be improved while updating. (The Comprehensive Plan of Flood Management for all the 23 river systems comprising the Ganga Sub-basin, prepared by GFCC, have already been circulated to all concerned). The specific reasons of updating of the above Comprehensive Plan may be summarised as below:-

(I) Report prepared with inadequate data base which can not be largely improved in a subsequent updating.

(II) To remove the weaknesses in the report by concretising formulation of future proposals of flood management which may be vague at present it may be mentioned that the non-availability of relevant data has been a major constraint in preparation of Comprehensive Plan for all the river systems. A list of data (Copy enclosed at annexure-I) had already been circulated to the State Government and they were reminded also from time to time but only partial data for many of the plans were supplied to the GFCC. If the remaining data are made available at a later date, the updating can be taken up to with the help of the same which might lead to more appropriate and definite future proposals. The impact of non availability of data is explained in some detail later.

(III) A major change in the river regime might have taken place after the Comprehensive plan was prepared. For example, the river course might have avulsed or a stream from adjacent river system had entered the regime of the river under consideration.

(IV) There has been a new spurt in the main activity in the river system. The Government Departments, like Railway, Water Resources, PWD etc. might have extended their activity. New road might have come up without proper waterways in the bridge/ culvert affecting public and private properties like railways, industrial installations etc. severely leading to the drainage congestion and aggravation of flood.

(V) In case of international rivers, sufficient data/information pertaining to other country is made available for the part of catchment outside India, which would help plan flood management work in that country viz. reservoirs, embankments, watershed management works etc. and would enable the study of their effect downstream on the existing, ongoing and proposed works. Particularly, if a proposal for reservoir in Nepal gets activated by more favorable response from the HMG Nepal, this may necessitate updating of the plan accordingly. Data on existing works carried out on international rivers out side India will help significantly plan flood management and other measures in India.

(VI) Analysis done in the report could be improved/new analysis done by various tools used in the plan hitherto. For example, an estimate of flood moderation from a proposed reservoir in an ungauged catchment could be realistically done by some acceptable suitable tool.

(VII) The existing flood management works have become defunct for some reasons.

(VIII) Works/studies suggested in the Plan, viz flood plain zoning, cubature studies for rise in river bed etc. are carried out by the State Government to its logical conclusion for incorporation in the Plan.

(IX) Results of ongoing specific studies, (like Mathematical Model studies for Kosi Forward Embankment) become available for implementation.

(X) Periodic updating.

(XI) Any other reason the State Government finds suitable to update the Plans.

Limitation of the Data Base

(I) Rainfall Data

(a) The rainfall data base are severely limited. Generally while preparing a Comprehensive Plan of the river system reliance had to be placed on published data of the IMD mainly in terms of average monthly, seasonal and annual rainfall data and isohyetal lines. In a few cases, rainfall estimate like frequency of occurrence of different amount of daily rainfall data from IMD/State Govt. could be had and utilized (only in one river system i.e. the Punpun river system one-day, two -day, three-day, four-day five-day maximum rainfall of 5,10,25,50 & 100 years of return period were available from IMD and utilized).

Lack of proper response from the State Government and longer time needed in the procedures for obtaining the data from the IMD are normally faced.

(b) A proper knowledge of spatial and temporal distribution of rainfall in the catchment is essential. Actually hourly rainfall data for the period of storm are required. In its absence, it is not possible to arrive accurately at the unit hydrograph of medium size catchment or even the rainfall-runoff relationship may not be developed. (Available daily rainfall data could be utilized for studies only in case of Punpun river system). It may be recalled that unit hydrograph sums up response of the catchment to rainfall and it can be used to compute flood discharges of various return period or

may be helpful in obtaining design flood hydrograph for the purpose of reservoir and channels routing.

(c) The major catchment of most of the Northern tributaries of the Ganga, which in fact are mighty rivers, responsible for substantial portion of the flood problem, lie in Nepal. Rainfall data are altogether not available in Nepal. Only since 1988-89, 3-hourly rainfall data of twelve raingauge station in Nepal are being supplied to India by them on real time basis. Though the number of the rainfall stations are still very limited, this data will prove of much help for the above mentioned analysis and in updating the Plan.

(II) Gauge, Discharge & Silt Data

(a) In case of major river gauge discharge and silt data observed at sites maintained by CWC are more or less systematic and consistent and have been utilized in formulation of Plan. However, they are often of short duration and the record available is rarely sufficiently long to predict 100 or even 50 years flood with high level of confidence. Many of the rivers, particularly tributaries to the main rivers, remain ungauged making difficult, among others, to ascertain its capacity to drain flood water. The sites maintained on rivers are also not closely spaced to estimate the spill discharge of the river in between the sites.

