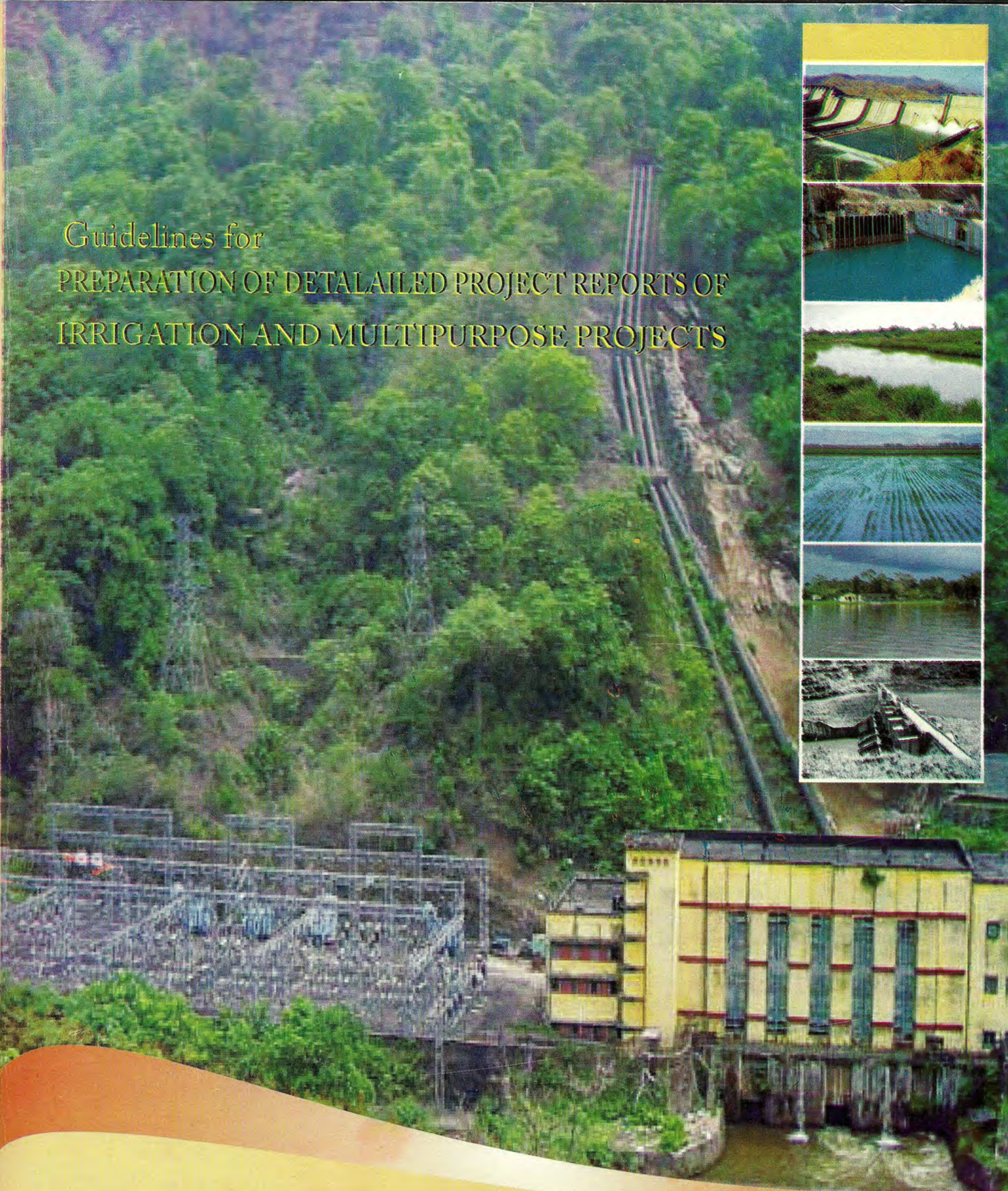
Guidelines for

PREPARATION OF DETALAILED PROJECT REPORTS OF IRRIGATION AND MULTIPURPOSE PROJECTS



GOVERNMENT OF INDIA

MINISTRY OF WATER RESOURCES

2010

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GUIDELINES FOR PREPARATION OF DETAILED PROJECT REPORT OF IRRIGATION & MULTIPURPOSE PROJECTS

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FOREWORD

Detailed Project Report is an important document for examining techno-economic viability of a project and arriving at a decision for making investment. Therefore, it is essential that the project report is prepared well and is based on reliable data, adequate investigations and after comprehensive studies on various techno-economic aspects. A good project report enables the scrutinizing agencies speedier examination and minimizes the time taken for its approval.

Presently "Guidelines for Preparation of Detailed Project Reports of Irrigation and Multipurpose Projects-1980" is being used. In view of the changes in policy and technological developments in formulation, funding, execution, operation and maintenance of the projects and the experience gained in the use of these guidelines since 1980, it has been felt necessary to update them. Accordingly the Ministry of Water Resources constituted in May 1999, a Working Group under the chairmanship of the Chief Engineer, Project Preparation Organization, Central Water Commission with representatives from the State Governments, Union Ministries and the Central Government Departments and Institutions as its members. The Working Group submitted its report to Ministry of Water Resources in August, 2000.

Thereafter, the latest circulars/guidelines issued by the Planning Commission, Central Water Commission, Central Ground Water Board and various concerned ministries have been incorporated in the guidelines. Use of modern techniques such as remote sensing, satellite imageries, aerial photography, DGPS have been included for cutting short the time required in topographical surveys, site selection etc. Details of instrumentation have been included which will help in assessing the safety and proper functioning of dams and other hydraulic structures in river valley projects. Emphasis has been laid for inclusion of PERT/ CPM diagrams for construction programme of various components. This would help in effective monitoring of milestones and taking timely remedial measures. Details required for lift irrigation, pump storage schemes, power transmission system, power potential studies have also been incorporated. The guidelines also seek information on similar/pending project in the concerned States, their physical and financial expenditure during last five years etc to assess whether the State has capacity and resources to start new projects.

I acknowledge with thanks the valuable contribution made by the Working Group as well as the officers from the various organizations and hope that these guidelines would go a long way in the preparation of comprehensive Detailed Project Report.

Umesh Narayan Panjiar

(U.N.Panjiar)
Secretary(WR)

PREFACE

Substantial outlay under the five Year plans in the country is being allocated to the irrigation sector including construction of projects. These projects are investigated, formulated and implemented by the State Governments concerned. However, before implementation, the projects require clearance from the Planning Commission and inclusion in the state plans. The procedure for formulation and appraisal of irrigation and multipurpose projects has been laid down by the Planning Commission in their circulars to the State Governments from time to time. These circulars inter-alia give a list of items on which information and details are to be incorporated at the time of preparation of project reports.

Central Water Commission has been entrusted with the responsibility of examination of technical and economic viability of the proposals prepared by the State Govts for major and medium irrigation and multipurpose projects before Planning Commission considers them. Recently, however, the State Governments have been permitted to accord investment approval to the major & medium irrigation projects not located on inter-state rivers or their tributaries subject to the condition that they will obtain confirmation/certification from the CWC to the effect that the proposed project does not have inter-state ramifications. However, major & medium projects located on interstate rivers and their tributaries are examined by CWC and put up to the Advisory Committee of MoWR for techno-economic acceptance . The environmental and ecological aspects which have to be addressed in the project reports have been outlined by the Ministry of Environment and Forests. They have also issued guidelines/check lists for submission of application for clearance of projects from environmental and forest angles. Similarly, Ministry of Tribal Affairs have also issued guidelines for resettlement and rehabilitation of SC & ST population.

Presently the guidelines issued in 1980 are being referred for preparation of detailed project reports of irrigation and multipurpose projects. In view of the changes in policies & priorities of the Government, technological advancements and experience gained through use of the guidelines since 1980, Ministry of Water Resources set up a working group under the chairmanship of Chief Engineer, PPO, Central Water Commission in May, 1999 with representatives from the State Governments, Union Ministries and the Central Government Departments and Institutions as its members. The Working Group submitted its report to MOWR in August, 2000. Thereafter, the draft guidelines have undergone several revisions in order to incorporate suggestions/ observations of various central agencies as well as State Governments. The present volume contains the finalized guidelines divided into four parts: Part-I -Guidelines for Preparation of Detailed Project reports of Irrigation and Multipurpose Projects, Part-II -Guidelines for Preparation Detailed Project reports for Flood Management Schemes, Part-III - Guidelines for Preparation of DPRs for Modernisation of Irrigation Projects and Part-IV -Guidelines for Preparation of DPRs for Command Area Development.

The modifications made in the 1980 guidelines cover use of modern techniques such as remote sensing, use of satellite imageries, aerial photography, Differential Global Positioning System (DGPS) for cutting short the time required in topographical surveys, site selection etc. Details of instrumentation to be provided on the civil structures have been included which will help in assessing the safety and proper functioning of dams and other hydraulic structures in river valley projects. Emphasis has been laid for inclusion of PERT Chart and CPM diagrams for construction programme of various components. This would help in effective monitoring of milestones and taking timely remedial measures. Details required for lift irrigation, pump storage schemes, power transmission system, power potential studies have also been incorporated.

The guidelines have been formulated in such a manner so as to facilitate not only the agencies responsible for formulation of the project reports but also the agencies charged with the responsibility of techno-economic scrutiny of the project. The list of references useful for formulation of the project report is also given at the end of guidelines.

The present edition of guidelines is the result of commendable efforts and hard work put in by Chief Engineer(PPO), other members of the working group & Officers of Project Preparation Organisation of CWC. I place on record appreciation for all Central and State agencies for their valuable contributions in preparation and finalization of these guidelines.

(A.K. BAJAJ)
Chairman
Central Water Commission

EXECUTIVE SUMMARY

1. Introduction

Water Resources Sector has made significant progress since independence. Still a lot more needs to be done for meeting overgrowing and competing demands of water for agriculture, domestic and industrial water supply, power generation (both thermal and hydel), aqua-culture, recreational & tourism activities etc. The experience gained over the years has shown that the time and cost over run on the projects could have been minimized, if not avoided altogether, if the projects were thoroughly investigated and properly formulated. For this purpose comprehensive guidelines for the preparation of project reports, were issued by the then Ministry of Irrigation (now Ministry of Water Resources) in 1980. The same guidelines are being used at present.

The revision of the guidelines has been felt necessary in view of the various changes that have taken place in the project formulation, funding and execution of the projects since then. For updating the Guidelines, Ministry of Water Resources constituted a Working Group in May,1999. The Working Group submitted its report to MOWR in August, 2000 for approval. Thereafter, it was circulated to Central Govt. Department/State Govt and scrutinized by setting up a committee in CWC. The revised draft Report was forwarded to MOWR in Sept 2008 after incorporating various suggestions/ observation of Central Govt. Departments as well as State Govts. The report was also sent to the Chief Advisor (cost),Deptt of expenditure, Ministry of Finance. Comments/suggestions offered by various wings of MOWR and Deptt of expenditure have been incorporated in the present updated version of guidelines

2. The format of the Guidelines

The Guidelines has four parts: Part-I -Guidelines for Preparation of Detailed Project reports of Irrigation and Multipurpose Projects, Part-II -Guidelines for Preparation Detailed Project reports for Flood Management Schemes, Part-III - Guidelines for Preparation of DPRs of Modernisation of Irrigation Projects and Part-IV -Guidelines for Preparation of DPRs of Command Area Development.

Part-I - Irrigation and Multipurpose Projects:

Section-1 deals with the comprehensive check list and Section-2 deals with the salient features of the projects. Section-3 describes the details required under various chapters like physical features, interstate and international aspects, surveys and investigations, hydrology, design for various stuctures, reservoir operation, irrigation Planning, drainage, construction programme, manpower & plant planning, estimates, benefit cost Ratio, internal rate of Return, apportionment of cost among various purposes of multipurpose projects etc. The detailed proforma for compilation of information on surveys and investigations, hydrology, rainfall, crop water requirement, irrigation demand table, reservoir operation B.C. ratio and I.R.R. calculations are enclosed as annexures. To facilitate the project engineers, sample calculations for requirement of category and size of production equipment, B.C. ratio, I.R.R., cost apportionment have also been appended.

Irrigation projects with culturable command area (CCA) more than 10,000 ha., between 2000 ha. and 10,000 ha. and less than 2,000 ha. are classified as major, medium and minor projects respectively. The procedure for submission ,appraisal and clearance has been outlined in the ' Guidelines for submission ,appraisal and clearance of Irrigation and Multipurpose Projects 2010'. The guidelines are applicable to the major & medium irrigation projects located on inter-state rivers or their tributaries. The State Governments are empowered to accord investment approval to the major & medium irrigation projects which do not have inter-state ramifications subject to the condition that they will obtain confirmation/certification from the CWC to the effect that proposed project does not have inter-state ramifications. The State Governments are required to obtain statutory clearances like environmental and forests clearances from the Min. of Environment & Forests, approval for rehabilitation and resettlement plan from Ministry of Tribal affairs and all other clearances, as may be required before the investment approval is accorded.

The projects proposed for external assistance from the World Bank, Asian Development Bank, Japan Bank of International Cooperation, European Economic Community etc. are also to be prepared as per guidelines for Irrigation & Multipurpose Projects. Lift Irrigation Schemes are classified into Major, Medium and Minor Schemes as for any other project depending upon the CCA. The same procedure for scrutiny and approval as applicable for other projects, would apply to these schemes as well. The pumped storage schemes are planned for increasing the availability of peaking power by utilising the available surplus power during the lean period of the day. This increases the availability of water in reservoir during power generation in peak hour.

Part-II- Flood Management Schemes:

The guidelines for preparation of flood management schemes give the details of schemes e.g.embankment and anti erosion works, length of embankment and drainage channels, cost estimates, inter-state issues, design particulars, B.C. ratio calculation etc. It also includes the guidelines for submission, appraisal and clearance of flood management schemes. To facilitate the project engineers references of relevant Indian Standard for planning and design of revetments, groynes etc have been given. Model bill for flood plain zoning is also enclosed.

Flood management schemes are first considered & accepted by the state level Flood Control Technical Advisory Committee and then by the State Flood Control Board. Approval to these schemes is then accorded by the State Govt. Major & Medium schemes approved by the Flood Control Advisory Committee & the State Flood Control Board are examined by

CWC/GFCC (Schemes in Ganga Basin). While the medium schemes are recommended by CWC/GFCC directly to the Planning Commission, Major schemes need acceptance by the Advisory Committee for Irrigation, Flood Control & Multipurpose Projects before investment clearance is accorded by the Planning Commission

The structural measures of flood management consist of embankments and flood walls, dams or reservoirs, detention basins, channel improvement, emergency flood ways, river diversions, bank stablisation, anti-erosion measures, ring bunds, underground storage etc. Among the non-structural measures, the measures that modify the susceptibility to flood damage are flood plain management, flood proofing including disaster preparedness & response planning and flood forecasting & warning etc. Those which modify loss burden are disaster relief, flood fighting including public health measures and flood insurance. The extent of protection by structural measures i.e. flood control schemes is dependent on the design criteria adopted (such as flood frequency, intensity of rainfall and return period etc.) which in turn depend upon economic consideration and they cannot afford complete protection in all circumstances. Therefore a judicious mix of structural and non-structural measures is the best strategy for management of floods and restricting the total monetary loss and distress to the people resulting from floods with the available resources. Rashtriya Barh Ayog in its Report has covered extensively about these schemes and it may be referred to while planning a flood control project.

Part-III- Modernisation Of Irrigation Projects:

Modernisation of Irrigation Project includes extension, renovation & modernisation components of existing project to optimize the benefits in view of the deficiencies experience in operation & maintenance of the project over the past years and as a result of technology advancements made during the period. This also takes into account the deterioration of the system due to lack of proper maintenance. Important aspects to be looked into are to review water availability, design flood, cropping pattern, water demand, operation and safety of the headworks & water distribution system. It would include measures for conjunctive use of water & drainage of surplus water. It also includes review & strengthening of agricultural support services & plan for involvement of beneficiaries in management of the project for self sustainability in future. The modernisation of irrigation projects inter-alia would mean upgrading the existing headworks, canals, command area development works etc. in view of experience gained and deficiencies felt in operation and maintenance of the project over the past years in order to derive optimum benefits for the present day irrigated agriculture.

While undertaking the modernisation of existing irrigation projects, the differentiation between restoration or rehabilitation vis-à-vis modernisation needs to be understood. The restoration or rehabilitation of irrigation projects may include the works required to bring the canals components to their originally designed parameters i.e. restoring them to original sections and the canal capacities etc. The modernisation would be updating and improving the components to meet modern day concepts on safety and present day demand of water for irrigation, water supply and other diverse uses. The modernisation also includes extension of the existing system. The existing canals which were designed for traditional crops may be found wanting to meet the present day enhanced requirements of high yielding varieties of crops. Moreover, the old systems were mostly designed for protective irrigation. In order to meet the rising demand of foodgrains, the concept of irrigation has undergone a major change from protective to productive irrigation. The productive irrigation implies that for any unit of water supply on a unit of land, the production should be optimum. Due to inadequate maintenance of the system for want of adequate funds, these have deteriorated and are required to be rehabilitated/restored in the first instance. Considering present day needs, these would also require to be modernised.

Most of the existing irrigation systems in the country were planned with unlined canals for traditional cropping pattern and assumed irrigation efficiencies. These systems are therefore, not able to cope up to the modern day agriculture and a lot of deficiencies like seepage losses, inadequacy of systems/canal structure to meet higher demands have been noticed. Modernisation of irrigation system does not mean merely improvement of the engineering parameters such as lining of canal and distribution system, improvement and modification of structures but also may include review of cropping pattern, crop water requirement, efficiencies of irrigation i.e. field application of water, remodelling/re-sectioning, re-aligning of canal, maintaining of required L Section and X Section of the canal and canal banks/berms. This would also include review of hydrology i.e water availability, design flood, sedimentation etc. & strengthening/remodelling of headworks if found necessary.

Section-1 gives the comprehensive check list and Section-2 gives the salient features of the schemes . Section-3 gives the details to be included under various chapters like hydrology, reservoir operation, structures to be modified, cropping pattern and crop water requirement, demand table, improvement in the canal system, water management aspects, construction programme, estimates, B.C. ratio etc. Proforma for compilation of information on proposed and existing cropping pattern and results of experiments on seepage losses have also been enclosed as annexures.

Part-IV- Command Area Development (CAD):

The guidelines of Command Area Development project report includes format of contents of project report, check list, salient feature of irrigation project, salient features of CAD projects. The text of report includes various chapters like project details, available water resources at project head, status of conveyance system, irrigation development of command area, status of on farm water management system, crops and cropping pattern, technical details of works to be carried out, participatory approach to implement the programme , agriculture infrastructure facilities etc.

Earlier the distribution system upto the outlet of 40 ha was constructed by the State Government & further conveyance of water was responsibility of the farmers. This resulted in slow development of irrigation. The GOI launched in 1974, CAD Programme in which assistance is provided to the States on matching basis for on-farm development works such as land leveling & shaping, field channels, field drains, farm roads, agricultural & irrigation extension services etc. Necessity of involvement of farmers in management of irrigation system through farmers organizations (Water Users Associations at Minor level, Distributaries Committees & Project Management Committee) has been felt & it is now a part of CAD Programme. MOWR have prepared guiding principles for implementation of restructured command area development and water management programme which is available in MoWR website. This may be referred to while formulating proposals for inclusion of a project under centrally sponsored CAD&WM programme.

The command area development works can be divided in two parts namely, the off-farm works and the on-farm works. The off-farm works include marketing centres, roads for communication, financial institutions, cold storages, supply centres for agriculture inputs (seeds, fertilizers, pesticides), agricultural extension services, major drainage channels, lateral drains etc. The on-farm works include land levelling and shaping, construction of field channels below 5 to 8ha (lined or unlined), field drains and farm roads etc. The scope and extent of these measures are influenced by topography, nature of soil, pattern of cropping and the mode of irrigation. The implementation of warabandi /osrabandi is an important management tool for equitable distribution of water among farmers. Strengthening of agricultural and irrigation extension in the command area are equally necessary.

Involvement of farmers in irrigation water distribution, fixation and collection of water rates and proper upkeep of distribution system is the need of hour to improve the performance of the Project. Their involvement from the planning stage to completion of the project will help the executing agency in maintaining the construction standards. This will bring the sense of ownership of the project. For this formation of Water Users Associations (WUAs) at minor level and their confederation at distributary level has to be encouraged. Representatives of Distributary Committees should be included in the Project Level Management Committee. Rules and regulations for this activity are required to be prepared and notified either under an existing act or a new Act to be enacted by the State Legislature. For technical, managerial and motivational support to WUAs, the NGOs involvement as catalysts/facilitators can be considered.

Participatory Irrigation Management (PIM) is the manner of managing irrigation, water distribution and its use with all its related aspects, under which the management responsibilities (including decision making) are taken over by the Water Users' Association (WUA), in an upwardly tapering manner, as we proceed from outlets through minors, distributaries and branch canals to main canals and headworks. The basic essence of PIM is the transfer of authority and responsibility for irrigation management alongwith operation &

management of the system below an agreed interface from the Water Resources/Irrigation Department to the WUAs and their participation in management of the components which are retained by the Water Resources/Irrigation Department for O&M..

3. Acknowledgement

The guidelines have been formulated in such a manner so as to facilitate not only the agencies responsible for formulation of the project reports but also the agencies charged with the responsibility of techno-economic scrutiny of the project. At the end of guidelines, references of relevant BIS codes, manuals, text books and guidelines issued by various agencies on different aspects, list of abbreviations, glossary of technical terms and conversion factors have been added.

I acknowledge the valuable contribution made by the Working Group, officers from the various organizations and Project Preparation Organization, CWC in preparation/ finalization of guidelines.

(R.C.JHA)
Member (WP&P)
Central Water Commission

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PART-1

GUIDELINES FOR PREPARATION
OF
DETAILED PROJECT REPORT
OF
IRRIGATION & MULTIPURPOSE
PROJECTS

DETAILED PROJECT REPORT
SECTION-1
Check List

I. GENERAL DATA

1. Name of the project

2. Location

   (a) State(s)
   (b) District(s)
   (c) Taluka(s)/Tehsil(s)
   (d) Longitude/Latitude
   (e) Survey of India Topographical Map reference No.(s)
   (f) Earthquake Zone number
   (g) Complete address for correspondence along with pin code/e-mail

3. Category of the project

   (a) Irrigation/Multipurpose
   (b) Storage/diversion

II. PLANNING

4. Has the Master plan for overall development of the river basin been prepared and stages of basin development discussed ?

5. Have the alternative proposals (including set of smaller developments vis-à-vis a single large development) been studied and their merits and demerits discussed

6. Does the scheme fit in the overall development of the river basin and has its priority in the overall development of the basin been discussed?

7. Have the other Departments concerned with the development been informed?

8. Is the present scheme proposed to be executed in stages? If so, are its various stages of execution and development discussed in the report?

9. Are the effects of the scheme on the riparian rights & existing

upstream and downstream projects etc. discussed?

10. Has the provision for municipal and industrial water supply been made?

III. INTERSTATE AND INTERNATIONAL ASPECTS

11. Are there any International/Interstate issues involved? If so, have these issues been identified and present status of agreement or tribunal decision indicated specially in respect of

(a) Sharing of water
(b) Sharing of cost
(c) Sharing of benefits (irrigation, flood control, power etc.)
(d) Acceptance of the submergence by the upstream state(s)
(e) Acceptance by the upstream state(s) of compensation of land coming under submergence
(f) Settlement of oustees
(g) Any other

NOTE:- If there is no agreement state the present position against each of the above item.

IV. SURVEYS

12. Have the detailed topographical surveys been carried out for the following items and maps prepared as per prescribed scales

(a) River surveys
(b) Reservoir surveys
(c) Headwork surveys (dam(s), dyke(s), barrage(s), weir(s) etc. and auxiliary components)
(d) Plant and Colonies' sites
(e) Canal(s), branch canal(s) and water distribution system
(f) Major canal structures
(g) Power house, switch-yard, surge shafts, tailrace
(h) Tunnel(s), adit(s), penstocks etc.
(i) Surveys (detailed and sample) of areas of the command for OFD and drainage works
(j) Soil surveys
(k) Surveys for soil conservation
(l) Any other surveys i.e. archaeological, right of way, communication etc.

V. GEOLOGICAL INVESTIGATIONS

13. Have the geological surveys for the following items been carried out and report on geology of the following appended?

(a) Region as a whole
(b) Reservoir
(c) Headwork and energy dissipation area
(d) Power house and appurtenances
(e) Intakes and regulators
(f) Major canal structures
(g) Tunnel(s), Penstock(s), hill(s) etc.
(h) Communication routes
(i) Any other

VI. SEISMIC INVESTIGATIONS

14. Has the seismicity of the region been studied and co-efficient of vertical/horizontal acceleration for the various structures discussed?

15. Has the approval of the Standing Committee for recommending design of seismic coefficients for River Valley Project been obtained?

16. Is there possibility of liquefaction of foundations? If so whether liquefaction studies been carried out?

VII. FOUNDATION INVESTIGATIONS

17. Have the detailed foundation investigations (including in-situ tests and laboratory tests) for the following structures been carried out and detailed report(s) appended?

(a) Earth and rock fill dam(s)
(b) Masonry/concrete dam(s)
(c) Barrage(s)/Weir(s)/head regulator(s) etc
(d) Canal(s) & Canal Structures
(e) Power house(s), tunnel(s), transformer cavern(s), de-silting chamber(s), surge tank(s)/shaft(s), intake(s)
(f) Pump House(s)
(g) Any other

18. Are there any special features affecting the designs?

VIII. CONSTRUCTION MATERIAL SURVEYS

19. Have the surveys and laboratory tests for the following

construction materials been carried out and report(s) appended?

(a) Soils for impervious, semi-pervious and pervious zones of earth and rock-fill dam(s)
(b) Sand
(c) Rock and coarse aggregates
(d) Bricks and tiles
(e) Pozzolona
(f) Cement and lime stone
(g) Steel
(h) Any other

20. Have the sources for each of the above material been identified and need etc. indicated?

21. Have the proposals for procurement of scarce materials been indicated?

IX. HYDROLOGICAL AND METEOROLOGICAL INVESTIGATIONS

22. (a) Have the hydrological and meteorological investigations been carried out and status of following data discussed in report?

(i) Rainfall
(ii) Temperature
(iii) Sunshine
(iv) Gauge & Discharge
(v) Sediment
(vi) Water quality
(vii) Evaporation

(b) Has the above data been collected & appended?

X. HYDROLOGY

23. Is the hydrology dealt with in detail in a separate volume? Have its brief details been included in this Report?

24. Have an index map and bar chart showing locations of various hydro-metric, climatic and rainfall stations existing/ongoing/planned water resources projects and the data availability at those stations been attached?

25. Have required detail note about project specific hydro-meteorological data observatories been attached.

26. Have required detail in case of Himalayan rivers, if project being planned in upper reaches, the satellite imageries of project catchment especially one during snowmelt period (March-May) and one during monsoon (June-September) period been attached?

27. Are detail notes about quality, consistency, processing and gap filling of the data included

28. Have hydrological studies been carried out for the following:

    (a) To establish the availability of water for the benefits envisaged?
    (b) To determine design flood for the various structures (spillway, weir, barrage etc.)
    (c) Sediments storage
    (d) Design flood for diversion during construction
    (e) Tail water rating curve
    (f) Evaporation rates from reservoirs/concerned area
    (g) Command area rainfall

29. Has the Ground Water Potential (existing use and additional availability) been indicated?

30. Have the studies regarding reservoir sedimentation been carried out and revised elevation-area capacity curves been used in the simulation studies (Working Table)?

31. Have the ecological requirements of water such as low flow augmentation and water quality control etc. and water requirement for domestic, industrial use and power generation (thermal, hydel, nuclear) been considered and included in the Project Report and incorporated in the simulation studies?

32. Have the details of the simulation studies (Working Tables) and conclusions arrived from the various alternatives explaining the factors and assumptions been included and discussed?

33 Has the number of failures for different aspects been indicated?

34. Have the likely desirable and undesirable changes in the hydrologic regime due to the project been brought out in the report?

35. Is the criteria adopted for selection of the construction diversion flood discussed?

36. Has the basis for determining the storage capacity been discussed.?

37. Have integrated working tables (for more than one reservoir in the system) been prepared?

38. Has carry over storage been provided? If so, whether studies for most economic carry over storage been done?

39. Have the flood routing studies, been carried out?

40. Have the back water studies been carried out?

XI. LAND ACQUISITION AND RESETTLEMENT OF OUSTEES

41. Have the type and quantum of land proposed to be acquired in the submerged area, project area, area coming under canals and distribution system, area required for rehabilitation of the oustees been detailed?

42. Is the basis for provision for land compensation indicated?

43. Have the rehabilitation measures, amenities and facilities to be provided to the Project Affected Persons been discussed and whether their provisions included in the report? Are these in accordance State's policy/project specific policy/draft national policy for rehabilitation and resettlement

44. Are the basis of land acquisition of the submerged area upto FRL/MWL etc. discussed?

XII. DESIGNS

45. Does the state have established a Central Design Organisation and State level multidisciplinary Advisory Committee and whether its composition has been indicated in the report?

46. Has the selection of final location of the headworks and appurtenances, in preference to the other sites investigated been discussed?

47. Have the layout of the project viz location of headworks, workshop sheds, offices, colonies etc. been finalised and discussed?

48. Has the layout of the various major components of the headworks been discussed in the light of site features, geology, foundation characteristics etc?

49. Have the detailed designs been prepared for the following components & got vetted by CDO?

(a) Earth or rockfill dam, masonry or concrete dam, spillway, barrage, weir, etc. and appurtenances.

(b) Energy dissipation arrangements, training walls etc.

(c) Openings through dams-galleries, head regulators, penstocks other outlets, sluices etc.

(d) Regulators

(e) Canal and water conductor system

(f) Canal structures

(g)Pump house, intake structures

(h) Power House, tunnels, surge shaft

(i) Instrumentation

(j) Power evacuation arrangement

(k) Design of Hydro Mechanical equipments

50. Have the salient features of the above components and the assumptions made in the design of above components of the project been indicated and their basis discussed?

51. Have any model studies been carried out for location of the dam, spillway and other appurtenances & checking the design profile of the spillway, energy dissipation arrangements, location of outlets/regulators etc?

52. Has the final alignment of canal(s) and branch canals(s) been discussed in the light of various alignments studied?

(a) Does the canal design provide for meeting requirements of rush irrigation?

(b) Have any intermediate storages and tail tanks been considered to reduce the canal capacities?

53. Are the canals and distribution system being lined and if so what is the minimum capacity of the channel proposed to be lined?

54. Is the location of canal structures on main and branch canals fixed after detailed surveys of the final alignments?

55. Are the regulation arrangements of the off-taking channel both near and away from the cross regulators discussed?

56. Are sufficient escapes including terminal escapes provided on the main/branch canal distributaries/minors?

57. Have the basis for adopting water way for the cross drainage works been discussed?

58. Have the proposals for rating the canal section by providing standing wave flumes, rating of the falls, broad crested weirs. V- notches etc. been discussed for the canal and distribution system?

59. Have any model studies for major canal structure(s) been carried out and if so are the results discussed and incorporated in the design?

XIII. IRRIGATION AND COMMAND AREA DEVELOPMENT

60. Have the conveyance and field irrigation efficiencies for paddy and upland crops during kharif, rabi etc. been indicated, discussed and justified?

61. Have the 10-daily/monthly crop water requirements at the canal head been worked out?

62. Are there any proposals for introducing warabandi and if so have these proposals been discussed in the report and sample calculations for a typical distributary/minor/sub-minor furnished?

63. Has the present position of irrigation in the command through existing canals, tanks, lift schemes, wells etc. been brought out in the report?

64. Are the particulars of all irrigation projects (including minor schemes) existing/proposed in the command been indicated?

65. Are there any potential areas, where ground water is available? If so, has the quantity & quality of the ground water been indicated?

66. Has the quantum of available ground water been assessed and plan for its conjunctive use with surface water been prepared and incorporated in the report?

67. Have the semi-detailed soil surveys been carried out for the entire

command? If not the extent of area surveyed may be indicated.

68. Have soil and land irrigability classifications brought out in the report?

69. Is the method used for determining the crop water requirements discussed?

70. Has the pre-project cropping pattern and the proposed cropping pattern alongwith justification been furnished?

71. Has the proposed cropping pattern been certified by Centre/State Agricultural Authorities giving the statement of having considered the soil characteristics and land irrigability characteristics of the command area in deciding the percentage of the command area falling under respective crops as suggested in DPR.

72. Whether drinking water needs of the population projected for the 25-30 years after construction of the project on enroute and that in the command of the project considered.

73. Whether the proposed G.W utilisation is certified by CGWB and a statement furnished.

74. Are the areas and percentages of the CCA that will be irrigated during kharif, rabi, two seasonal, summer and perennial been indicated?

75. Is justification furnished for irrigating perennials and summer crops from the reservoir?

76. Have the monthly reservoir operation studies been carried out at least for 20 years and summary on annual basis attached?

77. Have the number of blocks selected for detailed surveys for On Farm Development (OFD) works including drainage and total area covered by such blocks been indicated?

78. Have the existing locations of the Trial cum Demonstration Farm, input centres (seeds, fertiliser and insecticides) in the command been indicated and proposal to strengthen the same discussed?

79. Have the arrangements for financing the OFD works and proposals, if any, for strengthening the same been discussed?

80. Have the agencies responsible for execution of OFD works been identified and simultaneous planning of execution of OFD works along with engineering works discussed?

81. Has the year-wise phasing of irrigation development as a result of the project been discussed?

82. Is the existing communication system telephone, wireless and roads within command area sufficient to meet the requirement after full development of irrigation? If not, have the new proposals been planned and discussed?

83. Is the adequacy of the marketing centres in the Command Area and new proposals to meet the requirements after full development of irrigation been discussed?

84. Is there any stablisation of existing irrigation proposed?

XIV. FLOOD CONTROL AND DRAINAGE

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

86. Have the damage areas in pre-project & post project situations been identified and flood intensities worked out at each of the damage centre(s) which gets affected?

87. Have the following flood aspects been discussed?

    (a) Flood cushion in the reservoir.
    (b)Maximum moderated flood out flows over the spillway etc. and its frequency.
    (c) Existing and proposed safe carrying capacities of the channel below the dam after construction of flood embankment, channel improvement, river diversion etc.
    (d) Synchronized moderated peak floods due to release(s) from the dam upstream and unintercepted catchment upto the damage centres.
    (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 in annual loss of life, property, cattle, crops etc. (evaluated in terms of money) due to flood control.

88. Have the following drainage aspects of command area been discussed?

    (a) Existing Surface and sub-surface drainage network and problems of the drainage congestion, water logging, alkalinity/salinity if any.
    (b) Studies on sub soil water table (pre-monsoon, post-

monsoon etc.).

(c) Maximum intensity of 1, 2 and 3 day rainfall.

(d) Deficiencies in farm drains.

(e) Deficiencies in existing natural drains

(f) Proposal for improvement of drainage/water logging /alkalinity/salinity of the area alongwith justification thereof..

(g) 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.

XV. NAVIGATION

89. Is the present scheme for remodelling of the existing facilities and/or extension of the navigable reach or establishing new navigable reach?

90. Is the existing inland transport system being fully utilised? If not, have the bottlenecks in its full utilisation been identified and discussed?

91. Have the surveys for goods and passenger traffic been carried out and discussed?

92. Is the extent of modification required in the existing system discussed and justified?

93. Do design for the canal section and structures take into account the navigation requirements?

94. Have the proposals to develop the new scheme and phases of development in the different reaches been discussed?

95. If the area is being served by inland water transport, have the following been discussed:

(a) The existing toll rates and registration fees for the crafts (size-wise)

(b) Proposals for revision of tollage rates and fees, if any.

(c) Concurrence of the competent authorities for revision of rates and fees.

(d) Proposal to subsidies the tariff, tollage, craft registration fee, passenger fare etc. to attract traffic.

96. Has the State Inland Water Authority been consulted while finalising the scheme and its view point discussed?

97. Has economic justification and viability of the navigation component of the multipurpose project been discussed?

XVI. POWER

98. Have the following points been discussed?

(a) Availability of the power generating capacity in the state as well as in the region from different sources.

(b) Total energy available and peaking capacity of the system in the state as well as in the region from different sources.

(c) Integrated operation of the system and present status of utilisation in the state as well as in the region.

(d) Surpluses and shortfalls in the system in the state as well as in the region.

(e) Future plans of power development from different sources in the State/region.

(f) Fitment of the scheme in planning of power development of the State/region.

(g) Energy generated from the project, firm power, seasonal power and total power

(h) Proposal for transmission lines connecting to the existing system/grid.

(i) Project cost per kwh installed and per kwh generated at bus bar as compared to the different hydro-electric, thermal generation and gas projects and different sources in the State as well as in the region to justify the power component of the project.

(j) Whether the proposed addition to the transmission system has been shown on a geographical map. Whether options considered for the proposed addition have been discussed with statement of justification for the selected option after carrying out supporting studies covering load flow studies, short-circuit studies (three phase and single phase) and stability studies.

(k) *Whether sufficient surplus off peak power is available for pumping of water from lower to upper reservoir.

(l) *Actual off peak energy requirement of proposed scheme

(m)*Cost of peak and off peak energy

for pumped storage schemes only

XVII. CONSTRUCTION PROGRAMME AND PLANT AND MANPOWER PLANNING

99. Are the major components of work proposed to be done

departmentally or through contractor?

100. Have the various alternative construction programme been studied and proper justification furnished for the final programme adopted?

101. Has the proposed construction programme been prepared and synchronised for timely completion of each of the major component of work including Command Area Development?

102. Have the year wise quantities of the following materials of construction been worked out for various components of the project:

(a) Excavation separately in -soft and hard strata
(b) Earthwork in filling-impervious, semi-pervious and pervious
(c) Rockfill- for dam, toe, riprap etc.
(d) Stone for masonry
(e) Coarse aggregate for concrete
(f) Sand- for filter, masonry/concrete
(g) Gravel- for filter
(h) Steel of various sizes and type
(i) Cement-normal, quick/slow setting with or without pozzolona, special types
(j) Lime-surkhi-pozzolona
(k) Scarce material-special steel
(l) Other material-fuel, electricity, explosive etc.

103. Have the year wise quantities to be executed by machine/labour for each of the major component been worked out for each of the above material?

104. Have the labour intensive items of the various major components of the project been identified and the quantities of such items worked out?

105. Have PERT chart or CPM diagrams for construction programme of various components been made and included in report? Has organisational set up and frequency for project monitoring been indicated in the Report?.

XVIII. FOREIGN EXCHANGE

106. Have the details of the plant and machinery, spares, instruments and scarce materials to be imported worked out?

107. Has the phasing of imports and source(s) of imports been discussed itemwise?

108. Are the imports to be affected under foreign grants/credits or internal resources of the country?

109. Is the scheme covered under State sector or Central sector?

XIX. FINANCIAL RESOURCES

110. Has the concurrence of the State Finance Department been obtained?

111. Is the scheme included in the Five Year/Annual Plan? If not what is the present position regarding its inclusion in the plan?

112. Whether the scheme has already been started? If so, is the present stage of construction indicated?

113. Have the yearwise requirement of funds been indicated?

114. Is the scheme covered or proposed to be covered under any foreign assistance/aid agreement?

XX. ESTIMATE

115. Is the separate volume of estimate attached as appendix?

116. Is the year to which the rates adopted in the estimate relate to indicated?

117. Have the analysis of rates for various major items of work for the major components of the project been furnished and with basis of analysis described?

118. Are the provision for the following items made on the basis of sample survey and sub- estimates:

(a) Distributaries, minor and sub-minors
(b) Water courses
(c) Drainage
(d) CAD Works

XXI. REVENUE

119. Are the basis for the following sources of revenues furnished?

(a) Betterment levy and proposal for its recovery
(b) Irrigation cess
(c) Flood protection cess
(d) Crop wise water rates
(e) Sale of water for village/city/industrial/power/water supply
(f) Miscellaneous

120. Have these rates been compared with the existing rates at the other projects in the State/region?

121. In case the rates are being enhanced, has the concurrence of the concerned department(s) been obtained?

122. Have the organisational set up for the collection of revenue been indicated?

XXII. B.C. RATIO

123. Are the allocated cost for the following components of the multipurpose project worked out and basis therein furnished?
(a) Irrigation
(b) Power
(c) Flood Control
(d) Navigation
(e) Water supply
(f) Any other

124. Have the various departments of the State/Centre agreed to the sharing of the above allocated cost?

125. Have the crop wise benefits been worked out for irrigated and un irrigated crops being grown before project in consultation with the agriculture department and statement furnished?

126. Have the crop wise benefits been worked out for proposed cropping pattern after the introduction of irrigation in consultation with the agriculture department and statement furnished?

127. Is the B.C. ratio of Irrigation Projects acceptable or otherwise justified?

128. Is the B.C. Ratio for Flood Control Projects acceptable or otherwise justified?

129. Is the B.C. ratio for power component of the project acceptable or otherwise justified?

130. Have the financial and economic return statements been furnished keeping in view the phasing of development?

131. Are the benefits other than those considered in the B.C. Ratio and financial return statement been identified?

132. Is the benefit from Gallper land, if proposed, based on lease rates admissible and statement from concerned Central/State authorities furnished?

133. Are the benefits from fisheries, horticulture, if proposed, based on lease rates admissible and statement from concerned Central/ State authorities furnished.

XXIII. ECOLOGICAL ASPECTS

134. (a) Is the area likely to have any of the following environmental and ecological problems due to the altered surface water pattern? If yes, whether preventive measures have been discussed?

(i) Excessive sedimentation of the reservoir and the upper reaches of the river and its tributaries tailing into reservoir
(ii)Water logging, salinity/alkalinity
(iii)Quality of surface and ground water
(iv)Ground water recharge
(v) Health hazards-water borne diseases, industrial pollution etc.
(vi) Submergence of important minerals deposits
(vii) Submergence of monuments/archeological sites
(viii)Fish culture and aquatic life
(ix) Plant life (flora)
(x) Wild Life
(xi) Migratory birds
(xii) National parks and sanctuaries
(xiii)Seismicisty due to filling of reservoir
(xiv) Likely change in the regime of the river
(xv) Any other

(b) Have the environmental and forest clearances from MOE&F been obtained? If not what is status thereof?

XXIV. COLONIES AND BUILDINGS

135. Has the planning of the colony/building been done keeping in view the ultimate use for optimum utilisation of investment?

136. Has an estimate of the extent of higher cost involved been made and details discussed?

137. Are the permanent buildings being constructed required for maintenance of the project only?

138. Can the buildings other than required for maintenance of the project being constructed be put to some other use after the completion of the project by the department or any other agencies?

139 Have the interested agencies been consulted in planning of the buildings to suit their requirements later on?

140. Have the proposals for disposal of temporary buildings been discussed?

XXV. PUBLIC PARTICIPATION AND COOPERATION

141. Are the possibilities of these been discussed in:

(a) Planning
(b) Construction
(c) Improved agricultural practices
(d) Any other

142. Have public debates about utility of projects been held and the response thereof outlined in the Report?

XXVI. SOIL CONSERVATION

143. Is the need for soil conservation measures in the catchment of the project discussed?

SECTION 2

SALIENT FEATURES

The following salient features (and any others) as applicable to the project, shall be furnished:

1. Name of the Project

2. Type of Project (Irrigation or Multipurpose)

3. Location

3.1 River Basin

(a) Name
(b) Located in
(i) State(s)
(ii) Countries (if international river)

3.2 River / Tributary

3.3 State(s) / District(s) / Taluka(s) or Tehsils in which following are located:

(a) Reservoir
(b) Headwork
(c) Command Area
(d) Power house

3.4 Name of village near the Head-works

3.5 Location of Head-works

(a) Longitude
(b) Latitude
(c) Lies in Earthquake Zone No.

3.6 Project area reference to:

(a) Degree Sheets
(b) Index Plan

3.7 Access to the project

	Name	Distance from project site
(a) Airport		
(b) Rail head		
(c) Road head		
(d) River port		
(e) Sea port		

3.8 Rail / Road transportation limit of

(a) Weights (T)
(b) Dimensions (Lx B x H)

4. International / Interstate aspects of the project

(a) Catchments area of the basin
(b) State-wise / country-wise details of catchments area
(c) Submergence due to projects
  (i) In the state
  (ii) In other states
  (iii)In other countries
(d) Water allocation for the state (if any)/country
(e) Water allocation for other states/countries
(f) Committed utilisation

Upstream Projects

	Irrigation	Water Supply	Thermal	Industrial	Hydel (evaporation losses)
(i) Projects completed					
(ii) Projects under construction					
(iii) Future Projects					
(iv) Any other					

Downstream Projects

	Irrigation	Water Supply	Thermal	Industrial	Hydel (evaporation losses)
(i) Projects completed					
(ii) Projects under construction					
(iii)Future Projects					
(iv)Any other					
	-------	------- -------	---------	----------	--------------------
Sub Total (f) :	---------	------- -------	---------	----------	--------------------

(g) Proposed annual utilisation by the project

(i) Irrigation
- Kharif
- Rabi
- Hot weather

Total:

(ii) Water Supply
(iii) Hydel (evaporation losses)
(iv) Thermal power
(v) Industrial

Gross annual utilisation {sum of (i) to (v)}

(h) Minimum agreed/proposed flow in the river for maintaining ecology

5. Estimated life of the project (years)

6. Irrigation (ha.)

	By flow	By lift
(a) Gross command area (GCA)		
(b) Culturable command area (CCA)		
(c) Area under Irrigation (break up):		
(i) Kharif		
(ii) Rabi		
(iii) Hot weather		
(iv) Two seasonal		
(v) Perennial		
(vi) Gross irrigated area (GIA)**		
(vii) Intensity of irrigation $\left(\frac{GIA}{CCA} \times 100\,\%\right)$		
(viii)District(s) Benefited (if the district benefited is predominantly tribal or drought prone, it may be so indicated against each district).		

** Irrigated area under Kharif, two seasonal, perennial, rabi and hot weather shall be indicated.

(d) Cost per hectare of gross area irrigated
(e) Cost per 1000 cum of gross/live storage
(f) Cost per 1000 cum of water delivered at the (Canal head/outlet)
(g) Water utilisation

7. Flood control

(a) Area protected from floods (ha)
(b) Population protected from floods (no.)
(c) Average annual flood damage (Rs. million)
  (i) Without project
  (ii) With project (anticipated)
(d) Safe carrying capacity of the river (m^3/s.)
  (i) Without project
  (ii) With project

8. Navigation

(a) Location of the navigable reach
(b) Length of the navigable reach
(c) Minimum draft
(d) Total tonnage of goods to be carried annually
(e) Expected passenger traffic (annual)

9. Water supply

9.1 Domestic
(a) Names of towns/villages served
(b) Size of population served
(c) Quantum of water made available (Cu.m.)
(d) Quantum of water per capita (litre)

9.2 Industrial

(a) Name(s) {location(s)}
(b) Quantum of water made available (Cu.m.)

10. Project Performance

	Period of Simulation	No. of failure
(a) Irrigation		
(b) Power		
(c) Flood Control		
(d) Water Supply		
(e) Navigation		

11. Hydrology

11.1 Catchments

11.1.1 Catchments area at headwork site (sq. km)

(a) Gross
(b) Intercepted:

(i) By existing projects
(ii) By ongoing projects
(iii)By contemplated projects

(c) Un intercepted

Note *:-In case of a downstream weir/barrage regulating the supply to the canal(s) similar details shall be furnished for the catchments between head works and the weir/barrage.*

11.1.2 Catchments area classification according to mode of precipitation (sq. km.)

(a) Rain fed
(b) Snow fed

11.2 Precipitation

11.2.1 Catchments

	Rainfall (weighted mm)		Snowfall (mm)
	Annual	Monsoon (June-Oct.)	Annual
(a) Average (b) Maximum (c) Minimum (d) Co-efficient of variation			

11.2.2 Command

	Cropping Season			
	Annual	Kharif (June-October)	Rabi (November-February)	Hot (March-May)
(a) Average				
(b) 80 % dependable				
(c) ETO (mm)				

11.3 Annual yield calculated at the proposed site (Mm^3)

	Gross	Net
(a) Maximum		
(b) Minimum		
(c) Average		
(d) Dependable (per cent)		

	Annual	Monsoon (June-October)
(i) 50		
(ii) 75		
(iii)90		
(iv)98		

11.4 Climatic Data (Command)

11.4.1 Name of Station(s) and period of record

Sl. No.	Names	Period of Record	
		From	To
1.			
2.			
3.			
4.			

11.4.2 Data (average of all stations in command area)

	Normal	Maximum	Minimum
(a) Air temp.(^{o} C)			
(b) Humidity (per cent)			
(c) Wind (km/hr)			
(d) Water temperature (^{o}C)			

11.5 Seismic coefficients

(a) Horizontal

(b) Vertical

11.6 Utilisation within the State (Mm^3)

11.6.1 Water availability (State's share in case of interstate river)
11.6.2 Committed Utilisation

(a) Upstream Projects	Major	Medium	Minor
(i) Projects completed			
(ii) Projects under construction			
(iii)Future projects			
(iv)Any other			

(b) Downstream Projects	Major	Medium	Minor
(i) Projects completed			
(ii) Projects under construction			
(iii)Future projects			
(iv)Any other			

11.6.3 Proposed utilisation by the project

(a) Irrigation
(i) Kharif
(ii) Rabi
(iii) Hot Weather
(iv) Perennials

Total:-

(b) Water Supply

11.7 Floods near the headwork site

11.7.1 Historical-period of record from................to.............

	Location(s)		
	1	2	3
(a) Maximum water level (El-m)			
(b) Maximum Discharge estimated ($m^3/s.$)			
(c) Year of occurrence, date			

11.7.2 Observed-period of record from ....to..........

	Location(s)		
	1	2	3
(a) Maximum water level (El-m)			
(b) Maximum Discharge ($m^3/s.$)			
(c) Year of occurrence, date			

11.7.3 Estimated Flood

	Magnitude ($m^3/s.$)
(a) 50 year return period	
(b) 100 year return period	
(c) 1000 year return period	
(d) Standard project flood	
(e) Maximum probable flood	

11.7.4 Design flood ($m^3/s.$)

(a) Dam
(b)Weir/Barrage
(c) Construction Diversion
(d) Flood Control Works

11.7.5 River flows (minimum observed)

(a) Water level (El-m)
(b) Discharge ($m^3/s.$)
(c) Months of 'nil' flow, if any.

12. Reservoir

12.1 Water levels (El-m)

(a) Maximum Water Level (MWL)
(b) Full Reservoir Level (FRL)
(c) Minimum Draw Down Level (MDDL)
(d) Outlet levels
 (i) Irrigation
 (ii) Power
 (iii)Others (Please specify)
(e) Dead Storage Level

12.2 Free board (m)

12.3 Wave height (m)

12.4 Live storage (Mm^3)

12.5 Capacity (Mm^3) at :

(a) Maximum water level
(b) Full reservoir level
(c) Minimum draw down level
(d) Dead storage level

12.6 Flood absorption capacity (Mm^3)

(a) Below FRL
(b) Between FRL & MWL

12.7 Sedimentation (Mm^3) and levels after

	Years	
	50	100
(a) Above MDDL		
(b) Below MDDL		
(c) Encroachment of live storage (per cent)		
(d) New zero elevation		

12.8 Average monthly evaporation losses from the reservoir (Mm^3)

Month	Average Evaporation Loss (Mm^3)
January	
February	
March	
April	
May	
June	
July	
August	
September	
October	
November	
December	

12.9 Seepage in the reservoir

13. Submergence

13.1 Land and property submerged

	MWL	FRL
(a) Villages affected (No.)		
(i) Fully		
(ii)Partially		
(b) Land affected (ha.)		
(i) Gross		
(ii) Culturable		
(iii)Irrigated		
(iv)Forest		
(v) Others (specify)		

(c) Buildings/houses (No.)

(i) Private
(ii) Community's
(iii) Govt.

(d) Wells (No.)

(e) Road/rail (km)

(f) Transmission lines (km.)

(g) Any other

13.2 Submergence ratio (with reference to culturable command areas)

13.3 Number of families/persons affected

	Families	Persons
(a) Total		
(b) Scheduled Castes		
(c) Scheduled Tribes		
(d) Other Backwards Castes		
(e) General		

13.4 Anticipated back water levels at important places along the periphery of the reservoir

S. No.	Name of place	Back water level (El-m)

14. Headworks

14.1 Dam

14.1.1 Embankment Dam

(a) Type of dam
(Homogenous/Zoned/Rock-fill/Concrete faced
(b) Length of the dam at top (m)

(i) Right Flank
(ii) Left Flank

(c) Top width (m).

(d) Maximum Height above G.L. (m)

(i) Right Flank
(ii) Left Flank

(e) Dyke(s)

(i) Number
(ii) Total length(m)
(iii)Maximum height (m)

(f) Type of cut off and maximum depth

(Upstream blanket/open trench/diaphragm/grout curtain/combination of alternatives)

14.1.2 Masonry and Concrete Dam (Non-over flow section)

Left side Right side

(a) Type of Dam (Masonry/Concrete/Composite any other)
(b) EL of top (m)
(c) EL of deepest foundation (m)
(d) Length at top (m)
(e) Length at the river bed (m)
(f) Width at top (m)
(g) Width at deepest bed level (m)
(h) Maximum height above deepest foundation level (m)

14.1.3 Spillway (overflow section)

(a) Type of spillway
(Ogee/chute/side channel/tunnel/syphon/any other type (specify)
(b) Full reservoir level (EL-m)
(c) Maximum water level (EL-m)
(d) Length (m)
(e) Maximum height above the deepest foundation (m)
(f) Crest level (El-m)
(g) Number of gates
(h)Type of gate
(i) Size of gate (mxm)
(j) Maximum discharging capacity ($m^3/s.$) at
(i) FRL
(ii)MWL
(k)Flood lift (m)
(l) Tail water level (EL-m)
(i) Maximum
(ii) Minimum

(m)Type of energy dissipation arrangement
(n) Type of hoisting arrangement and its capacity
Note:- Similar details shall be furnished for subsidiary and auxiliary spillway, if any.

14.1.4 River sluice(s), Irrigation/Power outlet(s)

(a) Purpose
(b) Number
(c) Size (m)
(d) Sill level (El-m)
(e) Discharging capacity at (m^3/s.)
(i) Full reservoir level
(ii) Minimum draw down level
(f) Number of gates
(g) Type of gate
(h) Size of gate (mxm)
(i) Type of hoisting arrangement and its capacity

***Note**:-The above detail shall be furnished for all the sluices provided for different purposes.*

14.2 Barrage

14.2.1 Location with respect to dam, if any

14.2.2 Length (m)

14.2.3 Spillway bays

(a) Total length (m)
(b) Full Pond level (El-m)
(c) Maximum water level (El-m)
(d) Maximum height of spillway crest above deepest foundation (m)
(e) Length of bay (m)
(f) Crest level (El-m)
(g) Number of gates
(h) Type of gates
(i) Size of gate (mxm)
(j) Type of energy dissipation arrangement
(k) Maximum discharging capacity (m^3/s.)
(l) Tail water level (El-m)
(i) Maximum
(ii Minimum
(m) Type of hoisting arrangement and its capacity

14.2.4 Under Sluice Bays

	Left side	Right side
(a) Total length (m)		
(b) Crest level (El-m)		
(c) Maximum height of under sluice crest above deepest foundation-(m)		
(d) Length of bay (m)		
(e) Sill level (El-m)		
(f) Number of gates		
(g) Type of gates		
(h) Size of gate(mxm)		
(i) Type of energy dissipation arrangement		
(j) Maximum discharging capacity of undersluices (m^3/s.)		
(k) Silt excluder tunnel(s)		
(i) Number		
(ii) Length		
(iii)Size (m)		
(iv) Floor level (El-m)		
(l) Type of hoisting arrangement and its capacity		

14.2.5 Guide bunds/afflux bunds

	Left Side		Right side	
	length (m)	top level (El-m)	length (m)	top level (El-m)
(a) Guide bunds				
(i) Upstream				
(ii) Downstream				
(b) Afflux bunds				
(c) Other protective works (if any)				

14.3 Weir

(a) Type of weir Concrete/Masonry/any other type
(b) Length of weir (m)
(c) Deepest foundation (El-m)
(d) Type of energy dissipation arrangement
(e) Crest level (El-m)
(f) Maximum water level (El-m)
(g) Tail water level (El-m)
(i) Maximum
(ii)Minimum
(h) Maximum discharging (m^3/sec) capacity

Note :- For gated weir, information as asked under 14.2 Barrage shall be furnished.

14.4 Head Regulator(s)

	Left side	Right side
(a) Total length (m)		
(b) Height above deepest foundation (m)		
(c) Length of bay (m)		
(d) Sill level (El-m)		
(e) Number of gates		
(f) Type of gates		
(g) Size of gate		
(h) Number of silt excluder bays		
(i) Type of energy dissipation arrangement		
(j) Type of hoisting arrangement and its capacity		

15. Canal System

15.1 Main Canal (Name)

15.1.1 Purpose of canal (Irrigation/Power/Navigation/Diversion/Water Supply/Multipurpose)

15.1.2 Type

(a) Flow/lift
(b) Lined-unlined
(c) Discharging capacity of the channel above which lining is proposed
(d) Type of lining

15.1.3 Design data

(a) Length (km)
(b) Full supply level at head/tail (El-m)
(c) Full supply depth at head/tail (El-m)
(d) Bed width at head/tail (El-m)
(e) Side slope at head/tail (El-m)
(f) Bed slope (range)
(g) Maximum discharging capacity at head/tail (El-m)(m^3/s.)
(h)Total number of canal structures
(i) Total assumed head losses across the structure (m)
(j) Gross Command Area (ha)
(k)Culturable Command area (ha)

Note : Similar information to be furnished for all main canals off taking from headworks and branch canals.

15.1.4 Distribution System

	Distributaries	Minors	Sub-minors	Water Courses
(a) Number				
(b) Total length (km)				

Note : Total length of distribution system upto minimum discharge capacity of 0.7 m3/sec. may be given.

15.2 Efficiencies (percent)
(a) Conveyance
(b)Field application

16. Cropping Pattern

	Percentage area (CCA)	
	Existing	Proposed
16.1 Name of crop (season-wise)		
(a)		
(b)		
(c)		
(d)		
(e)		

Note :- If there are different cropping patterns in different reaches of the canal, information for each reach shall be given separately.

17. Power

17.1 Type – Conventional/Pumped storage
17.2 Installed capacity (MW)
17.3 Load factor
17.4 Annual energy (kwh)
(a) Firm
(b) Seasonal
(c) Total
17.5 Off peak requirement for pumping*
17.6 Cost per kW installed
17.7 Cost per kWh at the bus bar
17.8 Head Race Channel/Tunnel
(a) Length (m)
(b) Shape
(c) Size (m)
(d) Rock type reach-wise-RMR/Q values
(e) Rock cover reach-wise
(f) Free/Pressure flow

(g) Lining type-PCC/RCC/Steel
(h)Reach-wise Design Internal & external pressures
(i) Thickness of lining (m)
(j) Designed discharge (m^3/s.)
(k) Invert level at (El-m)
(l) Gates-No., type & size

*For pumped storage projects only.

17.9 Balancing Reservoir

(a) Capacity (Mm^3)
(b) Full reservoir level (El-m)
(c) Maximum reservoir level (El-m)
(d) Minimum Drawdown Level (EL-m)
(e) Live Storage (Mm^3)
(f) Balancing period (hrs.)

17.10 Forebay

(a)Size of forebay (m)
(b)Sill level of forebay (El-m)
(c)Full reservoir level (El-m)
(d)Maximum reservoir level (El-m)
(e)Minimum drawdown level (El-m)
(f)Duration of storage
(g)Number of off-takes
(h) Size of off-takes
(i)Invert level at off-take (El-m)
(j)Capacity of each off-take (m^3/s.)
(k)Escape arrangement

- Location
- Length
- Discharging capacity (m^3/s.)

17.11 Intakes

(a) Upper Intake
(i) Type & size of intake
(ii) Entry profile with details of transition
(iii) Stability of the slope/cuts around intake
(iv) Design valocity through trash rack and bellmouth
(v) Submergence of the entry below water level
(vi) Intake gates-number,type,size
(vii)Details of anti-vortex arrangements

(viii) Type of hoisting arrangement and its capacity

(b) Lower Intake (for pumped storage scheme)
(i) Type & size of intake
(ii) Entry profile with details of transition
(iii)Stability of the slope/cuts around intake
(iv)Design valocity through trash rack and bellmouth
(v) Submergence of the entry below water level
(vi) Intake gates-number. type. size
(vii)Details of anti-vortex arrangements

17.12 Surge tank/shaft

(a) Nos. & location (HRT/TRT or both)
(b) Type. height & size
(c) Orifice –size & position (or any other relevant detail)
(d) Top level (El-m)
(e) Bottom Level (El-m)
(f) Steady state level (El-m)
(g) Capacity (Mm^3)
(h) Lower expansion chamber –size & location
(i) Upper expansion chamber –size & location
(j) Maximum surge level (El-m)
(k)Minimum surge level (El-m)
(l) Size of gates and capacity of hoists

17.13 **Penstocks/pressure shafts:**
(a) Number, diameter & length
(b) Inclination
(c) Liner type
(d) Grade of steel
(e) Reachwise rock cover
(f) Reachwise rock properties –RMR/Q
(g) Reachwise rock participation factors –computed & adopted
(h) Reachwise liner thickness
(i) Necessity for heat treatment, if any.
(j) Bifurcation/trifurcation
(k) Gate –Number; Type & Size
(l) Size of gates and capacity of hoists

17.14 Power House:

(a) Type:- (Surface or underground)
(b) Orientation
(c) Rock types encountered –RMR/Q Values
(d) Major wedge formations, if any
(e) Rock ledge dimension between cavities
(f) Maximum head (m)
(g) Minimum head (m)
(h) Average head (m)
(i) Head loss in water conductor system
(j) Design head (m)
(k)Dimensions (m)
(l) Unit capacity
(m)Installed capacity (MW)
(n) Type of turbine
(o) Type of generator
(p) Type of power house crane
(q) Number and size of draft tube gates / bulk head and capacity of hoists

17.15 Switch yard

(a) Type
(b) Voltage level
(c) No. of incoming and outgoing bays

17.16 Transformer Cavern

(a) Dimension
(b) Orientation
(c) Rock types encountered –RMR/Q Values
(d) Major wedge formations, if any
(e) Rock ledge –dimension between cavities

17.17 Tail Race Channel

(a) Shape & size
(b) Length
(c) Recovery slope
(d) Side slope
(e) Maximum tail water level (El-m)
(f) Minimum tail water level (El-m)
(g) Average tail water level (El-m)
(h) Tail water level corresponding to one unit discharge.
(i) Tail water level corresponding to maximum flood condition/one in thousand years flood.

(j) HFL of recipient river channel at outfall
(k) Draft tube gates –number, type, size

17.18 Tail Race Tunnel

(a) Number, Size and shape
(b) Length
(c) Reachwise rock cover
(d) Reachwise rock properties –RMR/Q
(e) Type of lining
(f) Maximum tail water level (El-m)
(g) Minimum tail water level (El-m)
(h)Average tail water level (El-m)
(i) Tail water level corresponding to one unit discharge.
(j) Tail water level corresponding to maximum flood condition/one in thousand years flood.
(k) HFL of recipient river channel at outfall
(l) Draft tube gates number, type, size

18. Construction facilities

19. Cost

19.1 Cost of the project (Rs. Lakh) Unitwise (Refer Part II Section-3 para 18)

19.2 Allocated cost (Rs. lakh)
(a) Irrigation
(b) Power
(c) Flood control
(d) Navigation
(e) Water Supply
(f) Any other

20. Benefits/Revenue

20.1 Benefits

Item	Benefits		
	Quantity	Unit price	Value Rs. lakh
(a) Food Production (tonne) (b) Power (kwh) (c) Flood Protection(ha) (d) Navigation (tonnage) (e) Water supply (Population served) (f) Any other (fisheries)			
Total:			

20.2 Revenue

Item :	Revenue		
	Quantity	Rate	Amount Rs lakh
1. Betterment levy 2. Water Rates 3. Irrigation Cess 4. Pisciculture rights auction 5. Power Rates 6. Navigation (i) Cargo Rates (ii) Regd. Charges (iii)Passenger Tax 7. Others.			
Total:			

21. Benefit Cost Ratio

(a) B.C. Ratio
- (i) Irrigation
  - -with cost of CAD works
  - -without cost of CAD works
- (ii) Flood control
- (iii)Power

(b) Internal Rate of Return (IRR)
- -with cost of CAD works
- -without cost of CAD works

(c) B.C. Ratio with discounted cash flow method
- Irrigation
- -with cost of CAD works
- -without cost of CAD works

(d) Financial Rate of Return (FRR)
- -with cost of CAD works
- -without cost of CAD works

SECTION-3

REPORT

Introduction

The following important items and additional items, if any, as relevant to the project shall be discussed briefly under this chapter.

1.1 Aim(s) of the project and description of works

1.2 Location of project area including longitude and latitude and district(s) and tehsil/taluka(s) affected/benefited

1.3 Access by air/rail/road/ferry/ sea/ port / and other communication facilities available in the area

1.4 General climatic conditions of the state and project area in particular

1.5 General description of topography, physiography and geology of the area

1.6 Population

(a) Affected (no.)
- (i) General
- (ii) S.C.
- (iii) S.T.
- (iv) O.B.C.
- (v) Total

(b) Benefited (no.)
- (i) General
- (ii) S.C.
- (iii) S.T.
- (iv) O.B.C.
- (v) Total

(c) Occupation (no.)
- (i) Agriculture
- (ii) Other than agriculture etc.

1.7 Natural resources –

Salient features of master plan for overall development of water resources of basin, the present level of utilisation of land & water resources and system efficiency be given.

1.8 Land-use and socio-economic aspects (including tribal, backward and drought areas etc.)

1.9 History (Earlier proposals)

1.10 Choice of project: Alternative studies, carried out for various major components of the project and including water resources planning and final choice of project.

1.11 Stages/phases of development of the project

1.12 Fitment of the scheme in overall development of the river basin

1.13 Intimation to the other development authorities regarding this Scheme.

1.14 Public announcement and public hearings.

1.15 Inter-linking of the scheme with neighboring schemes.

1.16 Inter-state/International aspect(s)

1.17 Cost and Benefit of the scheme

1.18 Public Cooperation and participation

1.19 Provision for domestic and industrial power supply

2. Physical features

Details of the following important items shall be discussed under this chapter.

2.1 Geographical disposition

2.2 Topography of the basin, reservoir and command area.

2.3 Geology of the basin, reservoir and command area.

River system and basin characteristic.

3. Interstate/International Aspect(s)

DPR should contain a separate chapter on interstate/international aspects discussing details of the following important items and additional items, if any, as relevant to the project.

3.1 State/countries traversed by the river.

3.2 Distribution of catchment in states/countries and yields from the catchment of the state/country concerned.

3.3 Effect of the following on project & of the project on the following

(a) Interstate/International agreement on sharing of waters, sharing the benefits and costs, acceptance of submergence in the upstream state(s)/ country(s) etc., if any.
(b) Interstate/International adjudication, if any.
(c) Interstate/International aspect of territory, property, etc. coming under submergence, project affected people, rehabilitation, compensation, etc. Prior concurrence of other country(ies)/other State(s) where territory/property is affected by the project should be obtained and appended in the DPR.
(d) Existing and sanctioned projects (to the extent the information on existing & sanctioned projects can be obtained with reasonable efforts).
(e) Any other aspect of the project involving Interstate/International problems.

3.4 Existing riparian use, quantum of water presently utilised, commitments for ongoing projects, plans for future development, balance share of the state/country and proposed utilisation by this project. (Discuss relevant items both for upstream and downstream usages).

3.5 Whether operation and regulation of the project conform to the stipulation made in the Tribunal award/agreement and also the mechanism for such operation.

3.6 In case of addition/alterations for existing project involving submergence in other states and additional utilisation of water, concurrence of the concerned states is to be included.

3.7 Details regarding consumptive use of water in case of Hydro electric or Thermal Power Projects

3.8 While giving details of water diverted for cooling/drinking/industrial purpose, quantity diverted for such use shall correspond to gross requirement (not actually consumed) and accounting return flow into the river. Where there is tribunal decision, the details of water diverted for cooling/drinking/industrial purpose from the project, the gross quantity and also quantity for purpose of water use account in terms of tribunal decision shall be stated.

3.9 In respect of Multipurpose projects proposed on Western Rivers of the Indus Basin, it shall be necessary that:-

(i) Every effort shall be made to harness the potential of the water resources to the maximum extent permissible under the Treaty.

(ii) The design, construction, initial filling and operation of projects as applicable shall confirm to the provision of the Indus Water Treaty, 1960. A chapter showing compliance to this effect shall be included in the Detailed Project Report (DPR).

(iii) In respect of Irrigation schemes, the irrigated cropped area (ICA) shall confirm to the provisions of the Indus Water Treaty, 1960

4. Surveys and Investigations

The surveys and investigations carried out for the various alternatives considered to justify the final choice of the location and type of various components of the project shall be discussed.

(The scales of maps, contour interval etc. shall be as indicated in Annex.-I unless otherwise stated in the text)

4.1 Topographical Surveys

Brief details of the surveys carried out for items listed below as relevant to this project shall be furnished. The methodology and scales to be adopted for these surveys shall be as indicated in Annex.-I. Modern techniques such as remote sensing, satellite imageries, aerial photography etc will be used in surveys for cutting short the time required in these activities of project preparation. .

The satellite images may prove very effective in site selection procedure. Using aerospace data in conjunction with seismological data and supporting ground truth identification of faults and active faults can be done. Precise geological maps can be prepared by visual interpretation of aerospace data with limited field checks in shortest time. Geo-morphological terrain classification, assessment during the reconnaissance and planning phase of the project and subsequently detailed engineering geo-morphological studies can be carried out which help to understand relief and genetic land form, soil and sub soil conditions and source location of construction materials.

A brief description about the Global Positioning System (GPS) is given below:

The Global Positioning System (GPS) - It is worldwide radio navigation system formed from a constellation of 24 satellites and their ground stations. GPS uses these 'man-made stars' as reference points to calculate position accurate to matter of meters. The basis of GPS is 'triangulation' from satellites.

DGPS (Differential GPS)

Differential GPS', a way to correct the various inaccuracies fin the GPS system, pushing its accuracy even further. Differential GPS or 'DGPS' can yield measurements good to a couple of meters in moving applications and even better in stationary situations. It involves the cooperation of two receives, one that's stationery and another that's roving around making position measurements. The stationery receiver is the key. It ties all the satellite measurements into a solid local reference.

Real world applications of GPS. fall into five broad categories.

1.	Location	-	determining a basic position
2.	Navigation	-	getting from one location to another
3.	Tracking	-	monitoring/the movement of people and things
4.	Mapping	-	creating maps of the world
5.	Timing	-	bringing precise timing to the world

Additional topographical surveys. if any shall also be covered. For such surveys. suggested methodology shall be as under:

(a) Block level surveys shall be generally carried out on 50 m or less grid basis depending upon the site conditions.

(b) Cross-section and D-section shall be taken by taking levels at 50m or less interval depending on the bed/bank slopes.

(c) The contour interval for slopes less than 10^{0} to the horizontal shall be 0.10 or 0.30 or 0.50 or 1 m depending upon the purpose of surveys. For slopes $10^{0} - 30^{0}$ the contour interval shall be 2 m and more than 30^{0} - 3m or more depending upon the steepness of the slopes.

4.1.1 River

4.1.2 Reservoir

4.1.3 Headworks (Dams. including Dykes. Barrages. weirs etc.)

4.1.4 Plant and Colony layout

4.1.5 Canal and Water Conductor System and Canal Structures.

4.1.6 Power house switch-yard. surge-shaft. Tail race. etc.

4.1.7 Tunnel. Adits and Penstocks

4.1.8 Command area (detailed and sample)

4.1.9 Catchment area/water shed survey. identification of inter-se priorities of water sheds for soil conservation.

4.1.10 Any other

4.2 Other Surveys

4.2.1 Archaeological survey in the reservoir area.

4.2.2 Mineral survey in the catchment/reservoir/canals area.
The nature of such minerals. quantum and location in the reservoir area and/its vicinity shall be indicated.

4.2.3 Right of way surveys for the reservoir.
These shall cover surveys for right of approach roads which may be claimed by owners to various structures above F.R.L.

4.2.4 Communication Surveys
This shall cover surveys for assessing the present status and future requirement of roads, railways transmission lines, telephone lines etc. both in the reservoir and command area.

4.2.5 Drainage Survey
For details refer para 3 and 5 of Part-IV Section-3 –Command Area Development.

4.2.6 Soil surveys
For details refer Annex.-I Part-IV Section-3 - Command Area Development.

4.3 Geology, geo-technical features and seismicity.

Detailed report on geological, geo-technical features and seismicity discussing the following points and additional points, if any, as applicable to the project shall form an appendix of the Detailed Project Report. While it would be preferable that subsurface exploration programme for different features of the project is finalised in consultation with project geological organisation, GSI, CSMRS and CWC for all projects. For projects envisaging irrigation of 50,000 ha. and above or having gross utilization of 1000 Mcum and above investigation shall always be carried out in consultation with the project geological organisation, Geological Survey of India, CSMRS and Central Water Commission.

Summary of the report covering the following points shall be furnished in the detailed Project Report under this Chapter.

(The scales of maps shall be as indicated in Annex.-I unless otherwise stated in the text. The location and depth of exploratory holes, pits/drifts shall be as in Annex.-2)

4.3.1 Geology and Geo-technical Features:

(a) Regional geology, geomorphology structure and techtonics of the project areas and in vicinity.

Regional geology including the basic geological conditions prevailing in the project area shall be compiled from the available published literature and maps. Wherever geological maps are not available such data shall be collected on 1:50,000 scale maps by undertaking traverses. It is desirable to study the geomorphology and general geological features of the region in air photo mosaics. Ladsat Imagery and Multispectral scanner data. In addition, suitable ground traverses shall also be made to check relevant geological features.

(b) Status and location of sub-surface investigation (pitting, drilling, drifting, geophysical probing rock mechanics etc) in the project area.

Status of sub-surface investigation shall include location details of pits, drill holes, drifts completed along with details of in-situ-laboratory testing, geophysical exploration, if any. Details of rock samples/drill core collected together with the field rock mechanics and other in-situ-tests conducted shall be given. Analysis and interpretation of the data shall be furnished.

(c) Result of exploration and tests (pits/drifts excavated and bore holes drilled in the foundation/abutment, etc.).

Results of the exploration and tests shall include details of the observations in the field as well as the result of the laboratory/field tests data; interpretation and suggested treatment.

(d) Surface and sub-surface geology of the project area:

(i) Soil and rock type(s)

Brief description of the overburden shall be given classifying clay, silt, sand, gravel, water table etc. The rock type at the site shall be described. Rock weathering lateritisation with its type, intensity & extent and effect on excavation shall be mentioned.

(ii) Delimitation/evaluation of

- Rock falls and land slides

Demarcation of the zones of rock falls and landslides shall be done on plan. Magnitude of landslide and the estimate of the volume of the material involved in the slide shall be given in the report.

- Structurally weak zones.

Faults, shear zones joint plates and fracture zones are the structurally weak zones. Their pattern relating to structure etc. shall be demarcated on plan. The causes of instability and remedial measures proposed shall be outlined in the report.

- Stresses in rock and neo-tectonic features.

In case of underground works (cavities and tunnels) proposed where undesirable rock stresses are anticipated, their likely extent and magnitude shall be defined on the basis of the explorations and field test (specially in situ stress measurement). Possible zones of squeezing ground shall also be demarcated and design measures treatment outlined. Physical and experimental data, field evidence on the actual rise of depression because of neo-tectonic activity, will also be given.

- Geo-thermal gradient

  Where underground works (cavities and tunnels) are proposed and high temperatures are anticipated an estimation of underground conditions based on exploratory data shall be made. If high temperatures are expected, their likely extent shall be outlined.

- Undesirable gases

  Where undesirable gases are expected either at surface or in underground excavations, possible details of occurrence and geologic associations shall be given.

- Reservoir leakage and effect of impoundment.

  Geological conditions of the reservoir area shall be described with likely avenues of leakage of reservoir water. Anticipated loss of reservoir water shall be indicated. Effect of impoundment on seismicity shall be discussed.

- Other adverse features

  Any other adverse features like heavy siltation, ground water problem etc. shall also be discussed in the report.

(iii) Valuable mineral deposits

Mineral deposits present in the project area and its close vicinity shall be described. Where the deposit is likely to be affected by the project and reservoir impoundment, its implications shall be discussed.

(iv) Construction material

Sources of construction materials like soil, sand, gravel, aggregate rock, lime, pozzolona etc. shall be identified and their mode of occurrence indicated.

(v) Submergence of injurious material likely to create health hazard shall be identified and mode of occurrence indicated.

(e) Details of local geology of the foundations and evaluation of physical parameters, depth and nature of overburden, fresh sound rock, summary of the field work, results of exploration, treatment and other recommendations for the following major components of the River valley projects.

(i) Reservoir
(ii) Headworks
(iii) Energy dissipation devices
(iv) Power house(s) & appurtenances
(v) Intake(s)
(vi) Head regulator(s)
(vii) Major canal structures
(viii) Tunnel(s), penstock(s), hill, etc.
(ix) Communication routes etc.

4.3.2 Seismicity

(a) History of earthquakes in the area with details of epicenter(s) date(s) of occurrence etc.

(b) Details of the available seismological observatory(s) instrument(s) within the project area nearest to the site.

(c) Need for establishing a seismological observatory at and around the project site, its location and proposal(s).

(d) Details of seismological data collected from the seismological observatory(s) and other available sources and evaluation of seismic status of faults, thrusts and other weak features etc.

(e) Local seismicity for design of structure

(i) Seismic magnitude on Richter's scale and intensity of earthquake.
(ii) Value of co-efficient of horizontal and vertical accelerations as applicable to the various major river valley structures.

(f) Seismological reports on the effect of project i.e. effect of weight/pressure of reservoir (at various level of water in it) on seismic faults /thrusts and other weak seismic features of the project location.

4.4 Foundation Investigations

Detailed Investigation Reports on the foundation investigations of different structures components of the River Valley Project discussing the following points and additional points, if any, as relevant to the structure shall form an appendix of the Detailed Project Report. Summary of the Investigation carried out results, treatment, recommendations etc. shall be furnished under this chapter of the Detailed Project Report for each of the major component/structure, of the project.

(The scales of maps shall be as indicated in Annexure-1 unless otherwise stated in the text. The location and depth of explanatory holes/pits/drifts shall be as in Annexure-2)

4.4.1 Earth and rock fill dam/barrage/weir etc.

(a) Details and location of the auger/drill holes, pits and drifts excavated and in-situ tests conducted for the foundation investigations along with axis, abutments and other locations.

(b) Logging of the auger/drill holes, pits and drifts description of sub/strata, including weak and vulnerable zones..

(c) Details of the disturbed and undisturbed soil samples collected for classification of the foundation material and result of the laboratory tests thereof.

(d) Details and results of the in-situ tests (density, shear, permeability, bearing capacity, penetration etc.) conducted in different depths in selected bore holes and other locations.

(e) Description of the foundation rocks, detail of samples collected and its properties including core recovery, permeability etc.

(f) Summary of the field observations, investigations and in-situ and laboratory tests data, evaluation of the design parameters and treatment proposed.

(g) In case of earth and rock-fill dams, type of cut off chosen viz. conventional open trench/diaphragm/sheet pile etc. and its depth as well as nature such as positive or partial with or without a grout curtain may be furnished.

(h) Details regarding testing for determination of dynamic properties of soil or liquefaction susceptibility.

(i) Details regarding testing for determination of dynamic properties of rock foundation strata.

4.4.2 Masonry/concrete dam/weirs etc.

(a) Details and location of the drill holes, along the dam axis and abutment, along toe line of the dam (river bed and spillway) and along a line upstream of the dam axis at a distance equal to the distance between the dam axis and toe line (river bed and spillway or at locations decided in consultation with the geologist) and in-situ tests conducted for foundation investigation including other locations.

(b) Details and location of pits/drills excavated in the abutments.

(c) Logging of the drill holes and drifts and description of sub-strata including weak and vulnerable areas.

(d) Details of the rock samples collected and results of the laboratory test.

(e) Details and results of the in-situ permeability tests conducted in different rock strata at various depth in selected bore holes to check the water tightness of the foundation.

(f) Details and results of the in-situ rock mechanic tests carried out in the foundation/drifts/other locations.

(g) Summary of the field investigations/observations, in-situ and laboratory tests data, evaluation of the design parameters and treatment proposed.

4.4.3 Canal

(a) Detail and logging of the auger hole/drill holes/pits excavated, classification of the strata in the various reaches and identification of the problematic reaches including reaches involving deep cutting/filling.

(b) In case of deep cutting in rock strata, details regarding the feasibility of a tunnel and its details.

(c) Details and results of the samples collected to confirm the field classification.

(d) Details and results of the in-situ density tests, conducted, if necessary.

(e) Summary of the field investigations/observations, laboratory and in-situ tests data and general recommendations regarding evaluation of design parameters and treatment proposed.

4.4.4 Power house tunnels, de-silting chamber, surge tanks, transformer cavern etc. and canal structures.

(a) Details and location of drill holes/pits/drifts excavated and in-situ tests conducted.

(b) Logging of the drill holes/pits/drifts and description of the material at the site of in-situ tests etc.

(c) Details of the samples collected for classification of materials and results of in-situ and laboratory tests.

(d) Summary of the field observations/investigation works and in-situ and laboratory tests, evaluation of properties of the foundation materials and suggested locations of the various components.

4.5 Construction Material Investigations:

Detailed report on the investigation of the following materials and more, if any, as relevant to the project shall form an appendix to the Detailed Project Report. The report shall discuss the details of the field work undertaken logging of the bore/auger holes/pits, profile of the soils along the grids, samples collected, tests results and evaluation of the design parameters as relevant in each material.

Summary of the investigations shall form this chapter of the Detailed Project Report discussing the quantitative and qualitative aspects and bringing out clearly the conclusions based on the field observations/investigations/laboratory tests.

(The scales of maps shall be as indicated in Annexure-1, unless otherwise stated in the text. The field surveys of materials shall be carried out as per Annexure-3).

4.5.1 Soils and rock-fill -Location(s) of different types of soils in the borrow area--quantities, properties lead etc.

4.5.2 Sand--Location(s) of sand quarry/other source (crushed sand) quantity available properties, lead etc.

4.5.3 Rock and Aggregates--Location(s) of the quarries for different types of rocks available and their properties, quantity available, lead etc.

4.5.4 Bricks Tiles--Location(s) of the soils suitable for manufacture of bricks/tiles, quantum available, properties of the soil/bricks including lead etc.

4.5.5 Pozzolana--Location of the natural, pozzolonic material, fly ash or soil suitable for manufacture of surkhi, available quantity, properties, lead, etc.

4.5.6 Cement/lime stone--Location of the lime stone quarry quantity available for manufacture of cement/lime, properties, lead etc.

4.5.7 Cement and Steel--Location of the rail head/stockyard and lead from the site of work(s).

4.5.8 Scarce Materials--Source quantities required and procedures for procurement etc.

4.5.9 Investigation of material that is available from compulsory excavation like underground power house, foundation for overflow and non-overflow structures etc.

4.5.10 Any other material

4.6. Hydrological and Meteorological Investigations

4.6.1 Hydrological data requirement for project planning has been indicated in Chapter-II of the detailed guidelines for hydrology (Annexure-4).

4.6.2 Type and extent of these investigations to be discussed under the chapter shall be determined by the following

- Nature and purpose of development i.e. the use to which these data would be put to availability of hydrological and meteorological data in the general region from existing networks/sites.
- Establishment of project specific hydro-meteorological data network
- Constraints of time and money

Against the above background the extent of hydrological and meteorological data collected and specifically as a part of the project investigations shall be discussed.

4.6.3 Broad guidelines regarding the length and frequency of hydrological observations are indicated in the table below. However, in situations where long term data of any hydrological phenomenon which is likely to be co-related with the relevant phenomenon are not available in the vicinity, in general substantially longer data would be required. Conversely, where there is sufficiently long term data available in the vicinity of the desired location, a smaller length than indicated in table below may be adequate.

Type of Information	Minimum length	Frequency
1. River Gauge Data	10 Years	- Daily at 0800 hrs. during low flows seasons— - Thrice daily at 0800,.1300 and 1800 hrs during high flow season. - Continuous with an automatic water level recorder with back up arrangements, for hourly, quarter hourly observations manually for flood periods and peak(s) respectively. In Himalayan catchment, having substantial snow/glacier cover. For snowmelt period, diurnal variation in flow also needs to be established, through water level measurement matching with the leading travel time of snowmelt contributions flow at project diversion site, last observation should match the arrival of snowmelt at site" The measurements should be carried out during higher flows and also it should be representative across the width having convergence with flow velocity, as maximum silt carrying capacity vary with flow rate
2. River Flows Discharge	10 Years	Weekly during low flow season daily during high flow season. For rivers with stable beds 20 to 30 observations during high flows covering rising and

		falling stages shall be sufficient after a few years.
3. Sediment flow and grain size composition	3 Years	-do- alongwith discharge observations.
4. Water Quality	3 Years	About once a month with more frequent observation during low flows and concurrent with discharge observations.
5. Water Salinity	3 Years	Same as above but additional observations in tidal reach of the river twice a month and at closer interval (3 hours), during spring and neep tides.
6. River profiles cross sections showing flow levels	-	The surveys may have to be repeated occasionally for moveable bed rivers. Information to cover all major floods and all critical low flows in recent years.
7. Pan evaporation concurrent with ordinary rain gauge & observations measuring temperature (maximum and minimum - dry and bulb) wind velocity, sunshine etc.	3 Years	Daily
8. Rainfall (ordinary rain gauge) as necessary for strengthening existing network	10 yrs. Concurrent with flow observations for rainfall—runoff co-relation and longer period as available for hind casting	Daily
9. Self Recording Rain gauge	10 yrs. Concurrent with flow observation	Continuous to be tabulated as hourly/quarter hourly.

Usually these observed data would not be available for desired locations or for desired length of period and therefore the inputs will have to be prepared using data transfer and data extension techniques.

All locations of sites and observations shall be as per IS/IMD Standards. Where these are not available the location/methodology adopted shall be described. All measurements should be carried out by scientific method by using State of the Art technology available.

For establishing network of RG stations, relevant BIS can be referred

Discharge measurement shall be done by area velocity method using current meter.

Hydraulic structures across the rivers can also be used for flow measurement provided the structures have been properly calibrated preferably by model tests.

In case of storage reservoirs, lake levels reasonably accurate area capacity tables and withdrawal and lake evaporation data would be required for indirect computation of flow volumes.

Number of ordinary rain gauge stations will be so decided as to bring the density to about one station per 600 sq. km. in non-orographic regions (less than 1000m elevation) and about one station per 150 sq. km. in orographic regions. One station out of every four ordinary rain gauge station shall preferably be equipped with a self recording rain gauge, with a minimum of one such station in the drainage area and other areas of interest. Where no flood studies or water balance studies are required, rainfall data requirements would be much less.

Pan evaporation and other meteorological data measurement stations shall be set up at major storage reservoir sites and in the irrigation command areas keeping in view the availability of such stations.

While deciding the location of additional hydrological and meteorological stations, future requirements for operational stage of the project shall be kept in view.

5. Hydrology

The details of the up-to date data collected and various studies made in regard to Hydrology shall be furnished/discussed in a separate volume and appended to the project report. These studies shall be based on the detailed guidelines given in Annexure-4.

The following points regarding the hydrologic studies done shall be briefly discussed in this chapter.

Note : The references indicated below are to the chapters of the guidelines on Hydrology. (Annexure-4).

5.1 Hydrologic inputs to the project planning (Chapter I, II, III & IV)

5.1.1 Processing of the hydrologic data available for studies appropriate to the specific plan of development bringing out the quality of available data, internal and external consistency of the data, adjustment, gap filling etc.

5.1.2 Discussion of the type of proposed data development, corresponding choice of time, units and inputs required--overall approach viz. whether historical or synthetic data is to be used for simulation (working tables)--inter-relation between different inputs at various points considering water availability and demands incorporated in the data generation.

5.1.3 Analysis of data for preparation of inputs relevant to the project.

5.1.4 Seriousness of the sediment problem and its effect on reservoir storage--adjustments to be made in performance testing.

5.2 Simulation and performance testing of alternative plans (Chapter VI).

5.2.1 Details of the system configuration for each alternative tested.

5.2.2 Period of simulation and operational policies used.

5.2.3 Demands, their time distribution and justification in the light of existing and proposed utilisation of the system.

5.2.4 External constraints on the system.

5.2.5 Criteria considered and used in performance testing of alternative plans, comparative results and final choice.

5.3 Hydrologic studies for design flood, design flood levels etc. (Chapter V).

5.3.1 Design flood for safety of structure

(a) Design criteria and overall approach viz. hydro-meteorological or frequency approach.
(b) Salient details of the studies made and final estimates.
(c) Comparison of estimated flood with the design floods of existing projects in the vicinity.
(d) In case of Himalayan rivers, Glacier Lake Outburst Flood (GLOF) may also be discussed with rational detail
(e) Design storm input SPS/PMP/Particular return period rainfall value needs to be discussed in detail
(f) Inundation map corresponding to SPF/PMF water level can be attached

5.3.2 Design flood for flood control component.

(a) Criteria adopted for flood storage and specific flood control structures discussing studies made.
(b) Flood discharge for 'without project' and 'with project' conditions.
(c) Results of alternative T-year or SPF flood situation and present results as discussed in para 5.3.1.
(d) Inundation maps corresponding to MWL/FRL

5.3.3 Hydrologic design of surface drainage.

Give details of design criteria for hydrologic design of drainage and different studies made (Refer IS : 8835--1978 and para 11 "Flood Control" & para 12 "Drainage" of this section)..

Criteria for selection of design flood and selection of critical seasons or flood characteristics relevant to the plan--the studies made to determine the flood intensity.

5.3.4 Design floods for planning construction and diversion arrangement

Criteria for selection of design flood and selection of critical season or flood characteristics relevant to the construction plan- the studies made to determine the flood intensity.

5.3.5 Determination of flood levels for structure on river bank.

Criteria adopted--overall approach and salient details of the frequency analysis of water levels, discharges as the case may be, stage discharge rating curve used.

5.3.6 Determination of outlet levels

Fixing of elevation of outlets in the dam, criteria for selection of the time period and details of the sedimentation rates adopted, sediment distribution and estimation of new zero elevation.

5.3.7 Tail water rating curves.

Points at which these are required, approach, assumptions and analysis used for development of these curves, assumption regarding long term changes in river regimé near these points.

5.4 Effect of project development on hydrologic regime (Chapter-VII). - Changes hydrologic regime (desirable/undesirable) –effect on the following:

(a) Impact on existing projects in the downstream of planned projects
(b) Low flows
(c) Flood hydrology
(d) Total run-off
(e) River hydraulics (short and long terms)
(f) Sediment yields, sediment carrying capacities and aggradations and degradation at various locations.
(g) Water quality and
(h) Water demand

6. Hydro-geology

6.1 Hydro-geological set-up –

(a) Water bearing properties of litho units

(b) Depths to water levels and seasonal fluctuations (pre-monsoon and post-monsoon).
(c) Water table contours
(d) Long term water level trends
(e) Aquifer characteristics

6.2 Ground water resource availability

a) Location (shallow or deep) and extent of potential water bearing, strata/aquifer based on the field observation/test conducted to prove availability - brief.
b) Quantum available
c) Status of present utilisation

6.3 Ground water development prospects

6.4 Anticipated behavior of ground water on downstream after creation of the reservoir based on the experience in the similar projects/areas.

6.5 Quality of ground water (Salinity, pH, SAR, Boron, Fluorine etc.) and its suitability for irrigation.

6.6 Identification of areas of rising/declining water tables and explore the feasibility of conjunctive use of surface and ground water.

6.7 Proposal of conjunctive use of surface and ground water CWC's guidelines on conjunctive use of surface and ground water for irrigation projects may be referred (Annex.7 Part-I).

7. Design feature and criteria for different river valley structures

A separate volume discussing in details (unless otherwise stated) the following points and additional points if any as relevant to the project shall form an appendix of the project report. It shall include structural and hydraulic design calculations for the following components of the project:-

Earth Dam, masonry dam, spillway with gates and energy dissipation arrangements, coffer dam, diversion tunnel, diversion channel, outlets--regulators, river sluices, penstocks (typical), Monoliths, with openings like stair-wells, shaft, step foundation treatment, Barrage--spillway, under sluices, silt excluder, regulators (with gates), Intake structures, conduit systems, surge shafts, Power house, canal, canal lining in typical reaches, canal structures costing more than Rs. 0.5 crore etc.

To reduce the bulk of the volume only essential structural calculations considered absolutely necessary shall be furnished. However, for stability analysis loading diagrams considering various conditions of water level, earthquake, drainage other forces stresses considered, shall be included.

Summary of the report appended for the relevant items shall be furnished under this Chapter.

Scales of maps and other relevant details shall be as per Annex. 1, 2 and 3.

Cross reference shall be given to other chapters and appendices wherever necessary.

7.1 Structure and layout

7.1.1 General--Brief

(a) Headwork's its site and vicinity--stage of the river (Mountain/sub-mountain/plain with slope of the river in the vicinity of the structure).

(b) Reasons for choice of the layout of the project

(c) Type of structure--Dam Earth/Rock-fill/Masonry/Concrete/Barrage/Weir).

(d) Layout of the Dam and Spillway/Barrage/Weir/approach channel and tail channel in case of spillway is located in other than main river gorge and appurtenant/auxiliary works, reasons for choice of site.

(e) Layout of the Power House, Canal alignment etc.

7.1.2 Geology, seismicity and foundation--Brief

(a) Geology of the entire project areas.

(b) Geo technical evaluation of foundations, abutments, reservoir and other major components.

(c) Seismicity of the region indicating the history of the earthquakes that have occurred with dates, distance/depth of epi-centres. Evaluation of seismic co-efficient (horizontal and vertical) as per IS Standard 1893-1984, clearance by the National Committee for Seismic Design Parameters for river valley projects. Details of dynamic analyses proposed to be undertaken at the detailed design stage and the dynamic analysis undertaken at DPR including the seismic parameters adopted should be mentioned.

d) Geological log of bore/drill holes, pits, drifts, geo-physical data etc.

e) Evaluation of foundation and abutments and other major components for treatment (including grouting, drainage etc.)

f) Engineering properties of the foundation materials including results of the in-situ tests like density, permeability, shear, bearing capacity, penetration, modulus of elasticity, bulk modulus, Deformation Modulus etc. and evaluation of design parameters.

7.1.3 Alternative studies carried out for selection of site and type of structures/Dam(s)(Earth/Rock-fill/Concrete/Masonry/Barrage/Weir, Regulator(s), Outlet(s), Power House(s) and appurtenances etc. and alignment of main and branch canals/Water Conductor system.)

7.1.4 Choice of final layout of all major components of the project and reason--Details.

7.1.5 Design Flood and Sediment Studies--Brief.

(a) Design flood approved by CWC its frequency, stage discharge curve at the proposed site with supporting data etc. Any other flood to be considered along with Deign flood such as Glacil lake outburst flood.

(b) Yield and sediment studies approved by CWC (Moody's/Area Reduction method)--Basis for fixing reservoir and other control levels (MWL, FRL, DSL/LWL and Tail Water Level (TWL) (maximum and minimum)

(c) Flood routing studies, different Crest levels, length of spillway and size of gates to arrive at economical height and layout of the structure(s).

(d) Afflux and back water studies, (special attention to be paid at confluence points of major rivers/tributaries).

7.1.6 Free Board

Free board calculations by relevant IS standards for FRL and MWL conditions in the Reservoir to fix the top elevation of the structure.

7.1.7 River Diversion arrangements--choice of design flood with Hydrographs.

(a) Coffer dam(s)
(b) Tunnel(s), Construction Sluices etc.

7.1.8 Construction materials--Brief

(a) Qualitative and quantitative assessment of availability of construction material for core and casing (borrow area) sand, transition filters, aggregate, rock-fill (quarry), pozzolana, lime, cement, steel, explosive (source) etc. indicating lead(s) involved. Transport constraints if any.

(b) Engineering properties of the materials and evaluation of design parameters (shear/compression/tensile strength, permeability, gradation, density, moisture etc.)

(c) Special considerations with regards to the scarce materials, if any.

(d) Details of tests undertaken for assessing the suitability of the construction materials

7.1.9 Details of the model studies for important structures

7.2 Dam

7.2.1 Embankment Dam

(a) Design criteria for

(i) Section and economic zoning in relation to availability of suitable material.
(ii) Cut-off trench/diaphragm/sheet pile etc.
(iii) Key trenches
(iv) Key arrangements with masonry/concrete/abutments--interface aspects, treatment at steps in foundations, and outlet locations etc.
(v) Upstream impervious blanket
(vi) Upstream rip-rap
(vii) Filters transition zones, drainage, relief wells etc.
(viii) Rock toe.
(ix) Stability analysis including pseudo static and pseudo dynamic analysis and factor of safety for checking the stability of the earth/rock-fill dam/natural slope (a closed grid pattern of centers of slip circles tested, shall be followed). The dam section may be checked by dynamic analysis at detailed design stage.

- Upstream slopes to be tested for sudden draw down condition, Steady seepage condition considering tail-water with and without earthquake.

- Downstream slopes to be tested for steady seepage condition considering tail water level with and without earthquake and heavy downpour condition, downstream slope protection against surface flow and tail water erosion.

7.2.2 Concrete/Masonry Dam/Weirs

(a) Non overflow section-design criteria
(i) Section
(ii) Stress allowed (Masonry/Concrete/Steel/Foundation.
(iii) Grout curtain, consolidation grouting and drainage including internal drainage.
(iv) Uplift
(v) Cooling of concrete and thermal stresses.
(vi) Joints and seals
(vii) Hydraulic conditions considered
(viii) Keying arrangements, interface aspect, treatment of steps etc.
(ix) Shear friction
(x) Sliding factor

(xi) Various conditions of NWL, FRL, TWL, uplift, drainage, earthquake stresses etc. considered for stability analysis of the dam and other components and factor of safety.

(b) Spillway -- design criteria

(i) Type of foundation i.e., rock foundation or permeable foundation
(ii) Spillway profile and pier shape
(iii) Capacity of spillway.
(iv) Energy dissipation arrangements and protective works down stream.
(v) Spillway gates, type, size and hoisting arrangements and stop-logs, including operating cranes.
(vi) Spillway bridge.
(vii) Scouring/river sluice Gates type, Size and hoisting arrangement and stop logs including operative cranes etc.
(viii) By pass arrangements--Sluices.
(ix) All items under 7.2.2(a) (i)-(xi)
(x) Approach channel and tail channel in case the spillway is located in other than main river gorge.

7.2.3 Opening through dams.

(a) Galleries, adits, shafts, stairs-wells etc.
(i) Location, layout and purpose.
(ii) Shape(s) and size(s).
(iii) Stress around the opening and design criteria.
(iv) Air supply to openings.
(v) Special problems of design, if any.

(b) Outlet(s)/sluice(s)
(i) Location, layout and purpose.
(ii) Geology of the foundation (where required)
(iii) Capacity, hydraulic design, size and shape of the conduit.
(iv) Entry and exit conditions, invert levels and energy dissipation arrangements discussing measures for ensuring free flow.
(v) Size and type of gates and hoisting.
(vi) Flow profile and air supply.
(vii) Junction with earth dam on either side provision against seepage along contact plane, differential settlement etc.
(viii)Design criteria for intake well.
(ix) Loading condition and structural design criteria for box/barrel etc.
(x) Siltation problem.

7.3 Barrage(s)/weir(s) and Head regulator(s)

7.3.1 Sediment data

(a) Suspended silt carried by the river during various stages, supported with data.
(b) Gradation of the river bed material with Lacey's silt factor adopted, where applicable.

7.3.2 Assumed retrogression at maximum and minimum discharges.

7.3.3 Looseness factor

7.3.4 Scour factor

7.3.5 Intensity of discharge under design/super flood condition.

(a) Spillway
(b) Under sluice

7.3.6 Co-efficient of discharge

7.3.7 Exit gradient value

7.3.8 Stress allowed (Concrete/Masonry/Steel Foundation etc.)

7.3.9 Type (concrete/Masonry)/Profile cutoffs up-stream and downstream aprons, uplift pressure relief arrangements etc.

7.3.10 Various conditions of MWL, TWL, Drainage, Earthquake etc. considered for stability analysis of the different components of Barrage (spillway, under sluice, divide wall, canal-bay, fish ladder, bridge etc.) and values of factor of safety.

7.3.11 Gates, type, size and hoist arrangement and stop-logs including operating cranes.

7.3.12 Detail of spillway bridge Guide and afflux bunds, sheet piles, abutments, divide wall, wings wall, flare out wall, upstream/downstream protection etc.

7.4 Canals

7.4.1 Description of canal system including ridge/contour/lift canal capacity and considerations for fixing alignment etc.

7.4.2 Study of Integrated network of canal system and its operation to utilize the water potential of streams crossed by the main canal system by provision of storages/tail tank etc.

7.4.3 Description of the soil profile along the canal alignment based on the pit/auger holes.

7.4.4 Evaluation of the design parameter based on the samples collected along with canal alignment, borrow area and suggested treatment for problematic reaches.

7.4.5 Details of lining if provided.

7.4.6 Transmission losses assumed for lined/unlined channel with justification for (cumec/million sq. m.)

(a) Main canal
(b) Branch canal
(c) Distributaries
(d) Minors and sub-minors
(e) Field channel (losses covered under delta at outlet)
(f) Overall efficiency of the system.

7.4.7 Cut off statement showing the detail of the discharge required from tail to the head considering the irrigation requirement and transmission losses in the off taking channel.

7.4.8 Design calculation for adequacy of canal sections adopted indicating

(a) Formula used and values of constants, bed slopes.
(b) Design of canal sides in various reaches, slope.
(c) Velocities allowed.
(d) Critical velocity ratio
(e) Full supply depth and free board
(f) Ratio of bed width to depth
(g) Head loss at the canal structures

7.4.9 Design discharge data (Irrigation requirements, transmission losses, evaporation losses etc.) for each distributary supported by detailed calculation for a representative distributary.

7.4.10 Canal operation and Criteria for fixing the level of outlets/off taking channels.

7.4.11 (For lift schemes only) Storage of water just before pumping (to take care of failure of pumping system due to power failure or otherwise) & after pumping for ensuring uninterrupted water supply specially for drinking water supply schemes should be planned. Capacity will depend upon response time for shutting the water supply in case of storage before pumping and time required to adjust to stoppage of water supply for storage after pumping.

7.5 Canal Structures/Gates etc. (cross drainage works/regulators etc.)

(a) List of canal structures with salient features, location, type, capacities etc.
(b) Layout of the proposed structure
(c) Test pit/bore-hole data for deciding the nature of the foundation.

(d) Bed level, FSL & capacity of the canal at the point of entry of the structure.
(e) Transition in canal section and head losses.
(f) Stresses allowed (concrete/masonry/steel/foundation etc.)
(g) Cross drainage.
  (i) Criteria for maximum flood discharge and HFL of the drainage.
  (ii) Choice of structure i.e. syphon/supper passage/aquaduct etc.
  (iii) Percentage of fluming proposed.
(h) Regulators--cross regulators (spacing etc.)--basic design criteria.
(i) Escapes, falls, road bridges, standing wave flumes--basic design criteria.
(j) Conditions assumed to check the stability of the structure.

7.6 Power House—intake, de-silting arrangement, power channel, Tunnel, Balancing Reservoir, Fore bay, penstock, power house, Tail race and Switchyard.

7.6.1 Intake(s)

a) Type of intake location
b) Location
c) Stability of the slopes/cuts around intake
d) Velocity through trash rack and bell mouth adopted
e) Submergence of the entry below water level
f) Intake gates and hoists
g) Anti-vortex arrangements
h) Air vent

7.6.2 De-silting Arrangement

a) Type
b) Size/location
c) Flow through velocity
d) Settling velocity
e) Max. size of particles permitted
f) Flushing arrangement
g) Sediment concentration

7.6.3 Power Channel

a) Capacity (cumec)
b) Bed slope
c) Side slopes and bed width
d) Lined/unlined
e) Length
f) For design detail refer para 7.4 Canals

7.6.4 Tunnel(s) Pressure Shaft(s)

a) Type of tunnel (Pressure/non-pressure). Pressure intensity reach-wise transfer of stress to rock etc.
b) Nature of overburden/rock
c) Reach wise minimum cover of overburden/rock (vertical and horizontal)
d) Shape and size of tunnel
e) Velocity in the tunnel
f) Friction factor
g) Loss of head
h) Lining including steel lining for pressure shaft
i) Supports temporary and permanent
j) Stability of slopes in the portal areas and along the alignment
k) Grouting

7.6.5 Balancing Reservoir(s)

a) Capacity (storage-cum)
b) Duration for which the storage is sufficient
c) Full reservoir level
d) Max. reservoir level
e) Min. reservoir level
f) Live storage

7.6.6 Fore bay

a) Description
b) Gates and hoist
c) Number of opening
d) For other details refer item 7.6.1 i.e. Intake
e) Escape arrangements
   - Location
   - Length
   - discharge capacity

7.6.7 Penstock and surge shaft

a) Number, diameter, length
b) Inclination
c) Types of steel/material used, maximum thickness
   - Velocity adopted
   - Stress adopted
d) Design criteria for water hammer
e) Type of surge shaft shape and size
f) Surge shaft criteria for
   - Maximum surge
   - Minimum surge
   - Area of surge shaft/tank
   - Structural design
g) Stability of slopes in the penstock area

h) Anchor blocks, chain valves, manholes, expansion joints
i) Bifurcation and other special provisions
j) Paints

7.6.8 Power House

a) Details of civil structures of –

- Power house and appurtenances (surface/underground)
  For underground power house
    - Dimension
    - Orientation of the cavern
    - Rock type encountered- RMR/Q values
    - In-situ stress
    - Major wedge formation if any
    - Rock ledge dimension between cavities

  For underground transformer cavern:
    - Dimension
    - Orientation of the cavern
    - Rock type encountered- RMR/Q values
    - Rock ledge dimension between cavities
    - Major wedge formation of any
    - In-situ stress
- Tail Race
- Switch yard

b) Stability of power & slopes around power house area

7.7 Instrumentation

The instruments embedded in, or installed at the surface of the dams and other hydraulic structures keep a constant watch over their performance in service and indicate the distress spots which call for remedial measures. Thus, these instruments play an important role in diagnosing the health of the structure. In addition observations from the instruments form a commutative record of the structural behavior. This information promotes the understanding of the influence of various parameters on the structural behavior and leads to formulation of more realistic design criteria. The details of instrumentation are given at Annexure-5.