(b) The gauge discharge data on daily basis and on hourly basis during the storm is essential which are also not available in some cases. They are essential for a large number of purpose viz. estimation of design flood, to have indication of the depth and duration of flooding, to estimate spill discharge, to ascertain amount of water to be diverted to diversion channel, to estimate spacing and height of embankments, to estimate amount of drainage congestion, to help plan capacity for reservoirs etc.

(III) Maps

(a) Contour Map

For perspective planning of flood management works in pre-feasibility stage like embankments, diversion channel, detention basin etc. to estimate at a particular stage in the river and also for flood plain zoning, the contour maps on a scale 1:15,000 at contour interval of ½ to 1 m. is essentially required. The Survey of India has already taken initiative to prepare such maps and for some of the flood plains these have recently been prepared. Such contour maps could not be utilized while preparing the earlier Comprehensive Plans. These maps are now gradually being made available for the entire flood plains of the Ganga sub-basin. Once these are available, they may be used for specific recommendation of flood management works besides taking up flood plain zoning also.

(b) Map showing Flooded Area

State Governments were requested to supply maps showing the area flooded each year with the demarcation specially of the area flooded by the failure of engineering structures. Even these basic data are not generally made available except in a few sporadic years from a particular State and on a map of very small scale (which really does not serve the purpose).

(c) Longitudinal Section & Cross Section of River

The precise longitudinal section of the river too in the required length are often not made available except only for few segments of some rivers, making difficult to precisely design the embankment, estimate the Water Level in post embanked condition etc. Also the cross sections of the rivers likewise were not supplied at most of the salient points of the river and at interval of 10 km every year in pre and post monsoon period for the above work. Many of the rivers are showing tendency of siltation of their bed necessitating raising and strengthening of embankments, aggravating drainage problems etc. Which may not be possible to tackle accurately in absence of above information.

(IV) Waterways of Existing Road & Railway Bridges

Waterways in road and railway bridges wherever available have been incorporated, but the GFCC as one of its main tasks, is conducting study of these waterways in all the river systems of the Ganga Sub-basin. It is essential that the results of such studies be incorporated in the updated plan. It may be mentioned that many new roads have come up in almost every catchments without providing sufficient waterways causing severe aggravation of flood problem. These roads too are damaged very often due to the above reason.

(V) Reservoirs

Reservoirs are thought to be indispensable for long term flood management. As already mentioned, reservoir sites on all the northern tributaries of the Ganga are available only in Nepal and little data/information is available about them at present. Once the relevant hydrological and topographical data/details become available, study can be made and incorporated in the updated report.

(VI) Water Resources Development Outside India's Borders

Very little details of water resources development activities outside India and affecting the lower reaches of rivers emanating from other countries are available. If all the Hydrological, hydrometeorological, irrigation & flood control (including diversion & storage structures & their operation). Soil conservation and other data are made available, a more appropriate study could be under taken to enrich the Comprehensive Master Plan.

ANNEXURE -I

List of data required for preparation on Comprehensive Plan for flood management of the various river systems in the Ganga Sub-basin.

List No-I

Map/Data for the preparation of Comprehensive plan

(A) MAPS

1. Flood maps: Maps on a scale of approx. 1cm. =0.64 km. Showing flooded areas for each year for the last 10 year. These maps should show contours at interval of one meter and include the existing/under construction/proposed flood control works. These should also show the existing course of rivers and tributaries indicating railways, national highways, P.W.D roads and important installations.

2. A map on a scale of approx, 1 cm. = 2.54 km. showing the existing raingauge stations, gauge, discharge and silt observation sites. Any proposal in hand or contemplated to add to or reduce the number of these sites be also indicated.

3. Soil map on a scale of approx. 1 cm. = 2.54 km for the whole catchment.

4. Cross-sections upto the HFL of all rivers (of consequence) at 10 km. interval and at all key points including confluence points of major tributary, Low water levels as well as HFL should be marked on each cross-section.

5. Longitudinal section of river prepared from these above cross-sections along deepest bed levels. These should be on a suitable scale say 1 cm. = 10 km. horizontal and 1 cm. = 10 m. vertical depending upon the length of the river concerned.