8. Reservoir

The following points and additional points, if any, as relevant to the project shall be discussed in details under this chapter :

Note : Where the information is asked in form of table(s) it shall be followed by discussions of tabulated data

8.1 Fixation of Storage and Reservoir Levels-Approach- Criteria (Refer para 8.2 and 8.4)

8.1.1 Dead storage Level (El-m)

8.1.2 Low Water Level (Minimum draw down) (El-m).

8.1.3 Full Reservoir Level (El-m)

8.1.4 Maximum Water Level (El-m)

8.1.5 Maximum Back Water Level at Full Reservoir Level and Maximum Water Level and its effect. Points to which back water effect is felt. Maximum distance of such point(s) from the axis of the structure.

8.1.6 Any saddles present along the rim of the reservoir, how they are being tackled etc.

8.1.7 Fetch

8.1.8 Direction of wind-velocity of wind-wave-height-Free board-Top of dam

8.2 Sedimentation data and studies

8.2.1 Rates of sedimentation (Tonnes or million cubic meters/sq. km. of catchment per year) with basis(Rates experienced in completed project in the basin/adjacent basin be given).

8.2.2 Sedimentation fraction expected (Tonnes/M cum) fraction

	Load	
	Suspended	Bed
(a) Coarse		
(b) Medium		

(c) Fine

8.2.3 Quantity of sediment (Tonnes or M cum during the life of the Reservoir)

8.2.4 Type and shape of Reservoir

8.2.5 Sediment studies (Refer CBIP technical report No. 19)

8.2.6 Sedimentation in the reservoir after 50 and 100 years (million cubic meters).

(i) Below MDDL
(ii) Above MDDL
(iii) Percentage encroachment of live storage during the anticipated life of reservoir
(iv) New Zero Elevation (El-m)

8.3 Life of Reservoir in years with basis

8.4 Capacities (M cum)

8.4.1 Capacities (M cum.)

	Capacity		
	At the time of construction of dam	After 50 years of operation	After 100 years of operation
(a) Full Reservoir Level (FRL)			
(b) Maximum Water Level (MWL)			
(c) Low Water Level (LWL)/ Minimum draw down Level (MDDL)			

8.4.2 Storage (M Cum)

(a) Storage capacity provided with basis for different uses. It shall be followed by discussion on inter-state aspects, storage capacity reserved, if any, for any of the down stream users and mode of sharing/utilisation of the reserved capacity etc. 10% of the storage capacity of the reservoir should be reserved for meeting drinking water requirements of towns/cities/villages. Provision should also be made for release of water from reservoir for maintaining minimum flow in the river downstream for ecological/other specific reasons. Normally 10% of lean season flow should be maintained. (Supported by simulation studies considering the entire river basin as a unit) followed by discussion of tabulated data used for the simulation such as :

(i) Additional reservoir data

Bed level, silt level and crest level.

(ii) Hydrology

Monthly run-off series used for simulation with detailed discussion, if synthetic data is used.

(iii) Diversion requirement

Monthly irrigation, Municipal & Industrial, other general diversion requirements.

(iv) Return flow details

Location, Return flow from..............to............. and return flow in % of diversion.

(v) Minimum flow demands in the system.

(vi) Power details such as number of turbines installed capacity of turbines, maximum utilisable capacity of turbines, efficiency at design head, design head, maximum net head, minimum net head, head loss at design head, head vs. efficiency relation and tail water rating curve etc. and minimum monthly total system lower demand.

(b) Annual Carry over capacity provided, if any, with basis.
(c) Gross annual utilisation and dependability (M cum) for each use.

8.4.3 Water tightness of the reservoir

Water tightness of the reservoir is to be dealt mainly by two angles viz. (i) through the bed of the reservoir and/or (ii) through the foundation of the dam with special attention in case of earth and rock fill dams. Special care may be taken in case of soluble rocks like limestone, marble etc. and highly permeable and the alluvial deposits present in part or full reservoir area and at the dam site.

8.4.4 Annual Losses (M cum) and basis

(a) Evaporation:

Rate of monthly evaporation in reservoir, it shall be followed by discussion on measures proposed to be adopted to check evaporation losses if any.

(b) Seepage in the reservoir

8.4.5 Flood Absorption (M cum)

(a) Below FRL
(b) Between FRL and MWL

8.5 Effect on sub soil water table in the adjoining areas particularly downstream of the dam

8.6 Reservoir rim stability

Geo-technical studies shall be carried along the reservoir periphery and the hill slopes along the reservoir rim to identify the weak areas with potential to cause slips, because of alternate drying and wetting draw down affect, wave action, gully formation, toe erosion etc. The study shall also include the potential weak zones in the hill slopes along the periphery which could get activated due to reservoir filling. Suitable treatment/ measures shall be adopted for stablising such slopes.

8.7 Area of submergence (ha) at:

8.7.1 Maximum Water Level

8.7.2 Full Reservoir Level

8.7.3 Submergence ratio(s) Submerged (cultivated) Area/CCA

8.8 Land Acquisition, property submerged and rehabilitation

8.8.1 Land Acquisition (ha)

(a) Quantum of land:

(i) Up to Full Reservoir Level
(ii) Between maximum Water Level and Full Reservoir Level
(iii) Criteria followed for acquisition of land above Full Reservoir Level and Maximum Water Level.

(b) Classification of land

(i) Forest
(ii) Cultivable
- Irrigated
- Un irrigated
- Pastures & Orchard etc.
- Fallow
(iii)Cultivable Waste
(iv) Waste Land

(c) Any other peculiar problem

8.8.2 Details of property submerged (no.)

(a) Houses, Buildings & Factories

	Private	Government
(i) Kucha		
(ii) Semi-permanent		
(iii)Permanent		

(b) Wells:

	Private	Government
(i) Manually operated		
(ii) Animal operated		
(iii) Power operated		

(c) Details of dislocation of communication (Railway(s) Road(s) Right of way, Telegraphs lines etc.) as a result of the project.

(d) Details of valuable Mineral Deposits/Mines

(e) Historic/archaeological monuments

(f) Any other peculiar problem

(g) Information regarding following items in the area to be submerged
   (i) No. and type of trees
   (ii) Type, depth & volume of soil available having value for use as construction material/ brick making in kilns.
   (iii) Minable resources e.g., minerals, valuable stones etc. The information may be analysed to consider their exploitation for generating revenue before they become in-extractable/minable/exploitable after submergence. The potential of additional revenue on this account may be estimated and taken into account in cost-benefit analysis of the project.

8.8.3 Rehabilitation of Oustees (Descriptive)

a) Number of Villages affected

b) Number of families affected

- SC
- ST
- OBC
- Others

c) Number of persons affected:

i) Agriculturists
ii) Agricultural labour
iii) Artisans
iv) Ordinary labour
v) Others

8.9 Recreation facilities

8.10 Pisciculture

8.11 Need and recommendation for soil conservation measure in the catchments

8.12 Any other relevant information

9. Irrigation Planning

The following items and additional items if any, as relevant to the project shall be discussed under the Chapter Irrigation Planning of the Detailed Project Report.

Note: Wherever information is asked in a tabular form it shall be followed by discussion of the tabulated data

9.1 Existing/proposed Irrigation facilities in the proposed project command area

Source in the project command	Gross command area (ha.)	Culturable command area (net ha)	Gross irrigated area (ha)	Quantity of water utilised/to be utilised (M.cum.)	Kharif (ha.)	Rabi (ha.)	Hot Weather (ha.)	Two seasonal (ha.)	Perennial (ha.)
1	2	3	4	5	6	7	8	9	10
(a) Canals -name(s)									
(b) Tanks - name(s)									
(c) River lift(s) Location(s)									
(d) Open well (number)									
(e) Tube well (number)									

Note :-- For existing schemes, average of the last 3 years shall be furnished for col. (4) to col. (10).The information shall cover all major, medium and minor schemes.

While information for each major and medium scheme shall be furnished separately, information in respect of total area under minor schemes shall be furnished for each source (Col. 1 above)

--Information will be compiled separately for existing and proposed schemes.

9.2 Existing crop pattern

9.2.1 Existing area under rain fed cultivation

(a) Rainfall during Monsoon (Max. Min. & Average)
(b) Rainfall during non-monsoon (Max., Min., and Average)
(c) Area under rain fed cultivation

9.2.2 Area under each crop: Orchard/fruits/vegetables/water bodies like ponds, tanks and lakes for aquatic farming

	Rainfed		Irrigated	
--Kharif Crop	Area (ha.)	Yield (T/ha)	Area (ha.)	Yield (T/ha)
(i)				
(ii)				
(iii)				
(iv)				
(v)				

Sub-total ________				
--Rabi Crop				
(i)				
(ii)				
(iii)				
(iv)				
(v)				

Sub-total ________				
--Hot Weather crop				
(i)				

(ii)
(iii)

Sub-total ________

--Two seasonal crop

(i)
(ii)
(iii)

Sub-total ________

--Perennial

(i)
(ii)
(iii)

Sub-total ________

--Orchards/fruits/vegetables

--Water Bodies	Area (ha)	Area under farming (ha)	Yield (th/ha)
i) Ponds			
ii) Tanks			
iii) Lakes			
Sub total			
Grand total			

9.2.3 Net increase in the irrigation facilities due to project.

9.3 Soil Surveys

9.3.1 Soil capability classification

9.3.2 Land Irrigability classification

9.4 **Agro-climatic Conditions**

9.4.1 **Rainfall**
9.4.2 **Temperature**
9.4.3 **Humidity**
9.4.4 **Sunshine**
9.4.5 **Wind velocity**
9.4.6 **Evaporation**
9.4.7 **Cloud cover**
9.4.8 **Frost free days (no.)**

Details may be given in Annex. 6&7`

9.5 Proposed cropping pattern

Similar details as under para 9.2 may be given

9.6 Crop water requirements:-

Crop water requirements for the crops proposed by the agronomist shall be worked out as per modified Penman's/Christiansen's method (NIR). For details refer FAO publication No. 24 and WMD, Ministry of Agriculture Technical Series No. 2,(revised) May 1984. Detailed computations may be given as per Annexure-8

9.7 Water Planning

9.7.1 Water Resources Development Project should as far as possible be planned and developed as multi-purpose project. Irrigation and multipurpose projects should invariably include a drinking water component, whenever there is no alternative source of drinking water. Drinking water needs of human beings and animals should be first charge on any available water. For details refer CWC's Guidelines on Provision for Drinking Water Supply System's in Multipurpose and Irrigation Projects and Manual on Water Supply and Treatment brought out by Ministry of Urban Development.

9.7..2 Multipurpose projects should provide for irrigation, drinking water, flood mitigation, hydro-electric power generation, navigation, pisciculture and recreation wherever possible.

9.7.3 Surface (M cum)

a) Availability of water and proposed gross utilisation under the project
b) Live storage
c) Quality of Water (Salinity, Sodium alkalinity ratio, pH, boron, flourine etc.) - suitability for irrigation and drinking.

d) Efficiencies assumed with basis

i) Canal and distribution system
ii) Field application

e) Enroute losses in case of integrated systems involving more than one reservoir.
f) Working Tables

Success of the scheme to be checked by matching availability of water with demand in tabular form for a period of 20-40 years on monthly basis for storage projects and for a period of 20 years on 10 daily basis for diversion projects. Success rate for different uses to be achieved :

i) Drinking water	-	100%
ii) Industry	-	100%
iii) Hydro-power	-	90%
iv) Irrigation	-	75%

g) Canal Capacity

Demand table at Canal head to be prepared covering Gross Irrigation requirement crop wise as well as drinking water requirement. Canal capacity to be fixed on the basis of peak requirement including 10% extra for rush irrigation. Tables showing irrigation demand at canal head, total demand, capacity statement of canal and reservoir operation studies be given as per Annexures-9,10, 11 & 12 respectively.

9.8 Command Area Drainage

The following points and additional points, if any as relevant to this chapter shall be discussed in detail:

9.8.1 Review of existing drainage system:

(a) Maximum 1, 2 and 3 day rainfall in the command.
(b) Assessment of water logging, soil salinity and alkalinity
(c) Identification of areas needing drainage
(d) Length of the existing drains and its intensity per sq. km. of CCA.

9.8.2 Type of drainage needed with proposals

(a) Surface drainage
(b) Sub-surface drainage
(c) Vertical drainage (tube wells)

(d) Provision for above to be made on the basis of rate per hectare of CCA. The rate per hectare shall be arrived at on the basis of sub-estimate of a representative sample area surveyed to cover about 10% of CCA.

Central Soil Salinity Research Institute, Karnal on behalf of Ministry of Water Resources has published in 1995 a manual on 'Reclamation & management of water logged and salt affected areas in irrigation commands' and National Institute of Hydrology (NIH) has also published in 1995-96 a Drainage Manual, which may be referred to.

9.9 Water Course/field channels

The provision for water courses/field channels serving up to 5 to 8 ha. block of about 40 ha. shall be indicated on the basis of rate/ha. of CCA. The rate per ha. shall be arrived at on the basis of sub-estimate of a representative sample area surveyed to cover about 10% of the culturable command area.

9.10 Water Management

The following points and additional points, if any as relevant to the project shall be discussed in detail under this chapter:

9.10.1 Review and evaluation of existing system of operation and distribution in the command and/or in some adjoining project, if any.

9.10.2 Proposals for Participatory Irrigation Management including formation of Water Users Association.

9.10.3 Scope of introduction of modern technology like sprinklers, drip irrigation etc. (generally for lift schemes).

9.10.4 Existing practice of Dept. of Agriculture for popularising micro irrigation

9.10.5 Facilities for Training the Operation and Maintenance personnel at different levels of management & farmers – adequacy of existing facilities & proposals for augmentation, if any be given.

9.10.6 Existing extension activity & proposals for its improvement be described.

9.11 Agricultural support services
- Existing
- Proposed

10. Command Area

The Chapter on Command Area Development shall be prepared in accordance with the guidelines prescribed in Part IV (Command Area Development) of the report of this Working Group. This Chapter shall discuss briefly the following items covered in the detailed volume.

Note:- Wherever information is asked in a tabular form it shall be followed by discussion of the tabulated data.

10.1 Command Area

10.1.1 Command Area Details

(a) Location

(b) Classification of land (Forest, grass land, cultivated land. cultivated follow, culturable waste barren

(c) Gross command area, Culturable command area

(d) Size of land holding

Sl. No	Size of Holding (ha)	Farmers		Area held by each category		Remarks
		Number	Percentage of the Total Farmers	Area (ha.)	Percentage of Total Area	
	0 – 1 1 – 2 2 – 4 Above 4					

(e) Date of last revenue survey and land consolidation conducted in the proposed command area to be given village/holding wise (only abstracts).

Note:- Information on (a) to (e) to be furnished Talukawise for the Project Command Area.

10.1.2 Climate of Command Area

(a) Average Annual Rainfall (weighted) (mm)
(b) Seasonal distribution (Monsoon & non-monsoon) (mm)
(c) Co-efficient of variation
(d) Temperature (maximum, minimum and average) (^{o}C)
(e) Humidity (maximum minimum & average)
(f) Evapo-transpiration (ETO)-annual

10.1.3 Irrigation

(a) Present sources of Irrigation in the command
(b) Method(s) of irrigation followed
(c) Status of land development for Irrigated Areas
   (i) Condition of channels (lined/unlined)
   (ii) Longitudinal slopes in the field

(iii)Status of field channels/drains
(d) Assumed field application efficiency with justification
(e) Record of water logging, salinity and flooding

10.1.4 Socio-economic aspect

(a) Population major occupation(s) income etc.
(b) Classification of farmers (marginal-small-medium-big)
(c) Land tenure
(d) Income-average

(i) from farm
(ii) subsidiary sources
(iii) Total

This information be furnished separately for following categories:

(a) Land less
(b) Marginal farmers
(c) Medium farmers
(d) Big farmers
(e) Availability of agriculture labour and wages
(f) Bench mark sample surveys for a representative area in the command.

10.1.5 Infrastructure facilities

(a) Railways and roads (villages, district etc.)
(b) Marketing facilities
(c) Agro-industries
(d) Banks; credit societies etc.

10.2 Topography and Soils

10.2.1 Topography and relief (gentle, rolling, steep)

10.2.2 Land slopes

10.2.3 Soils

(a) Origin
(b) Texture
(c) Depth
(d) Infiltration and drainability
(e) Salinity
(f) Base-exchange and pH
(g) Fertility status

10.3 Drainage -Density of natural drainage (km. per sq. km. of the command area)

10.4 Agriculture

10.4.1 Present land use

10.4.2 Cropping pattern followed with average yield of 3 years irrigated and rain fed crops separately for each crop

	Irrigated		Rainfed	
	% Area	Yield (T/ha)	% Area	Yield (T/ha)
(a) Kharif				
(b) Rabi				
(c) Summer				
(d) Two seasonal				
(e) Perennials				

Crop wise information to be furnished (source of information to be indicated)

10.4.3 Agriculture practices adopted-use of

(a) Improved implements and seeds
(b) Fertilizers, insecticides, pesticides, etc.
(c) Extension services.

10.4.4 Farmers' attitude towards improved agricultural practices and willingness for payment of water rates to meet O&M expenses.

10.4.5 Preparedness by State Irrigation/Agriculture Departments/WUAs/Cooperatives to adopt improved farming system.

10.4.6 Identification of problems in command area

10.5.1 Physical problems (including hazards)

(a) Land slopes
(b) Soil depth
(c) Salinity/alkalinity
(d) Soil erosion
(e) Water logging
(f) Drainage
(g) Any other

10.5.2 Financial problems

(a) Socio-economic conditions
(b) Availability of improved implements/machines and other inputs.

(c) Credit facilities - Existing Cooperative structures/Number of primary agricultural societies in the area
(d) Infrastructure facilities
(e) Department of Agriculture and Soil Conservation's Plan for agricultural development with details of financial sharing.

10.6 Proposed Cropping pattern with justification based on land irrigability classification agro-climatic conditions, developed irrigated cropping pattern in the adjoining projects/areas etc.

10.7 Land Development Works (proposals)

10.7.1 Area involved

(a) Land leveling/shaping
(b) Field channels
(c) Field drainage
(d) Implementation of warabandi
(e) Reclamation of water logged areas.
(f) Farm roads

10.7.2 Measures proposed

10.7.3 Agency responsible for survey planning and execution of land development works. Availability of experienced agencies/contractors and their willingness to employ local population especially displaced persons .

10.7.4 Cost estimates and cost per ha for land development.

10.7.5 Financing arrangement for execution of works

10.7.6 Schedule for completion of land development

10.7.7 Status of existing extension services, credit agencies, TCD farms etc. and location of inputs like seeds fertilizers, insecticides, pesticides etc. Depots and proposals for their strengthening if required with justification.

10.7.8 Conducting adaptive trials and demonstration on farmers field.

10.7..9 Action Research Programme

10.7.10 Participatory Irrigation Management

10.7.11 Training of

(a) Senior Level Officers
(b) Middle level officers

(c) Farmers

10.8 Ayacut roads

10.9 Benefits- Information relating to existing facilities, proposed facilities after implementation of project and net increase in benefits due to project may also be compiled in project reports. This information may be compiled in the tabular form prescribed at point 20.1 and 20.2 of Chapter-2 'Salient Features' under those broad heads but in more details.

10.9.1 Crop-wise increase in yield per ha and total expected output from the command

10.9.2 Estimated cost of increased production with basis for unit rates assumed

10.9.3 Likely socio-economic impact

(a) Increase in employment
(b) Agriculture based industry
(c) Marketing facilities
(d) Any other

11. Flood control

The following points and additional points, if any, pertaining to flood control and drainage aspects of the multipurpose project shall be discussed under this Chapter.

11.1 Description of the flood problem in the tributary/sub-basin in which the reservoir proposed as well as in the main river basin with particular reference to the command area of the project.

11.2 Details of the inter-state international aspects of the flood/drainage problems, if any.

11.3 Flood Data

(a) Historical floods

(i) Source of information
(ii) Years of occurrence
(iii) Estimated peak discharge
(iv) Peak Gauge
(v) Area affected (Map to be enclosed if available).
(vi) Flood damages

(b) Observed floods (year-wise):

The following data shall be furnished for the period since observations were started:

(i) Year
(ii) Flood hydrograph
(iii)Observed/estimated peak discharge
(iv)Maximum gauge
(v) Area affected with average depth of flooding

11.4 Flood damage (year-wise)

The following information shall be supplied for a minimum period of preceding 10 years

(a) Village, Taluka or Tehsils/Towns/Districts etc. affected
(b) Population affected
(c) Area affected (in the proposed project)

(i) Gross area
(ii) Culturable area
(iii)Cultivated area
(iv) Damage/loss

(d) Physical and monetary year-wise (in particular river basin/sub-basin)

(i) Property
(ii) Crops
(iii)Human Life
(iv) Cattle
(v) Public utility services
(vi) Any other

(e) Flood relief expenditure (year wise)

11.5 Existing storage and flood control works in the tributary/main river basin

(a) Existing storage works

(i) Location
(ii) Catchment area intercepted
(iii)Live storage
(iv) Specific flood storage, if any
(v) Flood moderation by the existing reservoir

(vi) Residual floods
(vii)Possible modification for improvement of flood situation

(b) Flood control works -Details of existing works like embankments

(i) Location
(ii) Spacing of embankments in case of double embankments and distance from present river bank in case of single embankments.
(iii) Design HFL and frequency of floods for which embankments were designed
(iv) Top level of embankment
(v) Carrying capacity of river with embankments
(vi) Possible modification for improvement of flood situation

11.6 Flood control by proposed reservoir

(a) Existing safe carrying capacity of the tributary/river in the flood prone areas

(b) Hydrological considerations for flood moderation by reservoir

(i) Peak floods and flood hydrographs at dam site for 25, 50 and 100 year frequencies
(ii) Peak floods and flood hydrographs at damage centres without reservoir
(iii) Peak floods and floods hydrographs of synchronizable contribution of the controlled catchment upto the dam site and the uncontrolled catchment between the dam and the damage centres
(iv) Synchronization of the releases from the existing storage upto the damages centres
(v) Storage routing of the above and historical floods to determine the extent of flood moderation by providing alternative specific flood storages.
(vi) Moderated outflows with proposed specific flood storage with reference to the peak inflows
(vii) Degree of flood moderation by suitable operation of reservoir without providing specific flood storage-fixation of ruling levels of reservoir.

(c) Impact of the proposed flood protection works including likely reduction in general damage, expenditure on relief, remission of revenues etc.

11.7 Flood control measures for command area:

(a) Peak flood of 25, 50 and 100 year frequency at damage centres after taking into account moderation by reservoir(s) and synchronizable contribution of uncontrolled catchment.
(b) Safe carrying capacity of river in flood prone area
(c) Technical details of proposals for flood protection of command area

(i) Embankments

(ii) Channel improvement
(iii) River diversion
(iv) Programme of completion
(v) Degree of protection

12. Drainage

12.1 Basin Characteristics

(a) Geological history/geology
(b) Physiography
(c) Existing Drainage lines
(d) Farm drainage
(e) Rainfall, its distribution over space and time (give 1, 2 and 3 days rainfall of 5 years frequency)

12.2 Investigation--Brief

(a) Water-table investigation and Artesian conditions, if any
(b) Soil surveys-texture and permeability

12.3 Cultivation practices

(a) Existing cultivation practices
(b) Proposed cultivation practices

12.4 Existing Drainage

12.5 Drainage deficiencies

12.6 Drainage requirements including alternative layout of drains, their capacities (surface and sub-surface).

Manual for 'Reclamation & management of water logged and salt affected areas in irrigation commands 1995', published by CSSRI on behalf of MOWR and "Drainage manual" published by NIH which describes in detail the surface and sub-surface drainage system, parameters needed for design of surface drainage and sub-surface drainage system and laboratories and field investigations needed for design, may be referred to.

13. Power

13.1 The following points and additional points, if any, as relevant to the Power aspect of Multipurpose project shall be discussed under this chapter.

13.1.1 Available generating capacity (MW) in the **State/region from different sources with location, category-wise:**

(a) Hydro Power (for ROR, ROR with pondage, storage, pumped storage separately).
(b) Thermal power
(c) Diesel power
(d) Gas Turbine
(e) Atomic power
(f) Tidal Power
(g) Solar power
(h) Geothermal power
(i) Pumped storage plants
(j) Any other

13.1.2 Present status of utilisation of power:

(a) Agriculture
(b) Industry
(c) Domestic
(d) Commercial
(e) Others

13.1.3 Energy availability (kWh) and peaking capability (MW) monthwise and category-wise.

(a) Hydro Power (for a hydro power station, on a 90% dependable year basis for ROR, ROR with pondage, storage and pumped storage separately)
(b) Thermal power
(c) Diesel power
(d) Gas Turbine
(e) Atomic power
(f) Tidal Power
(g) Solar power
(h) Geothermal power
(i) Pumped storage plants
(j) Any other

13.1.4 Shortages/surpluses and import/export of power from/to the neighbouring States/regions.

13.1.5 Transmission system

A write-up on the associated transmission system required for evacuating the energy generated, whether on the transmission system already existing or involving construction of new lines/sub-stations would be required to be given along with the participation of executing agency and the time frame by which the evacuation system is proposed to be completed.

The information should be supported by necessary system studies. Details of type of switchyard i.e. outdoor or conventional or GIS, location, requirement of inter-bus transformer(s) and other switchyard equipment should be given.

A single line diagram of the layout of the switchyard indicating Bus arrangement, Circuit Breakers, Isolators, transformers and other equipment proposed to be installed should be given.

13.2 Power requirements

13.2.1 Existing

a) Energy (Kwh) and peak load (MW) requirement - daily, monthly and seasonal variations.
b) Daily, monthly and annual load factors in the States/region
c) State/Regional load curve on monthly/annual basis (maximum load day and minimum load day).

13.2.2 Anticipated requirements of energy (kWh) and peak load (MW) with daily, monthly and annual variations and load factors upto the likely year of completion of project proposed 10-15 years.

13.3 Future plans of power development in the States/region.

13.3.1 Schemes under construction/expansion/RM&U with location.

13.3.2 New schemes sanctioned - brief.

13.3.3 Month-wise energy (kWh) and capacity (MW) contribution from the schemes existing, under construction/expansion and new (in case of hydro projects generation in 90% dependable year).

13.3.4 Integrated operation studies of the regional power system for justification of the scheme - shortfall/surplus, if any, and proposals to meet the shortfall/disposal of surplus energy.

13.3.5 Status of present proposal in overall planning based on the study of alternative modes of generation viz. Thermal, Atomic, Tidal etc.

13.4 Assessment of power benefits of the proposed project.

13.4.1 Nature of Multipurpose project viz., run off of the river, conventional storage based with and without carry over, pumped storage etc. - brief.

13.4.2 Power potential of river basin, stage of development and effect of future upstream/downstream development on the potential of proposed schemes.

13.4.3 Hydrology, sedimentation studies and criteria/optimisation studies for fixing up full reservoir level and minimum draw-down level - brief etc. (including lower reservoir in case of Pumped Storage Scheme).

13.4.4 Mode of operation of reservoir depending upon the requirement of irrigation, power, flood control, water supply, riparian rights etc. (including operation criteria in generating mode and pumping mode, availability of pumping energy and combined cycle efficiency in case of pumped storage scheme).

13.4.5 Long Term Water power studies depending upon the nature of project (13.4.1) above. The period of simulation for the studies shall be as indicated in Annexure-4. The studies may be carried out for different FRLs in case of storage schemes.

13.4.6 Annual and month-wise design energy based on 90% dependable year and of plant based on hydro power potential studies for run-off of the river scheme and reservoirs schemes (Annual and carry over). A time interval of not more than one month may be used for simulation studies for lean period. For monsoon period flows studies for monthly/ten-days basis may be made.

13.4.7 Month-wise availability of firm and seasonal power.

13.5 Power house & equipment

13.5.1 .Criteria for selection of type of power House i.e. underground semi-underground/surface.

13.5.2 Criteria for selection of location of power house and various alternatives considered.

13.5.2 Dimensions

- Length
- Width
- Height

13.5.4 Number of units

Installed capacity

13.5.5 Turbine

- Type
- Rated output

13.5.6 Generator

- Type (Bearing Arrangement)
- Rated capacity
- Frequency
- Generation Voltage
- Shaft Vertical/Horizontal

13.5.7 Transformer

- Nos.
- Single phase/Three phase
- Voltage Ratio
- MVA rating

13.5.8 Power House Cranes

- Nos.
- Capacity (Main/Aux. hook)

13.5.9 Switchgear

- Type -GIS/Conventional etc.
- Rating etc. of Switchgear
- Size of Switchyard (LxB)
- Type of Switchyard –Indoor/Outdoor

13.6 Power Plant Head and Flow

- Minimum net head at MDDL
- Maximum net head at FRL
- Rated net head
- Design net head
- Maximum discharge at MDDL
- Minimum discharge at FRL
- TWL

- Minimum
- Maximum
- Maximum under flood condition

13.7 Transmission Arrangement

- Transmission Voltage
- Number of Circuits
- Single Circuit/Double Circuit
- Terminal Sub-station Details

13.8 Installed capacity

13.8.1 Anticipated load factor of operation of the power house - Annual and month wise.

13.8.2 Total installed capacity to be provided based on the power benefits and anticipated load factor of operation and capacity optimisation studies.

13.8.3 Size and type of generating units with justification, their design and rated head, specific speed, synchronous speed, setting of pump/turbine etc., type of MIV, type and size of Power Transformer, type of switchyard etc. and brief specification of the various equipment. Description of auxiliary system including LTAC and DC system, Fixing of Tail water levels.

13.8.4 Number of generating units including stand by units (if any) to be installed and criteria of deciding the number - transportation limits, weight & size.

13.8.5 Layout of the power generating units including auxiliary equipment, transformer yard and switchyard, single line diagram, control and protection details.

13.8.6 Selection of EHV/HV switch gear and switching scheme.

13.8.7 Auxiliary systems –description, justification for selection and schematic diagram.

13.8.8 Arrangement for black start of the power plant.

13.8.9 Description of plant control system.

13:8.10 Selection of EHV cables/GI bus for interconnection alongwith justification.

13.9 Power Benefits

- Firm power
- Annual Energy Generation in 90% dependable year

13.10 Financial Package proposed for construction of the project.

13.11 Capital Cost (base year)

- Civil works cost
- Electromechanical equipment
- Transmission cost
- Interest during Construction
- Total project cost
- Capital cost per kilowatt hour
  (Capital cost per kWh generated in dependable year as per latest Govt. of India's Notification)

13.12 Implementation Schedule

- Pre-construction (years)
- Construction (years)

13.13 Allocated cost of head works.

13.14 Comparison of the total cost of the hydro-electric components of the project with any other viable category viz. thermal, atomic, tidal etc.

13.15 Construction power requirement and proposed supply arrangement.

13.16 Economic Evaluation

- Unit cost of generation at Bus Bar
- B.C. ratio
- Internal rate of return (IRR)

NOTE ; For financial return statements of "Power" component of Multipurpose power project refer Annexure – 13.

14. Navigation

The following points and additional points, if any, as relevant to the Multipurpose project shall be discussed under the chapter.

14.1 Traffic surveys:

(a) Existing transport system of the region
- Road
- Railways

- Waterways
- Air

(b) Percentage of the traffic covered by river transport (Inland Water Transport)
(c) Present population and projected growth in the project area
(d) Present assessment and projection of inland water transport in the context of the introduction of new project
(e) Present and projected flow pattern of different commodities/passenger traffic
(f) Freight rates by existing system of transport as per (a) above
(g) Total cost of transport of various commodities including transhipment
(h) Comparative cost of various modes of transport
(i) Feasibility of Inland Water Transport
    (i) Technical
    (ii) Socio-economic

14.2 Navigability of the waterways

14.2.1 Existing system
    (a) Rivers
    (b) Canals

Discuss the following items in respect of existing class of waterways i.e. both rivers and canals separately

(i) Length of navigable portion (km)
(ii) Width of navigable portion (m) (Bed width in case of canal)
(iii) Side slopes (in case of canal)
(iv) Minimum draft available during (different seasons (m)
(v) period of navigability
(vi) Indicate whether canal is lined or unlined.
(vii) Location and size of navigation locks, if any
(viii) Discharge (cumec)-velocity of current (m/sec) during different periods of the year
(ix) Type, size and number of crafts
(x) Clearance available under the existing structures (m) -Vertical and Horizontal
    (a) Bridges
    (b) Aqueducts
    (c) Super passages
        - Horizontal
    (a) spurs
    (b) Quays, jetties and berths
    (c) Sheltering basins
    (d) Bye-pass channels
(xi) Condition of the bed of river and canal in different regions (silting-shoals)
(xii) Towns connected
(xiii) Industries served
(xiv) Traffic catered

- Passenger (numbers)
- Goods-commodities-wise (tonne)
- General
- Specific

(xv) Class of Waterway

(c) Conservancy measures

(i) Periodical hydrographic surveys and hydrological observations
(ii) Nature of conservancy and other river training works.

Temporary:

- Bandalling
- Bottom paneling
- Dredging etc.
- Permanent
- Construction of spurs, greynes and bank revetments
- Capital dredging
- Regulation of flows by construction of retention dams in the higher reaches of the river

(iii) Navigational aids:

- Buoys
- Beacons
- Lights etc.
- Wrecks and snags in the navigable portion; its location, marking and lighting
- Marking of channel for day and night navigation

(iv) Pilotage services, if any
(v) Facilities for salvage operation such as removing wrecks, snags clearing etc.
(vi) Type of organisation for carrying out the conservancy measures listed at (i) to (v)

(d) Training facilities to crew of launches, tugs boats etc.

(e) Radio communication facilities

(f) Annual expenditure on the maintenance of navigable waterways including conservancy measures listed under item (xiv) above.

(g) Type of agency/organisation for running Inland Water Transport Services

(h) Annual Revenue:

(i) Passenger
(ii) Goods

(j) Inland Water Transport Facilities

(i) Berthing facilities viz. jetties, berths, ghats.

(ii) Loading and unloading facilities for cargo at various river stations
(iii)Terminal facilities for passengers and goods

(j) Integrated behaviour of the system (river and canal)

(k) Maximum flood discharge/level up to which the system can work.

(l) Period of shut down of traffic due to floods and maintenance works

14.2.2 Future Planning of Waterways in the basin/region

(a) Possibility of inter-linking of rivers in the region for development of water transport;
(b) Indicate the details of power projects and storage schemes to be taken up during next ten years which may provide release through out the year and create new navigable stretches.

14.2.3 Present Proposal

(a) Broad details of the present proposals in the light of para 14.2.2--Discuss items under para 14.2.1 above as relevant to the present proposal

(b) Provision, location and design of navigation locks in head-works and other structures with data on foundation and construction materials.

(c) Development of reservoir for navigation

(i) Provision for cutting down the trees to the root in the bed of reservoir and removal of other obstacles before water is allowed to enter into reservoir.

(ii) Details of infrastructures such as provision of approach roads to ghats, construction of ghats, jetties and berths etc.

(iii) Ferry and boat services for transshipment of passengers and cargo.

(d) Effect of withdrawal of water for irrigation, power etc. on the existing navigation on the main river and the minor ports located below proposed dam. In case any adverse effect is anticipated, discuss measures for maintaining the navigability.

(e) If the river affords possibilities of navigation alongwith multipurpose development by the construction of series of dams, provision of navigation locks in these structures needs to be examined.

(f) Indicate, if any Act(s) are enforced for regulating ferry services and other traffic on the navigable waterway.

(g) Details and dimensions of the existing structures and proposal for remodelling, if any specially with respect to horizontal and vertical clearances and draft available/required.

(i) Bridges
(ii) Aqueducts
(iii) Super passages
(iv) Spurs
(v) Quays, jetties and berths
(vi) Sheltering basins
(vii) Bye-pass channels
(viii) Locks
(ix) Regulators
(x) Weirs

(h) Details and dimensions of new proposed structures including horizontal and vertical clearance and draft provided Types of structures as referred under item (g)-(i) to (x) above.

(i) Proposed Class of Waterway

15. Construction programme and manpower and plant planning

Information on the following points and additional points, if any, shall be furnished under this chapter of the Detailed Project Report. Wherever tabulated information is called for, the inference drawn shall be discussed briefly. For calculating the requirement of equipment, its life and unit rate of productions Annexure-14 may be referred to.

15.1 Construction Programme

(a) Details of year-wise construction programme for each of the major components of the work. The programme shall be supported by Critical Path Methods (C.P.M.) high-lighting the critical activities.

(b) Bar Charts, showing the Construction Programme, quantity-wise, item-wise and year- wise target of construction.

15.2 KeyMaterials Planning

15.2.1 Special Materials

Year-wise requirement

(a) Cement

(b) Steel

(i) Structurals
(ii) Plates
(iii) Bars & rounds
(iv) Special Steels, if any

(c) Explosives

(i) Gelatin
(ii) Detonators
(iii) Fuse coil
(iv) Explosives-Ammonia Nitrate

(d) Oils and Lubricants

(i) H.S.D. Oil
(ii) Petrol
(iii)Lubricants

(e) Any other material(s) Including scarce material

15.2.2 (a) Suggested source of supply for each key item and availability, proposed mode of transportation and constraints/limitations, if any.
(b) Distance from nearest railway station to work-site
(c) Mode of handling including railway siding and transportation
(d) Road Transport

15.3 Construction power requirement & proposed supply arrangement

15.4 Plant/Equipment Planning (to be incorporated in case works are to be executed departmentally)

For working out detailed quantities of equipment required refer Annexure-14. Give separate justification for auxiliary equipment such as loading/unloading cranes, trailers etc. Planning should normally be on two shift working basis.

15 4.1 Quantities of excavation involved

Proposed excavation ('000 cum)

ITEM	Manually			By Machine		
	Quantity	Lead	Lift	*Type	Quantity	Lead
(a) Levels and Approaches						
(i) Soft Strata						
(ii) Hard Strata						
(iii)Rock						
(b) Head-works and Appurtenant Works						
(i) Soft Strata						
(ii) Hard Strata						
(iii)Rock						
(c) Tunnels						
(i) Soft Strata						
(ii) Hard Strata						
(iii)Rock						
(d) Canals						
(i) Soft Strata						
(ii) Hard Strata						
(iii)Rock						
(e) Water Conductor System including Surge shaft						
(i) Soft Strata						
(ii) Hard Strata						
(iii)Rock						
(f) Power House and appurtenant works						
(i) Soft Strata						
(ii) Hard Strata						
(iii)Rock						
(g) Other Misc. Works						
(i) Soft Strata						
(ii) Hard Strata						
(iii)Rock						

* Construction equipment combinations such as Shovel-dumper, Scrapper-pusher etc.

NOTE :-

Soft strata : Shall include all excavations in soil, silt, sand, gravel, soft material, shift clays, kanker and other similar materials including isolated boulders of diameter up to 0.3 m.

Hard strata : This shall include all excavations in hard murrum, indurated clay, silts and sands, conglomerates, disintegrated rocks and other similar materials with scattered boulders of diameter up to 1 m which may have to be removed even by blasting.

Rock : This shall include all excavation in soil and hard rock other than category of hard strata (above) which has to be excavated by blasting or chiseling wherever necessary.

For the purposes of manual excavations the materials shall be classified in three categories viz. soft strata, hard strata and rock. For the purposes of excavation by Machine, the material shall be classified in two categories viz. overburden (soft and hard strata) and Rock.

The above definitions of strata shall be followed in this chapter and elsewhere in the other chapters of Detailed Project Report and its appendices, drawings etc. for the purposes of classifying the excavations.

15.4.2 De-watering

(a) Expected quantity to be de-watered
(b) Nature of Strata

15.4.3 Dredging to be done, if any

15.4.4 Drilling & Grouting

(a) Depth of drilling (m)

(i) Soft strata

(ii) Hard strata

(iii)Rock

Indicate type of drilling anticipated viz. percussion, rotary etc.

(b) Grouting (High and low pressure)

(i) Estimated grout intake

(ii) Material(s) for grouting

(iii) Quantity of material(s) required

(c) Any other special foundation treatment required such as diaphragm etc. indicating details of the same.

15.4.5 Earth Works and Rock Filling

	Usable Quantity available from excavation							Quantity to be available from Borrow areas/quarries (Th. cum)				
	Manual			Machine				Manually		By Machine		
	Qty	Lead	Lift	Type	Qty	Lead	Qty	Lead	Lift	Type	Qty	Lead
a) Levels & approaches												
(i) Soft strata												
(ii) Hard strata												
(iii) Rock												
b) Headworks & appurtnant works												
(i) Soft strata												
(ii) Hard strata												
(iii) Rock												
c) Canals												
(i) Soft strata												
(ii) Hard strata												
(iii) Rock												

15.4.6 Concrete/masonry

	Total Quantity Involved	Manual			Machine		
		Qty	Lead	Lift	Type	Qty	Lead
(a) Dam and Appurtenant works (i) Concrete (ii) Stone Masonry							
(b) Tunnels (i) Lining (ii) Supports							
(c)Shotcreting							
(d)Canals structures (i) Concrete (ii) Stone masonry							
(e) Lining of canals Type of Lining (i) Concrete (ii) Brick (iii) Stone slabs (iv) Tiles (v) Polythene etc.							
(f)Power House Concrete/Masonry							
(g)Water Conductor System Concrete/Masonry or any other							
(h)Other Misc. Works Concrete/Masonry or any other							

15.4.7 The list of plants/equipment required together with the cost based on current prices shall be furnished. The equipment shall be planned for work required to be executed during the peak year. The work phasing within the time during which it is required to be accomplished shall be such that the peak requirement of equipment is not substantially higher than that of the average equipment.

Detailed calculation to justify the type, size and number of machines required indicating number of shifts, the equipment is proposed to be used during the day, number of days available for construction during the year, borrow pit locations with maps, and various assumptions made like swell factor, job management factor, efficiency factor etc. shall be furnished.

Year wise scheduling of procurement of equipment including stand by equipment and/or induction replacement equipment for large projects shall be given as under:-

Sl. No.	Name of the equipment	Unit	Year of purchase				Expected percentage of utilisation
			I	II	III	IV	

15.4.8 Workshop and stores facilities to be provided.

15.5 Manpower Planning

15.5.1 Year-wise requirement and source

(a) Professional personnel (Engineers, Doctors, Geologists etc.)
(b) Other Technical Personnel
(c) Administrative Personnel (Administrative, Accounts, Labour Officers etc.)
(d) Skilled labour and semi-skilled labour
(e) Unskilled labour

15.5.2 Facilities and amenities proposed to be provided to :-

(a) Regular Staff
(b) Work-charged Staff
(c) Daily wages Staff
(d) Contractor's staff and labour

16. Foreign exchange element

The following points and additional points, if any, as relevant to the project shall be discussed under this chapter.

16.1 Plant, machinery, instruments etc. to be imported including the details of spare parts.

16.2 Justification for importing the plant machinery, instruments etc. supported with details.

16.3 Name of the countries where available.

16.4 Estimates of cost and its basis.

16.5 Foreign exchange required and whether the required foreign exchange (or a part) is covered under any aid/loan agreement.

(a) Aid/Loan agreements

(b) Government resources of foreign exchange

16.6 Programme for import and yearly requirement of foreign exchange.

17. Environment, Ecology & Forest Aspects of the project

As per Planning Commission Lr. No: 16 (2)99-WR dated 30.11.2000, the State Government shall obtain all required statutory clearances from the Ministry of Environment and Forest and Ministry of Social justice and Empowerment like environmental clearance. Forest clearance approval for rehabilitation and resettlement plan and all other clearances, as may be required before the investment approval is accorded. Detailed Information for obtaining clearance of the project for environmental clearance is available in http://envfor.nic.in

18. Estimate

18.1 The Central Water Commission had issued "Broad Guidelines for preparation of Project estimates for Major irrigation and Multipurpose Projects" in July 1976. These had been revised first time in July, 1983. The same are further revised in March, 1997. These are based on the IS:4877-1968 and are entitled "Guidelines for preparation of estimate for river valley projects". These guidelines are to be followed in preparation of estimates. These guidelines as slightly modified by the Working Group are as under:

18.2 Classification of Units:-

The project works have to be grouped into the following units:

(i) Unit-I Head-Works including main dam and auxiliary dam, dykes, spillway, outlet works, energy dissipation devices, barrages, weirs, regulators including intake structures and diversion works.

(ii) Unit-II - Main canals, branches, and distribution system inclusive of all pucca works.

(iii) Unit III - Hydro-electric installation

a) Power Plant and appurtenant works:
   - Civil works, and
   - Power equipment.

b) Transmission lines.

c) Sub-stations.

(iv) Unit-IV - Navigation works.
(v) Unit-V - Water supply works.
(vi) Unit-VI - Command Area Development Works.

18.3 Account heads

18.3.1 Minor Heads :

Each unit and if necessary each sub-unit, should be covered under the following minor heads classified as direct and indirect charges.

(i) Direct Charges

These shall include the followings:

(I) Works
(II) Establishment
(III) Tools and Plant
(IV) Suspense.
(V) Receipts and recoveries on capital account

(ii) Indirect Charges:

These shall include the following:

a) Capitalized value of abatement of land revenue, and
b) Audit and account charges.

18.3.2 Detailed Sub-Heads under I-Works

A- Preliminary
B- Land
   i) Acquisition & Compensation
   ii) Rehabilitation and resettlement
C- Works
D- Regulators and measuring devices (for canals only)
E- Falls (for canals only)
F- Cross drainage works (for canals only).
G- Bridges (for canals only)
H- Escapes (for canals only)

I- Navigation works
J- Power Plant Civil Works
K- Buildings
L- i) Earthwork;
   ii) Lining and (for canals only)
   iii) Service Road (for canals only)
M- Plantation
N- Tanks and reservoirs
O- Miscellaneous
P- Maintenance
Q- Special T&P
R- Communications.
S- Power Plant and Electrical Mechanical system
T- Water Supply Works
U- Distributaries minors and sub-minors.
V- Water courses
W- Drainage (to be clubbed with Environment and ecology)
X- Environment and ecology
Y- Losses on stock

18.4 Abstract of cost

18.4.1 Detailed Abstract of Cost

To work out the total cost of the project in detail, the cost of various units mentioned in para 18.2 should be compiled in a tabular form according to the various accounts heads indicated in para 18.3.

18.4.2 General Abstract of Cost

On the basis of the detailed abstract of cost as in para 18.4.1 a general abstract of cost for the whole project tabulating all the units together may be compiled by minor and detailed heads.

18.5 Preparation of estimates

18.5.1 The capital cost of a project includes all cost associated with investigations, design, construction and maintenance during construction period of the project.

18.5.2 One of the most difficult tasks in connection with the preparation of cost estimates is the determination of the unit costs of labour, materials and equipment necessary to perform the work designated in the various pay-items for the proposed construction. Current unit cost should be used in all estimates and price level of the project estimate should be mentioned.

18.5.3 The analysis of rates for various items is worked out taking into consideration the cost of materials, carriage-handling- storing, labour and share of machines involved in executing various items of the work and overhead charges.

18.5.4 The quantitative assessment of material requirement may be adopted from authoritative books/publications or through independent calculations based on the data available at site or other projects. The unit cost of various materials may be taken as those prevalent in the State/region. The appropriate cost for freight, unloading, cartage, storage, inspection and testing should also be included.

18.5.5 The wages of workers are periodically revised by the State under the statutory labour laws. Daily wage rates, therefore, should be taken as those prevalent in the State at the time of formulation of the project.

18.5.6 For working out the use rates of machinery, the norms for life, depreciation, repair provision etc. may be adopted as recommended by the CWC Guide Book on use rate, hire charges and transfer value of Equipment and spare parts, December, 1988. Price of various equipment should be taken on the basis of recent quotations/price list of such equipment. All taxes and freight charges should be taken into consideration while arriving at the cost of equipment at site.

18.5.7 Provision for contingencies and work-charged establishment is generally considered up to 3% and 2% respectively of the works' cost and provided in the detailed works estimates prepared on the heads of items rates and quantities of works to be executed These percentage provisions should not be considered on lump-sum items.

18.5.8 Mention shall also be made regarding communication facilities available, terrain through which the roads are passing (hilly, plain etc.), type of road (Black top, water bound macadam, murum, kacha etc.).

18.6 Detailed estimates of costs - I-Works

The various items under minor and detailed sub heads for which estimates should be prepared are indicated below. Explanatory notes regarding the basis of provisions should be given for each item.

18.6.1 A- Preliminary:

The important items to be considered are:

a) Expenditure incurred on previous investigations.
b) Detailed surveys for final location;
c) Procurement and analysis of Remote sensing imageries/data

d) Arial Survey/Contour survey for reservoir basin (including establishment of permanent bench marks);
e) Geological surveys and geophysical surveys;
f) Hydrological and Meteorological surveys including establishment of rain gauges/and river gauge and discharge, sedimentation stations and their running charges;
g) Investigations for foundation and rock testing;
h) Investigation for availability of construction materials;
i) Construction of access roads to facilitate investigations;
j) Model experiments;
k) Computer & telecommunication facilities;
l) Preparation and printing of project reports;
m) Vehicles for inspecting officers for site investigations;
n) Camp equipment;
o) Preliminary soil tests, establishing soil testing laboratory;
p) Consultants fees (including charges for preliminary design work or advice);
q) Training of engineers during investigation and preparation of project reports;
r) Ground water studies;
s) Environmental and Ecological studies.
t) Seismological equipment and measurements.
u) Command area survey (contouring).
v) Detailed alignment survey (cross sectional survey) of canals.
w) Establishing and fixing bench marks on alignment of canals.
x) Taking trial pits or trenches and trial bores for foundation investigation of structures alongwith alignment of canals.
y) Taking auger holes for soil survey of command area.
z) Field tests for soil classification of command area.
za) Cost of other surveys, investigations and studies.(eg. Topographical surveys etc.)

The amounts required against each of the above items will vary from project to project and no general yardsticks can be laid down. It has, however, been the experience that the overall provisions under 'A-Preliminary' in a project estimate should be limited to 1% to 2% of the total cost of I-Works.

18.6.2 B-Land

18.6.2.1 Following information/statements should be furnished in the estimate for B-Land.

I. Level up to which land is to be acquired for submergence and construction works.

2. Statement showing villages submerged alongwith total area of the villages and the area to be acquired and also the percentage of the total area of the village.
3. Statement of village-wise structures such as buildings, stables, temples, other religious buildings and wells.
4. Statement of persons displaced and their occupation village-wise.
5. Alternative means of employment for the oustees.
6. No. of trees, girth at 3' above ground, fruit bearing etc. & their usefulness.

18.6.2.2 Acquisition and compensation

This sub head covers the following items:

a) Compensation of land (Private and Government for works and that coming under submergence;

The probable rate for acquisition of different types of lands should be enquired from and got certified by the district revenue, forest or other competent authorities and their certificate appended with the project estimate. Only such cost that will actually be paid for Government land shall be included in the estimates. However, quantities for Government land taken on transfer shall be indicated.

b) Compensation for other properties like houses, wells, trees etc.;

The cost of wells should be based on the evaluation of their numbers and present day costs; but the cost of structures such as buildings, temples etc. should be based on plinth area rates at present day cost less value of usable materials.

c) Compensation for standing crops;

The norms for crop compensation and interest charges are not uniform.. The provision of crop compensation is normally made at a suitable rate per hectare on a percentage of cultivated land being acquired. It is seen that this percentage ranges between generally 25% to 50% of the agricultural land being acquired.

d) Compensation for prospective mineral deposits, if any;

e) Rent for use of land;

f) Interest charges on the amount of award for the period between taking over possession of the land and the date of award;

The interest charges on compensation may also be necessary in view of the likely time lag in taking possession of the land and properties and actual payment of compensation. For estimating purpose this provision may be considered on about 25% of the total compensation for a period of about 2 years @ 12% per annum or as per prevailing rate

g) Solatium charges for compulsory acquisition:

Solatium charges may be provided @ 30% of the cost of permanent acquisition of private land.

h) Legal charges:

Provision for legal charges may also be considered as requirements on this account have been on the increase. For the purpose of estimation, this may also be considered as 1% of the total compensation.

i) Relocation of communications like roads, railways, telegraph lines etc.

j) Staff for Demarcation/Measurement of land;

In addition to L A. establishment charges, provision is also required for labour and materials for demarcation and measurements for land and properties. This is generally provided @ 1% of the cost of land acquisition

k) Establishment charges for land acquisition and compensation. Establishment charges are provided @ 6.25% of the cost of total compensation."

l) Miscellaneous expenses – if any (with details)

18.6.2.3 Rehabilitation and resettlement

The provision for rehabilitation would depend on the number of persons displaced and the rehabilitation measures proposed to be adopted which should be clearly indicated in the project report. Broadly, the following provisions need to be considered.

a) Acquisition of lands for new village sites and allotment of plots for housing to the villagers of suitable rates.
b) Making the acquired land fit for habitation and providing facilities such as village roads, wells, school buildings, post offices, dispensaries, Panchayat ghars etc.
c) Providing free transport for conveyance of dismantled materials and household articles from old place to new sites.

d) Development of lands (including reclamation if needed) to be allotted to agriculturist displaced persons.

e) Cost towards implementation of Rehabilitation & Resettlement plan.