6. Logs of bore holes, if any, done in the riverbed, substrata or of any bridge etc. across the river may also be shown.

(B) Data

1. Peak gauge discharge for periods of storms and silt data for various sites of the rivers for as many years as available.
2. Daily rainfall data for periods of storms for different raingauge stations for as many years as available. Data regarding the storm patterns for (i) Hourly, (ii) 1-day & (iii) 3-day, if available, be given.
3. Maximum HFL and discharge, observed on various rivers at different sites.
4. Data regarding duration and frequency of flooding.
5. Annual flood reports. - Technical (from Irrigation authority), Administrative, Financial (from Revenue authorities) covering districtwise damage data due to floods for the last 25 years.
6. Schemes for flood control/reports/recommendations of the Expert Committees/ Consultants prepared from time to time.

7. Earlier reports of studies carried out, if any, regarding possibility of storage for flood moderation. In case of existing dams, the extent of flood moderation achieved is given.
8. Master Plans/Basin wise Plans prepared if any.
9. Waterways of existing road and railway bridges and the affluxes created during maximum floods.
10. Upto-date Planwise expenditure of flood control/protection works/ measures with future proposals.
11. List of salient features of all existing under construction and proposed flood works of various types viz. embankments, drains, spurs etc.
12. Details about soil conservation works/measures executed /under progress /proposed if any.

List No 2

Map/Data for Evaluation of possible Effects of various Embankments

(A) MAPS

1. An index map at 1 cm = 2.54 km.
2. Plan showing pre and post embankment river channel (courses), banklines, embankments including retired lines on 1 cm = 0.64 km scale.
3. Cross-section upto HFL of the river taken at every 10 km. and at all key points including every confluence of major tributary in pre and post embanked stage. Top level of embankment and water level and HFL should be marked on these cross-sections. L-Section of the river prepared from these cross-sections along deepest bed level both for pre and post embanked stage be also supplied to study whether the river is aggrading, degrading or poised. Scale for L-section should be 1 cm. = 1m. vertical, Cross-sections of the embankments to a suitable scale at the above mentioned interval/points be also given.
4. Map showing area inundated before and after construction of the embankment to a scale of 1 cm = 0.64 km.

(B) DATA

1. Data before and after construction of the embankment regarding bed materials and silt load in reaches where embankment has been constructed.
2. All available reports on performance of embankment spurs, revetments or other protective works if any prepared or available.
3. Amount spent annually for the last 10 years on emergent works as a result of breaches/failures in embankments.
4. Annual expenditure on normal maintenance and repair of embankment excluding that covered under (3) above.

CHAPTER – VII

GUIDELINES FOR PREPARATION OF SCHEMES OF RAISED PLATFORM UNDER FLOOD PROOFING PROGRAMME

CHAPTER - VII

GUIDELINES FOR THE PREPARATION OF SCHEMES OF RAISED PLATFORM UNDER FLOOD PROOFING PROGRAMME

1. Types of schemes

The schemes of raised earthen platform may be implemented to provide shelter to people and livestock of the flood affected villages, which get marooned frequently resulting in acute hardship due to disruption of basic civic amenities and communication links.

2. Selection of area

This types of schemes are indicated for areas which suffer inundation of homestead areas of villages at least once in 5 years. Homestead areas should be identified on the basis of reliable flood records of the past 10 years also viz. demarcation could be done based on level of submergence shown on contoured index maps of the area, frequency of submergence/duration established by reliable flood records. Selection of village for such schemes are also to be supported by certified statements of damages suffered yearwise. A reliable damage assessment has to form basis for the investment.

3. Design criteria

(a) Top of platform

Top level of the platforms should be 0.6m above the flood level for 25 years frequency if the platform is to be constructed in unprotected areas. In case the platforms are on the countryside of embankments the freeboard is to be reckoned above the maximum water level observed due to drainage blockage with the proviso that platforms are generally at the same level as the top of the protecting levee adjoining.

(b) Size

Size of the platform may be determined on the basis of 40.50 sq.m area for each family plus 10% for animal and fodder plus 20% for internal passages, water and sanitary installations. These provisions can be subject to alteration on the basis of actual experience.

(c) Drinking water

Provision for tubewell at the rate of one tubewell for 20 families may be made.

(d) Public conveniences

One block of 4 toilets may be provided for 25 families with suitable disposal of wastes.

(e) Link road

All platforms shall be sited so that connection to nearest all weather road/service roads of flood embankments to provide all weather access is possible. The link roads may have 20 cm brick soling and 3.5 m top width.

(f) Provision of a motorboat may also be made for such platform clusters. Operational aspects have to be considered to ensure boat operation remains sustainable.

4. Justification

Since the programme aims to alleviate suffering of the people, the benefits of the schemes may be considered as social benefits and therefore a rigid benefit cost analysis on the lines of flood management schemes may not be sole requirement reflecting only the tangible damages avoided. However, both direct and indirect benefits by implementation of the scheme may be assessed and properly projected to justify the investment.

5. Estimate

Estimate for the raised platform shall not include cost of land whether temporary or permanent and over head charges. It is preferable to site platforms on Government land suitable and available.

6. Maintenance

Cost of subsequent maintenance of the platforms and services shall be worked out and reflected. These amount shall not be chargeable to this programme. Similarly R & M expenditure on motor boat, security etc. shall also not be met from this programme.

7. As far as practicable earth for construction of raised platform should be procured locally without involving mechanical transport.

8. A time frame for completion of the scheme is the essence of the scheme and included in the proposal.

9. Schemes may be submitted to GFCC in triplicate for processing their acceptance by the Steering Committee.

10. Funds released under this programme will not be diverted for any other work.

CHAPTER – VIII

GUIDELINES FOR PREPARATION OF SCHEMES FOR QUICK DRAINAGE FACILITIES UNDER THE FLOOD PROOFING PROGRAMME

CHAPTER -VIII

GUIDELINES FOR PREPARATION OF SCHEMES FOR QUICK DRAINAGE FACILITIES UNDER THE FLOOD PROOFING PROGRAMME

1. Types of Schemes

With a view to lessen water levels by relieving drainage congestion and thus alleviate suffering to the people in the chronically flood prone areas, schemes for quick drainage facilities by innovation in gates, sluices and related works may be included/sponsored under flood proofing programme.

2. Selection or area

Under this programme those areas be included which suffer drainage congestion at least once in 5 years. Such areas may be identified on the basis of reliable record of immediate past 10 years or so. Demarcation of pre project affected area may be related to a flood level and post project benefit also similarly to a alleviation at a lower flood level. The yearwise duration and levels should be marked on index map showing contours. Certified statement of damages suffered yearwise in the area shall form a basis for damage assessment and taken as its evidence.

3. Justification

Such schemes shall be considered under this programme which can ensure that no drainage congestion in the benefited area occurs more than once in 25 years. In other words the schemes are to be designed against submergence levels of 25 years return period. If in exceptional cases benefit is allowed to cropped areas, protection shall be to flood level of 1 in 5 year frequency with duration of over one week. Also as a rough guide the investment may not exceed Rs. 5000 per benefited family. Since the programme aims primarily to protect the population during floods and avoid resultant suffering and damage, a rigid benefit cost analysis on the lines of flood management schemes may not be relevant, reflecting only the tangible damage avoided . Both direct and indirect benefits should be assessed and highlighted to justify the investments. The direct benefits may be quantified.

4. Identification of problem and remedial measures

The existing drainage system down to micro level with blockage points may be identified on a large scale map showing general topographical features such as contours, communication system, location of bridges and culverts over the streams, area affected by drainage congestion supported with a pre project flood level and a post project level. Analysis is to be lucid enough to project the problem and justify the remedial measures.

5. Provision of additional waterways by remodeling/constructing culverts and bridges

Where natural drainage is obstructed because of restriction of waterways, additional waterways may be provided in the existing structures or new culverts etc. The adequacy of waterways may be carefully determined. In this connection, reports, prepared by GFCC or CWC to check adequacy or otherwise of waterways under the railways and road bridges may be consulted. The adequacy of waterways under the C.D. works on the irrigation canals and the functioning of the structures under them may be reviewed and suitable remedial measures may be assessed for additional waterways where found justifiable.

6. Cleaning of clogged cross drainage works like Culverts, Water ways etc.

Proposals for cleaning of the clogged waterways may involve manual works in case of small quantities and application of hydraulic jetting systems in case of works involving large quantities. An investigation be carried out to find out the reasons for clogging of waterways and measures to prevent such clogging in future may be proposed.

7. Resuscitation of secondary and primary drainage channels

Capacities and hydraulic conditions of the secondary and primary drainage channels have to be properly evaluated on the basis of topographical surveys such as longitudinal and cross-section, drainage area, rainfall pattern, flood slope and outfall levels etc. Measures necessary for improving the hydraulic performance of the channels such as removal of blockage, straightening of loops, re-sectioning etc. may be provided as called for.