In 1975 a committee was appointed by the Central Board of Irrigation and Power to consider the desirability of fixing norms for acquisition of land and structures on the projects throughout the country. The relevant extract from the recommendations of this Committee concerning the extent of land to be acquired is given below:

"Generally acquisition may be done up to FRL only. The area between FRL and MWL may be acquired only if the submerged land is fertile and the duration of submergence beyond FRL up to MWL is long enough to cause damage to crops i.e. over 15 days duration (for acquisition of land the effect of back water need not be taken into consideration).

All structures coming under submersion between FRL and MWL should be acquired. If the structures coming under submersion are of religious or archaeological interest, provision must be made for re-establishing these structures above MWL".

The provision for acquisition of land and structures should be made accordingly.

Provision should also be made for establishment charges towards implementation of R&R @ 6.25% of its total cost.

Note : If the submergence extends to other state(s), then details of provision under B-Land be made in consultation with the concerned state(s).

18.6.3 C-Works:

This head is intended to cover the provisions for various components of which the Head works are composed of viz. Dam, spillway, energy, dissipation works, outlets (irrigation, power, water supply and scour sluices), pick up weir, barrage, head regulators etc. The list of pay items to be considered for different works are given below:

18.6.3.1 Embankment Dam (earth and rock fill):

This includes the following important components:

a) River management during construction including such items such as coffer dams and diversion tunnels.

b) Foundations - These shall include the following

1) Site Clearance.

2) Excavations:
   i) Stripping for dam seat
   ii) Stripping for horizontal blanket (outside dam)
   iii) Stripping if any for upstream blanket.
   iv) Longitudinal, cross and toe-drains.
   v) Key for upstream riprap and
   vi) Cut off trench.

3) De-watering arrangements (with details)

4) Foundation treatment

   i) Guniting/shotcreting
   ii) Drilling in rock or in soil with casing
   iii) Foundation grouting tunnel.
   iv) Filling cut off trench with selected impervious materials:
      - from excavated materials.
      - from borrow areas.
   v) Grouting (cement, bentonite, chemicals)
   vi) Construction Diaphragm wall (concrete, plastic).
   vii) Relief wells
   viii)Upstream horizontal impervious blanket.
   ix) Sheet pile.
   x) Pile driving
   xi) Other treatments

5) Foundation drainage - This shall consist of :
   i) Drilling drainage holes, and
   ii) Making drainage and grouting tunnels.

c) Dam

1) Earthwork (in core, shell, random zones and upstream blanket);

   i) Impervious
   ii) Semi-pervious - Quantity to be indicated
   iii) Pervious - Separately for excavated materials and borrow areas.
   iv) Random fill

2) Rock fill including rock toe;

   i) from excavated materials.
   ii) from quarries

3) Filters (at downstream toe or hearting);

   i) Fine filter (sand) - sloping vertical or horizontal.
   ii) Coarse filter (gravel) or crusted stone) sloping, vertical or horizontal,

4) Upstream sealing:

   i) R.C.C. membrane
   ii) Blanket of special materials like geo-membrane or non dispersive soil layer.

5) Rip rap (dumped or hand placed)

6) Downstream slope protection:
   i) Turfing
   ii) Rip rap
   iii) Geo-textile etc. (woven fibres)
   iv Surface Drainage System (cross drains, longitudinal drains/pipes collecting and toe drain).

7) Instrumentation

8) Laying of open jointed pipes for drainage

9) Manholes

10) Parapet wall;

   i) Masonry or concrete with coping.
   ii) Railing and
   iii) Wheel guard stones

11) Road over the dam.

12) Gauge posts

18.6.3.2 Masonry Dam:

This will include the following items:

a) Diversion works during construction, such as coffer dams, diversion tunnels/channels

b) Foundations;

1) Clearing site

2) De-watering in foundation

3) Excavation for main dam, energy dissipation arrangements, approach and tail channels training/divide/retaining walls in:
   (i) Over-burden of soft strata
   (ii) Over-burden of hard strata and
   (iii) Hard rock

4) Preparation of dam seat:
5) All works relating to shear zones/faults/weak zones, treatment, wherever applicable.

6) Cement grouting including curtain and consolidation grouting.

7) Drilling holes:
   i) for grouting
   ii) for drainage, and
   iii) for anchor rods.

8) Anchor rods

c) Dam:

1) Masonry for:
   i) hearting
   ii) upstream face
   iii) downstream face (non-overflow section and overflow sections)
   iv) training/divide/retaining walls
   v) parapets; and
   vi) galleries, adits and other openings.

2) Cement concrete in:
   i) filling crevices and leveling course, over-foundations
   ii) training/divide/retaining walls
   iii) parapets
   iv) galleries, adits and other openings
   v) upstream concrete/sand-witched concrete membrane.

3) Form-work (if not included in rate for concrete) for items mentioned in 2.

4) Steel for reinforcement

5) Guniting for the upstream face of masonry

6) Drilling for Anchors

7) Anchor rods

8) Instrumentation

9) Joints and seals

10) Drilling and grouting of masonry

11) Porous pipe for drainage

18.6.3.3 Concrete Dam:

The various items of works in the construction of concrete dams are:

a) Diversion works during construction, such as coffer dams, diversion tunnels/channels etc.

b) Foundation (items same as under masonry dam(b)

c) Dams

1) Cement concrete in:

i) hearting (with or without plums)
ii) upstream facing,
iii) downstream facing which shall include the overflow section and non-overflow section,
iv) training/divide/retaining walls
v) parapet
vi) galleries, adits and other openings, and
vii) any other structures

2) Form-work (if not already included in rate for concrete for items mentioned in (1) above.
3) Steel reinforcement
4) Joints and seals

5) Drilling for anchors

6) Anchor rods

7) Instrumentation

18.6.3.4 Spillway:

The spillway structures may generally be of masonry or concrete and the items, therefore, are respectively the same as for masonry or concrete dam. Following additional items need to be estimated:

a) Cement concrete for :
   - spillway piers
   - bridge beams and slabs
   - tunnel lining wherever applicable
   - spillway crest, downstream glacis, chute etc.

b) Miscellaneous items of bridge like bearings
c) Tunnel excavation wherever applicable
d) Crest gates with hoisting equipment and hoist bridge.
e) Stop logs for crest gates, and lifting arrangement.

18.6.3.5 Energy Dissipation Works:

Same items as for concrete dam with the addition of cement concrete for:

a) Stilling basin/bucket/Apron,
b) floor blocks, and
c) end sills and chute blocks

18.6.3.6 Outlets:

This will include the following:

a) Excavation in soil and rock
b) Foundation treatment

   i) lean concrete in foundation
   ii) drilling and grouting
   iii) shotcreting/guniting

c) Structural concrete for:

   i) foundation, piers and abutments
   ii) conduit, cut off collars
   iii) gate control structures, beams, floor slabs etc.
   iv) block outs
   v) stilling basin including chute blocks, baffle blocks and end sills;
   vi) guide walls
   vii) lining in approach channels

d) Masonry in guide walls of approach channels or stilling basin

e) Steel for reinforcement

f) Rubber/PVC seals at joints

g) Gates

h) Hoisting equipment and auxiliary items

i) Filters around conduit

j) Trash rack

k) Steel lining

l) Stop logs

18.6.3.7 Disaster Management Measures

18.6.4 Canal structures:

The provision for canal structures is split up under the following sub-heads:

D-Regulators
E-Falls
F-Cross Drainage Works
G-Bridges
H-Escapes

It is seen that provision for canal structures is generally made on lump-sum basis. This practice is not only irrational but is one of the principal causes for steep rise in the costs of revised estimates. It is necessary that preliminary designs are made for all important structures after proper survey and for framing the estimates, Typical structures of different capacity (three or more in number) should be analysed to work out unit cost for each type of structure in each sub-head as follows:

D-Regulators	i). Head regulator - Cost per unit product of discharges of parent and off-taking canals.
	ii). Cross regulator – Cost per unit of water way width.
E-Falls	Cost per unit product of discharge and height of fall.
F-Cross Drainage Works	Cost per unit product of discharges of drainage and canal.
G-Bridges	Cost per meter span of bridges.

H-Escapes — Cost of structures may be worked out as mentioned above and for escape channel procedure may be same as for canals.

Where the actual cost of similar structures constructed on other project(s) is known, the data could with advantage be used in the estimate. It should however, be ensured and justified that the structures considered are similar in nature The difference in leads of materials in the two structures are accounted and escalations wherever necessary are taken into account. The basis for premium applied as well as the reference to the project where such costs were realised and the year of work should be mentioned in the estimate.

18.6.5 I-Navigation works:

Important items to be considered under this sub-head are:

a) Excavation of inter-connecting bye-pass channels etc.
b) Construction of structures.

   i) Wharfs
   ii) Quays
   iii) Jetties
   iv) Navigation locks.
   v) Any other.

c) Dredging Operations

   i) Equipment for maintenance dredging.
   ii) Other operations involved in dredging.

d) River training works

The provision for (a) channels etc. (b) structures shall be made in line with the procedure discussed under D-Regulators etc. and L-Earthwork. The provision for (c) dredging operations and (d) River training works shall be made in consultation with the State Inland Water Authorities.

18.6.6 J- Power plant civil works

Important items to be considered are -

(a) Intake structures
   i) Excavation
   ii) Foundation treatment
   iii) Cement concrete for foundation, piers and abutments
   iv) Masonry/concrete for guide walls of approach channel
   v) Concrete for trash racks including raking arrangement
   vi) Gates with auxiliary equipment
   vii) Reinforcement steel

viii)Instrumentation

(b) Tunnels (including cut and cover section)
- i) Excavation
  - Open cut
  - Tunnel including temporary supports
- ii) Rock bolts etc.
- iii) permanent support. ventilation
- iv) Drainage
- v) Cement concrete for lining
- vi) Steel lining
- vii)Drilling and grouting
- viii)Gates and ancillaries where required
- ix) Reinforcement steel
- x) Instrumentation

(c) Power channel and Tail race channel
- i) Excavation
- ii) Embankment
- iii) Lining with cement concrete in bed and sides with drainage pipes and valves.
- iv) Pucca works
  - Cross Drainage(s)
  - Escape(s)
  - Bridge(s)
  - Meter flume
  - Balancing tank
- v) Instrumentation

d) Surge shaft
- i) Excavation
- ii) Cement concrete lining
- iii) Drilling and grouting
- iv) Miscellaneous items such as masonry, griniting, steel lining ladder, bolts etc.
- v) Reinforcement steel.
- vi) Instrumentation

e) Penstock
- i) Excavation
- ii Cement concrete for
  - Bed
  - Anchor blocks
  - Intermediate supports
- iii) Steel pipes for
  - Straight rings
  - Reducers
  - Bends

- Wye pieces
- Penstock valves

iv) Instrumentation

f) Power House

i) Excavation

ii) Concrete for foundation, sub-structure super structure and supports for turbines and generators.

iii) Masonry/concrete for super-structure, and other necessary items for building work.

iv) Scroll casing

v) Draft tube lining

vi) Bulkhead gates, crane and hoisting equipment

vii) Power-house crane

viii)Miscellaneous items such as anchor bolts, guiniting etc.

ix) Instrumentation

Note: The provision shall be made in line with the procedure discussed under C-. Works.

18.6.7 K-Building

Requirement of buildings for execution of the project depends upon whether the works are to be carried out departmentally or on contract.

The sub-head would include buildings for all units including electrical/mechanical works.

The buildings may be classified into residential buildings and non-residential buildings.

18.6.7.1 Residential buildings should be provided for all officers and staff (regular as well as work-charged) engaged on site of work as necessary.

Non-residential buildings shall include :-

a) Office buildings;
b) Testing laboratory;
c) Rest houses and field hostels;
d) Workshops including site workshops;
e) Stores including site stores;
f) Sheds; and
g) Other service buildings such as :

i) Hospitals or dispensaries or both;
ii) Welfare centres;

iii) Police stations;
iv) Schools;
v) Post offices, telegraph and telephone offices;
vi) Community centres;
vii) Diesel generating station and sub-stations
viii) Canteens;
ix) Co-operative stores & markets;
x) Bus Stops;
xi) Public Utilities;
xii) Banks and treasuries;
xiii) Pump houses and fire stations etc.

18.6.7.2 The buildings both residential and non-residential shall be further divided in two categories - permanent and semi-permanent or temporary. Permanent buildings may be considered only if these are required in the post construction period also.

18.6.7.3 The usual practice is to make the provision under this sub-head on the basis of plinth area and prevailing market rates per unit area for different types of buildings. The type of construction proposed should be clearly described.

It is observed that the total cost of buildings in a project generally amounts to 5% to 7% in plain region and 6% to 8% in hilly region of the cost of I-Works. Provision less than 5% is likely to be adequate only in cases where the project is located near urban areas or some existing project, where other buildings could be obtained for use.

18.6.7.4 Other items chargeable to buildings:

In addition to the cost of buildings, provision for following items is also required under this sub-head;

a) Land development: (Leveling and filling)
b) Colony roads
c) Fencing/boundary walls, security/observation booths.
d) Service connection such as water supply, sanitation drainage and electrification.
e) Lawns, gardens and plantation (other than plantation under the head M-Plantation and Environment & Ecology)
f) Retaining walls, terracing etc.

The provision for the above items may be made as per norms fixed by the State Governments.

18.6.7.5 While planning buildings, the scope for their use after the project's construction is over, should also be considered in consultation with the other State Departments and the extra cost, if any, on this account clearly spelt out.

It is essential that labour employed on works is appropriately accommodated near the work site. Since the provision under buildings does not cover labour huts, provision for labour huts should be made under the individual works estimates.

18.6.8 L- Earth work

Important items to be considered under this sub-head are:

a) Excavation
b) Embankment from
   i) Excavated material
   ii) Borrow areas
c) Lining
e) Pitching
d) Miscellaneous items, such as construction of drains, inspection and service road/path etc.

The provision under this sub-head shall cover main/branch canal(s). The provision shall be based on detailed surveys of main/branch canal(s). The analysis of rates for major items of work shall be furnished indicating lead/lift involved and shall be in line with the procedure indicated under C-Works.

18.6.9 M-Plantation:

This item provides for establishing of avenue trees and arboriculture etc. The cost depends upon the plantation programme including gardens etc. required for beautification as considered necessary downstream of dam, around power house and other important structures as well as plantation of trees along main and branch canals. The provision made under this sub-head should not be included in X-Environment & Ecology.

For main/branch canal(s), the provision shall be made on the basis of per Km. rate of plantation for the total length of the canal(s) etc. The basis for adopting certain km. rate should be indicated. The provision shall include maintenance and protection for 2/3 years.

18.6.10 N-Tanks and reservoirs:

This sub-head is intended to cover remodelling of the Tank(s)/Reservoir(s) in the project area considered beneficial/economical for augmentation of the irrigation supplies. All items of work considered necessary for remodelling shall be provided.

Important items to be considered under this sub-head are:

a) Earth work in
   i) Excavation
   ii) Filling
b) Repair of the spillway portion
c) Repair of outlets
d) Repair of the channels
e) Any other work

18.6.11 O-Miscellaneous:

18.6.11.1 The main items to be considered under this sub-head are:

(a) Capital cost of:

   i) Electrification
   ii) Water supply, purification and distribution
   iii) Sewage disposal and storm water drainage works
   iv) Fire fighting equipment
   v) Telephone, Telegraph, Post Office and Wireless.
   vi) Medical equipment for hospital/dispensary(s) etc.
   vii) Any other item such as fountains, recreation facilities, special lighting arrangements for beautification of areas in the project.

(b) Maintenance and Service of:

   i) Electrification
   ii) Water supply, purification and distribution works
   iii) Sewage disposal and storm water drainage works
   iv) Recreation
   v) Medical Assistance
   vi) Post Office, telephone and telegraph office.
   vii) Security Arrangements
   viii) Fire Fighting equipment
   ix) Inspection Vehicles
   x) Transport for labour and staff
   xi) School bus
   xii) School
   xiii) Pay Van
   xiv) Ambulance

(c) Other Items

   i) Visits of dignitaries

ii) Technical record, photographic record, completion report and history of the project
iii) Inaugural ceremonies
iv) Compensation to workmen. (for work-charge staff only)
v) Boundary pillars and stones, distance marks and bench marks.
vi) Power supply
vii) Model and exhibits.
viii) Testing laboratory and exhibits
ix) Publicity, information centres.
x) Subsidy for school bus
xi) Publications, Pamphlets
xii) Running of transit camps/rest sheds/guest house/rest house/inspection bungalow.
xiii) Training of Engineers
xiv) Canteen facilities
xv) Co-operative Stores
xvi) Library facilities
xvii) Time keeping cabin
xviii) Wireless communication system
xix) Inflow forecasting and flood waning system
xx) Retrenchment compensation (for work-charged staff only)
xxi) Police Station
xxii) Community Centre
xxiii) Photographic and Cinematographic equipment, establishment and R/M charges
xxiv) Crèches
xv) Maintenance of office equipment such as computer & reprographic facilities, fax, telex etc.

The above list is illustrative and not exhaustive. Provision should be made for all the items, which are relevant to the project. The provision is meant for regular and work charged staff and not for casual/contract labour.

18.6.11.2 The total provision under this sub head is generally of the order of 4% of I-Works.

18.6.11.3 Credit on account of resale of electrical installations, water supply fittings etc. after completion of the project if anticipated, shall be shown under item V-Receipts and Recoveries.

18.6.12 P-Maintenance

This sub head is intended to cover the cost of maintenance of buildings, roads and other structures during the period of construction.

The usual norm for provision under this sub-head is 1% of the cost of I-works less A-Preliminary, B-Land, O-Miscellaneous, M-Plantation, Q-Special T&P and X-Environment & Ecology, Y-Losses on stocks and covers maintenance of all works during the construction period.

18.6.13 Q-Special T&P

The capital outlay on construction equipment on a project varies from 10 to 30 percent of the total cost of civil structure. This percentage is likely to go up with the increase in the mechanisation of construction methods. It is imperative that extreme care should be exercised in the selection of various machinery and equipment and as far as possible accurate provision for their depreciation and salvage value should be made.

Important items of equipment considered under this sub head are given at Annexure 15.

The capital cost of the construction equipment will depend upon type and quantity of machinery (worked out on the basis of quantum of work contemplated to be carried out by machinery). For an economically planned project, the construction machinery should generally be so planned that it spends 75% of its life at project i.e. 75% of its cost is recovered from the works as hourly use rates. The provision under the sub-head Q-Special T&P therefore, should be 25% of the capital cost of the production oriented special T&P and 75% of this provision should be shown under head V-Receipt and Recoveries towards resale/transfer value.

For highly specialised Capital Intensive Equipment like aerial cable-ways, road header, tunnel boring machines etc., which cannot be planned on the criteria mentioned under para above, the anticipated cost chargeable to the sub-head C-Works should be calculated and the residual value should be shown under the sub-head Q-Special T&P as well as the head V-Receipt and Recoveries.

For inspection and transport vehicles (other than those required for construction material transportation) 100% of the capital cost should be provided under this sub-head. 20% of this value should be considered as resale/transfer value of the vehicles and shown under the head V-Receipts and Recoveries.

All the equipment required inclusive of capital intensive equipment should be provided on the basis of the latest rates including their transport cost up to the requirement of funds worked out. However, the provision for this sub-head should be worked out as under:-

Capital cost of production oriented construction Plant & Machinery (other than specialised capital intensive equipment and inspection/transport vehicles)	P
Cost recoverable as hourly use rate (debited to works)	0.75 P
Capital cost of inspection/transport vehicles	Q
Capital cost of specialised capital intensive equipment	R
Cost of specialised capital intensive Equipment recoverable as hourly use rate (debitable to works)	Ra
Provision to be made under the sub-head Q-Special T&P	0.25 P+Q+R-Ra
Recoveries to be shown under head V-Receipt & Recoveries	0.75 (0.25P) +(R-Ra)+0.2Q

In case of old machinery received on transfer, only 50% of the transfer value shall be charged to the works and balance 50% to the sub-head Q-Special T&P. Further, 25% of the provision under special T&P shall be shown under V-Receipts and Recoveries towards resale and transfer value.

Similarly, in case of projects where 75% of scheduled life of equipment is not expected to be recovered during the execution of project (or in other words less than 75% of the cost of equipment shall be recovered through cost of works), the cost proportional to their unused life shall be booked under this sub-head and the same amount shall be shown under V-Receipts and Recoveries. This method is to be adopted to provide for funds for procuring the equipment. Same method shall also be followed in case where specialised Capital Intensive Equipment is procured by the Government Department (owner of the project) and given to the contractors on hire. It may be mentioned here that practice of procurement of equipment by Govt. Department for hiring out to contractors should be discouraged as far as possible, since this practice has been found to be neither economical nor conducive to efficient working. Therefore, no provision of job specific construction equipment should be kept under the sub-head Q-Special T&P, when the works are proposed to be carried out through contracting agencies. In such cases, provision of general purpose equipment capable of taking up emergency works such as road clearance, earth work, hill cutting and inspection and transport vehicles etc. only should be made under sub head Q-Special T&P.

For privately owned and executed projects, however, no provision for production oriented and specialised capital intensive construction equipment is to be made under the sub-head Q-Special T&P. The cost incurred on account of deployment of such equipment on the project shall be directly recovered through the cost of works as hourly use rates. For inspection and transport vehicles on privately owned projects, only the cost equivalent to its life in years as would be spent on the project should be booked under this sub-head.

No provision should be made under this sub-head for spares as they are directly covered under the hourly rate chargeable to the item of works.

18.6.14 R-Communications:

Important items to be considered are:

a) Construction of the main approach road to dam site.
b) Construction of quarry roads.
c) Construction of temporary roads in the work areas.
d) Construction of temporary or permanent river crossings.
e) Railway including sidings, bridges, connecting roads, water-ways, air strips, helipads etc.

The cost for each type of road should be provided on the basis of calculated road length and rate per km. Major items on this account should be supported by sub-estimates or rates certified by local State PWD.

For road bridges the provision should made in line with canal structures.

For railway sidings and the railway bridges the provision should be made in Consultation with the Railway Authorities.

For the provision of airstrip/helipad, civil aviation authorities should be consulted.

For provision of water-ways State Inland Water Authority should be consulted.

18.6.15 S-Power plant and electrical system:

This sub-head is intended to cover the provisions for the equipment for power plant, switchyard, etc. and other items connected with installation.

The provision should be realistic and may be based on the budgetary offers or the latest market rates. The price levels stating month/year for which the rates are applicable should be indicated.

The half yearly phasing of expenditure for the construction period may be furnished. It may be suitably escalated to arrive at the completed cost.

The cost may be indicated in foreign currency (ies) (FC) applicable for the imported equipment and in Indian rupees (INR) for local component. The total cost may be given as sum of FC+INR.

The cost estimate for electro-mechanical equipment of power house should cover the following items.

1. Preliminary-including Design & consultancy, model test, construction power, etc. Annex-16(i).
2. Turbine, generator and Accessories –Annex-16(ii).
3. Auxiliary electrical equipment- Annex.-16(iii).
4. Auxiliary Equipment & Services- Annex. 16(iv).
5. Switchyard Equipment & Services-Annex. 16(v).
6. Financial Package –Annex-16(vi), 16(vii), 16(viii) and 16(ix).

The central sales tax, transportation & insurance, erection and commissioning, losses on stock, maintenance during construction, procurement & inspection, contingencies, establishment, T&P and audit & Account charges may be taken as per 'Abstract of cost estimates'.

However, care may be taken that overheads like establishment, contingencies, Audit and Accounts, procurement and inspection, etc. may not be repeated in cost of civil works.

18.6.16 T-Water supply works:

This sub-head is intended to cover works required for delivering water upto a point beyond which the supply system will be taken over by the Public Health Department. This should normally consist of water conductor system and pucca structures on open channels. The provision for various items of work should be made in line with that of canal structures.

18.6.17 U-Distributaries, minors and sub-minors

The cost is generally indicated on the basis of rate per ha. of CCA. There is a very wide variation in the rates from project to project depending upon the local conditions. It is, therefore, necessary that for a realistic estimate the rate should be arrived at from a detailed estimate for a typical block of command area of the site of about 10% of CCA after detailed contour surveys and micro planning. The relevant drawings showing therein the alignment of channels, location of structures, outlets, provision of lining etc. should be enclosed with the estimate.

18.6.18 V-Water courses

The provision for water courses should be made for serving up to 5 to 8 ha. block. The cost may be assessed on the basis of rate per hectare of CCA. The rates per hectare should be arrived at on the basis of a sub-estimate of a representative sample area surveyed to cover about 10% of the culturable command area in a similar way as adopted for distributaries and minors.

18.6.19 W-Drainage

Provision should be made under X-Environment and Ecology.

18.6.20 X-Environment and ecology;

This sub head is intended to cover the provisions for the following important items concerning environment and ecological impact due to coming of the project into being:

a) Compensatory afforestation including cost of acquisition of forest/revenue land, payment to be made to forest Department for compensatory afforestation. Provision made under M-Plantation should not be included under this sub head.

b) Catchment area treatment: Cost of treatment of directly draining water sheds (which is to be borne as part of project cost), soil conservation measures etc. as Environment & Ecology damage/mitigation works. The treatment would generally be for improving land to prevent movement of soil.

c) Establishment of fuel depots etc. to meet fuel requirement of labour force to prevent indiscriminate felling of trees.

d) Measures to salvage/rehabilitate any rare or endangered species of flora and fauna found in the affected area and relocation of archaeological monuments.

e) Control of aquatic weeds in submerged areas to provide improved habitat for aquatic life.

f) Public health measures to control spread of water and soil borne diseases, anti-malaria measures, studies relating to monitoring of water quality and effect of pesticides, weedicides etc. on effluent water from irrigation system.

g) Restoration of land in construction areas by filling, grading etc. to prevent further erosion and to provide healthy surroundings.

h) Drainage in command area, conjunctive use, ground water monitoring etc.

Provision for drainage should be made for improvement of existing drains and construction of new drains carrying a discharge of 50 litres/sec. and above in the command area. The other drains should form part of the Command

Area Development Programme. Provision for drainage in the command area is indicated on the basis of rate per hectare of CCA. The rates per hectare should be arrived at on the basis of sub-estimates for sample area in line with U-Distributaries and Minors etc. taking into account land use mapping, soil surveys and ground water investigations. Further where apparently no drainage arrangements are considered necessary due to existing natural ground slope conditions, a minimum provision may be kept on a suitable percentage basis.

i) Provision of fish ladder if necessary (to be considered under sub head C-Works)

Provision of the items should be made in consultation with the concerned departments as under:

1. Items a, b, c, d - Forest Department, Soil Conservation Department, Archaeology Department
2. Items e & i - Fisheries Department
3. Item f - Health Department
4. Item h - Central/State Ground Water Board

18.6.21 Y-Losses on stock

The provision under this sub-head is generally made at 0.25% of the cost of I-Works less A-Preliminary, B-Land, O-Miscellaneous, M-Plantation, P-Maintenance, Q-Special T&P and X-Environment and Ecology.

18.7 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 percent for concentrated works and 10 to 12 percent for scattered works like canals.

For works to be executed departmentally the provisions could be higher, than those given above say 12 to 15 percent.

The above provision is inclusive of costs towards setting up of Cost Control Cells at the project and Head Quarter level to exercise proper control over construction costs.

Since land acquisition staff is separately provided under the sub-head B-Land, the percentage provision for II- Establishment should be considered on the cost of I-Works, less B-Land.

18.8 III-Tools & Plants

The provision here as distinct from that under Q-Special T&P is meant to cover survey instruments, camp equipment, office equipment and other small tools. Expenses for small tools and plant are generally not charged directly to units of work but added as a percentage charge to the cost of the project. This percentage would depend on the class and value of the work. The general practice is to charge 1 percent of the cost of I-Works including cost of land.

18.9 IV-Suspense:

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

18.10 V-Receipts & recoveries on capital account:

This head is meant to account for estimated recoveries by way of resale or transfer of temporary buildings and special T&P. Miscellaneous receipts like rent charges of buildings, electricity charges etc., should also be accounted for under this head.

The recoveries on account of temporary buildings may generally be taken at 15 percent of the cost unless a higher recovery is anticipated due to some special reason such as tubular construction, vicinity to city/village/town industrial undertaking etc. Such special reasons should be indicated in the report. The recoveries on account of special T&P should be indicated as explained in the sub-head Q-Special T&P. Credit on account of resale of electrical installations, water supply fittings etc., after execution of the project, if anticipated, should also be shown under the head.

18.11 Indirect charges:

The complete estimate for a project besides including all anticipated direct charges should further include as indirect charges, the amount required to cover the capitalisation of abatement of land revenue on the area occupied by the works and allowance for the cost of Audit and Accounts Establishment.

18.11.1 The provision for Audit and Account charges is generally made at one per cent of the cost of I-Works.

18.11.2 Charges for capitalisation of abatement of cost of land revenue are generally calculated at either 5 percent of the culturable land cost or 20 times of the annual revenue lost.

18.12 Revised Estimates for Major Multipurpose and Medium irrigation projects Guidelines of the Planning Commission in respect of revised estimates circulated by letter no. 16(12)/2003-WR dt. 18th May, 2004 is enclosed as annexure-22.

19. Financial resources

The following points and additional points, if any, as relevant to the project shall be discussed under this chapter.

19.1 Total resources of the state and their utilisation for developmental activities—sectorwise resources for the last five years

19.2 Present position of the scheme regarding its inclusion in the plan—concurrence of the State Planning Finance Department.

19.3 Provision for the sector/for the scheme in the plan.

19.4 Central/foreign aid contemplated, if any.

19.5 Information on similar / related pending projects in the state, their status, stage/percentage of completion, percentage of expenditure incurred and average annual expenditure by the state on these projects put together year-wise during the last 5 years.

19.6 Commitment on the work in progress in the plan and allocation available for starting new scheme.

19.7 Effect of inclusion of the scheme in the plan on the schedule of other works in progress budget staff etc.

19.8 Requirement of funds for the scheme and its yearly phasing as in project report.

19.9 Adequate/strengthening of organisational set up for execution for all projects together as contemplated..

19.10 Advance action proposal for starting the preliminaries of the project, if any.

20. Revenues

The following points and additional points, if any, shall be discussed under this chapter. Where information is asked in a tabular form, it shall be followed by the tabulated data.

20.1 Yearly programme of development with respect to date of starting of construction of the project

	Year I	II	III	IV	V	VI
a) Irrigation (ha.)						
b) Power (M kWh)						
c) Water supply (Mld)						

d) Navigation
   i) Cargo capacity (Tonne)
   ii) Passenger capacity (No)
e) Canal Bank Plantation
f) Forestry

20.2 Sources of revenue.

20.2.1 Water rates, irrigation cess, betterment levy, pisciculture sale of fishing rights etc.

20.2.2 Auction of ferry services, lease from galper (inundated) lands, auction of fruit bearing trees along canals, lease of land for shops in colony area, navigation permits etc.,

20.2.3 Power rate

20.2.4 Navigation-Cargo rates, passenger rates

20.2.5 Canal Bank plantation

20.2.6 Forestry

20.2.7 Other sources

20.3 Basis for levy of various rates for above items and comparison with existing rates and concurrence from the concerned departments.

20.4 Concessions in water rates (irrigation) cargo and passenger rates etc. (navigation) as incentives during first few years of introduction of irrigation and navigation.

20.5 Administrative charges for supply of water and collection of revenues etc.

20.6 If the area to be irrigated is prone to scarcity, the expenditure normally incurred to redress the effect of scarcity (give figures for the last ten years or so) shall be indicated.

20.7 If the project envisages flood control also, the expenditure normally incurred to redress the effect of flooding (give figures for the last ten years or so) shall be indicated.

20.8 Year in which revenue would start accruing from various sources counting from the first year of construction, indicating the sum at charge of the project with the normal rate of interest (the rate of interest assumed to be indicated)

20.9 Total income from the various sources indicated at sub-para 20.2

20.10 Details of staff proposed for collection of revenues and its basis.

20.11 Net revenue expected from different components of projects.

21. Benefit - Cost Ratio, Financial Return & Internal Rate of Return

21.1 This chapter shall contain details in respect of the assessment of Benefit-Cost Ratio(s), Financial Return(s) and Internal Rate of Return of the Multi-purpose Projects.

Note- The Guidelines given below are based on the recommendations of the following:

- Study Group set up by the Planning Commission in 1958.
- Committee of Directions, for evaluation of benefits of Irrigation Projects of the Planning Commission.
- Planning Commission report - criteria for appraising Feasibility of Irrigation Projects 1965.
- Third Conference of the State Ministers of Irrigation held in November, 1977.
- Nitin Desai Committee Report, 1983.
- Views of this Working Group.
- Report of National Commission for integrated development of water resources – 1999.

The existing procedure shall be followed till such time the revised instructions are issued by the Planning Commission.

21.2 Irrigation Projects.

21.2.1 Estimation of annual benefits.

i) Irrigation benefits

a) Net value of Agriculture production in the area to be irrigated under pre-project conditions.

b) Net value of Agriculture production in the area after completion of the Irrigation Project

Net irrigation benefit = (b) – (a)

ii) Drinking/Industrial water supply

If there is a specific reservation in storage of the reservoir, the proportionate cost of the dam be allocated to drinking/industrial water supply & the cost be excluded from the cost of the project for irrigation. Alternatively, the quantum of water supplied to the municipalities/industries be charged at the rates fixed by the Government or agreed to with the parties concerned & amount be considered as benefit.

iii) Pisciculture

The reservoir can be used for pisciculture. The output per ha. of the reservoir area (average of the area at FRL and MDDL can be considered) can be estimated & its value after deducting the expenditure at the prevalent market rate is to be considered as a benefit due to the project. In this case there is no specific water allocation for it and it is an incidental benefit.

However, if pisciculture is to be practiced in ponds fed by canals, water requirement can be estimated and provided for. Benefit may be considered in the similar way as from the reservoir.

iv) Animal husbandry

If any major farms are proposed in the project & water is to be supplied from the project, the net income may be considered as benefit. Augmentation of income of the farmers as a result of introduction of irrigation is difficult to estimate and need not be considered.

v) Hydro power

Generally, if power generation is proposed from the project, proportionate cost of the common works is allocated to power sector & B.C. ratio for irrigation is calculated with remaining cost of the project. If it is not possible to do so, hydro power benefits should be included in the project's benefits.

vi) Catchment area treatment

These reduce the soil erosion and augment water availability in the catchment area this results in improvement in productivity of land. Increased yield from direct draining area may be estimated and included in the benefits. Its cost is already included in the project cost.

vii) Canal bank plantation/reservoir territory afforestation

The benefits are easy to estimate and must be included in the benefits.

Note:- Yield/ha and the prices to be used for converting the benefits into monetary terms shall be obtained from the State Department of Agriculture, Pisciculture

& Forests. They would also furnish the basis for recommending the yields/ha under pre and post project conditions and prices to be used.

21.2.2 Estimation of annual cost

Annual cost shall consist of the following :

(a) Interest at the rate of 10 percent on the estimated cost of the project including the cost of land development

Note:- The cost of land development normally ranges between Rs.1000-3000 per ha depending upon the quantum of OFD works involved. The provisions made shall be justified.

(b) Operation and maintenance cost.

(c) Depreciation of the project based on the assumed life of the project e.g. 1 percent of the total cost (excluding land development) for 100 years life of the project & 2 percent of the total cost for 50 years life of the project

(d) Maintenance of the Head-works at 1 per cent of its cost.

(e) For lift canal:

(i) Depreciation of the pumping system and rising mains at 8.33 percent of its cost.

(ii) Charges for power at prevailing rates.

21.2.3 Benefit Cost Ratio Calculation – Benefit Cost Ratio = $\frac{\text{Annual Benefits}}{\text{Annual Cost}}$

Proforma for B.C. ratio calculation of an irrigation project is given at Annexure-17. Sample B.C. ratio calculation for Shivan River Project, District Nandurbar of Maharashtra is given at Annexure-18.

21.2.4 Estimation of Internal Rate of Return

a) For calculation of IRR, the actual construction cost incurred every year has to be taken into account till be project construction is completed. The net agricultural benefit, if any, coming when say 10% or 20% of the project area is irrigated, this net benefit should be taken into account. In the initial years, the net benefit should be deducted from the cost of construction. After the completion of project construction, the annual cost would be annual O &M cost and other costs as detailed at point 21.2.2. However, if any replacement or further capital investment is made, the cost incurred on that during the year also will be taken into account. The entire stream of cash flow has to be discounted with appropriate discount factor so as to arrive at the Net Project Value (NPV) which should be zero at the end of the life of the project.

b) The IRR is the rate of discount at which the net present value (NPV) of a project becomes zero. The equation of Internal Rate of Return is

$$\sum_{t=0}^{n} \frac{C\,Ft}{(1+r)^t}$$

CFt = Cash flow at the end of the t^{th} Year
r = Internal Rate of Return
n = Life of the project

Proforma for Internal Rate of Return calculation is given in Annexures-19.

21.2.5 Estimation of financial return

Proforma for Financial Return statement is given in Annexure-20.

21.3 Multipurpose Projects

21.3.1 Allocation of cost

The allocated cost for each component of the Multipurpose Project shall be worked as per IS 7560-1974. The cost of other components like water supply, road/railway bridge over the head-works shall be shared by the concerned departments on mutually agreed basis.

21.3.2 The B.C. ratio, financial return statements and Internal Rate of Return for the Irrigation component of the Project.

The B.C. ratio. Financial return statements and Internal Rate of Return for the Irrigation component of the project shall be prepared as per sub-para 21.2 above.

21.3.3 Financial Return for Power component of Multipurpose Project.

The financial return statement shall be prepared for the power component of the project as per proforma given in Annexure-13.

21.3.4 B.C. ratio of flood control component of the Project

(a) Estimation of annual benefits Annual benefits shall be computed as under:

(i) Average annual damage computed (This shall be based on last10 years data)
(ii) Average annual damage anticipated after the completion of the project.
(iii) Net benefits (i - ii)

(b) Estimation of annual cost shall consist of the following:

(i) Interest at the rate of 10 per cent on the allocated cost of the dam and full estimated cost of the flood embankment/anti-erosion works.
(ii) Depreciation of the dam based on the assumed life of the project e.g. 1 per cent of the allocated cost of the dam for 100 years life of the project.
(iii) Maintenance of the dam at 1 per cent of its allocated cost.
(iv) Depreciation of the flood embankment based on the assumed life e.g. 2 per cent for 50 years life.
(v) Maintenance cost of the flood embankment/anti-erosion work at 4 percent.

(c) B.C. Ratio = Annual benefits/ Annual cost. Proforma given in Annexure -21.

21.3.5 Major secondary benefits other than those considered in the B.C. Ratio, Financial Return and I.R.R may also be given. These benefits may be such as Water Supply for Drinking & Industrial use; Flood Control, Employment potential both during construction period and after construction/completion period and any other benefits accruing due to project.

22. Future utilisation of facilities created (buildings)

Various facilities and assets are created during the construction period as required in the project. Buildings, roads, heavy equipments and machineries are created to facilitate the construction. Depending on the schedule of construction, the facilities are developed in phases. Facilities required for the peak construction period will be maximum as compared to the lean phases of the construction. Some facilities become surplus on completion of the project. Some facilities and assets are required after the completion of the project the commencement of operation and maintenance of the project. Normally this demand is low compared to the peak demand.

To avoid wasteful expenditure, judicial planning must be done on the requirements so that temporary, semi-permanent and permanent structures or buildings are created accordingly. During the planning stage, a detailed survey should be done on the availability of existence of facilities of other government/semi-government organization. Even as assessment may also be made, if any other organizations are likely to be set up in the vicinity of project. If so, the creation of facilities and assets can be planned in such a way that the composite peak demand and the surplus on completion of the project. It should be matched in such a way that the surplus facilities of the project on completion can be handed over to other organizations. Life of the buildings or structures should accordingly be designed and constructed.

Apportionment of cost among various purposes of Multipurpose River Valley Projects.

Multipurpose project have various uses like irrigation, power, flood control, water supply, navigation, sanitation, recreation etc. For efficient techno economic management, apportionment of cost among various users is necessary. Guidelines for apportionment of cost among various uses are given in annexure- 23.

Annexure-1(a)

SURVEY: EXTENT, SCALES, CONTOUR INTERVALS, etc.

PREAMBLE : While preparing geological maps of dam sites and other components of the project like spillway, HRT, power house, etc., with the help of the site plans furnished by the project authorities prepared based on grid leveling, difficulty has been experienced, because of non-depiction of physiographic features like river boundaries, water channel course, river banks – their bottom and top; maximum HFL, nalas, escarpments, mounds, etc. These features form an essential part of a geological map for interpretation of geology; structure etc. with respect to the foundation conditions obtaining at the site of the proposed structure. Similarly, the L-sections and X-sections should clearly depict the physiographic features.

Therefore, it is suggested that the project should prepare detailed site plans, L-sections and X-sections by means of accurate topographic surveys (carried out by plane table or theodolite or any modern survey instrument) showing bench marks, coordinates, Reduced Distances along the proposed dam axis, etc. and all the physiographic features. Maps and sections prepared by chain survey and block leveling are not accurate and not considered adequate for the purpose.

The details of extent, scales, contour intervals, etc. are given at Table-I.

Table-1

Sl. No	Description	Area to be covered/Extent of Surveys	Scale		Contour Interval	Remarks
			Horizontal	Vertical		
1.	River Surveys					
	(a) L-Section	(i) Upstream L-Section upto MWL + 5m or to a point up to which the back water effect is likely to extend from the axis of the structure, whichever is less. In case of any headworks situated upstream within MWL + 5m or the farthest point affected by back water, L-Section to be taken upto the headworks	1:10,000	1:100		Levelling at 50 m or less interval along the fair weather deep channel. Following items shall be indicated on L-Section: i) Date of survey of the particular reach and water level on that day. ii) Deep pools and rapids including their bed, bed levels, rock outcrops, etc. iii) Maximum Historical observed HFL.
		(ii) Downstream 10 km from the axis of the structure or upto nearest headwork whichever is less	1:10,000	1:100	-	-do-
	(b) X-Section	(i) Upstream X-Section @ 200m interval upto MWL + 5m or 1 km on either side of the firm bank whichever is less and for a distance of 2 km from the axis of the structure and thereafter at one km interval corresponding to the length of the L-Section.	1:2,000	1:100	-	Levelling at 50 m or less intervals. Following items shall be shown on the X-Section: a. Date of survey and water level on that day. b. Minimum water level c. Maximum historical/observed HFL. d. Rapids and Rock Outcrops etc.
		(ii) Downstream X-Section @ 200m interval upto historical/observed HFL + 1 m on either side of firm bank for a distance of 2 to 5 km from the axis of the structure depending upon the meandering nature of the river.	1:2,000	1:100	-	-do-
		(iii) Along the axis of the structure	1:1,000	1:100	-	-do-

Sl. No.	Description	Area to be covered/Extent of Surveys	Scale		Contour Interval	Remarks
			Horizontal	Vertical		
2.	Reservoir	Contour plan covering an area upto an elevation of MWL + 5 m	1:2,000 to 1:10,000 (Depending on the total area)	-	1 or 2 or 3m	Contour interval for slope less than 10° to horizontal –1m or less; slope 10° to 30° – 2m; and slope more than 30° -3m.
3	Dam and Dyke	Topographic plan of the site with contours, covering the area upto 4 H on upstream and downstream of the axis OR a minimum of 250 m on the upstream and 500 m on the downstream of the axis, and extending upto MWL + 2H where H is the height of dam (tail channel area shall be adequately covered).	1:1,000	-	1 – 3 m	Contour intervals as per item 2 above. Levelling to be at least at 10 m grids.
4.	Barrage/Weir	Topographic plan with contours of the site covering an area upto 1 km on either side of the firm bank and 100 m from the upstream/downstream tip of the guide bunds, parallel to the flow (tail channel area shall be adequately covered).	1:2,000	-	0.5 to 1 m	Levelling to be at least at 50 m grids or less depending on the slope of the land.
5.	Canal and water conductor system	(i) L-section (ii) Cross-section at 50 m interval (iii) Strip Contour Plan covering 150 m on either side of the centre line of the canal or depending upon the requirement whichever is more.	1:2,000 1:2,000 1:1,000	1:100 1:100 -	- - 0.5	Levelling at 50 m or less interval. Levelling at 50 m or less interval. Levelling as per item 4 above.
6.	Canal structures	(i) Grid plan with contours of the site to cover an area upto 300 m on either side of the centre line of the canal – 100m downstream of the point of exit of water and 100 m upstream of the point of water inlet.	1:2,000	-	0.5	Levelling as per item 4 above.

Sl. No.	Description	Area to be covered/Extent of Surveys	Scale		Contour Interval	Remarks
			Horizontal	Vertical		
		(ii) Cross-section of the drain along the centre line of the canal	1:2,000	1:100	-	Bed level/bank level and FSL of the canal and Max HFL of drain to be indicated on the Cross section.
		(iii) Drainage surveys for upstream and downstream of the centre line of the canal for adequate length as required for hydraulic calculations; For plan Longitudinal & Cross-sections	 1:10,000 1:2,000	 - 1:100	 - -	 Refer item 1 also -do-
7.	Power House, Switch yard, Surge shaft, Tail Race etc.	Contour plan of the site to cover full area of the component(s) and alternative layouts. Area to include 50 to 100 m on all sides of the component(s).	1:1,000	-	0.5 or 1 or 2 or 3 m	Contour intervals as per item 2 above. Levelling as per item 4 above.
8.	Plant and Colony	Contour plan of required area	1:2,000	-	0.5	Block levelling as per item 4 above.
9.	Tunnel and Adit	(i) Contour plan of the area covering the length of the tunnel and 500 m on either side of the centre line of the tunnel/adit including approach, portal and dump areas.	1:1,000 to 1:10,000 (Depending on the length of the tunnel and adit)	-	1 or 2 or 3m	Contour interval as per item 2 above. Levelling as per item 4 above in case of ground survels.
		(ii) L-section	1:1,000 to1:10,000	1:100 to 1,000	-	Vertical scale depending upon steepness of the slope and drop.
10.	Penstocks	(i) Contour plan of the area covering the length of the structures and 150 m on either side of the centre line of penstocks	1:1,000	-	1 or 2 or 3m	Contour interval as per item 2 above. Levelling as per item 4 above.
		(ii) L-section	1:1,000	1:100 to 1:1,000	-	Vertical scale depending upon steepness of the slope.

Sl. No	Description	Area to be covered/Extent of Surveys	Scale		Contour Interval	Remarks
			Horizontal	Vertical		
11.	Command area survey including survey for drainage system	(i) Contour plan of the area	1:10,000 or 1:15,000	-	0.5 m	
		(a) Plains and plateau OFD works	1:2,000	-	0.1 or 0.2	Block levelling on 50 m or less grid basis. Contours interval depending upon the steepness of the country. Marshy land/depressions, if any, to be shown in the plan.
		(b) Hilly terrain OFD works	1:1,000 or 1:500	-	0.2 or 0.5 or 1 m	-do-
12.	Soil Conservation survey	Plan of area subject to erosion slides and slips	1:10,000 or 1:50,000	-	10 m or less	Depending upon the location of the area.
13.	Geological Maps	Reservoir and river valley structures (Dams, Barrage, Tunnel, Power House, Pen stocks important structures on canal and water conductor system)	Same as recommended under each item above or otherwise stated in the text			
14.	Foundation in Investigation Maps	(i) Plan	As specified above for correspon ding structures	-	As specified above for correspon ding structures	Showing locations of structures, boreholes, trial pits, drifts and points where in situ tests were conducted etc.
		(ii) Cross-section	-do-	1:100	-	Showing logs of boreholes, trial pits, drifts etc. and other features of the foundation
15.	Borrow Areas and Quarries	(i) Plan	1:2,000	-	0.5 or 1 m	Location of different materials of construction pit/drill holes.
		(ii) Sections	1:2,000	1:100	-	Showing profile along the grid lines upto the depth explored.
16.	Soil surveys	Plan	1:10,000 or 1:15,000	-	-	

Note : All the site plans and sections are to be prepared by accurate surveying methods.

Annexure-I (b)

LOCATION AND DEPTH OF EXPLORATORY / HOLES /DRIFTS / PITS ETC.

PREAMBLE : When it is decided that the Project sites have to be geologically studied, it would be appropriate and fruitful if the geologist of the State Organisation, GSI, CSMRS etc. are consulted before finalising the exploration programme which includes drilling, pitting and trenching, drifting, in situ testing, geophysical surveys, etc.

In case of explorations for earth and rock-fill dams, no particular attention is given in exploring the depth of overburden in terms of the thickness of different soil types, their physical parameters such as permeability, cohesion, classification, etc., occurring at the dam site or in the reservoir area. The thumb rule of taking down the COT up to a maximum depth of ½ FRL and therefore exploring the site only up to that depth has proved to be inadequate in sum cases where it has been observed that no water is retained in the reservoir after the earth dam is constructed. Therefore, it is imperative that the dam site is investigated for an economical alignment where a positive cut-off going into bad rock or into continuous impermeable strata is at a minimum depth.

In most cases, the core recoveries obtained in bore holes drill in hard rocks are poor and erratic leading to varying and sometimes in appropriate interpretations of the lost core. Therefore, it is suggested that the drilling should be done in such a manner as to achieve a core recovery of not less than 90% in hard rocks and not less than 70% in soft rocks. The cores obtained should be properly preserved as per standard practice and a record of colour photographs of the cores maintained.

The pattern of drilling has been discussed below:

Structures	Minimum Pattern of Drilling	
	Spacing of Drill holes/Pits/Drifts	**Depth of Drill Holes/Pits/Drifts**
(a) Earth and rock-fill dam	(i) Drill holes along the axis 150m or less apart, with intermediate pits to delineate weak and vulnerable strata with a minimum number of 3 to 5 holes in the gorge portion and additional two on each abutment parallel to the flow	Depth equal to half the height of dam at the elevation of the hole or 5 m in the fresh rock (proved by the geophysical or any other suitable method) whichever is less. About two holes to be extended deep (equal to the maximum height of the dam in the absence of rock at higher elevation or 5m in fresh rock whichever is higher), in the gorge portion and one each in abutments.
	(ii) Drift on each abutment at about 60m elevation interval with a minimum of one on each abutment.	Drifts to be extended 5m in geologically sound strata for keying the dam in the absence of rock.

(b) Masonry and Concrete dam	(i) Drill holes along the axis at 100m interval or less apart to delineate weak and vulnerable strata with a minimum number of 3 to 5 holes in the gorge portion and additional two on each abutment parallel to the flow.	10m in fresh rock (proved by geophysical or any other suitable method). About two holes to be extended deep (equal to the maximum height of dam in the absence of rock at higher elevation) in gorge portion, and one each in abutment.
	(ii) 2-3 drill holes down stream of spillway	10m in high rock or equal to maximum height of dam in absence of rock.
	(iii) Drifts on each abutment at about 60m elevation interval with a minimum of one on each abutment.	10m in fresh rock (proved by geophysical or any other suitable method.
(c) Tunnels	(i) Drill holes one at each of the portal and adit sites and additional at-least one every 1-5 km. interval depending upon the length of the tunnel.	**Drill** holes 5-10 m below the tunnel grade of maximum possible depth. **Wherever** it is not possible to drill along the central line of the tunnel the holes can be shifted. **The** explorations shall be so planned as to satisfactorily portray the geological structure and tunneling conditions.
	(ii) Drift one each at the portal and adit sites.	Drifts shall be extended up to 10m in fresh rock or up to tunnel face.
(d) Barrage and weirs	Drill holes along the axis, 150m or less less apart with intermediate pits to delineate weak and vulnerable strata with a minimum of two additional holes on each abutment parallel to the flow.	**Drill** hole 1.5-2 times to maximum head of water below the average foundation level or 5m in the fresh rock whichever is less. **Rock** to be proved by geophysical or any other method.
(e) Power House	Two to four or more drill holes and/or drifts covering the area to satisfactorily portray the geological condition and delineate weak and vulnerable zones, if any.	**Drill** hole one to two times the maximum width of the structure or 5-10 m in the fresh rock proved by geophysical or any other method whichever is less. **For** underground power house the strata shall be examined by the explorations with adequate number of drill holes. **If** found feasible and necessary according to the site conditions, one drift with cross cut may be excavated at the roof level to prove fresh rock conditions along the length and breadth of the cavity structure.

(f) Major canal structures	Sufficient number of drill holes with a minimum of three (one on each bank and one in tne bed)	Twice the width of the foundation of the biggest component of the structures below foundation level.
(g) Canal and water conductor system	Drill holes or pits 500m or less apart two depict the complete profiles details.	Equal to the full supply depth of canal or one meter below the design bed level in rock whichever is less.

Note:

1. A minimum pattern of drilling holes and excavation of pits and drifts has been suggested above. It is however suggested that the subsurface exploration programme of the Project is chalked out in consultation with the Geologist in order to bring out clearly the foundation and abutment characteristics especially the weak zones requiring special treatment and the type and depth of cut-off in case of earth and rock-fill dams, etc.
2. The core recoveries obtained from the bore-holes should be preferably not less than 90% in hard rock, and not less than 70% in soft rock. The cores should be properly labeled and preserved as per standard practice. Colour photographs of the core obtained may be taken for purpose of record.
3. Disturbed and/or undisturbed soil samples, foundation rock samples, etc. shall be collected and tested at an interval of 1.5 m depth or change of strata for laboratory tests. In situ permeability tests shall be carried out in the selected drill holes in different strata at different elevations including the overburden material. Other in situ tests, shear tests etc. shall be carried out in the holes or other suitable locations depending upon the nature of the strata and design requirements.
4. The bearing capacity test and in situ testing of the foundation rock shall be carried out for item (b) to (f) at average foundation level.
5. The plans and cross-sections shall be prepared on the scale as indicated in Annexure-I unless otherwise stated and shall be attached with the appendix.
6. The logs of the holes/pits/drifts shall be prepared as per IS No. 4453-1967 and 4464-1967 (Codes of practice).