8. Improvement of existing sluices

The condition of existing drainage sluices may be carefully investigated and assessed and reasons for malfunctioning, if any, determined. Suggestions for making suitable changes in the design of gates and hoisting arrangements to make their operations semiautomatic may be included. Provisions for other necessary repairs including replacement of defective parts, overhauling etc. may also be made wherever required. Usually the lifting arrangement of the gates of the side seals to prevent leakage of water are such that once the gates are operated it is likely that in the closed position it may not be able to completely seal the flow of water again. Many times the gates cannot be operated easily when required the most. All these work as a disincentive to a regular operation of gates in time of need. Hence there is a case for innovation in the design and operation, wherever possible the gates could be electrically operated. In other cases the mechanical arrangement in lifting mechanism should be such that one man could handle the operation with ease.

9. Approach and outfall drainage channels

Wherever necessary approach channels to sluices on the countryside of the embankment may be improved in such a way that the entire accumulated water has easy access to the sluices. Similarly to outfall channels from sluices to the recipient drains may need to be improved in some cases in respect of its discharging capacity and alignment to make it functional. If the leading (outfall) channels within embankments exhibit siltation, suitable revival of the same has to be undertaken in such a way that they can exhibit a sustained regime in future. For this purpose the sluice gates need to be operated periodically whenever the level in out falling drainage channel permits such an exercise. Most of the leading channels get silted up because of the non-operation of sluices, though they were available to relieve the drainage congestion. The sluice gates need to be kept functional by frequent operation so that they are able to flush out deposits, if any, in the leading channels, once the latter are cleared and made functional.

10. In the project estimate cost of land and over-heads shall not be included, but will have to be borne by the State Government. Funds released by the Central Government shall not be used for the purpose of up-keep and maintenance of scheme. Also these will not be diverted for any other work.

11. A time frame for completion of the scheme may also be included in the proposal.

12. All schemes should be submitted to GFCC in Triplicate for processing towards their acceptance by the Steering Committee.

CHAPTER IX

PLANNING COMMISSION GUIDELINES FOR CLEARANCE OF FLOOD CONTROL SCHEMES

Revised Guide lines for Investment clearance by the Planning Commission of Flood Control, drainage and anti water -logging scheme (No16(12)/1/99-WR, Planning Commission dated 9.9.2003

1.0 The flood control, drainage, anti-water logging project which are on inter-State rivers and tributaries will be sanctioned and included in the Plan as per the procedure detailed below:

(a) Schemes costing up to Rs.7.5 Crore
(b) Schemes costing more than Rs.7.5 Crore and not exceeding Rs.15.00 Crore and
(c) Schemes costing more than Rs15.00 Crore.

The procedure for submission of such schemes by the States and their examination at the Centre and consideration by the Advisory Committee for consideration of techno-economic viability of major, medium irrigation, flood control and multipurpose project proposals under Ministry of Water Resources (called hereafter as Advisory Committee) will be as follows:

2. **Schemes costing upto Rs7.5 Crore**

2.1 The schemes proposed by the Flood Control Department will be sanctioned by the State Govt. concerned after they are duly approved by the State Flood Control Board on the recommendation of the State Technical Advisory Committee, for their inclusion in the Annual Plan & Five Year Plan of the State Govt.

2.2 Schemes other than those in the Ganga Basin which, in the opinion of any member of the State Technical Advisory Committee have inter-State implications, should be got examined and cleared by the Central Water Commission (CWC) before they are finally approved by the State Flood Control Board and sanctioned by the State Government. Schemes in the Ganga Basin which, in the opinion of any member of the State Technical Advisory Committee, have inter- State implications should be got examined and got cleared by the Ganga Flood Control Commission (GFCC). Schemes which, in the opinion of any member of the State Technical Advisory Committee have international implications should be got cleared by the Ministry of Water Resources before they are finally approved by the State Flood Control Boards and sanctioned by he State Government.

2.3 The schemes under the following categories may be sanctioned by the State Governments after they are approved by the State Flood Control Board.

(a) Raising and strengthening of existing embankments;
(b) Retired lines for existing embankments;
(c) Investigations of flood control, drainage, anti-water logging and anti-sea erosion works;
(d) Raising of villages.

Reference of the schemes under the above categories to the State Technical Advisory Committee will not be necessary. A schematic report of the schemes of category (b) above should be sent by the State Government to the Ministry of Railways and to the Ministry of Surface Transport (Roads Wing) for information.