MATERIAL SURVEY

As far as possible the sample for testing shall be collected by qualified persons from the testing laboratory. Alternatively, sufficient quantity of samples shall be collected as per procedure prescribed in IS and in consultation with the laboratory.

1. **Soils**

Pits/auger holes (diameter 75mm to 100mm shall be taken in the proposed borrow area on 30 to 50 meter grid and representative samples collected/tested for different types of strata/soil to determine their properties and delineate the soil zones.

The depth of the pits/auger holes shall depend upon the availability of the soils and economic exploitation.

The borrow area shall be located as near the dam site as possible but at least at a distance 5-10 times the head (H) of water away from the toe or heal of the dam (for small and medium dams the distance shall not be less than 10 H and for high dams not less than 5 H)

Note: The plan and section showing the stratification of the borrow area shall be included in the appendix. The lead for different types of soils from the site(s) of work for different borrow areas shall be included in the appendix.

2. **Aggregate and rocks**

Samples from the different approved rock quarry(s) for different type of rocks shall be collected for laboratory tests. Lead from the site(s) of work of different quarry(s) shall be indicated. For assessment of quantities drill holes shall be taken in consultation with geologist, if required.

3. **Natural/crushed sand**

Samples from the approved quarry/source shall be collected for Laboratory tests. The type i.e., natural/crushed sand shall be indicated clearly. The lead from the sources to the site(s) of work and quantity available shall be indicated.

4. **Bricks/Tiles**

Samples shall be collected from the proposed areas demarcated for preparation of bricks/tiles for laboratory tests to prove the suitability of the soil. For preparation of Surkhi to be used for pozzolanic material representative samples of bricks shall be collected and tested in the laboratory to prove the suitability. The average lead from the site(s) of work shall be indicated.

5. **Natural Pozzolona**

Samples shall be collected from the quarry for laboratory test to prove its suitability. The lead and quantity available shall be indícated.

6. **Lime Stone**

Samples shall be collected for laboratory tests to prove its suitability for manufacture of cement/lime. The lead to the proposed site(s) of manufacture of cement/lime and quantity available shall be indicated.

7. **Cement**

The source of cement and the distance from the nearest railhead to the site(s) of work shall be indicated.

8. **Steel**

The sources/stockyard etc. and its distance from the work site(s) shall be indicated.

9. **Scarce material**

The source of the scarce material s shall be indicated.

10. **Any other material**

Required details as indicated in the earlier items shall be indicated

Annexure-3

GATES AND RELATED HYDRO-MECHANICAL EQUIPMENT IN DETAILED PROJECT REPORTS FOR WRD PROJECTS:

INTRODUCTION

In river valley projects, many types of gates and hydro-mechanical equipment are used. They include various means and devices intended to close openings in waterways, regulate the head water levels, pass through or retain floating debris. Gates are movable structures used to close openings of hydraulic works and to control discharges. Slots and guide supports are stationary members embedded into the body of the structure and intended to guide gates and racks, carry load, imposed on gate support and travel members to the structure, provide water tightness in the interface areas of gate and structures to prevent crushing of concrete surfaces and edges, and if necessary, to provide de-icing by suitable means.

Many hoisting equipments are also adopted to handle and operate gates during service and erection and rakes for cleaning trash racks.

PROVISION OF GATES AND RELATED HYDRO-MECHANICAL EQUIPMENT IN DETAILED PROJECT REPORTS:

The gates and hoists provided for different water resources projects in India generally conform to various applicable Indian Standards published by Bureau of Indian Standards. These standards are listed in Annexure 'A'. Detailed Project Reports should cover gates and their operating equipment in as much detail as possible by laying special emphasis on following points:

1. Overall description of gates at every location in the project, e.g. spillway, under sluices, intake etc. shall be given. Such description shall be provided in as much detail as possible.

2. Justification for adopting a particular type of gate at each control location in the water conductor system shall be provided. This should cover the techno-economic guidelines for selection of type of gate or hoist, their design principles, requirements regarding manufacturer and erection, tests etc. Gates and their operating equipment provided in any river valley project should conform to the applicable standards listed under Annexure 'A'.

   In the DPR, description shall be included covering type of gate and hoists at every location and the criteria selected for its adoption. This criteria may be ease of manufacture and installation, availability of manufacturing facilities, availability of bought out ready made items like hoist motors, hydraulic hoist power packs, bearings, components of electro-mechanical hoists such as couplings, reducers, brakes etc. For example, for a particular size of opening and operating head, the choice of gate may be either radial type or vertical lift type gate. These gates may be operable by either electro-mechanical hoisting devices or hydraulic hoists. In such cases, comparative studies may be furnished justifying adoption of a particular type of gate and hoist which result in low cost and higher efficiency as required at particular location.

3. Layouts of all types of gates and hoists commensurate with civil details like piers, operating chambers, accesses, head rooms etc. as suitable for DPR purpose which reveal the structural arrangement of various components like skin plates, horizontal girders, vertical stiffeners, lifting lugs, embedment showing load bearing tracks, sealing arrangements, arrangement of hoisting systems shall be provided. Since different types of hoists are required to be adopted at various locations, details covering layout of all important components as per following broad categories of hoisting systems shall be provided:

- **<u>Electro-mechanical Hoist</u>**: Rope drums, drive units, gears, position indicator, hand operation, hoist support structures etc.

- **<u>Hydraulic Hoist</u>**: Hoist cylinders, hydraulic oil circuit, overall arrangement of hydraulic piping, hanger studs, stoppers etc. Suitable description of the operating mechanism clarifying details regarding group operation, if any, shall also be stated.

- **<u>Screw Hoist</u>**: Screw rode, their supports, layouts of drive mechanism, position indicator, hand operation, hoist supports, gate hoist connection etc. shall be included

4. A chapter or a section in DPR should be dedicated to gates and hydro-mechanical equipment incorporated in the DPR. It should indicate the detail design criteria, selection criteria, materials and chemical composition of important and critical components as related to following parts:

  - Gate leaf
  - Embedded parts (Ist stage anchors as well as 2nd stage embedment)
  - Operating equipment details like hoists, gantry cranes etc.
  - Hoist support structure arrangement
  - Trash Pack cleaning machines, if included in the DPR.

- Description of instrumentation and electrical controls for the operating equipment.
- Details regarding remote control arrangement like local remotes or SCADA.
- Diesel Generating set for the operation of gates during power failures.

5. Typical design calculations covering hydraulic and structural details shall be supplied for typical installations. Hoisting capacity calculation and details of hoists components proposed at individual gates controls shall also be provided.

6. Estimate of all the gates and related hydro-mechanical equipment including electrical controls shall be based on the quantities of individual items. For the purpose of evaluation of quantities, suitable criteria as approved by State Governments, CDO's or design units of concerned organization, on behalf of whom the DPR is submitted shall be provided. Following may be kept in view while making submission of quantities:

   - As far as possible, quantities shall be based on the design of individual items like gate leaf, embedment like track, soal pacts, hvising mechanism, hoist support structure etc.

   - It has been observed that most of organizations, estimate the quantity of gates based on the area of gate leaf exposed to water pressure by assuming weights per sq. unit area. It is also seen that weights of gates are worked out on thumb rules or on the basis of empirical formulae. These practices are found to result in unrealistically high or low weight. Moreover, quantities of special materials like various grades of stainless steels, bought out items like bearings and modern materials like self lubricated maintenance free bearing are also not. It is common knowledge that quality of different grades of materials and bought out items affects the overall cost. Hence attempt shall be made to work out cost based on individual design, so that they are realistic.

   - Many modern gate installations require components of special grade steels like stainless steel of various grades, special technologies like pre-stressed concrete anchorages etc. For the projects located in sub-zero climatic regions, de-icing arrangements are adopted. The welded metal work fabrication is also required to be suitable for low temperatures, which involves special welding procedures which are costly over the normal welding. In such cases, it is necessary that quantities of special materials and related equipment are separately mentioned. Quantity/running cost due to de-icing system, if provided may also be separately added as the power consumption due to de-icing arrangements may be very high.

- Suitable provision towards revision of quantity during detailing stage and/or model studies during detailing shall also be made.

- Many new projects are equipped with remote operation features for various gates incorporated therein, like SCADA. Existing projects may

-4/-

also be modernized by adding such provisions. In such case, cost shall be based on all applicable components like sensors, cables. electrical and electronic controls, necessary software and hardware with proper provision for future up-gradation as well as provision of enclosures.

- Special items related with gates and hydro-mechanical equipment like hydraulic hoists or trash rack cleaning machines, are required to be provided as per the requirements of individual projects. In such cases lump sump provisions are made in the estimate. Since the exact quantities and process costs are not possible to be evaluated at DPR stage, these provisions shall be carefully based on the previous experience or as per the budgetary costs approved by the concerned State Govt. /agency. A certificate to this effect shall be provided in the estimate.

- Quantities for the all the gates and hydro-mechanical equipment shall be presented in a tabular form as per the sample format enclosed as per Annexure B.

Annexure-A

INDIAN STANDARD CODES AND SPECIFICATION GENERALLY FOLLOWED IN CONNECTION WITH HYDRAULIC GATES AND HOISTS.

1.	IS:4622-1992	Fixed.wheel gates structural design – Recommendations (Second Revision
2.	IS:4623-84	Recommendations for structural Design of Radial gates (Second Revision) Re-affirm July. 90.
3.	IS:9349-1986	Recommendations for structural design of Medium and High Head Slide Gates. (First revision) Reaffirm in July, 91.
4.	IS:5620-1985	Recommendations for structural design criteria for low head slide gates. (Second Revision) Re-affirm in Dec., 95.
5.	IS:11855-1985-1986	Guidelines for design and use of different type of rubber seals for Hydraulic gates. Re-affirm in July,91.
6.	IS: 10096 (Pt-I/Sec-I) – 1983	Recommendations for inspection, testing and maintenance of radial gates and their hoists. (Inspection, testing and assembly at the manufacturing stage section-1. Gate). Reaffirm in Oct., 1995.
7.	IS:10096 (Pt-I/Sec-2) – 1986	Recommendations for inspection, testing and maintenance of radial gates and their hoists. (Inspection, testing and assembly at the manufacturing stage section-2, Rope Drum Hoist). Reaffirm in Oct., 1995.
8.	IS:10096(Pt-II – 1992)	Recommendations for inspection, testing and maintenance of radial gates and their hoists. (After erection First Revision).
9	IS:10096 (Pt-II) - 1983	Recommendations for inspection, testing and maintenance of radial gates and their hoists. (Inspection, testing and assembly at the time of erection) Reaffirm in Oct., 1995)
10.	IS:10096 (Pt-II) – 1992	Recommendations for inspection, testing and maintenance of radial gates and their hoists. (After erection First Revision).
11.	IS: 7326 (Part-I) – 1992	Penstock and turbine inlet butterfly valves for hydropower stations and systems. (Criteria for structural and hydraulic design) (First Revision).

12.	IS:7326 (Part-II) – 1992	Penstock and turbine inlet butterfly valves for hydropower stations and systems. (Guidelines for design and selection of control equipment (Ist Revision).
13.	IS:7326 (Pt-III) – 1976	Penstock and turbine inlet butterfly valves for hydropower stations and systems. (Recommendations for operations and maintenance) Reaffirm in April, 1991.
14.	IS:13623-1993	Criteria for choice of gates and hoists.
15.	IS:5532-1969/84	Glossary of terms for cranes.
16.	IS:4410 (Pt-XVI/Sec.2) – 1981	Glossary of terms relating to river valley projects. (Part-XVI, Gates and valves) Related with valves.
17.	IS:4410 (Pt-XVI/Sec-I) -	Glossary of terms relating to river valley projects. (Part-XVI, Gates and valves) Related with Gates.
18.	IS:4410 (Pt-XVI/Sec-III) -	Glossary of terms relating to river valley projects. (Part-XVI, Gates and valves) Related with hoists.
19.	IS:6938 – 1989	Code of practice for design of rope drum and chain hoists for hydraulic gates. (First Revision) . Reaffirm in April, 1995.
20.	IS:3177 – 1977	Code of practice for electric over-head traveling cranes and gantry cranes other than steel works cranes (First Revision).
21.	IS:10210 – 1993	Criteria for design of hydraulic hoists for gates (First revision).
22.	IS:13041 – 1991	Recommendations for inspection, testing and maintenance of Hyd. Hoist (after erection).
23.	IS:11228 – 1985	Recommendations for design of screw hoists for hydraulic gates. Reaffirm in July, 1990.
24.	IS: 807 – 1976	Code of practice for design, manufacture, erection and testing (Structural portion) of cranes and hoist (First revision). Reaffirm in 1990.
25.	IS:13591 – 1992	Criteria for design of lifting beams.
26.	IS:1893 – 1984	Code of practice for earthquake resistant design of structures. (4th Revision).
27.	IS:3832 – 1986	Specification for hand operated chain pulley blocks. Reaffirm in 1990.
28.	IS:3443 – 1980	Specification for crane rail sections (Ist Revision).
29.	IS:456 - 1978	Code of practice for plain and reinforced concrete.
30.	IS: 2825 – 1969	Code for unfired pressure vessels. Reaffirm in 1977.

31.	IS: 2062 – 1992	Specification for general structural purpose. (Superseding IS: 226 – 1975).
32.	IS:1786 – 1966	Specification for cold twisted steel bars for concrete-reinforcement.
33.	IS:7332 (Pt-I) – 1991	Turbine inlet spherical valves for hydropower stations and systems. (Criteria for structural and hydraulic design). (Ist revision).
34.	IS:7332 (Pt-II) – 1993	Turbine inlet spherical valves for hydropower stations and systems. (Guidelines for design and selection of control equipment) (Ist Revision).
35.	IS:7332 (Pt-III) – 1994	Turbine inlet spherical valves for hydropower stations and systems. (Recommendations for operation and maintenance of spherical valves) (Ist Revision).
36.	IS:10021 – 1981	Guidelines for de-icing systems for hydraulic installations. Reaffirm in Jan., 1991.
37.	IS:11793 – 1986	Guidelines for design of float driven hoisting mechanism for automatic gated control. Reaffirm in July, 1991.
38.	IS:14177 – 1996	Guidelines for painting system for hydraulic gates and hoists.
39.	IS:1477 – 1971 (Pt-I & II)	Code of practice of painting of ferrous metals.
40.	IS:9595 – 1980	Recommendation for metal arc welding of carbon and carbon manganese steel.

ANNEXURE-4

GUIDELINES FOR PREPARATION OF HYDROLOGY VOLUME OF DETAILED PROJECT REPORT.

CHAPTER-I
Hydro meteorological Information

This chapter shall provide sufficient information about climatic and general hydrology of the hydrologic region and also provide specific information in respect of areas and reaches of interest appropriate to the plans of development.

Note: Various areas and reaches of interest from the hydrologic point of view considering different developmental possibilities have been classified as E1 to E13 as listed in Enclosure-A.

1.1 General information about region (Refer E5 - Enclosure-A)

1.1.1 Topography - types of climate seasons - type of monsoon causing rainfall - general hydrologic regime of the rivers - history of important historical storms and floods - geology - existing development of surface and ground water. cloud burst, Glacier Lake Outburst Flood (GLOF), etc

The above details shall be supported by the following maps and tables:

(a) One or more small index maps of size 25x20cm (approximately) showing the boundaries of all the areas and reaches of interest for the various alternatives.

(b) Annual normal rainfall map of the region (scale 1 : 1000,000)

(c) Tables or bar charts showing monthly normals and extremes of precipitation (rainfall & snowfall), number of rainy days, number of snowy days temperature, humidity, wind-speed, pan evaporation, potential evapo-transpiration (ETO) etc. for observatories (at least two in and around areas of interest): at least on of the observatory selected shall be in or nearest to the command area (Refer : climatological tables, other IMD publications etc.)

(d) Tables or bar charts giving average, maximum and minimum monthly seasonal and annual flow data for hydrological stations maintained by the State Governments/CWC/Other agencies (include stations with long period data).

(e) Area under seasonal snowline as well as permanent glacier and its justification with detail of local information

(f) Equivalent slope, total length of river, minimum of 2 satellite imageries i.e. one for snowmelt period (March-May) and another for monsoon season (June-September) in case of Himalayan rivers etc

1.2 Specific information required for different reaches and areas of interest relevant to the project shall be furnished.

1.2.1 Drainage basin (Refer E1 of Enclosure-A)

(a) Index map showing soil erodibility characteristics and infiltration.

The map shall show

(i) Land having gradient less than 1 per cent., 1-3 per cent and more than 3 percent.

(ii) Present land use classifying land under forest, cultivated area, fallow land, land under urban and other uses.

(iii) Soil types

(iv) Information about historical silt information related to regional reservoirs

(v) *Historical dam failure events of the project catchment*

Note: For preparing the above maps, information available in the Revenue records, District Gazetteers, Census report,. Irrigation Commission's report etc. shall be utilised.

Where sedimentation is of serious nature (Refer Chapter IV Item 4.3) land use data for two or more distinct periods shall be included as far as possible.

(b) Table giving the size of the drainage area at all control points indicating areas covered by lakes, swamps, permanent snow/glacier and points of diversion (natural or man made) for diverting flows from or into the drainage area.

The drainage area computations shall be made using sufficiently large scale maps (scale 1: 200,000) and condensed maps showing all the features shall be furnished.

(c) Areas altitude curves (hypsometric curve) for orographic region having sizable area above EL 1000 m.

(d) Water quality data depending upon the nature of development.

1.2.2. Hydrometeorological Data Observations

In order to meet project objective, the project specific Hydro Meteorological data observation Network is required to be put in place as soon as project investigation is started. The observations of water levels, discharge, silt, snow depth, in addition to full climatic parameters are essential and to be part of hydrology chapter. The observations shoud be carried out by using state of the art technology with scientific methods. The routine validation, processing & final report is necessary in order to make the observed data more meaningful and accurate

1.2.3.1 Command area (Refer E2 of Enclosure-A)

(a) Table of charts presenting monthly normal evaporation for few stations in or near the command.

(b) Monthly evaporation for few stations in or near the command.

(c) Infiltration characteristics of soils

(d) Ground water behaviour supported with data of fluctuation (maximum and average over a period):

1.2.3.2 Floods and drainage (Refer E3, E4 & E10 of Enclosure A)

(a) River profile showing flood levels and river cross-section with a highest observed historical water levels

Note: The longitudinal section and cross-section through the reach of interest are required for making computations of flood profiles, working out gauge, discharge and water rating curves, checking reservoir backwater studies, deciding channel capacities and for estimating historical flood discharges from flood marks by hydraulic calculations etc.

The river longitudinal section should be presented to such a vertical scale that the differences in normal low and high water will be presented by about 2 cm. It would show both banks, bed levels, normal, high and low flow levels, historical maximum flood levels with years of occurrence and position of important towns, gauge discharge stations, bridges, existing and proposed structures as also the position of river cross-sections. River cross-sections covering the reach of interest shall also be presented. The spacing of cross sections shall depend on river slope and uniformity of the channel. For smaller slopes or more uniform channels larger spacing can be adopted.

(b) Information of past floods and past events of drainage congestion giving levels, discharge, flooded areas and depth & duration of submergences.

(c) Notes about flood protection and drainage works already sanctioned/executed and their performance supported by index plans.

(d) Notes about the problems of bank erosion, aggradation, degradation and meandering of rivers.

1.2.4 River geometry (Refer E6 and E9 of Enclosure-A)

River profile and cross-section and roughness coefficient for the reaches relevant to the project details (Refer note 1.2.3 above.)

1.2.5 Ground water recharge (Refer E7 of Enclosure-A)

Details about the ground water behaviour and infiltration characteristics of the soils in the recharge area (For type of information refer para 1.2.2 (d) above).

1.2.6 Reservoir area (Refer E8 of Enclosure-A)

(a) Monthly average pan evaporation data for a station in or near the area.

(b) Elevation-area-capacity curves and methodology used in the computation.

1.2.7 Other water usage (Refer E11 & E13 of Enclosure-A)

Water quality data indicating both chemical and biological quality, temperature and other quality parameters. Indicate changes in these parameters from season to season.

1.2.8 Navigation (Refer E12-Enclosure-A)

(a) River profile and cross-section (Refer Notes 1.2.3 above)

(b) Low flow discharges and depth data.

(c) Historical changes in the levels and cross-section

(d) Problems of bank erosion, aggradation, degradation and meandering of river.

(e) River training works already sanctioned/executed and their performance.

1.3.1 Data availability

Description of the available meteorological and hydrological data supported by inventories in the form of bar diagrams indicating source location and altitude of the station, frequency of data, source agency, . Period of availability in respect of stations within the areas of interest and surrounding regions shall be furnished in respect of the following:

(a) Rainfall and snowfall

(b) Pan evaporation

(c) Climatological parameters like temperature-humidity-wind-sunshine etc.

(d) River gauge and discharge

(e) Sediment (suspended and bed load) inflow and grain size composition

(f) Water quality

Note: A map to a scale of 1:200,000 OR 1:1000,000 depending upon the size of the area involved showing the location of relevant meteorological and hydrological stations shall be furnished.

CHAPTER-II

Hydrological Inputs

This chapter shall discuss the type and extent of Hydrological Inputs required for the proposed plan(s) of development.

2.1 Alternatives and classifications

The type and form of Hydrological Inputs for simulation (working tables) and other studies depend upon the type of structures (which can be classified based on the element of storage) and on the contemplated use of water and storage space.

The classification of alternative plans by storage have been indicated as A1 to A5 as listed in Enclosure-B and by use as B1 to B11 as indicated in Enclosure-C.

Note: Alternative plans of development shall be discussed and their classification determined by storage or by use.

2.2 Type of inputs required

The inputs required for simulation and other studies for the development in question shall be discussed.

The nature of inputs which are generally required has been grouped as C-1 for simulation studies and C-2 for studies other than simulation in Enclosure-D. The inputs required for the study of a particular type of development can be determined using Enclosure-E and Enclosure-F, wherein various combinations are indicated.

2.3 Time unit for hydrological inputs required for simulation studies

The time units applicable to the various type of projects are given in Enclosure-G. The information given in this Enclosure shall be utilised in deciding the time units of the hydrological inputs for particular type of development.

2.4 Length of Hydrological inputs

In fixing the length of hydrological inputs for simulation, type of development and variability of inputs shall be kept in view. Brief Guidelines for fixing the minimum length of inputs required is given below:

Type of project (Encls. B)	Minimum length of data for use in simulation
A1 and A2	10 years
A3	25 years
A4	40 years
A5	depending upon the predominant element (A1 to A4)

2.5 Requirements of the inputs for the project

Taking into account the requirements of the project discussed under para 2.1 and 2.2 above, the inputs (including those required for simulation, flood studies and sedimentation) for the various components/at various control points shall be determined and discussed in details

CHAPTER-III

Compilation and Processing of Basic Hydrological Data

3.1 Hydrological investigations specially carried out for the proposed project keeping in view the Guidelines given in para 3.4.5 of the detailed project report shall be discussed. The details of the specific data collected with method of observation for the purpose shall be furnished.

3.2 Data from other sources

All the basic/processed hydrological data (flow, sedimentation, water quality etc.) available from the various sources as relevant to the project shall be collected, compiled and discussed. The source of such data collected shall be indicated at the appropriate place.

Where processed data is available need or otherwise of further processing of the data shall be indicated.

3.3 Processing of data

3.3.1 Quality of data

(a) Methods of measurement/observation of various types of hydrological and hydrometeorological data, standards followed, instruments used, frequency of observation etc. shall be discussed for different variables such as flow, sedimentation, gauging, temperature, humidity, evaporation etc.

(b) Details of history of station, shifts in the location, shifts in the rating curves shall be identified. Sample calculations for discharge and sediment load shall be furnished, mention shall be made as to whether discharge data is observed or estimated. Indicate methods of estimation.

(c) Discuss development of stage discharge curves at discharge site bringing out the extrapolations involved. The extrapolations shall be verified by other methods such as hydraulic calculations etc.

3.3.2 Filling up of short data gaps

The method used shall be discussed. Some of the techniques which can be used for gap filling as follows:

(a) Random choice from values observed for that period.

(b) Interpolation from adjoining values by plotting a smooth hydrograph (for run- off alone).

(c) Using the average production with normals for the adjoining stations.

(d) Double mass curve techniques.

(e) Correlations with adjoining stations either of the same hydrologic element, or of different hydrologic element.

(f) Auto correlation with earlier period at the same station.

(g) The time unit of parameter used for correlation should be either less than the time unit required for simulation studies or equal to it.

(h) Flow duration curves techniques in case of stations on the same river or hydro meteorological similar catchments

3.4 Adjustment of records

3.4.1 The adjustments of flows (and sediment) to natural and virgin conditions for historical uses in the upper reaches and the manner in which this has been done shall be discussed duly supported by the withdrawal data, reservoir operation data and irrigation statistics. Where adjustments due to upstream storage(s) are made, such storage changes and evaporation losses are to be properly accounted for.

Apart from adding upstream withdrawals, return flows have to be subtracted.

Note: (1) The adjustment of the observed flows/sediment data may not be necessary if:

- the utilisation by upstream projects has been same throughout the period of observation of flows and sediment, and
- the pattern of usage has not changed appreciably or with a definite need.

(2) Adjustment with the flow and sediment records shall be required in other cases e.g. where appreciable changes in land use have taken place.

(3) Adjustment of floods and low flows to remove the effect of upstream regulation may be required where this is appreciable.

3.5 Consistency of data

3.5.1 Internal

The study of consistency of the observed data at specific control points and corrections made if any, shall be checked and discussed. The main purpose is to identify any abrupt discontinuity in the data or existence of any positive or negative spikes which don't conform with expected hydrological behaviour.

The check can be done by study of stage discharge relationship. Water level and discharge on the 2 axis plot. mean. standard deviation. skewness of split samples for 2 different periods. Average flow hydrograph for 2 different populations. Annual hydrograph plot for all years of observations on daily/10-daily basis can be plotted and interpreted. and sedimentation rating curves for different periods large variations. if any shall be investigated. corrected and explained suitably. if required.

The Time Series analysis is also to be carried out to test the variability. homogeneity or trend of flow series. For this purpose common tools i.e. moving averages. mass curves & residual mass curves. storage analysis. water balances etc. can be used

3.5.2 External

The main objective is to identify systematic error and accordingly apply the correction. The consistency of the observed data shall be discussed with reference to the rainfall in the project catchment and observed data (yields and sediment loads) in adjacent locations/basins.

Note: The consistency can be checked by:

(a) Comparing monthly and annual rainfall with corresponding run-off.

(b) Comparing average annual specific flow expressed as ham/sq. km. with corresponding figures at other sites of the same river or adjacent basins.
(c) Comparison plots i.e. by comparing discharge vs discharge. gauge vs gauge of adjacent sites on the same river
(d) Residual flow technique. if 2 sites are on the same river
(e) Regression techniques
(f) By use of double mass curve techniques.

Details of the study made for various hydrological observations at the control points and sites maintained by the CWC/States and other agencies shall be summarised and presented as follows:

(a) Average annual/seasonal/monthly flow volume expressed as depth of water over drainage area.
(b) Average maximum and minimum discharge cumec/Sq. km. for concurrent period

3.6 Presentation of data

3.6.1 Data for simulation studies

The processed data shall be compiled and furnished keeping in view the hydrological inputs required for the studies for the development in question (Refer Enclosure-E and Enclosure-F).

The data shall be compiled for appropriate time unit (Refer Enclosure-G).

Note: (1) The average for each time unit and totals and averages for months/seasons/ hydrological year (generally from June to May) shall be given.

3.7 Data for studies other than simulation

Data on the annual maximum floods (peak discharges and levels) for all sites of interest shall be furnished for the entire period of record. Annual flood peaks need to be derived from hourly water level records available at a GD site, and accordingly instantaneous flood peak series may be prepared for frequency analysis

Flood hydrographs (plotted on the basis of hourly gauge) observed for a few large events for all sites of interest shall be included. These should cover the entire rise and fall of the flood including three days period antecedent and following each flood. The concurrent daily and hourly rainfall data for all stations in and near the drainage area shall also be included.

CHAPTER-IV

Preparation of Hydrologic Inputs for Simulation

This chapter shall discuss the details and results of the analysis made for preparation of the various hydrologic inputs required for simulation studies to supplement data presented in para 3.6.1 of Chapter-III

4.1 Water inflows

The overall approach whether historical or generated sequences of flow volumes used shall be indicated.

4.1.1 Data extension

The studies and methodology used for extending short-term run-off series to desired length of time (Chapter-II para 2.2.3) shall be discussed covering details of type(s) of co-relation transformation of data, correlation co-efficient, standard error etc. These studies can be done as follows:

(a) Co-relating run-off data with concurrent data on rainfall of long term stations in the same catchment or data of run-off of adjacent long-term stations and applying these co-relations developed to past data of long-term stations of rainfall/run-off. The Effective precipitation in annual correlation is derived by Rank Analysis. Time wise behavior of residuals stationary of the relationship is to be checked

(b) Such co-relations shall be developed for each time unit selected.
(c) In case discharge-discharge correlation for Himalayan catchment, having good amount of snowmelt contribution, correlation should be carried out w.r.t. distinct seasons affecting the flow pattern of river
(d) Flow Duration Curve technique can be used to extend the flow data at a site with short term record, provided the long-term data are available at any other site provided hydrological similarity exists
(e) Synthetic techniques can be used to generate flow series for longer period. The most commonly used stochastic processes for Hydrologic data generation are Markov process or Autoregressive (AR) model, Autoregressive-Moving Average(ARMA) model, Disaggregation model, Auto run model etc.

Note:

(1) Rainfall/run-off correlation may not be feasible or necessary for non-monsoon period.
(2) Overall acceptability of correlation shall be checked.
(3) Random components may be considered where corrections are not very strong .

4.1.2 Data generation (for storage Projects where relatively longer flow series is required).

The approach used may be discussed giving the type of model and its suitability to the problem on hand, its parameters and their evaluation, validation of model and generation of flow data. Two approaches that can be used are:

(a) Stochastic modeling (time series)
(b) Conceptual modeling

- For the stochastic approach following details may also be included.

- Trends and cycles in the data, their physical justification and the necessity or otherwise of removing these.

- Auto-co-relation in data, its physical explanation, need for modelling auto-correlation, possibilities of smoothening auto-correlation values from regional studies.

- Frequency distribution of random error component

- Generation of random numbers

- Where more than one site is involved, co-relation between random error components of different series and method of flow generation at different sites.

For data generation by conceptual modeling, details of input data may be included together with compilation of output data in appropriate time steps.

4.2 Lake evaporation

Depth of lake evaporation shall be indicated with basis for selected time units (10 daily, fortnightly or monthly). These depths shall be worked out from the averages of long-term data of pan evaporation or climatological data of a station close to the reservoir after adjusting these to the lake evaporation.

4.3 Sedimentation studies

4.3.1 Revised area capacity curves

The studies carried out to evaluate the effect of depletion of reservoir's useful capacity on performance due to sedimentation shall be discussed giving details of methodology adopted, time period considered, average annual rate of sedimentation and distribution of sediment volume (refer IS 12182 (latest version), IS:5477 (Part II & III) latest versions.

Note:

(a) *The elaborate studies may not be necessary for runoff the river schemes having barrage/weir as diversion structure only and provision of diurnal variation of storage, but basic information related to silt rate, silt concentration, percent of different fraction of sediments etc. is to be provided which may be useful for electro-mechanical design*

(b) *For storage reservoirs and also for runoff the river scheme having provision of dam , elaborate studies are to be carried out as per relevant BIS/CBIP publications. It should includes, sediment rating curve, silt rate, classification of sediment problem, reservoir classification, fixing the new zero elevation w.r.t. different life spans of reservoir, methods used, life of reservoir, sediment distribution in vertical as well as along the longitudinal section of reservoirs etc.*

(c) *The silt concentrations information based on observed silt data over the years can be put also in the report in 3 categories i.e. <1000 ppm, 1000-2500 ppm, >500 ppm clearly in order to assess the seriousness of silt problem*

4.3.2 Rate of Sedimentation

In deciding silt rate, in addition to observed site specific silt data the relevant regional silt informations i.e. silt rate based on hydrographic surveys/remote sensing techniques of some existing reservoirs in project catchment/regional reservoirs are to be taken into account

Note:

(1) Allowance shall be made for the anticipated changes in the rate of Sedimentation due to the changes in the land management practices.

(2) Allowance shall also be made for the existing upstream projects or projects under construction. No allowance shall be made for future projects.

4.4 Potential evapo-transpiration and rainfall

The number of stations considered, their locations, details of the data used and methodology adopted for working out the fortnightly weighted mean rainfall of the command shall be furnished.

This is an important factor for determining the releases at the canal head during different fortnights of the cropping season. The details regarding working out the crop water requirements have been discussed under command area development and modernisation (Volume-III) of this report.

4.5 Flood inputs

When planning is based on detailed simulation, flood inputs are required at all control points viz; reservoir site(s) and damage point(s). Further, simulation can be based on historical or generated data.

Where historical flood data are utilised, the methods of transferring the flood hydrographs of available gauging stations to required control points and the manner in which the sub-area flood hydrographs are obtained for controlled and uncontrolled parts of catchment should be discussed and details of studies included.

Note: Computation of historical flood hydrographs for sub- areas would involve channel routing. Method of routing and the co-efficient and assumptions may be indicated.

Where flood simulation is to be based on generated data, additional details such as monthwise flood frequencies, relations between peak discharges and volumes and inter-relationships between different sub-area floods and lags, consistency of flood volumes and water inflows etc. may be discussed and incorporated in the models and random component considered.

In case of Himalayan catchment susceptible for flash flood and GLOF, these phenomenon need to be explore in detail and can be considered, these events need to be catalogued for safety aspects of the structure in estimation of design flood

4.6 Inputs for water quality

The water quality problems in the various reaches such as salinity control and other aspects for preservations of fish and wild life shall be indicated and details of the water quality characteristics and the water flows of discharges and the interrelationship of such characteristics at different locations shall be discussed including data extension in time and space.

4.7 Low flows inputs.

The analysis of low flow data available for discharge sites of interest shall be discussed and the low flows determined for the required time units and locations. Method and details of extension in time and space shall also be given.

If any trends in low flows have been observed, it may be indicated whether the low flow data has been modified to allow for future changes due to such trends.

4.8 Surface to ground water recharge

The details of the analysis made for determining the infiltration characteristics of the recharge area and its variability with time and the estimated rainfall and evaporation during the recharge period may be discussed.

The methodology of preparing the inputs from the available data is also to be discussed.

CHAPTER-V

Preparation of hydrological inputs for studies other than simulation.

This chapter shall discuss the studies and their results relating to design flood. design flood level and tail water rating curve etc.

5.1 Design floods for safety of structures

(Recommended procedures given in CWC Manual - "Estimation of Design Flood" and other guidelines on the subject shall be referred to).

5.1.1. The criteria for selection of design flood for each structure taking into account the importance of each structures shall be discussed. IS : 11223 latest version and other relevant BIS codes for the specific structure shall be referred to. The selected floods may be:

(a) Probable maximum flood
(b) Standard project flood
(c) Flood of specified frequency (T-year flood)

5.1.2 Overall approach adopted

(a) Hydrometeorological (design storm and basin response approach).
(b) Frequency approach (including conversion of storm frequencies into flood frequencies).

5.1.2.1 Hydrometeorological approach.

(a) Design storms
(Recommendations of workshop on rationalisation of design storm parameters held in CWC-Dec. 1993 may be referred to.)

The details of the transposed storms/Depth Area Duration obtained from the storms considered transposable from those discussed in Chapter-I shall be included along with details of moisture adjustment & other types of maximisation (if any), short period distribution of storm rainfall and final depth-duration curve adopted for the design storm.

Note:

(1) For orographic area, where usually no transposition is done, depth duration analysis of historical storms over the problem drainage area to be made and given.

(2) For large basins, the aerial pattern and time sequence for sub-area rainfall shall be discussed.

(3) For complex system (A5 of Enclosure-B) alternate positioning of storm centre will be required to work out sub-areawise depth-duration curves in each case.

(4) The PMP atlases published by Central Water Commission for different basins can also be referred while cataloguing the extreme storm events and their values

(b) Basin Response

Details of analysis of observed flood hydrographs and their corresponding rainfall data including plotting of hydrographs from hourly river gauges and gauge discharge rating curves, separation of base flows, computation of mass curve and rainfall data of self-recording raingauges and details of derivation of unit hydrogrphs and routing equations (reservoir/channel) if any shall be given.

Note:

(1) In very large catchments (say exceeding 5,000 sq. km.) the areas may be sub-divided and unit hydro-graphs prepared for each sub area by the procedure mentioned above and the flood hydrograph may be synthesized to the desired location by channel routing. Where upstream reservoirs exist, reservoir routing shall also be necessary.

(2) Averaging and selection of unit hydrographs including maximization of unit hydrograph peak for increase of hydraulic efficiency shall be indicated.

(3) Use of Flood Estimation Report published by CWC for different subzones can be avoided as far as possible at DPR stage, as these reports are specifically meant for small and medium catchments for planning of Railway and Road bridges as well as other cross drainage works where risk to life and property in case of failure is negligible. Therefore in case of water resources project planning, Basin Response function should be based on site specific/nearby site/adjacent basins(hydrometeorologically homogeneous in nature) short interval rainfall-runoff records. Any Synthetic Unit Hydrograph developed must be validated for some observed events before transposing to project site

(4) In case use of any synthetic approach is inevitable, then especially for Himalayan rivers, the rainfed and permanently snow covered detail of catchment should be based on satellite imageries of past 2-3 years especially for monsoon season.

Transfer of unit hydrographs to desired locations wherever made and details of synthetic unit hydrographs for ungauged area shall be included. Reference may be made (if necessary) to regional flood estimation reports for relevant sub-zones published by CWC and updated from time to time.

(c) Infiltration loss rates, run-off co-efficient etc. shall be given based on information derived from observed flood hydrographs and common procedures followed in the region.

(d) Design flood hydrographs:
The synthesis of the flood hydrographs shall be indicated giving details of critical sequence of storm rainfall and antecedent storms, run-off and base flows adopted.

5.1.2.2 Frequency Approach

The following shall be included

(a) Details of analysis of observed series of annual maximum peak discharge-distribution and method of fitting adopted, plotting on probability paper-inclusion of known large historical floods to improve the estimates.
(b) This analysis is to be carried out for instantaneous annual maxima flood peaks for prediction of high floods required for safety of structure, whereas for regulation purpose of any hydraulic structures beyond a certain fixed boundary, partial duration flood peaks series can be used
(c) The flood peak series should be checked for 3 basic assumptions of frequency analysis stationarity, homogeneity and randomness. The basic causes of inhomogeneity should also be mentioned. The inhomogeneity may be resulting because of mixed flood events of rainfall, dam break or Glacier lake outburst phenomenon
(d) The basic statistics should include measurements of central tendency, dispersion, asymmetry, and peakedness
(e) In order to check randomness, homogeneity and stationarity, various parametric and non-parametric tests need to be carried out with basic details
(f) The series need to checked for outliers & jump phenomenon
(g) Theoretical distributions with detail of parameters estimation need to be discussed with variate, frequency & return period graphical plots
(h) Test goodness of fit of theoretical distribution to observed frequency distribution with different statistical tools
(i) Regional flood frequency should also be carried out with all detail as per standard practice
(j) Frequency analysis for low flows analysis should also include above details

5.1.3 Comparison of design flood estimates

Comparison shall be made wherever possible with similar estimates for other projects in the region and by interpretation of the discharges from flood levels obtained by hydraulic calculations.

5.2 Design floods for determination of flood storage and flood control works.

5.2.1 Flood problem

The problem in various reaches downstream of the storage or at specific reaches affecting the command areas, shall be discussed. The channel capacity at each of the centres when damage begins to occur, shall be indicated

5.2.2 Degree of protection

The degree of protection proposed shall be discussed.

The degree of protection will depend upon the magnitude of the average annual damage and the cost of the works to give the desired protection. The degree of protection is generally expressed in terms of protection against a flood of specific return period under natural conditions.

Normally, flood protection is provided for a defined flood which is normally a flood of specified return period, depending upon the assets protected.

5.2.3 Design flood for fixing flood storage and design of structures downstream.

The steps involved and details to be given shall be generally same as indicated under para 5.1 "Design of floods for safety of structures" except that in regions experiencing prolonged rainfall and for larger flood storages, series of flood may have to be considered.

Since design flood at the damage centre(s) may result from several combinations of floods from the controlled (i.e. a flood storage dam located in the upstream) and uncontrolled parts of the total catchment, it may be necessary to study a few acceptable combinations of the controlled and uncontrolled sub-area floods.

The estimation of design flood at the damage centre for post project conditions shall involve routing of the inflow flood hydrograph of controlled sub-area through the reservoir(s) and through the downstream river reach and combining with the uncontrolled sub-area flood. For reservoir routing, the assumption of initial levels, rules of operation (with or without the benefits of flood forecasting) shall have to be indicated For river routing, assumption of routing coefficients will have to be indicated and justified based on observed rainfall and flood data.

Where channel hydraulics and channels storage characteristics are appreciably changed such as in the case of long embankments, effects of such changes may have to be considered on flood hydrographs, storage discharge relationships and water levels for post project conditions.

5.3 Studies for design of drainage in the command area

5.3.1 The problem

The problem of drainage in the command area and the need for surface drainage and sub-surface drainage, if any, shall be discussed.

5.3.2 Surface drainage

The design criteria proposed, shall be discussed. The frequency of rainfall adopted, season of rainfall considered, the nature of crops grown and the acceptable submergence depth and period, shall also be indicated.

Note: The actual design of the drainage system, especially at the effluence points and outfall points of large systems should take into account the different conditions of flow in the trunk and tributary drains and also outfalling rivers.

5.4 Design flood for diversion arrangements

The criteria for selection of construction design flood and studies made, shall be discussed in relation to the proposed plan of river diversion works, construction seasons and schedule etc. selection of peak and volume of flood hydrographs for design shall depend upon the nature of diversion arrangements. The design flood could either be of a specified return period or selected on the basis of economic considerations taking into account the relative risk involved in the occurrence of flood of varying frequency during the construction period and consequent damage and delay in the execution of work.

The design flood can be worked out according the procedure indicated in para 5.1.

5.5 Studies for determination of levels for locating structures on river banks and outlets in the dam.

5.5.1 Location of structures

The studies made for determining the levels for locating pumping plants, power houses, roads, bridges etc., and elevation of the outlets as required in the project, shall be discussed. The design criteria used and rating curves, if any, developed shall also be indicated with details of studies.

The methodology of determination of flood magnitude and frequency studies is the same as in para 5.1

5.5.2 Location of outlets.

The details of the studies made shall be discussed.

Note (1) The studies for fixing outlet from sediment consideration, shall be as in para 4.3 of Chapter IV.

Note (2) The normal time period used for the purpose of studies is 100 years

5.6 Tail water rating curves

It should be based on observed discharge and corresponding water levels at the location of interest. In case, it is being finalized based on hydraulic approach, then manning's roughness co-efficients (n), energy slope (s_f) should be chosen very carefully as these are two governing parameters, the river cross- section should be surveyed and it should extent up to river bed inside the flowing water

Note: For important structures, the upper and lower limits of the rating curves may also be computed from statistical methods ,or by computations using different rugosity co-efficients.

CHAPTER-VI

Simulation Studies

This chapter shall discuss the details of the simulation studies and the conclusions arrived therefrom.

6.1 Simulation studies (Working tables)

The studies carried out for the alternative under consideration shall be discussed in detail explaining all the factors and assumptions that have been made.

Integrated tables shall be prepared in cases where the project under consideration will affect or be affected by other projects in the sub-basin.

Note: Such of the projects which will not have serious impact on the availability of flows can be ignored.

If necessary, allowance (approximate) can be made (as external constraints for meeting the requirements of upstream and downstream projects) while calculating the net inflows available for the projects under consideration without considering these as a part of the integrated system for purposes of simulation.

An indication whether such prohibitions will be applicable always or any allowance can be made during the period of scarcity shall be given.

While discussing the studies, the following shall be furnished:

(a) A schematic plan showing the various projects that have been considered while carrying out the studies, shall be furnished showing the control points, hydraulic structures points where inflows, outflows and return flows have been considered.

(b) The time unit and the period of simulation with reasons for adopting them, shall be indicated. All the inputs prepared for the studies shall be presented.

Where latest technique of economic evaluation based on discounting proceadure is being considered, the period of simulation shall be in line with the rate of discounting adopted.

Where carry over storage is involved, it is desirable and necessary to consider a long time series containing cycles of dry years.

(c) The series used in the simulation-single, historical, many likely historical or synthetic-shall be indicated with reasons.

(d) The various physical limits (constraint)-maximum and minimum limits of storages, diversion capacity of canal/water conductor systems, installed capacity of power houses, discharging capacity of the spillways and outlets at different water levels etc., in the studies, shall be detailed.

(e) In control of quality of water etc. is involved in the studies, the manner in which this has been provided for has to be discussed.

(f) The manner in which the losses/gains to the flows, have been accounted for and allowances made for changes in time distribution in cases involving travel of water over long distances or through storages, shall be discussed.

(g) If return flows have been considered at any specific points, the basis on which this has been done, and the time span and pattern considered shall be indicated.

(h) The demand of all the projects considered in the system for simulation studies including that of the projects under consideration shall be listed along with their time pattern and basis (give suitable references to the documents/studies made). In addition, it shall be indicated if the demands considered for existing and future projects are on the basis of any of the following as far as possible.

(i) Sanctioned or approved utilisations and legal right demands, or
(ii) historical actual use, or
(iii) demands if any, based on reassessment of requirements of the existing projects.

Note: In case detailed study is based on economic evaluation where the entire period of simulation is taken into account for working out the average annual benefits, the firm and secondary demands, priority of uses, sharing of shortages etc. considered shall be discussed with basis.

(i) The operation policies (priorities etc.) for different uses considered in the simulation studies, shall be indicated with reasons.

(j) In case of multipurpose projects involving flood control storages, rule curve(s) and flood release rules adopted in the studies, shall be indicated with basis thereof.

Note: The flood release rules shall be framed so that if incoming floods turn out to be spillway design flood, it can be negotiated safely without endangering the structure.

(k) In case of multi-reservoir system rules of sharing of deficit and priorities of releases between reservoirs both for conservation and flood control purposes shall be indicated with basis.

6.2 Project performance

The results of the simulation studies shall be tabulated and discussed.

Performance can be expressed as:

(a) The number of failure years compared with the total number of years considered in the studies to meet the demand of a particular use irrespective of the quantum and duration of failure.

(b) Number of failure years compared with the total years considered in the studies by neglecting the failure for short period or both.

The minimum success rates for considering the project viable as recommended by Planning Commission based on use of project are:

B-1 : 75%
B-2 : 90%
B-3 : nearly 100%

(c) Number of crop seasons in which failure takes place compared with total crop seasons, as in (a) and (b)

(d) The number of successive years of failures (exceeding two) in the entire period of simulation-usewise.

Note: In case the project evaluation is carried out on the basis of economic analysis with discounted rates, the following performance analysis shall be furnished:

(i)Average and annual quantum of shortages for use over the period of simulation.

(ii)Present value of cost of shortages, indicating loss functions, discount rates etc., with justification.

The performance is to be discussed usewise and for each alternative plan. Where alternative flow series are considered performance shall also be indicated for each series and by giving average, maximum and minimum values of performance indices.

CHAPTER – VII

Effect of project on hydrologic regime

This chapter shall discussed following aspects :

7.1 Effect on low flows

Likely changes (quantitatively) in low flows in different reaches of the river due to the project.

7.2 Effect on peak flood

The reaches where the flood peaks are reduced or become sharper due to the project and their quantitative effects.

The likely changes and their effects on existing facilities etc., as also likely changes in river hydrographs both on short and long term basis.

7.3 Effect on total run-off

The likely decrease in the total run-off yield of the basin due to increased evaporation from the altered water surface and evaporation in the command area.

7.4 Effect on sediment flow & qualitatively

Likely changes (quantitatively) on sediment flow upstream & downstream of the project and its effects on upstream and downstream structures, land fertility, aggradation & degradation of river bed etc.

7.5 Effect on water quality

Likely changes in water quality parameters in upstream & downstream of the project.

7.6 Effect on water demand

Likely changes in quantity & schedule of water demand in upstream & downstream areas.

E- Areas and Reaches of Interest

E-1 Drainage basins upto control points i.e., sites of hydraulic structures, hydrometric sites, flood damage points, confluence with large rivers etc.

E-2 Potential irrigation area

E-3 Potential flood damage area

E-4 Potential drainage congestion area

E-5 Hydrometeorologic region surrounding the project basin. The region E-5 system will thus include all other regions and reaches E-1 to E-4 and E-7 to E-13 described here and in addition will include surrounding areas of similar hydrometeorologic characteristics.

E-6 River system reach within and slightly upstream of a reservoir

E-7 Potential ground water recharge area

E-8 Reservoir submergence area

E-9 River system reach from a hydraulic structure to a downstream point which is a control point causing critical flood or a point sufficiently downstream for friction controlled channels, or a confluence with major river or sea.

E-10 River reach through the area of potential flood damage or potential drainage damage.

E-11 River reach in which industrial or domestic water supply is contemplated and where the quantity and quality of water is to be monitored.

E-12 River reach in which navigation is to be sustained by monitoring low flows.

E-13 River reach in which water quality (salinity) of low flows area to be monitored for fish and wild life substance and for recreation.

Enclosure-B

A- Classification by storage behind the structures

A-1 Diversion projects without pondage

A-2 Diversion projects with pondage

A-3 Within the year storage projects

A-4 'Over the year' storage projects

A-5 Complex system involving combinations of 1 to 4 above mentioned.

B- Classification by use of Project

B-1 Irrigation

B-2 Hydropower

B-3 Water supply and industrial use

B-4 Navigation

B-5 Salinity control

B-6 Water quality control

B-7 Recreation, fish and wild life

B-8 Flood control

B-9 Drainage

B-10 Surface to ground water recharge

B-11 Multipurpose

Enclosure-D

C-1 Types of Hydrologic inputs required

C-1 For simulation studies

C-1.1 Water inflows

C-1.2 Lake evaporation

C-1.3 Potential evapo-transpiration and rainfall

C-1.4 Sediment inflows

C-1.5 Flood inputs

C-1.6 Water quality inputs

C-1.7 Low flow inputs

C-1.8 Surface to ground water recharge

C-2 For studies other than simulation

C-2.1 Design floods for the safety of structures

C-2.2 Design floods and flood levels for flood control works

C-2.3 Design floods for design of drainage works

C-2.4 Design floods for planning construction and diversion arrangements

C-2.5 Studies for determination of levels for locating structures on river banks or for location of outlets.

C-2.6 Tail water rating curves

Types of Hydrological inputs required for simulation (Classified as per contemplated use)

Use	**Inputs**
B1	C 1.1
	C 1.2 (if storage is involved)
	C1.3
B2 and B3	C1.1
	C1.2 (if storage is involved0
B4 to B7	C1.1
	C1.2 (if storage is involved)
	C1.7
B8	C1.5
B9	C1.5
B10	C1.1
	C1.8
B11	All depending on individual uses

Note: If the project involves large pondage/storage input C 1.4 will also be required. Sediment inflows normally do not form direct input in the simulation from one time unit to another. Only the long term loss of storage in time horizon is considered and the revised area-capacity curve at the end of this time horizon is predicted. This revised area-capacity curve is used through out the period of simulation without any consideration for year to year changes.

Enclosure-F

Type of Hydrological inputs required for studies other than simulation (classified as per storage types and use)

Storage	Use	Hydraulic inputs required
A1 & A2	All Except B-2	C2.1 C2.4 C2.5
A1&A2	B2	Same as above and also C2.6
A3, A4 & A5	B1 to B7 B10 and B11	-do-
A3, A4 & A5	B8	same as above and also C2.2
Any	B9	C2.3

Type of Storage	Type of Use	Time unit required for simulation studies (except for studies of sediment inflow and deposition
A1	B1 to B7 & B10	Instantaneous discharges every day or at smaller units
A2	B2 to B7	1 day to 10 days depending on the extent of pondage.
A2	B1	3 days for upland crops, 10 days for paddy if extra pondage at head-works in addition to natural storage on field is provided, larger units can be used
A3/A 2	B8	1 hour to 24 hours depending on the damping provided by the drainage basin to the storage
A2	B10	1 day to 10 days depending on the pondage
A2	B11	Minimum of individual time units required by each type of use. If flood control is involved much shorter interval (1 hr. to 24 hrs.) operation is required only for critical flood periods
A3	B1 to B3	Monthly, However, it may be sufficient to divide the year in 4 to 8 blocks by grouping together periods of definite storage accumulation and storage depletion type, and the periods which cannot be classified as such being kept as separate blocks
A3	B4 to B7	Same as above, but during critical low flows, shorter time unit of about 10 days to 1 month may be required to simulate droughts and extra releases for control of water quality, salinity etc.
A3	B10	Same as A3-B1 to B3 discussed above, in dry season, but in rainy season where extra recharge will be affected by rainfall, 1 day to 10 day working will be necessary.
A3	B11	Minimum of individual time units for each type of use. However, shorter time units required for use B4 to B7 or for B8 will apply only during critical low flows or floods.
A4	B1 to B3	Monthly or shorter blocks
A4	B4 to B7. B10 or B11	Same as above, but during critical low flows, short time operating as indicated for storage type A3 and corresponding type of use may be adopted
A5	All uses	Adopt the minimum of the time unit required by each of the component storages involved in the complex system, after considering the type of use thorough that storage. However, structures or uses of minor importance the overall system may not dictate the choice of time used to be adopted in total simulation of the system.