2.4 The sanction of schemes by the State Governments would be subject to the financial provisions that may be made available from year to year. The schemes need not be referred to the Planning Commission for approval. A list of schemes sanctioned by the State Govt. together with the information in the proforma in Statement "A" in respect of each scheme should be supplied by the State Government, soon after sanctioning the scheme, to the CWC and the Planning Commission. Where the schemes relate to the Ganga basin, the above information will be furnished to the GFCC and the Ministry of Water Resources also. In case of schemes relating to the Indus Basin, the above information should be supplied to the Ministry of Water Resources also.

2.5 All emergent schemes costing upto Rs25 lakhs each to be carried out during the flood season which do not have inter-departmental/inter-State/international aspects and which do not affect the highways and the railways may be sanctioned by the State Governments on the recommendation of the State Chief Engineer.

3.0 Schemes costing more than Rs.7.5 Crore and not exceeding Rs.15 Crore

3.1 The scheme will be processed as follows:

(i) The schemes prepared by the Flood Control Departments which are on inter-State rivers and tributaries will be processed through the State Technical Advisory Committee and the State Flood Control Board and will be submitted to the CWC (for schemes in basins other than Ganga basin) and to the GFCC (for schemes in Ganga basin) in enclosed Statement "B".

(ii) All these schemes will be examined by the CWC and the GFCC as the case may be.

(iii) On the recommendation of the CWC/GFCC as the case may be, the approval of these schemes for inclusion in Plan will be processed by the Planning Commission.

3.2 Schemes with international implications will follow similar procedure as in para 3.1 except that the State Government will obtain specific clearance of the MOWR before they are recommended by the CWC/GFCC for approval of the Planning Commission in the manner indicated in para 3.1 (iii).

3.3 The following categories of embankment schemes may be considered as having inter-State implications.

(a) Such of the schemes which lie in or extend to a limit of 8 km from the border, on an inter-State river which does not flow down to any other State, but whose effect may extend in the upper State.

(b) Embankment schemes which are on rivers or tributaries which flow down to another State.

3.4 The following categories of embankment scheme may be considered as having international implications:

(a) Embankment schemes on the Indus river system.
(b) Embankments schemes in certain estuaries creeks affecting the adjoining estuaries in another country.
(c) Embankment schemes on rivers or tributaries which fall into parent rivers such as Ganga or Brahmaputra flowing ultimately into another country.

3.5 The following categories of schemes in the Ganga and Brahmaputra river basins which are prima-facie free from possible international repercussions need not be referred to the Ministry of Water Resources for clearance.

(a) Raising and strengthening of existing embankments.
(b) Drainage schemes comprising excavation of new drains and or provision of sluices in the various existing embankments.
(c) Schemes for channel improvement and closing of spill, well away from the Border.
(d) River training schemes sufficiently away from the border.
(e) Anti-erosion schemes sufficiently away from the border.

4.0 Schemes costing more than Rs 15 Crore

In case of schemes, each costing more than Rs.15 Crore, detailed project reports have to be prepared by the Flood Control Departments and processed in the same manner as indicated under Section 3.0 above and, thereafter, the project report will be sent by the State Governments to the CWC (to the GFCC in the case of schemes in the Ganga basin)for detailed examination with a copy to the Planning Commission and, where required, to the Ministry of Water Resources. The CWC/GFCC will process the schemes for consideration of the Advisory Committee. The schemes after the acceptance of the Advisory Committee will be considered for investment approval of the Planning Commission.

5.0 Modification and Revision of Schemes

5.1 The procedure mentioned hereunder will be followed in respect of flood control, drainage, anti-water logging schemes which undergo modification and/or revision subsequent to their approval on account of a change in their scope and/or a change in their estimated cost.

5.2 If the scope of the scheme in involving inter-State/International aspects requires a modification/ revision resulting in an increase in the cost of more than 10% but the revise cost of the scheme still continues to be the CWC (GFCC, in the case of schemes in Ganga basin) and the Ministry of Water Resources and the Planning Commission, for review and clearance/approval as required. Where

however, the revised cost is more than Rs 15 crore the revised estimate should be processed in the manner as indicated in Section 4.0 above for consideration of the Technical Advisory Committee of the Ministry of Water Resources and investment approval by the Planning Commission.

5.3 In the case of a scheme involving a change in its estimated cost only, if the revised cost of the scheme is Rs.15 crore or less, irrespective of the percentage increase in cost, only the increase in cost and the main reasons thereof need be intimated. Where, however, the revised cost is more than Rs 15 crore, if the revision results in an increase in the cost of more than 10% or Rs15 crore, whichever is less, the revised estimate should be processed in the manner as indicated in Section 4.0 above for consideration of the Advisory Committee of the Ministry of Water Resources and investment approval by the Planning Commission. This procedure will also be followed in the case of schemes involving a change in scope.

5.4 This is subject to obtaining the requisite administrative and statutory clearances by the competent authority as may be needed for processing a scheme under the procedure laid down hitherto.

In this connection, the Planning Commission wish to reiterate that no work or any flood control, drainage and anti- water logging scheme should be undertaken by the State Governments unless the schemes are approved in accordance with the procedure laid down in the paragraphs above. In the case of schemes which undergo modification and revision subsequent to their approval, the information required to be submitted to the CWC, the GFCC and the Planning Commission under para 5.0 above should be submitted well in advance so that the approval for the revised scheme is obtained from the Planning Commission before any additional commitments are made in respect of them.

STATEMENT – A

PROFORMA IN WHICH INFORMATION IS REQUIRED TO BE FURNISHED BY THE STATE GOVERMENT IN RESPECT OF FLOOD CONTROL DRAINAGE, ANTI - WATER LOGGING AND ANTI-SEA EROSION SCHEMES COSTING LESS THAN Rs7.50 CRORE EACH SANCTIONED BY THE STATES

1. Name of the scheme (attach Index map)

2. Name or river, river basin and district in which the scheme is situated

3. Nature of scheme - Whether new embankments, raising and strengthening of existing embankment, drainage, anti-erosion, town protection etc.

4. Length of embankment of damage channels

5. Estimated cost

6. Area benefitted

7. Date of sanction of the scheme

8. Whether inter-state/international aspect of the scheme if any has been examined by the State Technical Advisory Committee and, where necessary, clearance of the CWC/Ganga Flood Control Commission and the Ministry of Water Resources has been obtained.

9. Status of requisite administrative/statutory clearance

N.B Proforma extracted from circular No. 16(12)/1/99-I &CAD. dated 18.6.1999 issued by the Planning Commission and No. 16(12)/1/99-WR. dated 09.09.2003

STATEMENT – B

PROFORMA IN WHICH INFORMATION IS REQUIRED TO BE FURNISHED BY THE STATE GOVERMENT IN RESPECT OF FLOOD CONTROL DRAINAGE, ANTI - WATER LOGGING AND ANTI-SEA EROSION SCHEMES COSTING Rs 15 CRORE OR LESS BUT MORE THAN RS 7.5 CRORES EACH.

1. Name of the scheme (attach Index map)

2. Abstract of cost, including foreign exchange components, if any.

3. Skeleton report.

4. Area and population, which will get protected by the project.

5. (i) Betterment levy or flood cess if any proposed for area to be protected from floods or water logging or sea erosion.

(ii) Anticipated revenue there from.

6. (a) Benefit cost ratio.

(b) Cost per ha. of area protected.

7. The extent to which people's participation is envisaged for the execution of the schemes and in what from.

8. Whether inter-state/international aspect of the scheme if any has been examined by the State Technical Advisory Committee and where necessary clearance of the CWC/Ganga Flood Control Commission and the Ministry of Water Resources has been obtained.

9. Status of requisite administrative/statutory clearance.

N.B Proforma extracted from circular No. 16(12)/1/99-I &CAD. dated 18.6.1999 issued by the Planning Commission and No. 16(12)/1/99-WR. dated 09.09.2003

CHAPTER - X

FORMATS PRESCRIBED BY MINISTRY OF WATER RESOURES FOR ANALYSIS AND EVALUATION OF BENEFIT AND COST OF FLOOD MANAGEMENT SCHEMES

FORMATS PRESCRIBED BY MINISTRY OF WATER RESOURES (ERSTWHILE MINISTRY OF IRRIGATION AND POWER) FOR ANALYSIS AND EVALUATION OF BENEFIT AND COST OF FLOOD MANAGEMENT SCHEMES (STATEMENTS 1 TO 3).

STATEMENT OF FLOOD DAMAGES AND RELIEF MEASURES BEFORE CONSTRUCTION OF SCHEME (FOR LAST TEN Yrs.)