Annexure-5(a)

Instrumentation in Irrigation Projects

Large Dam

A Large Dam has been defined as :

a. a structure of height 15 meters or more above the foundation
b. a structure of 10 - 15 meters height with reservoir capacity of one million Cum or crest length of 500 meters or more
c. spillway discharging capacity more than 2000 cubic meter per second.
d. The dam has specially difficult foundation problem.
e. The dam is of unusual design.

In India there are about 3700 large dams and 600 are under construction. As per available record hardly, 5% of these dams have been provided with some kind of instrumentation and most of them are not under proper maintenance.

Purpose of Instrumentation

The purpose of instrumentation can be classified into under mentioned general categories:

1.Diagnostic Reasons :	Verification of design, verification of suitability of new construction techniques, diagnosing specific nature of adverse event.
2.Predictive Reasons :	For predicting behaviour of the structure.
3.Legal Reasons :	To form a cumulative record of the behaviour of a structure and thus the data can be used in possible litigation in future failure of the structure based on adherence to specifications.
4.Research Reasons:	Advancement of the state- of-the-art.
5.Public Relations :	To enhance public relation by assuring the continued safety of the structure based on the knowledge of health status

Gathering of instrumentation data is an important part of overall programme of assessing the safety and proper functioning of the dams and other hydraulic structures in river valley projects. Instrumentation is also required for verifying the design assumptions during the construction period also for long term monitoring of the structures.

Planning and design of instrumentation for any structure requires skill and knowledge of instruments, their construction and working. A meticulously planned instrumentation will yield more specific and useful performance reports which provide much needed feedback to designers and maintenance engineers to assess the status / health of the structure and for planning timely remedial measures where required.

Various type of field measurements often needed to evaluate the performance of hydraulic structures are given below. The probable instruments to be deployed are enlisted in Annex 5 (i) to (iv). For elaborate planning of instrumentation, the relevant BIS codes can be referred. The list of available codes on instrumentation is given at Annexure-5 (v).

The cost of instrumentation should preferably be based on prevailing rates. After assessing the requirements of instrumentation the cost may be worked out realistically covering all aspects of reading and interpretation. The overall cost may work out a maximum of 1% and 3% of the cost of relevant structure for manual reading and automation respectively.

Gravity Dams

If a gravity or buttress dam maintains its structural integrity and is stable against sliding, no safety hazard is likely to occur. Because contraction joints between blocks are much weaker than the mass concrete, any indication of loss of structural integrity in the dam or foundation will manifest itself at the joints. Instrumentation should be installed in all gravity or buttress dams to monitor relative movement between blocks exhibiting indications of previous movement or where movement might be reasonably anticipated. These measurements of relative movement between blocks should be correlated to other measurements that allow measurement of displacements of the dam relative to a remotely located fixed point. Other significant parameters that should be monitored in the majority of gravity or buttress dams are uplift pressures and seepage flows, including foundation drains. Results from these measurements may indicate open joints in the foundation. Additional monitoring devices should be installed to measure sliding or rotation along the plane. Water quality should be determined for seepage, reservoir and tail water.

Obligatory Measurements:

(a) Uplift Pressure
(b) Seepage
(c) Temperature
(d) Displacement

Optional Measurements

(a) Stress

(b) Strain
(c) Pore Pressure
(d) Seismicity

Embankment Dam

Earth dams differ from masonry and concrete dams because of relatively greater deformability and higher permeability of earth masses (excluding plastic clay hearting). Strains and displacements in earth dams are therefore very much larger, hence comparatively simple instruments can be used for measurements of strains and displacements. Distribution of stress in earth dams in more complex and the design analysis is based on radical simplification of the stress pattern and shape of rupture planes. Consequently, stress measurements require considerable judgement in interpretation. Seepage is of greater significance as it can cause internal erosion as well as increase in pore pressure resulting in instability.

The measurements often needed to evaluate the performance of embankments are given below

(a) Pore Water pressure
(b) Seepage / drainage
(c) Deformation
  i) Internal movement
  ii) Surface movement
(d) Seismic (vibration)

Other Measurements

(a) Reservoir and Tail water level
(b) Wave Height
(c) Rainfall
(d)Sstress and strain

Barrages

The diversion structures like barrage and weir are generally designed on the principles governing the percolation of water below the foundation of the structure. The floor of the structure is suitably designated either as a raft or gravity section to be safe against the uplift pressures created. Sufficient reinforcement is also provided such that the permissible stress limits are not exceeded. Due to the various assumptions to provide for the 'unknowns' in the design, sometimes the design become a little conservative. Hence in order to know the 'health' of the structure under different loading conditions and also to know the progressive behaviour of the structure, there is need to have instrumentation in the structure. By actual observations of their behaviour through instrumentation, the designs can be improved and economy effected. By having a continuous record of the observations with the instruments installed, the distress spots in the structure can be located and remedial measures to make the structure safe can be taken. Apart from this, the observations help reduce the 'unknowns' and place the future designs on sounder footings.

Obligatory Measurements:

1. Water Level
2. Uplift Pressure
3. Displacement

Optional Measurements :

1. Tilt
2. Stress and Strain

Tunnels / Underground Caverns

Hydro projects being very expensive and involves high risks, Instrumentation of underground openings is essential for their safety and cost optimisation of these underground construction. In the absence of a knowledge about the rock mass behaviour, the excavation design would necessarily be conservative. An understanding of the rock stresses and deformation can result in potentially large cost savings in future construction.

The following parameters are generally required to be measured in the field to know the behaviour of underground openings and the support system.

(i) Displacement/ Deformation
(ii) Load
(iii) Stress / Strain
(iv) Pore Pressure
(v) Earth Pressure
(vi) Seismicity

Annexure - 5 (b)

The parameters required to monitor the performance of gravity dams and various instruments used for same are given below:

Parameters	Suitable Instruments
1. Uplift Pressure	I Twin tube hydraulic piezometer II Pneumatic piezometer III Vibrating wire piezometer IV Unbonded electric resistance piezometers V Bonded electric resistance piezometer VI Multipoint piezometer with packers. VII Multipoint piezometer surrounded with grout VIII Multipoint push in piezometer
2. Seepage	I Weirs (i) V-Notch (ii) Rectangular weir II Flumes
3. Temperature	I Resistance Thermometer II Thermometer III Vibrating wire III Thermisters
4. Displacement	I Extensometer II Whitemore gauges III Crack monitoring IV Calipers V Micrometers VI Dial gauges
5. Stress	I Gloetzi cell II Carison load cell III Vibrating wire stress IV Flat jacks
6. Strain	I Resistance strainmeter II Vibrating wire strainmeter III No stress-strain meter
7. Pore Pressure	I. Open System Type (i) Porous tube piezometers (ii) Slotted pipe piezometers

	II Closed System Type (i) Hydraulic twin tube piezometers (ii) Pneumatic piezometers (iii) Electric piezometers (a) Vibrating wire strain gauge piezometer (b) Resistance strain gauge piezometer III Total pressure cells
8. Seismic	Seismographs
9. Joint	Jointmeters
10. Deformation	I Multipoint borehole extensometer II Foundation deformation gauges III Tunnel type gauges
11.Deflection / surface	I Plumb lines II Tiltmeters III Surveying techniques (i). Triangulation (ii) Trilateration (iii) Collimation

Annexure 5 (c)

The Parameters required to Monitor the Performance of Earth/ Rockfill Dams and various Instruments Used for same are given below:

Parameters	Suitable Instruments
1. Water Pressure	I. Open System Type (i) Porous tube piezometers (ii) Slotted pipe piezometers II. Closed System Type (i) Hydraulic twin tube piezometers (ii) Pneumatic piezometers (iii) Electric piezometers (a). Vibrating wire strain gauge piezometer (b) Resistance strain gauge piezometer III. Total pressure cells
2. Seepage	I. Bucket and stop watch II. Weirs (i) V-notch (ii) Cipolletti (iii) Rectangular III. Flumes (i) Trapezoidal (ii) Parshall IV. Flow meters V. Velocity meters (i) Based on pilot tube principle (ii) Propeller type device (iii) Accoustic flow meter (iv) Electromagnetic current indicator VI. Water quality meter VII. Turbidity meter VIII. Infrared aerial photography

	IX. Geophysical seepage monitoring
	(i) Thermotic surveys
	(ii) Self Potential surveys
	X. Resistivity surveys
3.Deformation	
i) Internal movement	I Cross arm
	II Foundation base plates
	III Pneumatic settlement centre
	IV Vibrating wire settlement sensor
	V Inclinometer
	VI Multi-point extensometer
	VII Shear strips
	VIII Radio-sonde systems
ii). Surface movement	I Tiltmeter
	II Theodolite
	III Electronic Distance Meter
	IV Crack meters
4. Vibration measurements	I . Geophones
	II. Strong Motion Accelerograph

Annexure 5 (d)

The parameters required to monitor the performance of Barrages and various Instruments used for same are given below:

Parameters	Suitable Instruments
1. Water Level	Automatic Water Level Records
2. Uplift Pressure	Uplift Pressure pipes
3. Stress in concrete and steel	Strainmeter
4. Stress in foundation	Soil stress meter i) contact pressure cells ii) Total pressure cells
5. Displacement of the different units	Joint meter
6. Tilt	Clinometer
7. Undershot flow monitor	Pressure cell

Annexure 5 (e)

The parameters required to monitor the performance of Tunnels / Underground Caverns and various Instruments used for same are given below:

Parameters	Suitable Instruments
1. Displacement/Deformation	I Borehole Extensometers II Inclinometers III Plumb Line IV Tilt meter V Tae extensometer
2. Load	I Load cells II Concrete stress cell III Strain gauge
3. Strain	I Stress meter II Total pressure cell
4 Pore pressure	Piezometers
5 Earth pressure	Earth pressure cell
6 Seismicity	Accelerographs

Annexure 5 (f)

List of BIS Codes of Practice for River Valley Projects

Sr. No	BISs. No./ DOC .No.	Title	Reaffirmed
1.	IS 6524 : 1972	Code of practice for installation and observation of instruments for temperature measurement inside dams : resistance type thermometers	OCT. 98
2.	IS 6532 : 1972	Code of practice for design, installation, observation and maintenance of uplift pressure pipes for hydraulic structures on permeable foundations	DEC. 2005
3.	IS 7356 (Part- 1) 2002	Code of practice for installation, maintenance and observation of instruments for pore pressure measurements in earth dams and rockfill dams : Part 1 Porous tube piezometers (first revision)	
4.	IS 7356 (Part - 2) : 2003	Installation, observation and maintenance of instruments for pore pressure measurements in earth and rockfill dams - Code of practice Part 2 - Twin tube hydraulic piezometers (second revision)	
5.	IS 7436 (Part - 1) : 1993	Guide for types of measurements for structures in river valley projects and criteria for choice and location of measuring instruments : Part 1 for earth and rockfill dams (second revision)	OCT. 98
6.	IS 7436 (Part - 2): 1997	Guide for types of measurements for structures in river valley projects and criteria for choice and location of measuring instruments : Part 2 Concrete and masonry dams (first revision)	
7.	IS 7500 : 2000	Code of practice for installation and observation of cross arm for measurement of internal vertical movement in earth dams.	
8	IS 8226 : 1976	Code of practice for installation and observation of base plates for measurement of foundation settlement in embankments	2005

9.	IS 8282 (Part - 1): 1976	Code of practice for installation, maintenance and observation of pore pressure measuring devices in concrete and masonry dams : Part 1 Electrical resistance type cell	OCT 98
10.	IS 8282 (Part - 2): 1996	Installation, maintenance and observation of pore pressure measuring devices in concrete and masonry dams - Code of practice : Part 2 Vibrating wire type cell	2005
11.	IS 10334 : 1982	Code of practice for selection, splicing, installation and providing protection to the open ends of cables used for connecting resistance type measuring devices in concrete and masonry dams	DEC 95
12.	IS 10434 (Part - 1): 2003	Guidelines for installation, maintenance and observation of deformation measuring devices in concrete and masonry dams : Part 1 Resistance type joint meters (1st edition)	
13.	IS 10434 (Part - 2): 1996	Guidelines for installation, maintenance and observation of deformation measuring devices in concrete and masonry dams : Part 2 Vibrating wire type joint meter	
14.	IS 12949 : 1990	Code of practice for installation, maintenance and observation of instruments for pore pressure measurements in earth dams and rockfill dams : Electrical pore pressure cells - vibrating wire type	OCT 98
15.	IS 13073 (Part - 1): 2002	Code of practice for installation, maintenance and observation of displacement measuring devices in concrete and masonry dams : Part 1 Deflection measurement using plumb lines (1st edition)	
16.	IS 13232 : 1992	Code of practice for installation, maintenance and observation of electrical strain measuring devices in concrete dams	FEB 97
17.	IS 14248 : 1995	Guidelines for instrumentation of barrages & weirs	
18.	IS 14278 : 1995	Stress measuring devices in concrete and masonry dams - Installation, commissioning	

		and observations - code of practice.	
19.	IS 13073: 2000	Code of practice for installation, maintenance and observation of displacement measuring devices for concrete and masonry dams – Part 2: Geodetic observation – Crest collimation	2005
20.	IS 14750: 2000	Code of practice for installation, maintenance and observation of Seepage measurement devices for concrete/masonry and Earth/Rockfill dams	2005
21.	IS 14793: 2000	Code of practice for installation, maintenance and observation of the Instruments for Vibration Studies other than Earthquakes.	2005
22.	IS 4967: 1968	Recommendations for seismic instrumentation for river valley projects.	2000

Annexure – 6

Fortnightly rainfall data (give 10 year's data)
(Command area)

Station ....Latitude..........Elevation ......metres........Longitude..........year

Year	Period	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct.	Nov.	Dec.	Total
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ist	I													
	II													
2nd	I													
	II													
3rd	I													
	II													
4th	I													
	II													
5th	I													
	II													
6th	I													
	II													
7th	I													
	II													
8th	I													
	II													
9th	I													
	II													
10th	I													
	II													

Note : This should be accompanied by a location plan with station(s) numbered for ready identification. The rainfall data shall be worked out by Theissen Polygon method if more than two stations are considered in the command.

Annexure–7

Fortnightly climate data
(Supply 10 year's data)

Station ……………Latitude ………Elevation ………metres……..Longitude …….Year

Year & Period	Temperature in degree C			Relative humidity %	Cloud cover (% Sunshine)	No. of Frost free days	Wind		Evaporation (mm)	Remarks
	Max	Min.	Avg.				Velocity km./hr	Height of Anemometer above ground level		
January I										
II										
February I										
II										
March I										
II										
April I										
II										
May I										
II										
June I										
II										
July I										
II										
August I										
II										
September I										
II										
October I										
II										
November I										
II										
December I										
II										

Annexure – 8

Crop Water Requirement

(Refer FAO Publication 24)

Name of IMD Station .... Distance from dam site .... Latitude .... Longitude............
Name of crop .... Crop Duration .... days from .... to .... Area proposed ....ha.

Sl. No	Item	June I II	July I II	Aug I II	Sept I II	Oct I II	Nov I II	Dec I II	Jan I II	Feb I II	Mar I II	Apr I II	May I II	Total
1.	Average Rainfall (mm)													
2.	Evapo-transpiration													
3.	ET_0 (mm)													
4.	Crop factor K_0 Consumptive use of crop ET_0 (mm) ($=ET_0 \times K_0$)													
5.	Irrigation requirements for land preparation and leaching wherever required													
6.	Percolation Losses (mm)													
7.	Nursery requirement (mm)													
8.	Total Water Requirement (col. 4+5+6+7)													
9.	Effective Rainfall (mm)													
10.	Net Irrigation Requirement (NIR) (mm) (Col. 8 – Col.9)													
11.	Field Irrigation efficiency e_1													
12.	Field Irrigation Requirement (FIR) (mm) =Col.10/Col.11													
13.	Conveyance efficiency e_2													
14.	Gross Irrigation Requirement (GIR) (mm) =Col.12//Col.13													
15.	Gross Water Requirement ('000 mm)													

Note : FIR (Item 12) = NIR/e_1.
GIR (Item 14)=FIR/e_2
Gross Water Requirement (Item 15)=GIR(mm) x Area under crop (ha)x10^{-2}=000cum or ha.m
e_2 = Conveyance Efficiency from head to Govt. outlet
e_1 = Field application efficiency (including efficiency of channel from Govt. outlet to field)

Annexure - 9

Irrigation Demand Table at Canal Head (in '000 Cubic meters)

Fortnight	CROPS									Total Irrigation Water Demand
	Paddy	Wheat	Cotton	Sugar-cane						
January I										
II										
February I										
II										
March I										
II										
April I										
II										
May I										
II										
June I										
II										
July I										
II										
August I										
II										
September I										
II										
October I										
II										
November I										
II										
December I										
II										

Note :- 1. Crop wise fortnightly demand shall be taken from Annexure-8
2. Season wise (Kharif, Rabi, Two Seasonal, Perennial, Hot weather) water demand shall be worked out separately.

Annexure-10

Demand Table at Canal Head (in '000 Cubic meters)

Fortnight	Irrigation	Pisci-culture	Horti-culture	Domestic and Industrial	Power generation			Navi-gation	Total Water Demand
					Hydel	Thermal	Nuclear		
January I									
II									
February I									
II									
March I									
II									
April I									
II									
May I									
II									
June I									
II									
July I									
II									
August I									
II									
September I									
II									
October I									
II									
November I									
II									
December I									
II									
Total									

Annexure-11

TYPICAL PRO-FORMA FOR CAPACITY STATEMENTS OF A CANAL

IS:5968-1970

S.No.	Reduced Distance of Outlet and Side (m)	Gross Area (m^2)	Culturable Commanded Area m^2)	Discharge at Outlet Head (m^3/sec.)	Discharge in the Reach ((m^3/sec.)	Discharge at head of Reach (m^3/sec.)	Reach From (m)	Reach From (m)	Length (m)	Transmission Losses (m^3/sec./$10^4 m^2$)	Wetted Area (m^2)	Wetted Perimeter (m)	Absorption Losses (m3/sec./$10^6 m^2$)	Total Discharge (m^3/sec.)	Slope of Reach ((m/1000m)	Sub soil water level	Bed Width (m)	Full Supply Depth (m)	Full Supply Level (m)	Remarks
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)

*Transmission losses for lined canals shall be assumed as given in IS 4745 – 1968 "Code of practice for design of cross-section of lined canals".

Annexure–12

Reservoir Operation Table

Year........................

Sl. No.	Name of the Month	Storage at the beginning of the month		Inflow of water into reser-voir M.cum.	Water proposed to be released at canal head M.cum.	Evapo-ration losses	Spill	Storage at the end of the month		Remarks
		Storage M.cum.	El-m					Storage M.cum.	El-m	
1.	January I									
	II									
	III									
2.	February I									
	II									
	III									
3.	March I									
	II									
	III									
4.	April I									
	II									
	III									
5.	May I									
	II									
	III									
6.	June I									
	II									
	III									
7.	July I									
	II									
	III									
8.	August I									
	II									
	III									
9.	September I									
	II									
	III									
10.	October I									
	II									
	III									
11.	November I									
	II									
	III									
12.	December I									
	II									
	III									

Annexure-13

Financial return for Power Component

Rs. in lakhs

SL. No.	Year	Civil Works Unit I	'P' Production		Total of Unit III	Grand Total
			Unit III (A)	Unit III (B)		
1. 2. 3. 4. 5. 6. 7. 8.						
Total						

(Name) HYDRO ELECTRIC PROJECT
Rate of Depreciation

Amount in Rs. lakhs

Item	Life years	Rs. lakhs (estimated)	Rate of depreciation for 90% of the Cost	Depreciation Amount
A – Civil Engineering Works 1 Dams, diversion structures and tunnels 2 Surge shaft, pressure shaft 3 Power House building machine foundations and tail race etc 4 Permanent Buildings 5 Roads 6 Other items prorata				
Total for Civil works				
B – Hydraulic and Electrical Engineering Works 7. Penstock lining 8. Generating plants 9. Power transformers and control equipments 10. Other items prorata				
Total for Hydraulic and Electrical Engineering works				
Total		X		Y
Average rate of Depreciation $\frac{Y}{X} \times 100 = ...$				

(Name) HYDRO ELECTRIC PROJECT
Statement of Revenue Forecast

Amount in Rs. lakhs

Sl. No.	Year	Capital outlay upto the commence-ment of the year	Expenditure during the year	Simple interest & % p.a. on col. 3 & @ - % p.a. on col. 4	Depre-ciation charges @-% on Col. 3	Operation and Main-tenance charges @ 1% p.a. on col. 3	Total working expenses Col. 6+7
1	2	3	4	5	6	7	8
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							

Energy generated per annum M. Kwh.	Gross Revenue per annum @ paise per KW Hrs.	Net Revenue Col. 10(10-8)	Surplus(+) or Deficit (-) Col. 11-5	Cummula-tive Surplus (+) or deficit (=)	Sum at charges at the end of the year (3+4+13)	Percent Return Col. 11x100 / Col. 14
9	10	11	12	13	14	15

Note:

1. The interest on capital outlay during the previous year is calculated at 3 p.a. and the interest on the expenditure incurred during the year is calculated at -- % p.a.
2. The average rate of depreciation is assumed at = % p.a. computed on straight line basis to depreciate 90% of capital cost of each structure. during the life time of each structure.
3. Operation & Maintenance charges are assumed at – p.a.
4. The project will start earning surplus revenue during the – th year from the commencement of the infrastructure during ---------.
5. First unit is proposed to be commissioned during the early part of the year ____viz. during the -------the year commencement of the preliminary works and the 2nd Unit – months later etc.
6. The accumulated deficit (col. 14) is wiped out by the end of ____th. year from the commencement of infrastructure.
7. The percentage return varies from ----% p.a. at the commencement of energy generation, to ----% p.a. after wiping the accumulated deficits.
8. Any other assumption.

Annexure-14

Guidelines/Norms for Detailed Calculations for the Requirement of Each Category and Size of the Production Equipment

The requirement of equipment shall be planned on the basis of peak work load in a year. In the interest of economy and optimum utilisation of equipment, programme of construction shall be drawn in such a way that the peak requirement of equipment does not substantially differ from the average. The equipment planning shall normally be such that at least 75 percent of the life of each equipment is utilised at the same project. Exception for capital intensive equipment like cable-ways etc., may be made but it will have to be for very good reasons which shall be explained in the project report.

I. Assumptions

For calculating the requirement of equipment, the following assumptions may be adopted :

( ) (i) Scheduled Working Hours

Schedule working hours in a year with 200 available working days shall be taken as below:

	Schedule Working Hours
Single shift work/day Two shift work/day Three shift work/day	1200 Hrs(25x8x6) 2000 Hrs (25x8x10) 2500 Hrs(25x8x12.5)

Notes :-

(i) Where 200 working days are not available because of peculiar situation existing on account of location of sites of works, the scheduled working hours shall be reduced proportionately. Similarly if more than 200 days are available the number of hours shall be increased proportionately.

(ii) For old machines scheduled working hours shall be taken as 80 percent of those given above

(iii) Standby provision shall be calculated on the following lines:

Single shift working	10 percent
Double shift working	20 percent
Three shift working	30 percent

(b) Material Weights & Swell Factor

Material	Weights kg.perM^3 lbs/cu.yd		Percent Swell	Swell Factor
	Bank	Loose		
Clay, dry	1605 2700	1189 2000	35	0.74
Clay, wet	1783 3000	1308 2200	35	0.74
Earth, Dry	1665 2800	1332 2240	25	0.80
Earth, Wet	1902 3200	1534 2580	25	0.80
Earth & Gravel	1902 3200	1581 2660	20	0.83
Gravel, dry	1665 2800	1480 2490	12	0.89
Gravel, wet	2021 3400	1772 2980	14	0.88
Lime-stone	2615 4400	1635 2750	60	0.63
Rock, well blasted	2497 4200	1569 2640	60	0.63
Sand, dry	1545 2600	1344 2260	15	0.87
Sand, wet	1605 2700	1403 2360	15	0.87
Shale	2081 3500	1474 2480	40	0.71

(c) Operating Factor

Classification	Minimum Operating efficiency Hours	Percentage
Excellent	55	92%
Average	50	83%
Fair	45	75%
Unfavourable	40	67%

Usually factor w.r.t. average classification is taken into account.

(d) Job and Management Factor

Job Conditions	Management Condition			
	Excellent	Good	Fair	Poor
Excellent	0.84	0.81	0.76	0.70
Good	0.78	0.75	0.71	0.65
Fair	0.72	0.69	0.65	0.60
Poor	0.63	0.61	0.57	0,52

(e) Bucket Fill Factors (Shovels & Loaders)

Material	Fill factor range
Sand and gravel	0.90 – 1.00
Common earth	0.80 – 0.90
Hard clay	0.65 – 0.75
Wet clay	0.50 – 0.60
Rock well blasted	0.60 – 0.75
Rock poorly blasted	0.40 – 0.50

(f) Estimated Hourly Production of Power Shovel

Shovel Dipper capacity in cu.m (cy.d)

	0.57 (¾)	0.76 (1)	0.96 (1¼)	1.15 (1½)	1-34 (1¾)	1.53 (2)	1.91 (2½)	2.29 (3)	2.68 (3½)	3.06 (4)	3.44 (4½)	3.82 (5)	4.59 (6)
Class of material													
Moist loam or sandy clay	126 (165)	157 (205)	191 (250)	218 (285)	245 (320)	271 (355)	310 (405)	356 (465)	401 525	443 (580)	485 (635)	524 (685)	608 (795)
Sand and Gravel	119 (155)	153 (200)	176 (230)	206 (270)	229 (300)	252 (330)	298 (390)	344 (450)	386 (505)	424 (555)	459 (600)	493 (645)	566 (740)
Common earth	103 (135)	134 (175)	161 (210)	183 (240)	206 (270)	229 (300)	271 (355)	310 (405)	348 (455)	390 (510)	428 (560)	463 (605)	524 (685
Clay, hard tough	84 (110)	111 (145)	138 (180)	161 (210)	180 (235)	203 (265)	237 (310)	275 (360)	310 (405)	344 (450)	375 (490)	405 (530)	460 (605)
Rock, well blasted	73 (95)	96 (125)	11 (155)	138 (180)	157 (205)	176 (230)	210 (275)	245 (320)	279 (365)	313 (410)	348 (455)	382 (500)	440 (575)
Common Excav W/Rocks & roots	61 (80)	80 (105)	99 (130)	119 (155)	138 (180)	153 (200)	187 (245)	222 (290)	256 (335)	291 (380)	321 (420)	352 (460)	413 (540)
Clay, wet & sticky	54 (70)	73 (95)	92 (120)	111 (145)	120 (165)	141 (185)	176 (230)	206 (270)	237 (310)	264 (345)	294 (385)	321 (420)	375 (490)
Rock, poorly blasted	38 (50)	57 (75)	73 (95)	88 (115)	107 (140)	122 (160)	149 (195)	180 (235)	206 (270)	233 (305)	260 (340)	287 (375)	336 (440)

(f) Factor for Depth of cut and angle of swing (Shovels)

	Angle of Swing (deg.)						
Percent of optimum depth	45	60	75	90	120	150	180
40	0.93	0.89	0.85	0.80	0.72	0.65	0.59
60	1.10	1.03	0.96	0.91	0.81	0.73	0.66
80	1.22	1.12	1.04	0.98	0.86	0.77	0.69
100	1.26	1.16	1.07	1.00	0.88	0.79	0.71
120	1.20	1.11	1.03	0.97	0.86	0.77	·0.70
140	1.12	1.04	0.97	0.91	0.81	0.73	0.66
160	1.03	0.96	0.90	0.85	0.75	0.67	0.62

(f) Ideal output of Loaders

(f) Crawler Loader cycle time

Haul distance m (ft)	7.62 (25)	15.24 (50)	30.48 (100)	45.72 (150)	60.96 (200)
Fixed time	0.40	0.40	0.40	0.40	0.40
Haul time	0.12	0.24	0.49	0.73	0.98
Return time.	0.07	0.14	0.28	0.42	0.56
Cycle time, min	0.59	0.78	1.17	1.55	1.94

Volume hauled per hour m^3 (Cyd.)(Bank Measure)

Size bucket Loose m^3(cyds)	M^3(cu yd) Bank*	One way haul distance m(ft.)				
		7.62(25)	15.24(50)	30.48(100)	45.72(150)	60.96(200)
1.15(1-1/2)	0.82(1.08)	62.92(82.3)	47.78(62.5)	31.80(41.6)	24.08(31.5)	19.19(25.1)
1.53(2)	0.10(1.44)	84.10(110.0)	63.84(83.5)	42.43(55.5)	32.11(42.0)	25.61(33.5)
1.91(2-1/2)	1.38(1.80)	101.68(133.0)	79.51(104.0)	53.13(69.5)	40.14(52.5)	31.19(40.8)
2.30(3)	1.65(2.16)	125.84(164.6)	95.57(125.0)	63.61(83.2)	48.17(63.0)	38.38(50.2)
3.06(4)	2.20(2.88)	168.20(220.0)	127.68(167.0)	84.86(111.0)	64.22(84.0)	51.22(67.0)

*Based on a swell factor of 25% and an average load equal to 90% of the rated capacity.

(ii) Wheel Loader
Cycle time

Haul distance m(ft)	7.62(25)	15.24(50)	30.48(100)	45.72(150)	60.96(200)
Fixed time	0.35	0.35	0.35	0.35	0.35
Haul time	0.09	0.18	0.36	0.55	0.73
Return time	0.05	0.09	0.13	0.19	0.26
Cycle time, min	0.49	0.62	0.84	1.09	1.34

Volume hauled per hour m^3 (cyd) (Bank Measure)

Size bucket, Loose M^3(cyd)	M^3(cyd) Bank*	One way haul distance m (ft.)				
		7.62(25)	15.24(50)	30.48(100)	45.72(150)	60.96(200)
1.53(2)	1.10(1.44)	101.30(132.5)	79.89(104.5)	59.02(77.2)	45.49(59.5)	30.96(40.5)
2.30(3)	1.65(2.16)	151.38(198.0)	120.03(157.0)	88.69(116.0)	68.04(89.0)	55.43(72.5)
3.06.(4)	2.20(2.88)	201.84(264.0)	156.35(204.5)	117.74(154.0)	90.60(118.5)	73.85(96.6)
3.82(5)	2.75(3.60)	253.07(331.0)	199.55(261.4)	147.56(193.0)	113.15(148.0)	93.27(122.0)
4.60(6)	3.30(4.32)	303.53(397.0)	239.30(313.0)	176.61(231.0)	135.32(177.0)	110.09(144.0)

*Based on a swell factor of 25% and an average load equal to 90% of the rated capacity.

(j) Hourly production of Diesel Draglines

Bucket Capacity in Cum. (cyd)

	0.76 (1)	0.96 (1-1/4)	1.15 (1-1/2)	1.34 (1-3/4)	1.53 (2)	1.91 (2-1/2)	2.29 (3)	2.68 (3-1/2)	3.06 (4)	3.82 (5)
Class of Material Light moist clay or loam	122 (160)	149 (195)	168 (220)	187 (245)	203 (265)	233 (305	268 (350)	298 (390)	356 (465)	413 (540)
Sand or gravel	119 (155)	141 (185)	161 (210)	180 (235)	195 (255)	226 (295)	260 (340)	291 (380)	348 (455)	405 (530)
Good common earth	103 (135)	126 (165)	145 (190)	161 (210)	176 (230)	203 (265)	233 (305	260 (340)	287 (375)	340 (445)
Clay, hard tough	84 (110)	103 (135)	122 (160)	138 (180)	149 (195)	176 (230)	206 (270)	233 (305)	260 (340)	313 (410)
Clay, wet sticky	57 (75)	73 (95)	84 (110)	99 (130)	111 (145)	134 (175)	161 (210)	184 (140)	206 (170)	252 (330)

(k) Factor for the depth of cut and angle of swing on the output of Draglines

Percent of optimum depth	Angle of swing in degrees							
	30^0	45^0	60^0	75^0	90^0	120^0	150^0	180^0
20	1.06	0.99	0.94	0.90	0.87	0.81	0.75	0.70
40	1.17	1.08	1.02	0.97	0.93	0.85	0.78	0.72
60	1.24	1.13	1.06	1.01	0.97	0.88	0.80	0.74
80	1.29	1.17	1.09	1.04	0.99	0.90	0.82	0.76
100	1.32	1.19	1.11	1.05	1.00	0.91	0.83	0.77
120	1.29	1.17	1.09	1.03	0.98	0.90	0.82	0.76
140	1.25	1.14	1.06	1.00	0.96	0.88	0.81	0.75
160	1.20	1.10	1.02	0.97	0.93	0.85	0.79	0.73
180	1.15	1.05	0.98	0.94	0.90	0.82	0.76	0.71
200	1.10	1.00	0.94	0.90	0.87	0.79	0.73	0.69

(l) Rolling Resistances for various types of wheels and surfaces in Kg./Tonne (Lbs per ton) of Gross load

Type of surface	Steel tyres, plain bearings	Crawler-type track and wheel	Rubber tyres, anti fraction bearings	
			High Pressures	Low Pressures
Smooth concrete	20(40)	27.5(55)	17.5(35)	22.5(45)
Good asphalt	25-35(50-70)	30-35(60-70)	20-32.5(40-65)	25-30(50-60)
Earth, compacted & well maintained	30-50(60-100)	30-40(60-80)	20-35(40-70)	25-35(50-70)
Earth, poorly maintained, rutted	50-75(100-150)	40-55(80-110)	50-70(100-140)	35-50(70-100)
Earth, rutted muddy, no maintenance	100-125(200-250)	70-90(140-180)	90-110(180-220)	75-100(150-200)
Loose Sand and gravel	140-160(280-320)	80-100(160-200)	130-145(260-290)	110-130(220-260)
Earth, very muddy rutted soft	175-200(350-400)	100-120(200-240)	150-200(300-400)	140-170(280-340)

(m) Co-efficients of traction for various road surface

Surface	Rubber tyres	Crawler tracks
Dry, rough concrete	0.80-1.00	0.45
Dry clay loam	0.50-0.70	0.90
Wet clay loam	0.40-0.50	0.70
Wet sand and gravel	0.30-0.40	0.35
Loose, dry sand	0.20-0.30	0.30
Dry snow	0.20	0.15-0.35
Ice	0.10	0.10-0.25

(n) Effect of Grade on the Tractive effect of vehicle in Kg./Tonne (Lbs per Gross tonne)

Slope %	Kg/Tonne (Pounds per 2000 lbs of gross weight)	Slope %	Kg/Tonne (Pounds Per 2000 lbs of gross weight)
1	10 (20.0)	12	119.2 (238.4)
2	20(40.0)	13	128.9(257.8)
3	30(60.0)	14	138.7(277.4)
4	40(80.0)	15	148.3(296.6)
5	50(100.0)	20	196.15(392.3)
6	59.9(119.8)	25	242.6(485.2)
7	69.9(139.8)	30	287.35(574.7)
8	74.6(149.2)	35	330.3(660.6)
9	89.6(179.2)	40	371.4(742.8)
10	99.5(199.0)	45	410.4(820.8)
11	109 (218.0)	50	447.2(894.4)

(o) Average Barometric Pressures for various altitudes above Sea level in mm (inches) of Mercury

Altitude above sea level, m (ft.)		Barometric pressure, mm(in) Hg.	
(0)	(0)	760.00	(29.92)
304.80	(1,000)	733.04	(28.86)
609.60	(2,000)	706.63	(27.82)
914.40	(3,000)	608.72	(26.80)
1219.20	(4,000)	655.83	(25.82)
1524.00	(5,000)	631.70	(24.87)
1828.80	(6,000)	608.33	(23.95)
2133.60	(7,000)	585.98	(23.01)
2438.40	(8,000)	654.13	(22.31)
2743.20	(9,000)	542.54	(21.36)
3048.00	(10,000)	521.97	(20.55)

(p) Correction Factors for Horsepower of four Cycle Engines, for various altitudes and temperatures.

Altitude above sea level m(ft.)		Temperatures, °F								
		110	90	70	60	50	40	20	0	-20
0	(0)	0.954	0.971	0.991	1.000	1.013	1.018	1.039	1.062	1.085
304.80	(1,000)	0.920	0.937	0.955	0.964	0.974	0.984	1.003	1.025	1.048
609.60	(2,000)	0.887	0.904	0.921`	0.930	0.938	0.948	0.968	0.988	1.010
914.40	(3,000)	0.855	0.872	0.888	0.896	0.905	0.914	0.933	0.952	0.974
1219.20	(4,000)	0.825	0.840	0.856	0.865	0.873	0.882	0.899	0.918	0.938
1524.00	(5,000)	0.795	0.809	0.825	0.833	0.842	0.849	0.867	0.885	0.904
1828.80	(6,000)	0.767	0.781	0.795	0.803	0.811	0.820	0.836	0.853	0.872
2133.60	(7,000)	0.738	0.752	0.767	0.775	0.782	0.790	0.806	0.823	0.840
2438.40	(8,000)	0.712	0.725	0.739	0.746	0.754	0.762	0.776	0.793	0.811
2743.20	(9,000)	0.686	0.699	0.713	0.720	0.727	0.734	0.748	0.764	0.782
3048.00	(10,000)	0.682	0.675	0.687	0.693	0.707	0.707	0.722	0.737	0.753

(q) Blade capacities and Bulldozer output

Blade length m(ft.)	Blade height cm(in)	Tractor draw-bar (hp)	Forwarde d speed in per minute (fpm)	Reverse speed in per minute (fpm)	Blade capacity cum (cu.yd)	Output cum. (cu-yd) per hour Haul distance m. (ft.)			
						30.48 (100)	60.96 (200)	91.44 (300)	121.92 (400)
3.43 (11 ft.3 in)	115.57 (45-1/2)	130	45.72 (150)	99.36 (326)	3.67 (4.8)	140.68 (184)	80.28 (105)	56.57 (74)	43.58 (57)
3.12 (10 ft. 3 in)	115.57 (45-1/2)	80	37.49 (123)	101.80 (334)	3.36 (4.4)	116.21 (152)	65.75 (86)	45.87 (60)	35.17 (46)
2.89 (9 ft.6 in)	96.52 (38)	65	37.49 (123)	104.55 (343)	2.14 (2.8)	74.93 (98)	42.05 (55)	29.05 (38)	22.17 (29)
2.49 (8 ft 2 in)	96.52 (38)	65	37.49 (123)	104.55 (343)	1.83 (2.4)	64.22 (84)	35.93 (47)	25.23 (33)	19.11 (25)
2.18 (7 ft 2 in)	82.55 (32-1/2)	43	45.72 (150)	50.90 (167)	1.15 (1.5)	71.87 (47)	19.88 (26)	13.76 (18)	10.70 (14)
1.73 (5 ft 8 in)	69.85 (27-1/2)	32	45.72 (150)	56.39 (185)	0.69 (0.9)	22.17 (29)	12.23 (16)	8.41 (11)	6.88 (9)
3.40 (11 ft 2 in)	109.22 (43)	*210	42.97 (141)	217.02 (712)	3.21 (4.2)	136.09 (178)	78.75 (103)	55.81 (73)	42.81 (56)
3.42 (11 ft 3 in)	91.44 (36)	*122	42.97 (141)	217.02 (712)	2.29 (3.0)	97.10 (127)	56.58 (74)	39.75 (52)	30.58 (40)

*These values are flywheel horsepower for wheel-mounted dozers.

(r) Typical air Consumption of various pneumatic tools

Equipment	Cum. .per minute (cfm) per unit at 5.62 kg/sq cm (80 p.s.i.)
Air track drills	16.99(600)
Drefter Cradle mounted	4.25 – 7.08(150-250)
Jackhammers	2.27 – 2.83(80-100)
Jack-picks	1.42 – 1.67(50-60)
Blast hole blow guns	4.25 – 5.66(150-200)
Sump pumps	2.27 – 2.83 (80-100)
One ton capacity winches	4.25 - (150)
Chipping hammer	0.57 – 0.85(20-30)
Riverting hammer	0.85 1.13 (30-40)
Bit grinder	0.85 – (30)
Wood borer	1.42 (50)
Concrete Vibrator	0.85 – 1.67(30-60)
Pile driving hammer No.9	16.99 - (600)

(s) Fixed Time Elements for Wheel Scrapers in minutes

Element	Hauling speed ranges, k.ph								
	8 to 13			13 to 24			24 to 48		
	(1)*	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Loading	0.8	1.0	1.4	0.8	1.0	1.4	0.8	1.0	1.4
Dumping-turning	0.4	0.5	0.6	0.4	0.5	0.6	0.4	0.5	0.6
Accelerating-decelerating	0.3	0.4	0.6	0.6	0.8	1.0	1.0	1.5	2.0
Total	1.5	1.9	2.6	1.8	2.3	3.0	2.2	3.0	4.0

*Columns 1, 2 and 3 indicate the time for favourable, average and unfavourable conditions respectively.

(i) Load Time

7cu.m	Elevating Scraper	.80 Min.
8 cu.m	Elevating Scraper	1.00 Min
17 cu.m	Elevating Scraper	1.00 Min
21 cu.m	ElevatingScraper (Twin Power)	.70 Min
24 cu.m	ElevatingScraper (Single Power)	1.00 Min
26 cu.m	Elevating Scraper (Twin Power)	.80 Min
16 cu.m	Conventional Scraper (Push Loaded)	.75 Min
19 cu.m	Conventional Scraper (Push Loaded)	1.00 Min
15 cu.m	Conventional Scraper (Push Pull)	1.00 Min
23 cu.m	Conventional Scraper (Push Pull)	1.10 Min

II. Hourly Use Rates

The hourly use rate of the equipment shall comprise of the following elements:-

(a) Ownership Cost

- Depreciation

(b) Operational Cost

(1) Repair Charges
(2) Depreciation and repair of tyres and tubes
(3) Operators and maintenance crew charges
(4) P.O.L. Energy Charges
(5) Miscellaneous supplies

The various elements as mentioned above shall be evaluated as below:-

(a) Depreciation

The equipment shall be depreciated by modified straight line methods starting from the acquisition cost till 50% of the cost in 40% of the life, and till the residual value of 10% of the cost in the remaining 60% of the life. The life of various equipment to be used for this purpose has been given in part IV of this annexure.

(b) Operational Cost

1. Repair charges: These shall be provided at relevant scaled provision taking into consideration the escalation of prices of spares and also severity of the job condition over operational hours during the year.

2. Depreciation and Repair of tyres and Tubes shall be calculated as cost of tyres over the life in hours. The hourly repair provision shall be taken as 15% of the hourly depreciation.

3. Operators & Maintenance Crew charges shall be taken as per actual annual cost over the operational hours during the year.

4. Provision of POL could be checked as per optimum fuel consumption and 20 to 25% of the cost of fuel shall be provided for purpose of lubricants depending on the type of equipment. The electrical energy charges shall be as per actuals.

5. Miscellaneous supplies: The hourly miscellaneous provision shall be kept at 10% of the hourly repair provision. This shall be suitably increased for machines using wire ropes, cutting edges, etc., and in -adverse job conditions.

III. Hourly Hire Charges

(i) The hourly hire charges shall include all the elements as mentioned in hourly use rate of the equyipment and in addition the interest charges on average capital investment, and supervision charges.

(ii) The average capital investment shall be calculated by the following formula:

$$\frac{C}{N}(0.514\,N + 0.48)$$

Where 'C' is the cost of the equipment and 'N' is the number of block of 2000 hours each of the life of the equipment in hours.

(iii) Supervision charges shall, generally be fixed by the owner of the equipment or the state and shall be 10 to 15% of the hourly use rate of the equipment.

(iv) The minimum hours to be charged for different periods while giving machines on hire shall be taken as below:

Annual basis	2000 hours
Monthly basis	250 hours
Weekly basis	60 hours
Daily basis	10 hours

Note: Number of hours given in paras (ii) & (iv) are w.r.t. two shift working . These figures will change in case of change in the number of shifts worked in a day.

IV. LIFE & REPAIR PROVISION OF EQUIPMENT

S. No.	Equipment		Life of the Equipment		Repair Provision (%age of cost Equipment)	Remarks
	Category	Capacity	Year	Hours		
1.	**Excavators**					
	Shovels & Draglines	Up to 1.5 cyd	10	12,000	150	
		1.5 to 3.0 cyd (diesel)	12	15,000	150	
		Above 3.0 cyd (diesel)	15	25,000	150	
		2.5 to 4 cyd. (Electric)	15	25,000	150	
		4 cyd and above (Electric)	20	40,000	150	
	Walking Draglines		20	30,000	150	
	Bucket Wheeled Excavators		20	40,000	150	
	Dredger in fresh water	Hull	25	-	60	
		Machine	10	-	60	
	Barger	Hull	16	-	60	
		Machine	10	-	60	
	Tugs	Hull	16	-	60	
		Machine	10	-	60	
2.	**Dumpers**					
	Bottom Dumpers	Upto 20 T	8	10,000	140	
		Upto 20 T to 50 T	10	16,000	140	
		Above 50 T	12	20,000	140	
	Rear Dumpers	Upto 15 T	8	10,000	140	
		15 T to 35 T	10	12,000	140	
		35 To 50 T	12	15,000	140	
		Above 50 T	15	20,000	140	
	Highway Dumpers		8	10,000	140	

3.	**Scrappers**					
	A. Motorised					
	Push	Upto 10 cyd	8	9,000	150	
	Loaded	Above 10 cyd	10	10,000	150	
	Elevating and self-loading	-	10	10,000	150	
	B.Towed	-	12	15,000	75	
4	**Tractors**					
	Crawler	Upto 100 HP	8	9,000	200	
		100 to 300 HP	10	12,000	240	
		Above 300 HP	12	16,000	240	
	Wheeled	Upto 75 HP	8	12,000	150	
		Above 75 HP	10	15,000	150	
5	**Graders**		10	12,000	150	
6.	**Loaders**					
	Crawler	-	10	12,000	200	
	Wheeled	-	10	15,000	150	
	Belt Loaders	-	16	20,000	70	
	Reclaimers & Stackers		20	30,000	70	
7.	**Compactors**					
	Self propelled Sheeps foot Roller		10	12,000	·80	
	Drawn sheepes foot rollers		8	10,000	70	
	Vibratory Rollers		6	8,000	150	
8.	**Cooling Plants**					
	(i) Aggregate Cooling Plant (ii) Ice Plant		20	40,000	75	
9.	**Water Sprinklers**		10	16,000	100	
10.	**Canal Trimmer and Lining Equipment above 200 cyds/ht.**		16	20,000	100	

11.	**Drills**					
	Blast hole drills		10	10,000	80	
	Core Drills		8	8,000	80	
	Wagon Drills		8	8,000	80	
	Tricone rotary Drills		10	10,000	80	
12.	**Compressors**					
	A. Diesel Compressors					
	(i) Portable upto 300 cfm.		8	10,000	100	
	(ii) Portable above 300 cfm.		10	12,000		
	B. Electric Compressors					
	(i) Portable upto 300 cfm.		10	16,000	80	
	(ii) Portable above 300 cfm.		12	20,000	80	
	(iii) Stationery		20	30,000	80	
13	**Blowers**		12	-	80	
14.	**Batching and Mixing Plant**					
	(i) Cement handling Batching & Mixing Plant		18	30,000	75	
	(ii) Transit Mixers (iii) Agitating Cars		10	10,000	120	
	(iv) Portable Concrete Mixers		5	6,000	80	
15.	**Pumps**					
	(i) Diesel engine driven	Above 10 H.P.	18	10,000	100	
	(ii) Electrical	-	12	20,000	70	
16.	**Well points**	-	12	20,000	100	

17.	**Cranes**					
	(i) Mobile (Pneumatic Wheeled)	4 to 6 Tons 5 to 12 Tons	10	12,000	120	
		15 Ton and above	12	15,000	120	
	(ii) Crawler Mounted	Upto 3 Tons 4 to 10 Tons	10	12,000	120	
		Over 10 Tons	12	15,000	120	
	(iii) Tower	-	20	30,000	120	
	(iv) Truck Mounted	-	10	16,000	140	
18.	**Transport Equipments**					
	(A) Heavy Transport Vehicles					
	(a) Trucks and Highway Dumpers	Diesel upto 3 Ton, Diesel 3 to 5 Ton, 5 Ton and above	10	200000 km.	140	
	(b) Tractor Trailers	Upto 5 Ton, 5 to 10 Ton	10	250000 km.	140	
		10 Ton and above	12	20,000 Hours	140	
	(B) Light Transport Vehicles	i)Jeeps ii)Station Wagons iii) Cars iv)Ambulence Cars		160000 km.	140	
	(C) Ariel Transport					
	(i) Ropeways		20	40,000	70	
	(ii) Cabeways					
	(D) Locomotives					
	- Diesel		10	16,000	120	
	-Electrical		22	40,000	100	
	-Wagons, Rail Cars		20	30,000	70	
19.	**Diesel Generating Sets**	Upto 50 KVA	10	20,000	100	
		Above 50 KVA	15	30,000	120	

V. BIBLIOGRAPHY

1 Construction Planning, Equipment and methods by RL Peurifoy
2. Art of earth moving by Jagman Singh
3. Guide Book on transfer of used equipment by CWC

Example No.1

Hydraulic excavator (Block hoe) – Dumper Combination

Total quantity to be handled	$= 37.67 \times 10^5\ m^3$
Type of material/soil	=Disintegrated rock
Programme	= To be completed in 5 yrs
Shift working	= Double shift
Work load per season	$= \frac{37.67}{5} \times 10^5\ m^3$
Peak work load per season	$= \frac{37.67}{5} \times 1.25 \times 10^5\ m^3$
	$= 9.41 \times 10^5\ m^3$
Work load per hour	$= \frac{9.41 \times 10^5}{2000}$
	$= 470.5\ m^3$

1. EXCAVATION :

Adopt 3m3 capacity hydraulic excavator (back-hoe)

Ideal production per hour	$=390 m^3$
Considering Job & Management factor	=0.84
Time factor	=0.83
Bucket fill factor	=0.9
Actual production per hour	=390x0.84x0.83x0.9
	$=245 m^3$
No. of excavators required	$= \frac{470.5}{245} = 1.92$

Add 20% stand by	(+).35

	2.30
	say 2 Nos

2. **TRANSPORTATION TO SITE :**

Quantity available per hour for handling	$= 245m^3$
Taking swell factor	0.75
Quantity per hour to be handled by Dumpers	$= \frac{245}{0.74}$
	$=326.66m^3$

Select 18.12m3 31.75(tonnes)capacity Dumpers Lead =3.75 K.M.

Dumper Cycle Time :

(a) Loading time	$=\frac{18.12x60}{326.66}$
	=3.32 minutes
(b) Dumping turning & spotting time	=3 minutes
(c) Speed of loaded Dumper	=22.5 K.P.H.
Speed of empty Dumper	=275 K.P.H.
Haul time	$=\frac{7.5x60}{25}$
	= 18 Minutes
(d) Total cycle time	= 24.32 Minutes
No. of trips per hour of 50 minutes	$= \frac{50}{24.32} = 2.06$
Quantity carried by one dumper	=18.12x2.06
	$=36.25m^3$
Excavator production per hour	$=326.66\ m^3$
No.of Dumpers required per excavator	$=\frac{326.66}{36.25}$= Nos
No.of Dumpers required for 2 excavators	=18

Provide 20% as standby	(+)3.6

	21.6
	SAY 22

Total No.of deumpers required =22

3. SPREADING :

Total quantity for spreading $=37.67\times10^5 m^3$

Programme =5 years

Work load per season $=\dfrac{37.67\times10^5 m^3}{5}$

Peak work load per season $=\dfrac{37.67}{5} \times 1.25\times10^5$

$=9.41\times10^5 m^3$

Output required per hour $=\dfrac{9,41,000}{2,000}$

$=471 m^3$(b.m.)

Select of Dozer of 275 HP $= 629 m^3$(loose)

Progress of Dozer per hour (inclusive of operating efficiency) $= 500\ m^3$

Considering:

Job and management factor =0.75

Load factor =0.75

Estimated output of dozer per hour =500x0.75x0.75

$=281 m^3$(b.m.)

No of dozer required $= \dfrac{629}{281} = 2.2$

Standby	= (+) 0.44

Total	2.64
	---------
	say 3 nos.

- Total No. of Dozers required is 3

COMPACTION:

Quantity required to be compacted per hour =471 m^3 (b.m.)
or 629m^3 (loose)

Taking Double Drum Sheep foot Roller of 1.5m dia of 1.2m width with 900-100 crawler tractors.

Considering :

(a) Efficiency factor =0.83
(b) Total width =2.4 meters
(c) Effective width =0.85
(d) Speed =4 K.M./hr
(e) Depth of layer =0.25 meters
(f) No. of passes =12

Compaction by Double Drum Sheep foot Roller

$$= \frac{\text{Efficiency x width x speed x depth of layer x effective width}}{\text{No. of passes}}$$

$$= \frac{.83 \times 2.4 \times 4 \times 1000 \times .25 \times 0.85}{12}$$

=141 m^3/hour

=No. of Double Drum Sheep foot rollers required

$$= \frac{629}{141} = 4.4$$

	Say 4 numbers
Standby	+ 1 number
Total:	6 numbers

EXAMPLE NO. 2

Scraper – Pusher combination

Total earth work to be handled =16×10^5 m^3

The earth work is proposed to be completed by Scraper – Pusher combination and is to be completed in three years as below :

1st year =6×10^5 m^3
2nd year =6×10^5 m^3
3rd year =4×10^5 m^3

The peak quantity to be handled in one season $=6.00 \times 10^5 m^3$

Quantity to be handled/hr $= \dfrac{6,00,000}{2,000}$

$=300\ m^3$

1. SCRAPERS ;

Selecting scraper of 11.50 m^3 capacity

Average lead = 3 K.M.