STATEMENT – 1

S.NO	ITEM	PARTICULARS
1.	Name of river:	
2.	Area affected by flood (every year):	
3.	Frequency of inundation:	
4.	Probable depth of inundation:	
5.	Duration of inundation:	
6.	Damages to crops :	
	a. Area of inundation:	
	b. Value of crop:	
7.	Damages of houses:	
	a. Pucca houses:	
	b. Kutcha houses:	
8.	Damages to public utility:	
	a. Wells:	
	b. Trees:	
	c. Land:	
9.	Total damages (6+7)	
10.	Relief:	
11.	Agriculture relief:	
12.	Remission of land revenue:	
13.	Other relief measures (for losses etc.):	
14.	Total relief:	
15.	Total cost of damages and relief:	
16.	Extent of beneficial value of fertilizing silt (10% of item no. 15):	
17.	Total flood losses every year (item no. 15-16):	

STATEMENT –2

STATEMENT OF FLOOD DAMAGES AND RELIEF MEASURES AFTER CONSTRUCTION OF THE SCHEME:

S.No.	ITEM	PARTICULARS

1. Name of river:
2. Name of scheme:
3. Name of district:
4. Area to be protected by the scheme:
5. Population to be protected by the scheme:
6. Annual flood damage after completion of scheme:
   a. Area flooded in hect:
   b. Population likely to be still affected:
   c. Frequency of flood:
   d. Probable depth of inundation in m:
7. Damage to the crop:
   a. Area in hectares:
   b. Value of crop:
8. Damages to houses:
   a. Number:
   b. Value:
9. Damages to public utility:
10. Total flood losses:

STATEMENT-3

BENEFIT COST RATIO ANALYSIS

S. No.	ITEMS	PARTICULARS

1. Net average loss due to flood before completion of schemes:
2. Net annual flood loss after completion of the scheme:
3. Annual benefit of the proposed scheme:
4. Operation and maintenance charges:
   a. Annual interest payable on total capital investment @ the general rate of 10% on upto date cost of scheme:
   b. Depreciation value of the project cost of scheme @ 2% per annum
   c. Annual maintenance charges covering the cost of staff and material cost of the scheme (4% for embankment schemes and 5% for anti-erosion schemes)

Total of item (4) = (a) +(b)+(c)

$$\text{Benefit cost ratio} = \frac{\text{Item no. 3}}{\text{Item no. 4}}$$

CHAPTER - XI

LIST OF PROFORMA FOR FURNISHING INFORMATION BY THE STATES TO THE CENTRAL AGENCIES

List of proforma for furnishing information by the States to the Central Agencies

Annually

1. Form no. CGA-I Annual report listing all major scheme (each scheme costing 15 crore or more) due for submission by 30th June. (Annexure I)
2. Form no. CGA-2 Annual report listing all medium schemes (each scheme costing more than Rs. 7.50 crore and less than Rs. 15.00crore) due for submission by 30th June. (Annexure II)
3. Form CGA-3 Annual report on other schemes (Schemes costing less than Rs. 7.50 crore each to be clubbed in convenient groups) due for submission by 30th June. (Annexure III)
4. Form No. CPA-1- Information on each major scheme to be separately given in this proforma due for submission by 30th June. (Annexure IV)

Quarterly

5. Form no. CPQ-1 Quarterly report separately for each major scheme. The quarterly report may be furnished by States to the Centre (CWC/GFCC as the case may be) within one month after the quarter is over (Annexure V)

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LIST OF IMPORTANT REFERENCES

1. Report of Rastriya Barh Ayog (Vol. I & II), Govt. of India, 1980.
2. River Behaviour Management and Training (Vol. I& II), Central Board of Irrigation and Power, 1994.
3. Broard Guidelines for Preparation of Project Estimate for Major Irrigation & Multipurpose Projects, Central Water Commission.
4. Embankment Manual, investigation, Design, Construction and Maintenance, Central Water Commission.
5. IS 8408:1994 Planning and Design of Groynes in alluvial river Guidelines (First revision).
6. IS 14262:1995 Planning & Design of Revetment
7. IS 10751:1994 Planning & Design of Guide Banks for alluvial rivers Guidelines (First revision)
8. IS 12094:2000 Guidelines for Planning & Design of River Embankments (levees).
9. IS 11532:1985 Guidelines for Construction of River Embankments (levees).
10. IS 12926:1995 Construction and maintenance of guide banks in alluvial rivers- Guideline (First revision).
11. IS 8835:1978 Planning & Design of Surface Drains