Speed of leaded scraper = 22.5K.M./hr

Speed of empty scraper = 27.5 K.M./hr

Average speed 25 K.M./hr

Cycle Time

(i) Loading time =1.00 mts

(ii)Haul time $\dfrac{6 \times 60}{25}$ =14.40 mts

(iii)Dumping Turning & accelerating time=1.50 mts

(iv) Total cycle time =16.9 mts

Say 17 mts

No of trips per hour $= \dfrac{50}{17}$

= 3

Production of scraper/hr $=11.50 \times 3\ m^3$

$=34.5\ m^3$ (loose)

or $=34.5 \times 8\ m^3$ (b.m.)

$=27.6\ m^3$

Therefore No. of scrapers required $= \dfrac{300}{27.6}$

= 11 Nos.

Add 20% stand by =2 Nos.

Total No. of scrapers required = 11+2=13 Nos.

2. **PUSHERS :**

It is proposed to deploy Pushers of 250 – 275 H.P. for above scrapers

Scraper cycle time	=17 mts
Pusher cycle time	=2.5 mts
Each Pusher will cater for	$= \frac{17}{2.5} = 6.8$ Say 7 scrapers
No. of Pusher required	$= \frac{11}{7}$ =1.6 Say 2 Nos.
Add 20% stand by	1 No
Total No. of Pushers required	= 2+ 1 = 3 Nos.

3. **SPREADING THE EARTH :**

Hourly output required = 375 m^3

Adopting dozer of 180 H.P. and taking spread area of 30.48 m (100 ft)

Ideal Production per hour	=300 m^3
Considering :	
Load factor	=0.8
Job & management factor	=0.75
Therefore output per dozer per hour	= 300 x 0.8 x 0.75 = 180 m^3
No of Dozers required	$= \frac{375}{180}$ = 2
Add 20% stand by	= 1
Total No. of dozers required	= 2 + 1 = 3 Nos.

4. **WETTING THE FILL :**

Quantity of earth to be wetted per hour	= 375 m^3
Weight of earth placed per hour	= 375 x 1661 = 6,22,875 kg
Water of to be added by weight	12% - 6% = 6%
Weight of water required per hour	= 6,22,875 x 0.06 = 37,370 kg Or 37,370 liters

Using water tanker of 10,000 liters capacity and water pump of 2.275liters per minute capacity.

Filling time required	=4.4 min
Haul time for 2 K.M. at 20 K.M. per hour	$= \frac{2 \times 60}{20} = 6$ min
Sprinkling time for 10,000 liters at the rate of 1,000 liters/min	= 10 Min
Return time at 25 K.M. per hour	= 4.8 min
Total cycle time	= 25.2 min
No. of trips per hour	$= \frac{50}{25.2} = 2$
Quantity of water handled per hour	=10,000 x 2 = 20,000 ltr
No of tankers required	$= \frac{37{,}370}{20{,}000} = 1.87$ say 2
Add stand by	(+) 1
Total No. of water tanker/sprinkler required	= 3 Nos.

5. COMPACTION :

Quantity required to be compacted per hour	= 375 m^3
Selecting self-propelled vibrators Tampering foot compactor with efficiency factor	= 0.83
Width	= 2.1 m
effective width	= o.85
speed	= 3 Km./hour
Depth of layer	= 30 cm
No. of passes	= 4
Progress of compaction per hour	$= \frac{0.83 \times 2.1 \times 0.85 \times 3000 \times 3}{4}$ = 335 m^3/hr
No of compactors required	$= \frac{375}{335} = 1.1$ say 1
stand by	(+) 1
Total No. of compactors required	= 2 Nos.

Note : Excavation with the scrapers have been worked out assuming level haul roads. Wherever grades are involved, due care is to be exercised to account of total resistance (grade resistance + rolling resistance) in arriving at haul & return times.

EXAMPLE NO. 3

Loader Dumper Combination

Total quantity to be handled	$= 58.28 \times 10^5\ m^3$
Type of material	= To be completed in 5 years
Programme Shift Working	= Double shift
Work load per season	$= \dfrac{58.28}{5} \times 10^5$
Peak work load	$= \dfrac{58.28}{5} \times 1.25 \times 10^5$
Work load per hour	$= \dfrac{14.5 \times 10^5}{2,000}$
	$= 728.5\ m^3$

Excavation

Select 2.3 m^3 capacity loader (Crawler)
Considering one-way haul distance of 25 ft

Ideal production per hour	$= 164.6\ m^3$ (b.m.)
Actual estimated output per hour	$= 164.6 \times 0.76 \times 0.75 \times 0.83$
	= 78.38 m (b.m)
	or $\dfrac{78.38}{0.8}$ (loose)
	= 98 m
No of loaders required	$= \dfrac{728.5}{98}$
	= 7.43
Stand by	(+) 1.48
	8.91
	say 9 Nos.

Provide 9 Nos. of loaders of 2.3 m^3 capacity

Transportation :

Quantity per hour available for handling = 98 m^3
Lead = 2 K.M.
Select 18.12 m^3 (31.75 tonnes) capacity rear Dumpers.

Dumper cycle time :

(a) Loading time = $\dfrac{18.12 \times 70}{98}$ = 11.00 min

(b) Dumping, turning & spotting time = 3.00 min
(c) Haul time @ 25 K.M. per hour = 9.6 min
(d) total cycle time 23.6 min

No of trips per hour = $\dfrac{50}{23.6}$ = 2.12

Quantity carried by one dumper = 18.12 x 2.12
= 38.38 m^3

- No. of Dumpers required/loader = $\dfrac{98}{38.8}$ - 2.55

Total No. of Dumpers required for 7 loaders = 2.55 x 7 = 17.8
Say 18 Nos
Stand by (+) 4

22

- Total No. of 18.12 m^3 capacity Dumpers required = 22 Nos

For spreading, wetting & compaction, proceed as under example No.2

EXAMPLE NO. 4

Excavation of Hard Rock

Total quantity to be excavated in a season = 2,85,00 m^3

Peak requirement in a season = 2,85,000 – 1.25 m^3
= 3,56,400 m^3
= $\dfrac{3,56,400}{200}$

Output required per day = 1782 m^3

I. **Drilling Operation :**

Estimated average progress of 120 cfm capacity heavy duty Jack hammer	= 4 holes of 1.5 meter per hour i.e. 6 m per hour
Estimated average progress per day (considering single shift working i.e. for 5 production hours)	= 6 x 5 m = 30 m/day

For 1 cum of material 1 m of drilling is achieved

- For 1982 m^3 of material per day drilling at rate of 30 meter per day, No. of Jack hammers required	= 1782 ------------ 30 = 59.4 say 60 nos.
Stand by at 30%	(+) 18 nos. ------------ 78 nos.
- Total No. of Jack hammers required	(120 cfm capacity) - 78 nos.

2. **Air Requirements** :

An Air compressor of 250 cfm capacity can cater for 2 Jack hammers and Air Compressor of 500 cfm capacity can cater for 4 Jack hammers

Therefore provide 250 cfm capacity air compressors	= 16 numbers
Stand by	+ 3 numbers
Total Nos.	19 numbers

and provide 500 cfm capacity air compressors= 7 Nos.

Stand by	+ 1 No.
Total Nos	8 Nos

Loading :

Peak requirement of boulders per season = $2,85,000 \times 1.25\ m^3$

= $3,56,400\ m^3$

Requirement per hour = $\dfrac{3,56,400}{2000}$

= $178.2\ m^3$

Select Tippers of $4.5\ m^3$ (6.5 T) capacity. Lead = 5 K.M.

Cycle Time :

(i) Spotting time = 1.5 minutes
(ii) Loading time (Manually) = 15.0 minutes
(iii)Haul time(average speed of 30 KMPH) = 20.0 minutes

i.e. $\dfrac{10 \times 60}{30} = 20$ min

(iv)Dumping time = 2.5 minutes
Total cycle time = 39.0 minutes

say 40 minutes

No. of tips per hour = $\dfrac{50}{40} = 1.25$

Out put per tipper per hour = 4.25×1.25
= $5.625\ m^3$

No of tippers required = $\dfrac{178.2}{5.625}$
= 32 Nos.

Provide 20% stand by + 6 Nos.

38 Nos.

Total No. of tippers required are 38 Nos.

EXAMPLE NO.5

Example of Concrete placing, concrete production and aggregate processing.

Select concrete placing, concrete production and aggregate processing for a solid gravity concrete dam :

Qty. 5,60,000 m^3 : to be completed in 4 years. Peak qty in2nd year is 2,10,000 m^3. Work is proposed to be carried out in double shift. Suitable granite rock is available for aggregate at a distance of 2 kms. from dam site and there is no over burden. Aggregate size required is 150-75 mm, 75-40mm, 40 to 20 mm and 20-6 mm. Good quality sand is not available and so proposed fines of crusher are proposed to be used.

Solution

Total quantity of concrete	= 5,60,000 m^3
Period	= 4 years
Average quantity	= 1,40,000 m^3
Peaak quantity in 2^{nd} year	= 2,10,000 m^3
Schedule in working hours in a year in Double shift Working	= 2000 hrs

Rate of concrete placement required $= \dfrac{210000}{2000} = 105\ m^3/hr$

There shall be loss of concrete on the following accounts

(a) During transportation due to spillage, leakage etc

(b) Discarding of mixed batch due to delay in placement or unsatisfactory mixing

So allowing 5% allowance for losses we obtain:

Rate of concrete production $= \dfrac{105 \times 105}{100} = 110\ m^3/hr$

Mixing Plant

We select a mixing plant of 2500 L capacity

(1) Charging time	-30 sec
(2) Mixing time	- 90 sec
(3) Discharge time	- 30 sec
(4) Drum closing or loss	-12 sec
	162 sec

i.e. 2.70 minutes

No. of batches per hour of 50 min $= \dfrac{50}{2.7} = 18.5$

Hourly production $= 18.5 \times 2.5 = 46.2$ cu.m.

No. of mixers required $\dfrac{110}{46.2} = 2.38$

say 3 Nos.

Provide l No. mixer as stand by.

Batching Plant

Assuming a mix proportion of Cement, sand and coarse aggregate of 1 : 2.5 : 7.0 and water cement ratio of 0.6

Density of materials is taken as

Sand	- 1542 kg/cu.m.
Coarse aggregate	- 1780 kg/cu.m.
Concrete	- 2314 kg/cu.m.

Then neglecting weight of water in concrete weight of one batch $= 2.5 \times 2314 = 5785$ kg

Weight of coarse aggregate $= \dfrac{5785 \times 7}{1 + 2.5 + 7} \times 3875$ kg

or volume of coarse aggregate $= \dfrac{3857}{1780}$ 2.17 cum.

Weight of sand $= \dfrac{5785 \text{x} 2.5}{1 + 2.5 + 7} = 1377$ Kg.

or

Volume of sand $= \dfrac{1377}{1542} = 0.89$ cum.

Weight of cement $= \dfrac{1 \times 5785}{1 + 2.5 + 7} = 550$ kg

Weight of water required per batch $= 550 \times 0.6 = 330$ kg

Assuming proportions of different grades of material in coarse aggregate as under :

150 to 75 mm	= 35 %
75 to 40 mm	= 30 %
40 to 20 mm	= 25 %
20 to 6 mm	= 10 %

So the weight of each grade can be worked out to determine cap. of the batcher

150 to 75 mm size	- 3857 x .35 = 1350 kg = 0.76 cum.
75 to 40 mm size	- 3857 x .3 = 1157 kg = 0.650 cum.
40 to 20 mm size	- 3857 x .25 = 964 kg = 0.54 cum.
20 to 6 mm size	- 3857 x .10 = 386 kg = 0.22 cum.

The batcher may be sized for an additional 33% capacity so we provide as under

Sizes of Batcher required for aggregate	Provided
1350 x 1.33 = 1805 kg 1157 x 1.33 = 1538 kg	2 batches of 1800 kg each + 1 stand by
964 x 1.33 = 1287 kg 386 x 1.33 = 513 kg	2 batcher of 1300 kg each + 1 stand by
For Sand size required 1337 x 1.33 = 1831	Provided 1 Batcher of 1800 kg. capacity
For Cement size required 550 x 1.33 = 731	Provided 1 Batcher of 800 kg capacity with 1 stand by

Size of the storage bins at the batching plant will depend upon the degree of reliability sought for the plant vis-à-vis dependability of supply arrangement for concrete ingradients. Normally a provision of about 3 hours requirement for concrete production is adequate suggested bin capacities for each in gradients are therefore as under :

Material	Qty. per batch of 2.5 cu.m. M.T.	Qty. per cu.m.	Qty reqd for 3 hours 3 x 110 cu.m. concrete M.T.	Recommended Bin size M.T.
Coarse aggregate				
150 – 75 mm	1.35	.54	178.20	180
75 – 40 mm	1.16	.46	153.12	160
40 –20 mm	.96	.38	126.72	130
20 - 6 mm	1.39	.16	51.48	60
Fine aggregate sand	1.38	.55	182.16	190
Cement	0.55	.22	72.60	80
Total			800 M.T.	

Cement required per hour = 24.30 M.T.

Cement may be transportation may be designed for carry capacity of = 24.30 x 1.30
= 31.5 M.T.
Say 30 M.T.

Aggregate Processing

$$\text{Coarse aggregate required per hour} = \frac{509.52}{3} = 170 \text{ M.T.}$$

$$\text{Fine aggregate required per hour} = \frac{182.16}{3} = 61 \text{ M.T.}$$

Total = 170 + 61 = 231 M.T.

Allowing Transit loss @ 5%

Finished out put required = 231 x 1.05 = 242 M.T.

Sl. .No.	Ingradient	Wt. .Kg.	Sq. Heat	Kcal Per °C	Initial temp	Initial Total Heat Kcal
1	Coarse aggregate	3857	.20	771.4	45	34713
2.	Fine aggregate	1377	.20	275.4	40	11016
3.	Cement	550	.27	148.5	40	5994
4.	Water	330	1	330.0	25	8250
5.	Moisture in fine aggregate say 5%	69	1	69.0	40	2760
	Total			1594.3		62733

Temp of concrete $= \frac{62733}{1594.3} = 39.34°$

Temperature of concrete desired at the time of placement = 20° C

Heat required to be removed = 1594.3 (39.34 - 20°)
= 30833 K cal per batch

If only ice is used for cooling the mix then quantity of heat removed by 1 kg of ice of flakes = 80 + (20 x 1) Kcal

Quantity of ice required $= \frac{30833}{100} = 308.33$ kg/Batch

Hourly requirement of ice $= \frac{308.33 \times 110}{2.5} = 13567$ kg

3 Irrigation/80 – 16

Assuming 10% product reject from the plant then capacity of processing plant = 242 x 1.1
= 266 M.T.
say 270 M.T.

The stockpile of the finished aggregate at the processing plant should be adequate for about 10 days requirement if the work is proposed to be done in 2 shifts per day then capacity of stock piles of each aggregate size can be worked out as under. Then schedule working production per day = 10 hrs.

Coarse aggregate :

150 – 75 mm $\frac{178.20}{3} \times 10 \times 10 = 5940$ MT

75 – 40 mm $\frac{153.12}{3} \times 10 \times 10 = 5100$ MT

40-20 m $\frac{126.72}{3} \times 10 \times 10 = 4224$ MT

20 – 6 mm $\frac{51.48}{3} \times 10 \times 10 = 1716$ MT

Fine aggregate sand $\frac{182.16}{3} \times 10 \times 10 = 6072$ MT

Cement storage for 10 days would require silos of cap = $\frac{72.60}{3} \times 10 \times 10 = 2420$ MT

Ice requirement for cooling the concrete

Mix design for batch size of 2.5 cum.. i.e. 5785 kg

Coarse aggregate	-- 2857 kg at 45° C
Fine aggregate	-- 1377 kg at 40° C
Cement	-- 550 kg at 40° C
Water	-- 330 lit at 25° C

Assuming that it is required to place concrete at 20° C

Thermal heat Balance for mix without cooling.

If 24 hrs manufacture of ice is contemplated with storage and concrete work is in 2 shifts, i.e., 10 hrs daily then capacity of ice plant

$$= \frac{13.567 \times 10}{24} = 5.67 \text{ MT}$$

Allowing 20% standby capacity = 5.67 + 1.12 = 6.9
Say 7 MT per hour

EXAMPLE NO . 6

Example of selection pump for de-watering coffer dams.

Water will flow under a coffer dam any time there is a difference in the hydrostatic levels on the two sides of the dam. The total quantity entering an area inside a coffer dam will depend on the velocity of flow and the area through which it flows. The variations in soil conditions in each case make it difficult to make an accurate estimate of the flow. The results of tests conducted by Hafer for sands varying from .1 to 3 mm in effective size are

$$V = cd^2s \; \frac{t + 10}{60}$$

Where v= velocity of flow m/day
c =a constant varying from 400 to 1000
d =effective size of sand mm
s =slope of hydraulic gradient
t = temp °F

EXAMPLE:

A steel sheet piling coffer dam enclosed an area50 ft vide by 200 ft long. The pit is excavated to a depth of 50 below the level of water outside the dam. If the bottom of the pit is 50 , the soil has an effective size of 0.5 mm and a porosity of 0.3

Assuming C for thiis porosity to be 400

$$d = 0.5 \quad p = 0.3 \quad s = \frac{50}{50} \quad k = \frac{3.3 x 400 x 0.5^2}{0.3}$$

$$= 1100$$

and frum table we have a value of 1070

$$s = \frac{50}{50} = 1$$

then

$$v = 1100x1 = 1100 \text{ ft}$$

$$Q = \frac{1100 \times 50 \times 200 \times 0.3}{10{,}800} = 305\text{gpm}$$

H.P. of pump regd

Static head = 50 ft.

Assuming a 2 ½ inches dia hose pipe is used frictional loss

1 foot valve & strainer	55 ft
suction pipe	10 ft
outlet pipe	150 ft
	215 ft

So we take the nearest equivalent length from standard tables.
Frictional loss equivalent 250 ft pipe 2 ½ inches dia = 37 ft

Total head regd 37+50 = 87 ft.

$$H.P. = \frac{WQH}{33000 \times n} \quad \frac{8.34x305x87}{33000 \times 0.60} = 11.17$$

So we select 2 pumps of 6.5 HP each suction & delivery 2 ½ inches size and 1 pump kept as stand by.

EXAMPLE NO. 7

Tunnel Excavation

-Diversion tunnels = 4 nos. (T-l, T-2 ,T-3, T-4)
-Diameter excavated 15 m
Finished 12 m

- Length 1000 meter each tunnel
- Tunnels are proposed to be excavation four sections/phases.
- Thickness of lining900 mm
- Rib depth 250 mm.

If refinement of correcting for variations in temp is omitted , the velocity is expressed in feet per day. We get the formula

$$V = \frac{3.3\ cd^2}{P} = k^2$$

V = true velocity of flow through the voids ft/day
P = porosity ratio of soil
$K = 3.3\ cd^2/p$

Q. flow through a given area A in gpm

$$= \frac{VAP}{10800} = \frac{3.3\ cd^2s}{p}\ \frac{Ap}{10800} = \frac{cd^2As}{3270}$$

value of k can be selected from the following table :

Porosity Ratio	Fine		Med.	Coarse			Fine gravel		
	0.10	**0.20**	**0.30**	**0.40**	**0.50**	**0.80**	**1.00**	**2.00**	**3.00**
0.25	27	112	250	460	700	1790	2800	11200	25000
0.30	43	172	386	686	1070	2740	4290	17200	38600
0.35	60	240	540	960	1500	3840	6800	24000	54000
0.40	82	330	740	1320	2060	5280	8250	33000	74000

- Three shifts work/day, working 10 months/year 25 days/month, 16 hours/day
- Total working hrs/years – 10x25x16=4000 hrs.
- Quantity of Excavated material for each tunnel = 1,76,700 m3.
- **Approximate X–section are phase-wise**

Phase I	=	35 m2
Phase II	=	57m2
Phase III	=	57m2
Phase Iv	=	27.70 m2
Total		**176.70 m2**

Construction Schedule – 36 months for all the four tunnels to suit the completion schedule of the project. Water to be diverted through tunnels T-1, T-2 on completion in 36 months and the work of first stage of main dam to be completed in one working season. The construction works on tunnels T-3 & T-4 to commence and complete 12 months later than that of tunnels T-1 & T-2. Dam will be raised to a maximum flood height likely to be attained with 4 diversion tunnels running.

Tunnel Excavation is proposed to be tackled with point excavator (Road Heading machine with N.A.T.M. (New Austrian Tunneling Method) support system which requires shotcreting reinforced with a wire mesh and widely spaced light ribs and radial anchoring immediately after excavation. This method is a deviation from conventional tunneling employing drilling, blasting and steel ribs supports. The adoption of new method which has distinct advantage of more speed will also result in substantial saving worth crore of rupees due to less excavation, less backfill concreting, minimisation of formation of cavities, less use of steel etc.

The N.A.T.M. which makes a very rational use of shotcrete as a tunnel support media was developed in Austria about 30 years ago and is universally applied in West Germany, Austria and some other European countires on the tunneling and sub-way construction.

In this method, the supporting system consists of a shotcrete shell of 200 mm + thickness reinforced with a wire mesh and widely spaced light section ribs. A system of full length mortar embedded radial anchors at desired spacing is provided along the tunnel X-section. The hard shotcrete shell carries the tangential component of the rock load and the radial anchors carry the radial shear component of the rock load. The anchors develop a load carrying arch around the tunnel X-section periphery. This arch has an appreciable load carrying capacity and reduces the load on the external tunnels supports ie., shotcrete shell and ribs. The N.A.T.M. is a flexible support system as the freshly applied shotcrete yields somewhat and accommodates the rock strata movements. This mothod is specially beneficial for squeezing ground conditions.

The actual application of N.A.T.M. consists in applying in initial shotcrete layer of 50 mm thickness immediately after the tunnel X section is cut. After this, wiremesh fabric/- is nailed to its entire surface, ribs are installed and final shotcrete of 100mm thickness is applied. Anchoring is carried out behind the cutting machine if the conference is within limits. Otherwise, anchoring of the freshly shotcreted heading is carried out before next round of cutting. Theoretically ribs are not the primary load carrying members in this method. These are however provided for maintenance of tunnel X-section and distribution of rock loads in the shotcrete shell support. The section of the ribs used in West Germany/Australia is a light U shaped section of 10-15 kg/M weight compared to the use of ISMB 250 of 37 kg/M in tunnel at Beas Project.

The various parameters of the N.A.T.M. support system viz shotcrete shell thickness, the weight and other specification of the wiremesh fabric, the size and spacing of the ribs, the dia, length and spacing of the anchor bars etc are all to be designed.

When rock cutting machine is employed for creating tunnel cavity instead of the conventional drilling and blasting methods, there is almost a tailor cutting of the tunnel X-section and the over-break nominal. However, the rock cutting machine with boom mounted rotary cutting head has limitation of height for cutting tunnel X-section. The rock cutting machine used in tunnels normally accommodates a height of 4.25 M with possibilities of additional height up-to 4.5 to 4.7 M max with the help of special attachments. Therefore, the tunnel X–section has to be divided in suitable lifts so as to enable the use of the machines.

The other limitation with rock cutting machines is the compressive strength of the rock. The machine cut rock very efficiently having a crushing strength of $700 kg/cm^2$ and with less efficiency up to $1000 kg/cm^2$. Beyond $1000 kg/cm^2$ rock strength, cutting machine does not remain economic. Due to the limitations of rock cutting machine, its deployment has to be judiciously examined by a log of test holes or bore holes in the alignment of the tunnels to ascertain the type of rock, rock strata and their thickness alongwith compressions strength details etc.

Equipment Planning

1. Point Excavators

4 nos. point excavators, one on each face of the tunnels T-1 & T-2 will be deployed for excavation of Section-I of the tunnel X-section (Annexure-A)

After driving the Section-I of T-1 & T-2, these excavators will be shifted to T-3 & T-4 for excavation of Section-I of T-3 and T-4 and subsequently sections-II,III&IV of T-3 & T-4 (Annexure-B)

4 nos. point excavators will be able to complete the job within construction schedule of tunnels.

The construction of the top section of the tunnels can be carried out more economically with these rock cutting machines combined with N.A.T.M. support system.

2. Hydraulic Excavators, crawler mounted 3-m^3

4 nos. hydraulic excavators, one on each face of tunnels T1 &T2 will be deployed to excavate Section-II,III&IV of the X-section and these will be able to complete the job within construction schedule of tunnels.(Annexure-C)

It is expected that hydraulic excavators would be able to excavate clay/shales strata with their own prying and breaking force and will handle excavated rock material obtained after blasting of hard and stone strata.

The X-section of tunnel and deployment of Point Excavators and Hydraulic Excavators are shown in Fig.1 & 2.

On completion of tunnel excavation job these hydraulic excavators will be used for damsfill placement, spillway excavation and power house excavation etc of the projects

3. Low Profile self filling shuttle dumpers

Low profile dumpers will be used in combination with point excavators as the maximum loading height of attached conveying system is about 2m above the ground level. Low profile dumper is specially designed for underground works. It has a by- directional four-wheel steering system. It has a steel conveyors along the bottom, which permits excellent filling from the rear. The vehicle is discharged without tipping of the body, which means that roof height can be kept low.

10 nos. of these dumpers will be required (Annexure D)

4. Rear Dumper25T

These rear dumpers will be developed to haul the muck of section-II, III &IV in tunnels T-1 & T-2 where hydraulic excavators will be used for tunnel excavation. These will also shift to open excavation sites after tunnel excavation is over.

12 nos. of these rear dumpers will be required. (Annexure-C)

5. Crawler Dozers (250-275 HP)

2 nos. crawler dozers at upstream and 2 nos. at downstream of the tunnels may be provided for dozing/spreading at dump sites and for other miscellaneous jobs.

In all 4 nos. crawlers dozers including stand by should suffice.

6. Shotcreting Machines

Shotcreting is employed for supporting tunnel roofs. The roof can be supported in about 23 hrs. of the creation of tunnel cavity. In weak rock the roof can be supported with shotcrete immediately even during cutting of rock by interrupting the cutting of rock with machine for a short duration. In this way the bridging time is very much reduced and can be adjusted to suit the rock requirement. Chemicals are used in the shotcrete mix for early strength

To maintain the continuity of shotcreting operations and to lose' no time in supporting the rock on account of Shotcreting, 2 nos. shotcreting machines at each face are required so that if one gets out of order, the other is immediately commissioned. Total requirement for 8 working faces would be 16 nos., 8 nos. on each upstream and downstream side of tunnels.

After completing the tunnels, these machine: vould also be used for shotcreting of open cut hill slopes along the spillway and powerhouse benches wherever the rocks are very weak.

7. Drilling rigs (Hydra booms)

For drilling of radial holes for installation of anchors, special boom mounted drills are required, as these anchors have to be provided at a fast rate to cope up with the rate of advance of tunnels. Also when hard strata is encountered and cutting with machine is not possible or economical, these drills will carry out drilling holes on the side berm which could not be drilled from the bench due to low head room available for accommodating drills at the bench. Drilling with these drills is very fast and accurate as compared to hand held machines and drilling can be carried out with them over a much wide section both in height and plan. These drills are wheel/track mounted and powered by a diesel engine. Since these can be moved to different places very quickly, 2 nos. may be provided for each upstream and downstream side of the tunnels. In all 6 nos. should suffice including stand by.

After carrying out the tunneling job, these drilling rigs would ensure a very fast rate of drilling of 55 to 60 mm holes for open cut excavation at the project.

8. Wagon Drills

4 nos. wagon drills may be provided for bench drilling in tunnels for any shortage of drilling rigs for bench drilling. These wagon drills would otherwise be required in large nos. for spillway excavation of the project.

9. Front End loaders (wheeled) + 2 cum.

Front-end loaders are required in the tunnel for back up operations. These will be employed for carrying out mucking in the tunnels other than the main excavations as it may not be feasible to shift the excavation machinery behind quickly. One loader is acquired each on upstream and downstream side of the tunnels. These loaders will also handle earthwork on the upstream Bell Mouth Entry and downstream buckets for diversion tunnels. One loader will be required for loading aggregates on left conveyor for feeding Batching & Mixing Plant. In all 4 nos. loaders are provided including standby.

10. Motor Graders (115-125 H.P.)

For maintenance of haul roads, two nos. motor graders one each for upstream and downstream side of tunnels may be provided.

11. Water sprinklers

For maintenance of haul roads, two-nos. truck mounted water sprinklers, one on upstream and one on downstream side, may be provided.

12. Boomers

Boomer is a hydraulic platform/cage mounted on a boom for the working crew to carry out the various operations like shotcreting an anchor belt installation on the periphery/roof of the tunnel. One boomer is required at each working face. Since all the 8 faces would be working concurrently, 8 nos. boomers would be required.

13 Tippers

For supplying the dry shotcrete mix from the mixing plant to the feed belt placed near the shotcrete machine; 11 T covered tippers would be deployed. 2 nos. tippers will work with each shotcreting machine. There will be shotcreting operation at least at two sites each on upstream and downstream sides. The requirement of tippers would work out to be 10 nos. including standby.

14. Mobile Belt Conveyor

There are required for ensuring a regulated feed to the shotcreting machines. 8 nos. Mobile Belt Conveyors would be required i.e., one at each working face.

15. Trucks

These are required for carrying of steel, cement, chemicals, pumps, anchors rods, drill machines and other miscellaneous civil, electrical and mechanical stores for the tunnel works. 8 to 10 tone capacity trucks will be required as follows:

One no. for Electrical Division

One no. for Mechanical Division

Two no for Civil Division.

Providing 4 nos. at upstream and 4 nos. at down stream total provision required is 8 nos.

16. Concrete Placers

Placers would be required to cater for any eventualities of filling up cavities in tunnel that may occur accidentally despite all precautions. 2 nos. Pneumatic placers on upstream and 2 nos. placers on down stream will meet the requirement of any emergency in tunnels.

17. Thread Rolling Equipment

In N.A.T.M. support system, anchors carry substantial loads their carrying capacity increases 15 to 20% if these have rolled threads instead of cut threads. In a 25 m dia lorqie steel anchor, cut thread gives strength for an effective root dia of 19 mm only shore as rolled threads give strength of 23 mm dia bar. One thread rolling machine will be required to roll threads in anchors to be used in tunnels.

18. Truck mounted concrete pumps

To achieve very fast pouring rates of concrete lining to tunnels, truck, mounted concrete pumps with hydhanbe rooms for feeding concrete to the concreting ganteries will be deployed.

Since the pump can be shifted after the pour to the other concreting site and there is likely to be only one pour per day, only 1 no. truck mounted concrete pump will be required at each up stream and down stream and of the tunnels total requirement of concrete pumps will be 2 nos. of 60 m^3/hr cap. (Annexure-E).

19. Transit Mixers

To provide matching supply of concrete to the truck mounted concrete pumps, high capacity transit mixers of 10m^3 capacity will be deployed for transportation of concrete from Batching and Mixing plant to the site of placement. Total requirement of l0m^3 capacity transit mixers on carriers works out to 8 nos. (Annexure-F)

20. Batching and Mixing plant

This would be required for supply of dry shotcrete mix and ready mix concrete for tunnel works.

In addition to the above major items of equipment, suitable provision of following supporting items will have to be made to accomplish construction of tunnels.

(i) Convergency measuring tapes, bore hole extensometer, stress/strain meters.

These are required for measuring accurately the closing in of the tunnel, at the excavated surface, for observing the movement of rock at various depth inside the tunnel abutment and for measuring the state of stress in the anchors and shotcerte shell. This instrument enable the variations parameters of support system to be varied so as to obtain a stable tunnel section viz-a-viz., on optimum design of tunnel supports system.

(ii) Pumps

These are required for pumping of seepage water from tunnels protection bunds and foundation pit of upstream and down stream works outside tunnel portal.

(iii) Rock drills and pusher legs

Drilling with hand held machines will have to be carried out for fixing of anchors for pipeline, fixing of rails, drilling of holes on outside tunnel work etc.

(iv) Paving Breakers

These are required for minor correction of the rock surface after machine cutting and for general demolition work.

(v) Axil flow fans and ducts
(vi) Gunteries and vibrators
(vii) Welding sets, transformers, cable and swiitch gear.

ANNEXURE – A

Excavation of section-I of tunnels T-I & T-2 with point excavators.

Progress of machine		= 20 m^3/hr(Average)
Quantity to be excavated per meter length		= 35m^3
Time for cutting & mucking		$= \frac{35}{20} = 1.75$
	say	= 2 hrs
Time for initial shotcreting		=1.0 hrs
Time for installation of wiremesh		=1.0 hrs
Time for final shotcreting		=2.0 hrs
Time for anchor bolting		=1.0 hrs
Total		=7.00 hrs.

2 Nos. machine will work on 2 faces of each tunnel.

Length to be excavated by each machine $\frac{1000}{2}$ = 500 meter

Time required for excavation = 500x7 =3500hrs

Taking 4000 working hrs/year

Time required = $\frac{12 \times 3500}{40000}$ = 10.5 months

Say 11 months.

ANNEXURE-B

Excavation of tunnels T-3 and T-4 with point Excavators

Excavation of Section-I

Time required 11 months as worked out for tunnels T-1 & T-2

Excavation of Section-II

Progress of machine	=	20 m^3/hr. (Average)
Quantity of muck	=	57x2 = 114 m3 (assuming 2 m advance will be made in one cycle)

Cutting and mucking time = $\frac{114}{20}$ = 5.7 hrs.

i)	Time for initial shotcreting	=	0.5 hrs.
ii)	Time for installation of wiremesh	=	1.00 hrs.
iii)	Time for final shotcreting	=	2.00 hrs.
	TOTAL:	=	**9.2 hrs.**

Time required for excavation of Section-II

$$= \frac{9.2 \times 500}{2}$$

$$= 2300 \text{ hrs.}$$

$$\text{or} = \frac{12 \times 2300}{4000} = 6.9 \text{ Months}$$

Say = 7 months

Excavation of Section-III

3m progress will be achieved in one cycle at one face Quantity of muck = 57x3 = 171 m^3

Time required for mucking = $\frac{171}{20}$ = 8.55 hrs.

Time required for excavation of portion-III = $\frac{8.55}{3}$ x500 = 1425 hrs.

$= \frac{1425 x 12}{4000} = 4.27$ months

Say = 4.30 months

Excavation of Section-IV

Quantity of muck to be removed by one machine = 500x27.70 = 13850 m^3

Mucking time $= \frac{13580}{20} = 692.5$ hrs.

$= \frac{692.5 x 12}{4000} = 2.07$ months

Say = 2 months

Total = 11 + 7 + 4.30 + 2 = 24.30

Say = 24 months

ANNEXURE – C

Hydraulic Excavator, Crawler mounted 3 m^3 capacity Excavation of section-II

2 m progress will be achieved in one cycle at one face.

Quantity of muck = 57 x 2 = 114m^3/cycle (loose)

$= \frac{114}{0.67} = 170.1 m^3$(loose)

Ideal progress with hydraulic excavator = 390m^3
(with 0.9 fill factor)

Considering (i) Job management factor = 0.75
(ii) Time factor

Actual production/hr = 390x0.75x0.83
= 242.7 m^3 (loose)

No. of excavators $= \frac{170}{242.7} = 0.7$
say = 1 No.

Due to one way traffic restriction for the dumpers inside the tunnel, maximum of 3 Nos. 25 T dumpers can be deployed with one hydraulic excavator. Thus the total requirements of dumpers will be 12 nos., 6 each on U/S & D/S side of the tunnels. Standby provision may not be necessary as the mucking operation of 2 hours in a cycle of 8 hours for each pull can easily be staggered.

Time required to excavate section-II

Quantity of muck/cycle = 57x2 = 114m^3

Taking swell factor as 0.67 for well blasted rock

Quantity of muck $= \dfrac{114}{0.67} = 170\ m^3$

Average lead inside the tunnel = 250 m

Average lead outside the tunnel = 500 m

Total = 750 m

Cycle time (Dumper)

(i) Loading Time $= \dfrac{11.47 \times 60}{242.7} = 2.83$ mts

(ii) Travel time @ 10 km/hr. = 4.50 mts

(iii) Return time @ 10 km/hr =4.50 mts

(iv) Dumping turning and spotting time = 2.00 mts

(v) Waiting due to restriction of one way traffic inside the tunnel = 4.00 mts.

17.83 mts.

No. of trips/dumper/hr = 3

Progress for 3 dumpers/hr = 34.41x3 = 103.23

Time required to haul the muck $= \dfrac{170}{3`4.41x3} = 1.64$hrs

Say = **2 hrs**

Cycle time

(i) Exhaust of gases after blast = 0.15 hrs
(ii) Main mucking = 2.00 hrs
(iii) Drilling on curved portion for smooth blasting = 1.00 hrs
(iv) Secondary blast for the bench and secondary mucking =1.50 hrs

(V) Eraction of ribs = 1.0 hrs

(vi) Shot creting = 2.0 hrs

7.65 hrs

Say =8 hrs

Total time required for Excavation of Section-II

$$= \frac{8x500}{2} = 2000 \text{ hrs}$$

i.e. $$\frac{2000x12}{4000} = 6 \text{ months}$$

Time required for excavation of Section-III

Quantity of muck/cycle = 57x3 = 171m^3
=255 m^3(loose)
Progress of dumper/hr = 11.47x3 = 34.41 m^3
Progress of 3 dumper = 34.41x3 = 103.23m^3

Time required to haul the muck $= \frac{255}{103.25} = 2.46$hrs

Say = 3 hrs

Cycle time

i) Exhausting of gases after blast = 0.15 hrs
ii) Main mucking = 3.00 hrs

iii) Drilling on curved portion for smooth blasting = 1.00 hrs
iv) Secondary blast for bench and secondary mucking = 1.50 hrs

Total = 5.65 hrs

Say = 6 hrs

Time required for excavation of portion-III

$$= \frac{6 \times 500}{3} = 1000 \text{ hrs}$$

$$= \frac{12 \times 1000}{4000} = 3 \text{ months}$$

Excavation of section-IV (T-l and T-2)

3 m progress will be achieved in one cycle at one face

Quantity of muck = 27.70 x 3

= 83 m^3

$$= \frac{83}{0.67} = 123.88 \text{ m}^3\text{(loose)}$$

Progress of 3 dumpers/hr = 34.4lx3 = 103.23 m^3

Time required to haul the muck $= \frac{123.88}{103.23} = 1.20$ hrs.

Say = 1.50 hrs

Cycle time

I) Exhausting gases after blast = 0.15 hrs
ii) Main mucking = 1.50 hrs
iii) Secondary drilling and mucking = 1.00 hr

Total = 2.65 hrs

Say = 3 hrs

Time required for excavation $= \dfrac{3 \times 500}{3} = 500\text{hrs}$

Or $= \dfrac{500 \times 12}{4000} = 1.5$ months

Total time excavate = 11+6+3+1.5

= 21.5 months

Say = 22 months

ANNEXURE - D

Low Profile Shuttle Dumpers (Capacity 7.0m³ – struck)

Production of point excavator $= 20 m^3/hr$

$= \dfrac{20}{0.67} = 29.85\ m^3$ (loose)

Cycle time

Lead = 750m (Assumed) outside tunnel 500m & inside tunnel 250 m.

i)	Loading time	= 14.10 mts
ii0	Travel time @l0km/hr	= 4.50 mts
iii0	Return time @ 10 km. hr	= 4.50 mts
iv)	Fixed time	= 2.00 mts
	Total	= 25.1 m
	Say	= 25 mts

Assuming 50 minutes an hour

No.of trips per hr = 2 trips

Production/hr =14 cum

Dumpers per excavator = 2 nos

Total No.of dumper with 4 Nos. point excavator =8 nos

ANNEXURE - E

Final concrete lining

Cross sectional area of tunnel =176.70 sq meter

Inner dia of tunnel = 12 m

Quantity of concete/m length = (176.70 = ¼ x $(12)^2$
=176.70=113.09
=63.61 m3

Quantity of concrete for invert = 1/5 (63.61)
= 12.72 m^3

Quantity of concrete for overt portion = 4/5(63.61)=50.89 m3

(Invert extends 72° angle to the centre of tunnel X-section)

Time required for overt portion

Length = 10 m

Quantity to be placed in 10 m length = 50.89 x10 = 508.9 m3

Cycle time

1. Reinforcement = 12 hrs
2. Shifting gantry = 2 hrs
3. setting of gantry = 4 hrs
4. Sealing, oiling, putting bulk head = 6 hrs
5. Placing bulk concrete = 10 hrs
6. setting of the pumpcrete = 1 hr
7. Finishing and final o.k. = 2 hrs
8. Concrete setting = 2 hrs

Total 61hrs

Concrete placement rate $= \frac{508.9}{10} = 50.89\ m^3$ hr

So we provide concrete pump of capacity $60m^3/hr$

Placing of concrete will be carried out on each side of the tunnel, hence time required for overt concreting.

$$= \frac{61}{10} \times 500$$
$$=3050 \text{ hrs}$$

$$\text{or} \quad = \frac{12 \times 3050}{4000} = 9.15 \text{ months}$$

Say 9 months

Time required for invert portion

1. .Length of pour	= 30 m
2. Quantity to be poured/pour	=12.72x30 = 381.60 m^3

Cycle time

1. Cleaning		= 5.0 hrs
2.Reinforcement		= 30.0 hrs
3.Welding		= 10.0 hrs
4.Putting bulk head		= 1.0 hr
5 Finishing & final okey		= 4.0 hrs
6. Pouring bulk concrete		= 10.0 hrs
	Total	=60.0 hrs

Time required for concreting $= \frac{60}{30} \times 500 = 1000$ hrs

$$\text{or} \quad \frac{1000 \times 12}{4000} = 3.0 \text{ months}$$

Total time required for the overt and invert concreting = 9 + 3 = 12 months

ANNEXURE – F

Assuming a lead of l km, cycle time will be as follows :

Cycle time :

1.Charging @ time B&M plant	= 6.0 mts
2. Hault time @ 8 km/hr	= 7.0 mts
3. Turn at tunnel portal	= 2.0 mts
4. Dumping	= 8.0 mts
5. Return of empty @ l0 km/hr	= 6.0 mts.
6. Spot at 3 M plant	= 1.0 mts
Total	**= 30.00 mts**

No. of trips per hour at 83 percent efficiency $= \dfrac{50}{30} = 1.66$

Concrete hauled/hr $= 10 \times 1.66$

$= 16.6\ m^3$

The average quantity to be poured/hr is $50m^3$. The peak pump capacity may be about $60m^3/hr$

No. of mixers required $= \dfrac{60}{16.6}$

$= 3.75$ say 4 mixers

Total of 8 nos. transit mixers of $10\ m^3$ capacity 4 each on U/S & D/S of the tunnels will be required.

Annexure-15

IMPORTANT ITEMS OF EQUIPMENT CONSIDERED UNDER SUB-HEAD Q-SPECIAL T&P

(a) Drilling & grouting equipment

(i) Compressed Air distribution system
(ii) Core drilling machine
(iii) Crawler drills
(iv) Wagon drills
(v) Jack hammers
(vi) Pavement breakers
(vii) Grouting equipment like grout, mixers pumps etc.
(viii) Rock Breaker

(b) Earth Moving Equipment

(i) Hydraulic Excavators
(ii) Cable Shovels and draglines
(iii) Scrapers (motorized and tractor drawn)
(iv) Front-end loaders (Wheeled/Crawler)
(v) Tractors, dozers and rippers (Wheeled/Crawler)
(vi) Motor graders
(vii) Dumper (Rear/Bottom/Side)
(viii)Belt loaders, elevating grader
(ix) Tipper trucks
(x) Trenchers
(xi) Wheel excavators
(xii) Dredging equipment

(c) Compaction Equipment

(i) Road rollers (8 to 12 tonne)
(ii) Sheep foot rollers
(iii)Pneumatic tyred rollers (20 to 50 tonne)
(iv)Vibratory rollers

(d) Construction Plant

(i) Crushers, classifiers
(ii) Washing and cleaning plant for aggregates
(iii) Batching/Mixing plants
(iv) Refrigerating plant
(v) Screening plants

(vi) Reclaiming plants
(vii) Belt conveyer
(viii) Cranes, Wagons, Cement soils and cement pumping plant
(ix) Cable ways
(x) Sand mills
(xi) Concrete mixers
(xii) Transit mixers/agitators
(xiii) Concrete pumps
(xiv) Concrete vibrators (pneumatic, electric, diesel, etc.)
(xv) Tram lines and rainfed equipment

(e) Tunneling Equipment

(i) Tunnel boring machine
(ii) Road header
(iii) Raise climbers
(iv) Raise borers
(v) Drilling jumbos (1/2/3 Booms)
(vi) Rocker shovel/Mucker
(vii) Shotcreting equipment
(viii) Rock bolting jumbos
(ix) Tipping wagon/Muck cars

(f) Transport Equipment

(i) Trucks of 3 to 20 tonne capacity
(ii) Motorised tanker (3000 to 10000 litre capacity)
(iii) Trailers
(iv) Pneumatic tyred tractors
(v) Railway locomotive and rolling stock
(vi) Jeeps, cars
(vii) Station wagons and pickups
(viii) Ambulances
(ix) Buses
(x) Explosive vans
(xi) Recovery vans
(xii) Motor boats
(xiii) MUVs

(g) Water Supply Works and Dewatering Arrangements

(h) Electrical Equipment

(i) Generators
(ii) Motors

(iii) Flood Lights

(i) Miscellaneous Equipment

- (i) Hoists
- (ii) Pulley block, lifting tackle, gantries
- (iii) Winches
- (iv) Mobile cranes
- (v) Welding machines
- (vi) Fire tender
- (vii) Barges with trawlers
- (viii) Fork lifters
- (ix) Gas cutting equipment
- (x) Laser alignment equipment
- (xi) Ultrasonic testing machine
- (xii) Gamma ray radiography machine
- (xiii) Mobile servicing unit
- (xiv) Car washing plant

(j) Workshops and ancillary equipment

- (i) Foundry shop
- (ii) Smithy shop
- (iii) Machine shop
- (iv) Structural shop
- (v) Welding shop
- (vi) Fitting and assembling shop
- (vii) Fitting and assembling shop
- (viii) Tyre retreading shop
- (ix) Carpentry shop
- (x) Paint shop
- (xi) Galvanizing shop
- (xii) Field repair shops such as carrier repair shop, tractor repair shop, auto shop, pipes and pumping shop and drill and hit repair shop.
- (xiii) Mobile workshop

Annexure-16(a)

COST OF ESTIMATES OF ……………………… HYDRO-ELECTRIC SCHEME

Electro-Mechanical Works
(Abstract of Cost)

Price Level

S. No.		**Item**	**Amount (Rs. Lakhs)**
1.	Preliminary – Annex –16(i)		
2.	Generating Plant & Equipment		
	a)	Generator, turbine and accessories – Annex-16(ii)	
	b)	Auxiliary Electrical Equipment for Power Stations – Annex-16(iii)	
	c)	Auxiliary Equipment & Services for power station- Annex.-16(iv)	
	d)	Central Sales Tax (as applicable) on 2 (a), (b) & (c)	
	e)	Transportation, handling and insurance charges @ 6% of 2(a), (b), (c)	
	f)	Erection and commissioning charges @ 8% of 2(a), (b), (c) excel. Spares.	
	Total (Generating Plant & Equipment)		
3.	a)	Sub-station equipment and auxiliary equipment and service for switchyard – (Annex.-16(v)	
	b)	Central Sales Tax (as applicable) on 3 (a)	
	c)	Transportation, handling and insurance charges @ 6% of 3(a)	
	d)	Erection and commissioning charges @ 8% of 3(a)	
	Total (Sub-station equipment and auxiliary equipment and service of switchyard)		
4.	Lsses on stock @ 0.25% on items 2&3 except erection and commissioning charges		
5.	Maintenance during construction @1%on items 2&3 except erection and commissioning charges		
6.	Procurement and Inspection charges @2%of items 2&3 except erection and commissioning charges		
7.	Contingencies @ 3% on items 2 and 3		
8.	Total (item 1 to 7)		
9.	Establishment @ 6-8% of item 2 to 4		
10.	T&P @ 1% of item 5		
11.	Audit and account charges @1%of item 8		
	Grand Total		

Annexure-16(b)

COST OF ESTIMATES OF .... HYDRO-ELECTRIC SCHEME **Electro-Mechanical Works** **Preliminary**							
S. No.	**Item Particulars**	**Qty**	**Rate**	**Amount (Rs. lakhs)**	**Excise Duty**		**Total Col. 5 + 7 (Rs. lakhs)**
					Rate %	**Amount (Rs. lakhs)**	
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1.	Consultancy charges /studies						
2.	Model Test						
3.	Construction Power						
	a) Diesel Generating Sets						
	b) Substation						
	c) Transmission Line						
	d) Distribution line						
	e) LT Switch gear, cable						
	f) Other Miscellaneous equipment						
	Total						

Annexure-16(c)

COST OF ESTIMATES OF .... HYDRO-ELECTRIC SCHEME

Electro-Mechanical Works

Generator, Turbine and Accessories

S. No.		Item Particulars	Qty	Rate (Rs.lakhs)	Amount (Rs.lakhs)	Excise Duty		Total Col. 5 + 7 (Rs. lakhs)
						Rate %	Amount (Rs. lakhs)	
1		2	3	4	5	6	7	8
1.	a)	Generating units ....MW.........Rpm ....m head.......p.f ....shaft turbine complete with steel housing with allied equipments such as main inlet valve. Governors, Lubricating oil system, suitable bearing system, high pressure compressed air system and Generator with Excitation system. AVR, space heaters, coolers, Co2 Equipment, etc.						
	b)	Unit Control Boards						
	c)	Surge protection and NG cubicles with CTs, PTs surge absorber, CBs, fuses, etc. Neutral grounding cubicles compete with grounding transformer resistor						
	d)	Penstock, Butterfly valve (if not covered in 1(a))						
	Sub Total							
2.	Spares @ 5% on item 1							
3.	Lubricating oil and governor oil for first filling [if not covered in item 1(a)]							
4.	a)	Bus Duct for GT connection (kv), length. (i)Main (.........Amp) (ii)Delta (........Amp)						
	b)	Spares @ 3% of 3 & 4						
5.	Miscellaneous equipments and devices required for completion							
	Total							

Annexure-16(d)

COST ESTIMATE OF...... HYDRO ELECTRIC SCHEME

Electro Mechanical Works

AUXILARY ELECTRICAL EQUIPMENT FOR POWER STATION (As applicable)

S. No.	Item Particulars	Qty	Rate (Rs.lakhs)	Amount (Rs.lakhs)	Excise Duty		Total Col. 5 + 7 (Rs.lakhs)
					Rate %	Amount (Rs.lakhs)	
1	2	3	4	5	6	7	8
1.	Step up transformer including oil for first filling (Rating , type)						
2.	Local Supply Transformer complete with oil for first filling (Rating type)						
3.	Unit Auxiliary Transformer . kv (Rating........ type)						
4.	Station Transformer (Rating ,type .)						
5.	Switchyard Transformer (if any) (Rating.............type.........)						
6.	LT AC Switchgear for aux. power supply to power house and outdoor switchyard complete						
7.	Batteries, Battery charging equipment, D.C. Distribution Board with D.C. Switchgear (Rating)						
8.	kV Distribution Board for auxiliary power supply						
9.	Supervisory control and data acquisition system comprising Microprocessor based relays, control boards and panels, protective relays, annunciation, synchronizing equipments, measuring, recording automation and protective system						
10.	Telecommunication equipments a)PLCC equipment with express facility, teleprinter, telecontrol						
	b)Telemetering equipment complete with transmitter receiver, transducer indicating recording instrument						
	c) Load frequency control equipment for control of generating unit for load despatch center complete with testing instruments Oscilloscope, transmitting equipment						
	d) Hire charges for microwave communication from site to load center						
11.	Diesel generating set (Rating kva) (in addition to construction power)						

12.	Control & Power cables (Rating, sizes)						
13.	Cable racks and accessories						
14.	Ground mat and internal earthing for power house						
15.	Transformer track rails in the power house (if any)						
16.	Illumination of Dam, Power House & Switchyard						
17.	Electrical Test Laboratory						
	Sub Total						
18.	Miscellaneous equipments and devices required for completion						
	Sub- Total(Items 1 to 10)						
19.	Spares for items 1 to 10 @ 3% **Total**						

Annexure-16(e)

COST OF ESTIMATES OF ………………………… HYDRO-ELECTRIC SCHEME **Electro Mechanical Works** AUXILIARY EQUIPMENT AND SERVICES FOR POWER STATION (As applicable)							
S. No.	Item Particulars	Qty	Rate (Rs. lakhs)	Amount (Rs. lakhs)	Excise Duty		Total Col. 5 + 7 (Rs. lakhs)
					Rate %	Amount (Rs. lakhs)	
1	2	3	4	5	6	7	8
1.	Electrical Overhead travelling crane (Capacity…………..T)						
2.	Gantry cranes (capacity)						
3.	Mobile Jib cranes (capacity)						
4.	Electric lifts and elevators						
5.	Cooling water system comprising pump sets, valves, piping, etc.						
6.	Drainage and dewatering systems						
7.	Hatchways						
8.	Compressed air system including piping, valves etc.						
9.	Fire fighting equipment with storage tanks, pumps, pipes, valves etc.						
10.	Fire protection system for power/stn. Transformer						
11.	Air conditioning, ventilation and heating equipments						
12.	Filtered water supply for power house						
13.	Oil handling equipment with pipes, valves, tanks, purifiers.						
14.	Workshop machines and equipment						
	Sub-Total						
15.	Miscellaneous equipment and devices required for completion						
	Sub-Total (1 to 13)						
16.	Spares for item No. 1 to 13 @ 3%						
	Total:						

Annexure-16(f)

COST OF ESTIMATES OF .... HYDRO-ELECTRIC SCHEME **Electro Mechanical Works** SUBSTATION EQUIPMENTS & AUX. EQUIPMENT & SERVICE FOR SWITCHYARD								
S. No.	Item Particulars		Qty	Rate (Rs. lakhs)	Amount (Rs.lakhs)	Excise Duty		Total Col. 5 + 7 (Rs. lakhs)
						Rate	Amount (Rs. lakhs)	
1	2		3	4	5	6	7	8
1.	Switchyard equipments							
	a)	Circuit breaker (Rating......)						
	b)	Isolator/Pantograph with/without earthing blade (Rating............)						
	c)	Current transformers (Rating...........)						
	d)	Potential transformer (Rating.........)						
	e)	Capacitative voltage transformer (Rating.............)						
	f)	Lightning arrestors (Rating..........)						
	g)	Wave traps						
2.	D.C. Battery, Charger distribution board							
3.	Bus conductors and hardware & Isolators							
4.	Switchyard galvanised steel structures							
5.	Fencing and Security							
6.	Drainage system							
7.	Grounding & shielding							
8.	Cable racks ducts and accessories							
9.	Foundation for structures and miscellaneous civil works for other equipment							
10.	Water supply works							
11.	Insulating oil handling storage & purification system including piping							
12.	Rail track for main trasformer							
	Sub Total							
13.	Miscellaneous equipment and services required for completion							
	Sub Total (1 to 4)							
14.	Spares for items 1 to 4 @ 3%							
	Total:							

Annexure-16(g)

FINANCIAL PACKAGE SUMMARY

1. Name of the Project	
2. Capacity (MW)	
3. Capital Cost of project	

		Foreign Currency Component				Indian Rs. Component	Total col. 4 + 5
		Name of currency	Amount	Ex. Rate & date	Equiv. Indian		
		(1)	(2)	(3)	(4)	(5)	(6)
i)	Hard Cost i.e. Cost excluding IDC and financing fees/charges						
ii)	Interest during construction						
iii)	Financing fee/ charges						
	Total:						

Annexure-16(h)

FINANCIAL PACKAGE ABSTRACT

1. Name of the Project	
2. Capacity (MW)	
3. Financial Structure	

S. No.	Name/Source of Debt financing		Foreign Currency Component				Indian Rs. Component	Total	% of total debt + equity
			Name of currency	Amount	Ex. Rate & date	Equiv. Indian			
			(1)	(2)	(3)	(4)	(5)	(6)	(7)
1.	Debt financing								
	i)	Package I							
	ii)	Package II							
	iii)	Package III							
	iv)	Package IV							
	v)	Package V							
	Total Debt								
2.	Equity Financing								
	i)	Promoters equity							
	ii)	Other equity (Please give details)							
		Total equity							
3.	TOTAL DEBT + EQUITY								

Annexure-16(i)

FINANCIAL PACKAGE DETAILS

(Figures in the currency of loan in percentage and absolute amount)

1.	Name of the Project							
2.	Capacity (MW)							
3.	Items			PACKAGE				
				I	II	III	IV	V
	a)	Name/Source of debt						
	b)	Amount						
	c)	Interest Rate i) Fixed ii) Floating						
	d)	Repayment period						
	e)	Moratorium period						
	f)	Up-front charges						
		i)	Closing fee					
		ii)	Lawyer's fee					
		iii)	Bank Engineer's fee					
		iv)	Syndicate Charges					
		v)	Financial Adviser's fee					
		vi)	Any other charges (please specify)					
	*g)	Commitment charges/ undisbursed amount fee						
	*h)	Guarantee fee						
	i)	i)	Equity raising charges					
		ii)	Lead Manager's fee					
		iii)	Underwriting charges					
	j)	Any other fee/charges not covered (Please specify)						
		Total :						

* Submit separate sheet with detailed calculation for guarantee fee and commitment fee.

Note: The above details should also be supported by the documents/commitment letters from lenders.

Annexure-16(j)

Phasing of Expenditure & Drawal of funds statement

Phasing of Hard Cost Expenditure (% of total Hard Cost)

		1^{st} Year (%) 2^{nd} Year (%) 3^{rd} Year (%)								
		Period in ……..								
		1	2	3	4	5	6	7	…	Total
1.	Hard Cost Expenditure Currency I Currency II …………..									
2.	Drawal of funds for Hard Cost Debt I Debt II Debt III Equity									
3.	Financing charges (FC) leviable on: Debt I Debt II Debt III									
4.	IDC Debt I Debt II Debt III									
5.	Drawal of funds for IDC and FC only Debt I Debt II Debt III Equity									
6.	Final phasing of funds (2+5) Debt I Debt II Debt III Equity									

Annexure-17

PROFORMA FOR THE CALCULATION OF BENEFIT COST RATIO (BCR) OF IRRIGATION PROJECT

	Before Irrigation (Without project)	After Irrigation (With project)
A. GROSS RECEIPTS		
1. Gross value of farm produce *		
2 Dung receipts (at 30% of the fodder expenditure) **		
3. Total (A): Gross Receipts (1+2)		
B. EXPENSES :		
1. Expenditure on seeds		
2. Expenditure on manure etc		
3. Expenditure on hired labour (human and bullock)		
4. Fodder expenses (as percentage of gross value of produce	15% of Item A.1	10% of Item A.1
5. Depreciation on implements	2.7% of Item A.1	2.7% of Item A.1
6. Share and Cash Rent	5% of Item A.1	3% of Item A.1
7. Land Revenue	2% of Item A.1	2% of Item A.1
8. Total (B): Expenses (1 to 7)		
C. NET VALUE OF PRODUCE		
1. Total Gross receipts (Total A.3)		
2. Minus total expenses (Total B.8		
3. Net value of produce (C): (1-2)		
D. ANNUAL AGRICULTURAL BENEFITS		
1. Net value after irrigation (C.3)		
2. Minus Net value before irrigation (C.3)		
3. Net Annual Benefits (D): (1-2)		

Other net annual benefits due to aqua-culture including pisciculture, drinking & industrial water supply, hydro-power generation, animal husbandry, catchment area treatment chargeable to project, canal bank plantation, reservoir periphery afforestation etc.

	Before Irrigation (Without project)	**After Irrigation (With project)**
F. TOTAL NET ANNUAL BENEFITS (D3+E)		

G. ANNUAL COSTS :

1. Interest on capital @ 10% (Estimated total cost of the project including cost of land development @ Rs........per ha.)

2. Depreciation of the project @ 1% of the cost of project for 100 years life of the project and @ 2% for 50 years life of the project

3. Annual operation and maintenance charges @ Rs.180 per ha. of CCA. ***

4. Maintenance of the head works @ 1% of its cost

5. Depreciation of the pumping system @ 8.33% of the estimated cost of the pumping system assuming life of the system as 12 years (Applicable to lift irrigation)

6. Depreciation of the raising mains @ 3.33% of the estimated cost of the raising mains assuming life of the system as 30 years (Applicable to lift irrigation)

7. Power charges for lift irrigation @ Rs..... per ha. (Applicable to lift irrigation) ****

8. Total (G): Annual costs (1 to 7)

BENEFIT COST RATIO = $\dfrac{\text{F: Annual Benefits}}{\text{G8: Annual Costs}}$

NOTES:- * 10% of the agricultural produce is valued at procurement/levy rates and 90% at market rates.

** Percentage indicated for Dung Receipts (Item A.2) and for Expenses (Item B.4 to B.7) are as suggested in Bor Model

*** Annual O&M charges @ Rs. 180 per ha. are as per recommendations of Ninth Finance Commission. This is likely to be revised upwards by Tenth Finance Commission which should be adopted..

**** This will depend upon the water required & unit charges of power applicable in the state.

Annexure-18(a)

Sample B.C. Ratio Calculation
For
(a)Shivan River Project
(Distt.- Nandurbar - State – Maharashtra)

A. Annual Benefits

I. Irrigation

i.	Value of agriculture production in post-project period (Certified by State Agriculture Department)	= Rs. 583.66 lakh
ii.	Value of agriculture production in pre-project period	= Rs. 175.62 lakh
	Net Irrigation benefit (583.66 – 175.62)	= Rs.408.04 lakh (I)

II. For Reservoir (Area between MWL & FRL)

i.	Area between MWL & FRL	= 8 ha.
ii.	Value of agricultural produce	= Rs.0.87lakh (II)

III. Drinking Water Supply

i.	Quantum of water reserved for drinking water including proportionate evaporation losses	= 11.0847 hm^3
ii.	Rate approved by Govt.	= Rs.53955. 35 per hm^3
iii	Benefit (amount chargeable) (11.0847x 53955. 35)	= Rs. 5.98 lakh (III)

IV. Industrial Water Supply

i.	Water for industrial water supply (including proportionate evaporation losses)	= 1.1064 hm^3
ii.	Rate approved by Govt.	=Rs.989369.65 per . hm^3
iii.	Benefits (1.1064x989369.65)	=Rs.10.95 lakh

V. Fisheries

i.	Reservoir area (average of area at FRL & MDDL)	= 174 ha.
ii.	Rates as per fisheries Department	= Rs. 5300 per ha.
iii.	Benefits (174 x 5300)	= Rs. 9.22 lakh (V)

VI. Animal Husbandry

i.	No. of Cows	= 1392
ii.	Yield per cow per month	= Rs. 400/-
iii.	Benefits = 1392x400x12	= Rs. 6681 lakh (VI)

VII.	Benefits from Hydro Power Generation	= Rs. 14.99 lakh
	Total Benefits (I + II+III+IV+V+VI+VII)	**= Rs. 516.86 lakh**

B. Annual Cost

	Total cost of the project including cost of Hydro power Station (2899.22 + 60.00)	= Rs. 2949.22 lakh
1.	Interest on the capital @ 10% of the total cost of the project	= Rs. 294.92 lakh
2.	Depreciation charges @ 2% of the cost of the Project	= Rs. 59.98 lakh
3.	Administrative charges 180/Ha. for 2396 Ha.	= Rs. 4.32 lakh
	Total Annual cost	**= Rs. 358.22 lakh**

B.C. Ratio = 516.86/358.22 = 1.44

Annexure-18(b)

Sample B.C. Ratio Calculation
For
Kirimiri – DarurLIS Medium Irrigation Project
(Maharashtra)

(Amount in Rs. Lakh)

(A)	**CAPITAL COST OF THE PROJECT**	
	1. Total cost of the project	2789.150
	2. Cost of land development @ Rs. 3000/- ha. for 20% area of CCA 2261 ha.	13.566
	Total (A)	**2802.716**
(B)	**ANNUAL BENEFITS**	
	(I) Benefits	
	1. Value of Agricultural produce after irrigation as per Statement II(A)	1376.497
	2. Cost of cultivation (expenses) as per Statement II(A)	676.392
	3. Net value of produce after irrigation (1-2)	700.105
	(II)Deductions	
	4. Value of Agricultural produce before irrigation as per Statement I(A)	166.054
	5. Cost of cultivation before irrigation (expenses) as per Statement I(A)	108.093
	6. Net Value of produce before irrigation (4-5)	57.961
	7. Loss in agriculture produce due to area going out of cultivation on acquisition of land. $\frac{57.961}{2036.0}$ x82.99 (H.W. 12.31 ha. + 70.68 ha. Canals)	2.363
	Total Deductions (II)	60.324
	Net Annual benefits (I)-(II)	**639.781**
(C)	**ANNUAL COST**	
	1. Interest at 10% on the capital cost of the project (Rs. 2803.80 lakh)	280.380
	2. Depreciation Cost	
	(i) Civil work @ 2% on Rs. 1561.632	31.233
	(ii) Rising main @ 3.33% on Rs. 322.240 lakh	10.634
	(iii) Pumping Machinery @ 8.33% on Rs. 366.848 lakh	30.558
	3. Power charges @ Rs. 600/HP for 975 HP	5.850
	4. O&M charges @ Rs.300/ha for 2443 ha	7.329
	5. Maintenance cost @ 1% of cost of Head Works (Rs. 2023.43 lakh)	20.234
	TOTAL ANNUAL COST ---(C)	**386.218**
	Benefit Cost Ratio = B/C= 639.781/386.218 =	**1.657**
	SAY	**1.66**

Annexure-19(a)

Proforma for Computation of Internal Rate of Return

CCA……………………ha.

Sl. No	Year	Project Cost (Expenditure on project during the year) Rs. in lakh.	CCA Developed		O&M Cost @ Rs. …. Per ha. (Rs. in lakh)	Total cost col.3 + col.6 (Rs. in lakh)	Benefits Rs. in lakh	Net cash col.8 – col. 7 (with – or + sign) Rs. in lakh	Discount factor		%age worth cash flow at discount with + or – sign	
			% age	Area in ha.					With A% rate	With B% rate	Col. 10 x col.9	Col.11 x col. 9
1	2	3	4	5	6	7	8	9	10	11	12	13
1												
2												
3												
4												
5												
6												
Upto 50 (For Medium Project) Upto 100 (For Major Project)												
										Total algebraic	+	–

I.R.R. = Discount Rate (A) + $\frac{\text{(Total of Col 12)}}{\text{Arithmetic sum of Col. 12 \& 13}}$ x (Difference of rate of Col.11 - Col.10)

+ Say 'C'

= (A+C) %

Annexure-19(b)

BCR CALCULATION BASED ON DISCOUNTED CASH FLOW METHOD
UTTAR PRADESH WATER SECTOR RESTRUCTURING PROJECT – PHASE I

Cost		Rs. 663.419 crore		CCA		2.954lakh ha	Net benefit
		(SOR 2005)		Annual Irrigation		4.439 lakh ha	Rs. 24064 lakhs
Year	Exp in Rs Lakhs	OM cost Rs Lakhs	Total Exp. Rs Lakhs	Benefit in Rs Lakhs	Discount Factor 9%	Discounted cost at 9%	Discounted Benefit at 9%
1	2	3	4	5	6	7	8
1	92.04		92.04	0	1	92.04	0
2	169.99	0.739	170.729	12.032	0.917	156.632	11.039
3	175.7	5.908	181.608	96.256	0.842	152.856	81.017
4	131.27	10.634	141.904	173.261	0.772	109.576	133.789
5	94.41	13.145	107.555	214.17	0.708	76.195	151.723
6		14.77	14.77	238.234	0.650	9.599	154.836
7		14.77	14.77	240.64	0.596	8.807	143.486
8		14.77	14.77	240.64	0.547	8.080	131.638
9		14.77	14.77	240.64	0.502	7.413	120.769
10		14.77	14.77	240.64	0.460	6.801	110.797
11		14.77	14.77	240.64	0.422	6.239	101.649
12		14.77	14.77	240.64	0.388	5.724	93.256
13		14.77	14.77	240.64	0.356	5.251	85.556
14		14.77	14.77	240.64	0.326	4.818	78.491
15		14.77	14.77	240.64	0.299	4.420	72.010
16		14.77	14.77	240.64	0.275	4.055	66.065
17		14.77	14.77	240.64	0.252	3.720	60.610
18		14.77	14.77	240.64	0.231	3.413	55.605
19		14.77	14.77	240.64	0.212	3.131	51.014
20		14.77	14.77	240.64	0.194	2.873	46.802
21		14.77	14.77	240.64	0.178	2.635	42.937
22		14.77	14.77	240.64	0.164	2.418	39.392
23		14.77	14.77	240.64	0.150	2.218	36.140
24		14.77	14.77	240.64	0.138	2.035	33.156
25		14.77	14.77	240.64	0.126	1.867	30.418
26		14.77	14.77	240.64	0.116	1.713	27.906

1	2	3	4	5	6	7	8
27		14.77	14.77	240.64	0.106	1.571	25.602
28		14.77	14.77	240.64	0.098	1.442	23.488
29		14.77	14.77	240.64	0.090	1.323	21.549
30		14.77	14.77	240.64	0.082	1.213	19.770
31		14.77	14.77	240.64	0.075	1.113	18.137
32		14.77	14.77	240.64	0.069	1.021	16.640
33		14.77	14.77	240.64	0.063	0.937	15.266
34		14.77	14.77	240.64	0.058	0.860	14.005
35		14.77	14.77	240.64	0.053	0.789	12.849
36		14.77	14.77	240.64	0.049	0.724	11.788
37		14.77	14.77	240.64	0.045	0.664	10.815
38		14.77	14.77	240.64	0.041	0.609	9.922
39		14.77	14.77	240.64	0.038	0.559	9.102
40		14.77	14.77	240.64	0.035	0.513	8.351
41		14.77	14.77	240.64	0.032	0.470	7.661
42		14.77	14.77	240.64	0.029	0.431	7.029
43		14.77	14.77	240.64	0.027	0.396	6.448
44		14.77	14.77	240.64	0.025	0.363	5.916
45		14.77	14.77	240.64	0.023	0.333	5.427
46		14.77	14.77	240.64	0.021	0.306	4.979
47		14.77	14.77	240.64	0.019	0.280	4.568
48		14.77	14.77	240.64	0.017	0.257	4.191
49		14.77	14.77	240.64	0.016	0.236	3.845
50		14.77	14.77	240.64	0.015	0.217	3.527
		Total				708.153	2238.975
			BCR at 9% (col 8/ col 7)			**3.162**	

Annexure-20

Name of the Project ______________________

Statement showing percentage return on sum at charges – figures are in Rs. Lakhs

Year	Expenditure during the years			Expenditure at the end of the year			Capital outlay on which interest is allowed ½ column 2+5 of previous year	Simple interest @ % Col. 8	Accumu-lated interest	Net Revenue after deducting working expenses	Accumu-lated Revenue	Accumu-lated simple interest (-) Accumu-lated Revenue column (10-12)	Sum at charge @ 7+13	%age return on sum at charge column 11x100 / Col.14	Remarks
	Direct charges	Indirect charges	Total cost	Direct charges	Interest charges better-ment levy	Total									
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

1. %age return on capital cost of project $= \dfrac{\text{Col. 11x100}}{\text{Col. 4 (Total)}}$

2. %age return on capital cost of the project less betterment levy $= \dfrac{\text{Col. 11x100}}{\text{Col. 4 (Total) – Betterment levy}}$

3. %age return on sum at charges = (Maximum of column 15)

Annexure -21

B.C. Ratio Calculation for flood control component of the Project (Refer Chapter 3.18)

1. Frequency of the moderated flood	Year
2. Allocated cost of the dam	Rs.
3. Cost of the flood embankment	Rs.
4. Annual cost of flood control component: **(i) 12% of allocated cost of dam (10% interest+1% Depreciation) and 1% maintenance** **(ii) 16% of allocated cost of embankment (10% interest+2% Depreciation+ 4% maintenance)** **(iii) Total annual cost (i + ii)**	 **Rs.** **Rs.** **Rs**
5. Average annual damage computed (on the basis of at least last 10 years data)	**Rs.**
6. Average annual damage anticipated after the execution of the project	**Rs.**
7. Saving in annual damage (Item 5-Item 6)	**Rs.**
8. B.C. Ratio = $\frac{\text{Item 7}}{\text{Item 4(iii)}}$	

Annexure-22

No. 16(12)/2003-WR
Government of India
Planning Commission
(WR Division)

Yojana Bhawan, New Delhi the 18th May, 2004

To

The Chief Secretary
Govt. of.............

Sub: Revised estimates of major, multipurpose & medium irrigation projects on inter- State rivers.

Sir,

1. The procedure for getting revised estimates of major, multipurpose & medium irrigation projects on inter-State rivers is outlined in the guidelines issued by the Central Water Commission in 2002 for submission, appraisal and clearance of irrigation and multipurpose projects. A copy of the relevant extract is enclosed for ready reference. On a review of the position of submission of revised estimates by State Government and getting them approved as per prescribed procedure it is seen that only in a very few cases, State Governments have got revised estimates approved. Such approvals sought are mostly confined to the first revisions. The latest estimated cost of practically all the irrigation projects in the country is thus unapproved. State Finance Department have been permitting expenditure on projects much beyond the approved cost. In some cases, State Government accord administrative approvals themselves for the revised cost without submission of the same to the CWC.

2. Keeping these facts in view, it has been decided to adopt the following procedure for submission of revised estimates of irrigation/multipurpose projects with immediate effect.

(i) While according investment clearance, Planning Commission will make a specific mention in the clearance order requesting State Finance Departments not to permit expenditure on the project beyond the approved cost unless the revised estimate is got approved following the prescribed procedure.

(ii) For major irrigation/multipurpose projects, State Governments will constitute a Standing Committee of State Finance, Planning & Water Resources Secretaries who will examine critically the reasons for cost overruns and give their report with relevant/findings recommendations. The revised estimate will be submitted by the State Govt. thereafter to the CWC together with this Report and Action Taken Report on the finding/recommendations of the Committee. CWC will thereafter examine the revised estimates on a fast track basis. The Standing Committee will be serviced by the State Irrigation/Water Resources Department for providing necessary documents etc.

(iii) For medium irrigation projects, where there is no change in scope of the project, State Governments may themselves approve the revised estimate as per procedure for such approvals in the states. A copy of such approval may be endorsed to CWC, MOWR & the Planning Commission. State Governments will have to first satisfy the CWC that there has been no change in the scope of the project and obtain their clearance for this before approving revised cost of medium projects. If required, CWC will carry out a site inspection of the project before issue of no objection. For projects where there is change in scope in terms of storage capacity, CCA, length of canals etc. the procedure in (ii) above will be followed.

3. State Governments are requested to ensure strict compliance of the above revised procedure with a view to bring in more fiscal discipline and accountability in the irrigation sector.

4. For ongoing approved projects, State Governments are urged to expeditiously submit the revised estimates to the CWC in a time frame of say 6 months. For ongoing unapproved projects, State Governments may obtain quickly the required statutory and other clearances, update costs where required and submit it to the CWC for appraisal so that the projects can be accorded investment clearance thereafter.

Yours faithfully,

(A. Sekhar)
Adviser (WR)

Copy to:

(i) All State State Finance, Planning, Water Resource Secretaries.
(ii) Secretary, MOWR.
(iii) JS&FA, MOWR.
(iv) Commissioner(Project)/PP, MOWR
(v) Chairman, CWC
(vi) Member(WP&P), CWC.
(vii) Chairman, Brahmaputra Board.
(viii) Chief Engineers PAO/PP Cell/PMO, CWC.
(ix) PS to DCH/PS to Secretary (PC).

Extract from Guidelines for submission, appraisal & clearance of Irrigation & Multipurpose project –2010 for Revised Project / Estimate

4.1 In case of major and medium project which have been approved by the Planning Commission and where the revised estimates of the project have increased by more than 15% of the original estimates, excluding escalation due to Price-rise, or where there is change in scope i.e. change in project parameters resulting in change in nature and benefits such as CCA, installed capacity, energy generation etc. Revised Project Reports including Estimates will be furnished to CWC for examination as new major/medium schemes and the procedure for scrutiny for such revised project/estimates shall be same as outlined in the preceding chapters. Statement of excess costs, as detailed in Para4.4, shall also be appended with the revised estimates.

4.2 The revised estimates for major irrigation and multipurpose projects, where there is no change in scope shall be critically examined in the state standing committee before submission to CWC. The estimates shall be submitted to CWC incorporating the action taken on the recommendation of the committee as per direction of the Planning commission vide Circular no. 16(12)/2003/WR, dt. 18.05.2004.

4.3 The revised estimates for medium projects in which there is no changing in scope can be approved by the TAC of the concerned States under intimation to CWC, MoWR and Planning Commission as per direction of the Planning Commission vide Circular no. 16(12)/2003/WR, dt. 18.05.2004. In this regard, a State Govt. will have to first satisfy the CWC that there has no change in the scope of the project and obtain their clearance for this before approving revised cost. If required, CWC will carry out its site inspection of the project before issue of No Objection.

4.4 In respect of revised project estimates for Major Irrigation and Multipurpose Project where there is no change in the scope and where the costs excluding escalation due to price rise have not changed by more than 15% the concerned State Government need not forward detailed estimates for examination at Centre. For such projects / estimates the State Government should send project-wise statements of excess costs to CWC giving the abstract of costs under major sub-heads indicating the excess costs over the sanctioned costs and reasons therof after obtaining concurrence of the State Finance Department. The covering not will include the salient features of the project contemplated in original proposal and that being executed at site. The CWC will examine such estimate broadly and send its views to the Advisory Committee for consideration and recommendation of the Planning Commission.

4.5 Time of appraisal of the revised estimates in CWC as well as in response time for compliance of the concerned State Govt. shall be same as Para 3.12

4.6 When revised estimates are prepared during construction, the quantities of items completed should be indicated separately and the cost thereof assessed on the basis of actual expenditure. Any liability arising out of the contract for the completed work and effecting the cost should also be considered in the estimate.

For works in progress the estimates should be based on contract rates. If the contract document contains any clause for escalation on the prices of materials and labour wages subsequent to the award of contract, the amount involved should be assessed and included in the estimate.

For works, not covered in any contract, prevailing local rates may be taken for items covered in the Schedule of Rates and for remaining item rates may be adopted on the basis of analysis of rates, prepared in accordance with the guidelines issued by CWC.

In case of any doubt on the viability of rate of any item, a certificate from the Stae/Project Chief Engineer, duly justifying reasonability of the rate, shall generally be taken as final and acceptable.

Annexure-23

GUIDELINES FOR APPORTIONMENT OF COST AMONG VARIOUS COMPONENTS OF MULTIPURPOSE RIVER VALLEY PROJECTS

Multipurpose Projects have at least more than one objectives among various created facilities such as irrigation, power, flood control, water supply, navigation, sanitation, recreation etc. Each user of facilities has its own respective jurisdiction of control and management. For formulating the recovery of cost or revenue generation n addition to efficient operation and maintenance (O&M) of the respective system (s), capital cost is the basic parameter. It is also required for post construction apportionment of O&M costs.

The main objective of allocation is to distribute the cost on equitable basis amongst various purposes usually to determine the sale price of power or water or to assess the amount of betterment levy to be imposed in case of irrigation or cess for flood control or other benefits.

The apportionment of costs is exactly complicated subject. Determination of costs and benefits of various uses is a difficult task. Complications further aggravate in cases of inter-state or international projects due to clash of interests etc. However a rational approach BIS has rought out the (Indian standard) (IS: 7560-1974) entitled "Guidelines for allocation of Cost Among Different Purposes of River Valley Projects".

In a multipurpose project, some structural components are used for various purposes whereas some structures are constructed exclusively for specific single purpose. Similarly various benefits are also accrued according to the types of structures. The BIS code has described the following methods in detail with concepts, principles along with illustration.

- i. Alternate cost method
- ii. Alternative justifiable cost method
- iii. Bearability concept
- iv. Benefits method
- v. Ceiling allocation method
- vi. Equal apportionment method
- vii. Separable cost remaining benefit method
- viii. Use of facilities method

Before arriving at the final apportionment of costs, it is suggested to adopt various selected methods for comparison and visualization. For better understanding and quick reference, a typical example of "Use of facilities Method" is given below.

APPORTIONMENT OF COST OF KISHAU DAM MULTIPURPOSE PROJECT

Kishau Dam is a multipurpose project covering mainly power, irrigation and water supply. Various methods applied for apportionment of cost. However "Use of Facilities Method" has been finally adopted. The method and the illustration for the same is given below.

Use of Facilities Method

As per the provision following sequences of benefits have been adopted.

a. The storage at the Kishau Dam is first used for power generation in the dam toe power house.

b. The storage is reutilized for augmentation of power at Chibru, Khodri, Dhakram, Dhalipur, Kulhal and Khara power houses for diverting water at Dak Pathar barrage.

c. Water is then picked up at Hathnikund barrage where Delhi's drinking water requirement of 617 hnr' is first met and the balance 658.06 hm3 (1275.06 hm^3 _ 617 hm^3) will be available for irrigation.

Let total cost	=	TC
Specific cost for power component	=	SC (PC)
Specific cost for water supply component	=	SC (WSC)
Specific cost for irrigation component	=	SC (IC)
Thus joint cost (JC)	=	TC - {SC(PC)+SC(IC)+SC(WSC)}

Quantum of water used for Dam for Power House $= QP_1 = 1275.06\ hm^3$

Proportionate quantum of water used for d/s Power House

$= QP_2 = 472 \text{ X } 1275.06/520$

$= 1157.36\ hm^3$

Quantum of water used for drinking water supply = QWS = 617.0 hm^3

Quantum of water used for irrigation = Q_I = 1275.06 - 617.00

= 658.08 hm^3

Joint cost factor for Power

$F1 = QP_1/\{(QP_1+OP_2)+QWS+QP_1\}+QP_2/\{(QP_1+QP_2)+QWS+Q_I\}$

Joint cost factor for water supply

$F2 = QWS/(QP_1+QP_2)+QWS+Q_I]$

Joint cost factor for irrigation

$F3 = Q_I/(QP_1+QP_2)+QWS+Q_I]$

Share cost for power component C(PC) = SC(PC)+Fl x JC

Share cost for water supply component C(WSC) = SC(WSC)+F2 x JC

Share cost for irrigation component C(IC) = SC(IC)+F x JC

Cost Allocation for Indirasagar Polavaram Project

	Total Cost of Project		16010.45	crore
Bearability Method:				
	Initial Stage energy Generation		2416.00	GWh
	Final Stage energy Generation		442.50	GWh
1	Average Energy Generation		1429.25	GWh
	Energy rate for Lift Irr. System	Rs.	2.60	per KWH
	Annual Revenue Generation	Rs.	371.61	crore
2	Water Supply		23.44	TMC
			663.75	MCM
	Rate	Rs.	4.50	per KL
	Annual Revenue Generated	Rs.	298.69	crore
Bearlibility				
	Taking interest of 10% on the capital cost:			
1	Capital Cost for Power Generation	Rs.	3716.05	crore
2	Capital Cost for Water Supply	Rs.	2986.86	crore
	Total	Rs.	6702.91	crore
3	Cost allocated to Irrigation Component (Rs 16010.45 cr-Rs 6702.91 cr)	Rs.	9307.54	crore

DETAILED PROJECT REPORT

LIST OF DRAWINGS

1. Location map of the area showing location of the headworks site, catchment area, submerged area, command area, approach road to the dam site, roads in the project area, (NH, SH, MDR, ODR etc.) railway line, nearest railway station, nearest airport, important places etc.

2. Hydrological map of the area showing the headworks site, catchment area, submerged area, command area, location of the IMD stations raingauge stations, gauge, discharge and sediment sites, considered in the project report, Isoihytels, etc.

3. Map showing area flooded under normal floods and depth of flooding at important points (in case of projects with flood component).

4. Condensed longitudinal section of the river showing maximum flood level, minimum water level (before project) and back water curve (upstream of the headwork site after project).

5. Reservoir contour plan.

6. Elevation versus area and capacity curves before and after 50 years of sedimentation.

7. Stage discharge curve of the site nearest to the headworks site and that water Rating curves.

8. Site contour plan and layout plan of the headworks and appurtenant/auxiliary works.

9. Plan showing the location of the bore-holes drilled and pits/drifts excavated site geology and bed rock contours. (to be marked on the layout plan of headworks).

10. Section along the axis of the headworks showing MWL, FRL, DWL, LWL, log of the bore holes drilled and pits/drifts excavated along the axis and log of the other holes drilled and pits/drifts excavated upstream and downstream (indicating the location).

11. Plan showing the location of the borrow area for different earth-fill materials, quarry site for rock aggregate sand etc., layout of haul roads etc.

12. Cross-section of the earth/rockfill dam in the deepest section showing the zoning, cut-off, blanket, grouting details etc.

13. Cross-section of the earth/rockfill dam showing the details of instrumentation.

14. Cross-section of the earth/rockfill dam showing details of the outlets upstream well, bridge etc.

15. Cross-section of the masonry/concrete dam at maximum height showing details of zoning gallery(s) outlets, foundation drainage, grouting etc.

16. Cross-section of the concrete/masonry spillway showing details of zoning, foundation treatment, sluices gallery(s) etc.

17. Cross-section of the masonry/concrete dam showing details of instrumentation.

18. Contour plan showing layout of the barrage weir, appurtenant/auxiliary works and location of the bore holes drilled and pits excavated.

19. Cross-section along the axis of the barrage/weir & regulated showing FRL, MWL, log of the bore holes.

20. Section along the axis of the barrage/weir and regulator showing FRL, MWL, logging of the bore holes drilled and pits excavated along the axis and log of the other bore holes, pits etc. drilled/excavated upstream and downstream indicating the location.

21. Cross/section(s) through spillway under sluice bay(s) fish ladder and regulator bay(s).

22. Layout of the power house from inlet to outlet.

23. L-section of the power generating system from inlet to outlet.

24. Layout Plan of the power house and appurtenant works with contours.

25. Longitudinal section and cross-section of the power house.

26. Map showing the general layout including the headworks, water conductor system power house, step up sub-station, out-going transmissions lines etc.

27. Plan of the command area (scale 1:10,000 contour interval .5m) showing the alignment of the canal(s), location of the off-taking channel(s), area commanded (CCA) by each off-taking channel alignment of the off-taking channels, bed level, full supply depth and discharge of the main canal at the off-taking point and bed level, full supply depth and discharge of the off-taking channel.

28. Condensed L-section of the canal showing the ground profile and logging of the auger/bore holes drilled and pits excavated demarcating the startification based on the logging.

29. Condensed L-section of the canal(s), ground profile full supply level, bed slopes, location of the canal structures indicating the type of the structures at each location.

30. Typical cross-section of the canal in deep cutting and deep filling upto 150 meters on either side of the centre line of the canal showing natural ground profile, bed level, bed width, side slopes, full supply depth berms, inspection path, drainage arrangement, lining free board etc.

31. Contour and layout plan L-section and cross-section of major canal structures designed. The location of the bore holes drilled and pits excavated to be shown on the plan and logs of the pits and bore holes on the sections.

32. Contour map of the sample area (surveyed for estimation of distributaries. minors, sub-minors, water courses drainage) showing the alignment of the channels of the distribution and drainage systems.

33. Index map showing the navigable reach of the river and canal system (existing and proposed) its hinter land, location of the industries, minerals, other resources, important industrial centres, towns etc.

34. Cross-section of the navigation log(s) provided in the body of the headworks or site channel(s).

35. Sounding charts for navigation.

36. Condensed longitudinal section of the navigable waterway/canal showing the location of the navigation structures.

37. Typical cross-sections of the navigable waterway/canal.

38. Plan showing the course of river at least for five years.

39. Plates showing the facilities of the current in the various regions of the waterway during floods and rainy season.

40. Route-wise traffic density chart indicating the present day traffic and further projections.

41. Bar charts showing the construction programme and programme of development of benefits (irrigation, power etc.)

42. Single line relaying and metering diagram.

43. EHV/HV switching scheme diagram.

44. Layout of switchyard with contours.

45. Longitudinal section and Cross section of switchyard with different bays.

46. Water analysis report.

47. Tail water rating curves.

NOTE: All drawings shall be prepared to the scale indicated in chapter 3.4.1 and annexure-1 unless and otherwise stated.

PART-II

GUIDELINES
FOR
PREPARATION, APPRAISAL
AND CLEARANCE
OF
FLOOD MANAGEMENT
SCHEMES

CHAPTER-I

Introduction :

1.1 Flood Management or Flood control has to be viewed in a broad perspective forming an integral part of the overall water resources development and also the economic perspective envisaged in the country.

1.2 Comprehensive approach to be problem of floods in the country should have for its objective not only water resources development but also land management, ecological and afforestation aspects, soil conservation, watershed management, etc., with main emphasis on humanitarian considerations. The schematic approach to solve the flood problem should contain the above broad perspectives so as to draw maximum benefits for the people of the region.

1.3 The proposals of the scheme for Flood Management should aim at the socio-economic development. All tangible benefits should be taken into account while formulating flood management projects for the specific regions.

1.4 The investment approval of the Planning Commission to new Flood Control and Drainage schemes has been a pre requisite for their inclusion in the Plans and for funding. Planning Commission vide their letter no. 16(12)/1/90-I&CAD dated 10/10/91 has laid down the procedure for submission and examination of flood control, drainage, anti-river erosion and anti-sea erosion projects.

1.5 In view of the escalation in the cost of material and wages and consequently increases in the estimated cost of individual schemes, Planning Commission has enhanced the powers of the State Govts. for the sanction of flood management, drainage, anti-river erosion and anti-sea erosion schemes vide their letter No. 16(12)/1/99-WR dt. .09.09.2003. The revised procedures for submission of the schemes by the States and their examination at the centre for consideration of techno-economic viability has been laid down by Planning Commission for the following categories of the flood management schemes.

(i) Schemes costing Rs. 7.5 crore or less (Minor Projects).

(ii) Schemes costing more than Rs. 7.5 crore and not exceeding Rs. 15.0 crore (Medium Projects).

(iii) Schemes costing more than Rs. 15.0 crore (Major Projects).

The procedure in detail has been described in the subsequent chapters.

1.6 These guidelines have been updated to help the State Govts. in preparation and submission of flood management schemes for appraisal at the Centre and will help in early clearance of the schemes.

CHAPTER - II

Guidelines for Preparation/Formulation of Detailed Project Report (D.P.R.)

2. General :

2.1 All flood management projects should be planned, investigated and formulated keeping in view the hydrological aspects such as flood frequency analysis for different periods i.e. for 5 years, 25 years, 50 years or 100 years as per the project requirement for arriving at the design flood level, design discharge and highest flood level (H.F.L.) as per the norms laid down by the Rashtriya Barh Ayog. A summary of the most important recommendations as accepted, which may be taken as guidance for preparing the flood management schemes is as follows :

(i) In the case of embankment schemes, the height of the embankment and the corresponding cost be worked out for various flood frequencies and the benefit cost ratio, taking into account the damage likely to occur for the relative flood frequencies. However, till such time as the details of all relevant parameters are available, embankment schemes may be prepared for a flood of 25 years' frequency for predominantly agricultural land areas and for a flood of 100 years frequency for works pertaining to town protection and protection of important industrial and other vital installations.

(ii) Anti-erosion works should normally he taken up only for protection of towns industrial areas, thickly populated group of villages/abadis, for agricultural lands where the benefit cost ratio justifies such works, and in the case of railway lines and roads where relocation is not possible on socio-techno-economic grounds.

2.2 While preparing/formulating flood management schemes, their inter-se priorities among the flood management projects from amongst those included in the Master Plan should be fixed in the light of the following factors :

(i) Extent and frequency of food damage as also loss of life;

(ii) Benefit cost ratio;

(iii) Employment potential;

(iv) Effects on the environment and ecology;

(v) Density of population in the food affected areas as well as per capita expenditure on food management in the project area.

2.3 The flood management projects should be formulated in close co-ordination with Railways, National Highway Authorities, State Irrigation/Flood Control Departments, so as to ensure that the structures like bridges, roads, railways etc. are not affected and in turn they also do not aggravate flood problems in nearby areas.

2.4 The project authorities may also ensure that the tendency to take up flood protection works to save a particular area does not pass on the problem to another area specially when inter-state ramifications are involved. Embankments terminating at or beginning from State boundaries are of crucial nature. Construction of spurs, encroachment into the water-ways etc. without adequate study may be guarded against. In respect of schemes related to Indus Basin, the design, construction and operation of Projects shall conform to the provision of Indus Water Treaty, 1960.

2.5 Apart from above, the following points should be kept in mind while preparing the detailed project reports.

(i) The nature of flood management scheme should be clear like management/protection works, measures for abatement of floods, modifying the susceptibility to flood damages, reducing the losses.

(ii) The category or scope of the project i.e. whether it is a flood management scheme or a multipurpose project having flood management component should be clearly indicated.

(iii) Project reports should include the following reports of the Flood Management Engineers of the State.

a) General Report of the Chief Engineer :

The report of the Chief Engineer should describe the following points :

(a.i) Broad description of the problem.
(a.ii) General discussion of viable alternatives.
(a.iii) Inspection details of the area to be benefited and the project site.
(a.iv) Master Plan for overall development of the river basin and the stages of basin development and the schemes fitting into the Master Plan for Flood Management and their interse priority.
(a.v) Recommendations.

(b) Report of the Superintending Engineer :

The report of the S.E. should include the following :

(b.i) A description of the present problem and the period since it has existed and the past approach towards its alleviation.
(b.ii) Comparison of merits an demerits of the various alternative proposals.

(b.iii) Inspection details of the alignment/site of the proposed scheme and the area benefited.

(b.iv) The rates adopted in the estimated cost of the scheme and lead indicated for construction material.

(b.v) The rates adopted in working out benefits from the scheme.

(b.vi) If the scheme is proposed to be executed in stages, the various stages and phasing of funds, the programme of construction and period of completion of the scheme should be discussed.

(b.vii) The staff required for execution of the scheme.

(b.viii) How does this scheme fit in the Master Plan for Flood Management if such a Plan exists? Else, can this scheme become a part of the Master Plan later on? Are there any feature which are not likely to fit in the overall development of the basin? Have the other department concerned with the development been informed?

(b.ix) Recommendations.

(c) Detailed Report of the Executive Engineer

The detailed report of Executive Engineer should contain following :

(c.i) Detailed description of the problem.

(c.ii) 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.iii) Inspection details regarding the area to be benefited, alignment of the proposed scheme and schemes in the vicinity.

(c.iv) Availability of suitable construction materials in adequate quantities and their leads.

(c.v) Discussion on the provisions under various sub heads.

(c.vi) Basis of rates adopted for estimate of work and benefits.

(c.vii) Description of design features.

(c.viii) Surveys conducted before formulation of the scheme.

(c.ix) Construction programme and completion period.

(c.x) Recommendations.

2.6 Drawings and Data

(i) An Index map showing various flood management components of the project and area to be benefited should be provided.

(ii) A vicinity map showing the location of the scheme on the State Map should be attached.

(iii) Basin plan indicating river system with gauge/discharge sites, rain gauges and catchment area with contour should be attached.

(iv) Data on affected areas identified and flood intensities worked out at each of the damage centre should be included in the report.

(v) Adequate hydrological, meteorological and other data should be incorporated in the report.

2.7 Status of the project

(i) Present status of the scheme showing provision in Annual/Five Year Plan and budget allocation should be given.

(ii) If it is an Inter-State scheme, the Inter-State aspect should be discussed in the report. The concurrence of the concerned State should be enclosed.

2.8 Design particulars to be discussed in the report

Following aspects should be fully discussed.

(i) Flood cushion in the reservoirs.

(ii) Maximum moderated flood, out flows over the spillways etc. and its frequency.

(iii) Safe carrying capacities of the channel below the existing dam and after construction of flood embankment, channel improvement, river diversion etc.

(iv) Synchronised moderated peak flows due to releases from the U/s dam and unintercepted catchment up to the damage centres.

(v) Average annual expenditure incurred on flood relief works.

(vi) Area and population affected/likely to be affected before/after the project.

(vii) Estimated saving to annual loss of life, property, cattle, crops etc. (evaluated in terms of money) due to Flood Management.

2.9 Drainage Characteristics of the Area

Following drainage aspects should be discussed in detail in the project report.

(i) Surface and subsurface drainage problems of the area.

(ii) Maximum intensity of 1, 2 and 3 days rainfall.

(iii) Characteristics of the land, soil, channel bed gradients and ground contours/topography responsible for drainage problems.

(iv) Deficiencies in existing natural drains.

(v) Proposals for improvement of drainage/water logging of the area with criteria.

(vi) Identification of the area which will get benefited due to execution of drainage network and benefits there of in terms of relief from crops damage, increased yields, improvement in communications and health of population.

(vii) Design calculation including routine studies, drawings with design aspect, L-section, X-section indicating ground level, formation level, design HFL, hydraulic gradient and type of soil and flood gradient etc. should be covered and presented in the project report.

2.10 Procedure for calculation of B.C. Ratio

B.C. ratio should be worked out on prescribed standard and annual loss supported by documents from the revenue department of the State. Average annual damage should be computed on the basis of at least last 10 years data. B.C. Ratio calculation for flood management 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) and item (ii)}.

(iv) Annual cost of flood management component.

(a) 12% of allocated cost of dam.
(b) 16% of allocated cost of embankment.
(c) 17% allocated cost for anti-erosion schemes.
(d) Total annual cost (a + b +c).

$$\text{B.C.Ratio} = \frac{\text{Item (iii)}}{\text{Item (iv)}}$$

2.11 Other particulars required

(i) Detailed estimate, showing analysis of rates, quantities of various items, and the base year adopted for arriving at the schedule of rates.

(ii) Planning of the colony/building should be made keeping in view the future requirements so that optimum utilization of the investment can be made.

(iii) Permanent building being constructed for maintenance of the project or proposal for disposal of temporary building should be discussed.

(iv) Details of works to be executed departmentally and through contractor should be given.

(v) Proposed construction programme and time of completion of major component and the project as a whole should be mentioned.

(vi) Details of model tests conducted, the results and follow-up action taken if any should be given.

(vii) Details of the alternate proposals considered should also be given to ascertain that the present proposal is the best suited for solving problems.

(viii) If any agreement is reached between various departments for sharing the cost of the schemes, the details may be given.

(ix) All the details of the proposed protection works including reservoir routing studies should be included in the report.

(x) Flood relief provided at the damage centre should also be kept in mind while preparing the project report.

(xi) Conservation and protection of environment should form a part of planning of project so as to reduce environmental degradation.

(xii) Environmental impact assessment for evaluating the beneficial and adverse effects of the project should also be included in the planning stage itself.

Chapter-III

Guidelines For Submission

3. General

3.1. While submitting flood management schemes, various alternatives should be presented, bringing out the effect of the construction of this project on contiguous areas. The State Flood control departments should ensure that all the schemes placed before the State TAC for clearance should contain studies of various alternative proposals also. The best proposals approved by State TAC, after giving due justification, may be forwarded to Central Water Commission as per the norms and procedure laid down by Planning Commission vide letter No. 16 12) /1/99-I & CAD dated 18-6-99 for Techno-economic appraisal and processing the case for investment clearance by Planning Commission.

The procedure for submission of the project reports is being reproduced as under:

(A) Schemes costing Rs 7.5 crore or less.

(i) The scheme proposed by the Flood Control department and recommended by the State Technical Advisory Committee should be considered and approved by State Flood Control Board with modifications if any.

(ii) Scheme 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 before they are finally approved by the State Flood Control Board and sanctioned by the State Govt. Scheme 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 Ganga Flood Control Commission. Schemes which in the opinion of any Member of the State Techincal Advisory Committee have international implications, should be got cleared from the Ministry of Water Resources before they are finally approved by the State Flood Control Board and sanctioned by the State Govt.

(iii) The schemes under the following categories may be sanctioned by the State Govts. after they are approved by the State Flood Control Boards.

(a) Raising and strengthening of existing embankments.
(b) Retired lines for existing embankment.
(c) Investigation of flood management, drainage, anti-river erosion 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 scheme of category (b) above should be sent by the State Govt. to the Ministry of Railways and to the ministry of Surface Transport (Roads Wing) for information.

(iv) The sanction of schemes by the State Govts. would be subject to the financial provisions that may be made available from year to year. The scheme 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" (Annexe-I), in respect of each scheme should be furnished by the State Govt. soon after sanctioning the scheme, to Central Water Commission and the Planning Commission. Where the scheme relate to the Ganga basin, the above information will be furnished to the G.F.C.C. and the Ministry of Water Resources also. In case of schemes relating to the Indus basin, the above information should be furnished to the Ministry of Water Resources also and therefore have to be cleared by Indus Wing of MoWR.

(v) All emergent schemes costing up to Rs 25 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 Govts. on the recommendation of the State Chief Engineer. A list of such schemes sanctioned by the State Govt. together with the information on Proforma "A" of each schemes should, however, be supplied soon after sanctioning the scheme to the various authorities as indicated in Para (iv) above.

(B) Schemes costing more than Rs 7.5 crore and not exceeding Rs 15.00 crore.

The scheme will be processed as follows :-

(i) The scheme prepared by the Flood Control department which have no Inter-state/international implications may be processed through the State Technical Advisory Committee and the State Flood Control Board and may be submitted to Central Water Commission (For scheme basins other than Ganga Basin) and to the GFCC (for schemes in Ganga Basin) in enclosed Statement "B" (Annex-II).

(ii) Schemes in the Indus Basin have international implications and therefore, have to be cleared by Ministry of Water Resources.

(iii) All these schemes will be examined by the Central Water Commission and the Ganga Flood Control Commission as the case may be.

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

(v) Scheme with inter-state/international implications will follow similar procedure as in para A (ii) except that the State Govt. will obtain specific clearance of the Ministry of Water Resources before they are recommended by the Central Water Commission/GFCC for approval of the planning Commission in the manner indicated in Para (iii).

(vi) The following categories of embankment scheme 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 or an inter-state river which does not flow down to any other State. but whose effect may extend in the upper States.

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

(vii) The following categories of embankment scheme may be considered as having international implications.

(a) Embankment schemes in the Indus river basin.

(b) Embankment scheme in certain estuaries. creeks. affecting the adjoining estuaries in another country.

c) Embankment scheme on rivers on tributaries which fall into main rivers such as Ganga or Brahmaputra flowing ultimately into another country.

(viii) The following categories of schemes in the Ganga & Brahmaputra River basins which are prima-facie free from possible international repercussion need not be referred to the MoWR for clearance.

a) Raising & strengthening of existing embankments.
b) Drainage schemes comprising excavation of new drains or provision of sluices in the various existing embankments.
c) Scheme of channel improvement & closing of spill sufficiently away from the Inter-national border.
d) River training scheme sufficiently away from the Inter-national border.
e) Anti-erosion scheme sufficiently away from the Inter-national border.

(C) Scheme costing more than Rs 15.00 crore.

For schemes costing more than Rs 15.00 crore, detailed project report should be prepared by the Flood Control department and processed in the same manner as indicated under section "B" above and thereafter the project report will be sent by the State Govt. to the Central Water Commission (to The Ganga Flood Control Commission in the case of schemes in the Ganga Basin) for detailed examination with a copy to the Planning Commission and where required, to Ministry of Water Resources (in respect of Indus basin). The Central Water Commission/GFCC will process the schemes for consideration of the Advisory Committee to Ministry of Water Resources.

(D) Modification and revision of schemes

The procedure mentioned here under will be followed in respect of flood management, drainage, anti-river erosion and anti-sea erosion schemes which undergo modification or revision subsequent to their approval on account of a change in their scopes and or a change in their estimated cost.

(i) If the scope of the scheme involving inter-state / International aspects requires a modification / revision resulting in an increase in the cost more than 10 % but the revised cost of the scheme still continues to be Rs 15.00 crore or less, such modification should be intimated by the State Govt to the Central Water Commission (GFCC in the case of scheme 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 15.00 crore the revised estimate should be processed in the manner as indicated in section "C" above for consideration of the Advisory Committee of the Ministry of Water Resources and Investment clearance by the Planning Commission.

(ii) In the case of a scheme involving a change in its estimated cost only, if the revised cost of the scheme is Rs. 15.0 crore or less irrespective of the percentage increase in cost only the increase in cost and the main reasons thereof need be intimated. However, where the revised cost is more than Rs.15.0 crore, the revision results in an increase in the cost of more than 10% or Rs. 1.5 crore which ever is less, the revised estimate should be processed in the manner as indicated in Section "C" above, for consideration of the Advisory Committee of the Ministry of Water Resources and investment clearance by the Planning Commission.

This procedure will also be followed in the case of schemes involving a change in scope but which are free from inter-state/International aspect.

(E) Revised Guidelines for Investment Clearance

Keeping in view the policy of decentralization the guidelines for investment approval by the Planning Commission for Irrigation and Flood Control including drainage projects under State Plans are revised as detailed below :

(i) All major and/or multi-purpose and medium irrigation projects and flood control including drainage projects which have Inter-State ramification will be subject to the techno-economic appraisal in Central Water Commission and then approval by the Advisory Committee on Irrigation, Flood Control and Multi-Purpose Projects in Ministry of Water Resources before the investment clearance of such projects/schemes is accorded by the Planning Commission in this case the prevailing procedure would continue. Guidelines issued earlier vide letter Nos. 16(12)/96-I&CAD dated 17-11-1997, No 16(12)/96-I&CAD dated 7-1-1998 and No. 16(12)/1/99-WR dated 09.09.2003 refer in this regard.

(ii) The State Governments are hereby empowered to accord investment approval for the major and/or multi-purpose & medium irrigation projects and flood control including drainage projects which do not have inter-state ramifications. It is also clarified that any project which is located on an inter-state river or its tributary will be deemed to involve inter-state ramification and as such shall need investment clearance from the Planning Commission as per the order no. 16(12)/99-WR dated 30-11-2000.

Chapter-IV

4. Appraisal & Clearance

Procedure for processing and acceptance by Central Water Commission and Planning Commission in respect of schemes costing more than Rs. 15 crore

(A) State Level Appraisal

1) The Planning and Design organization of the Flood Control Department of the State shall ensure that

   (i) The report has been prepared in accordance with the guidelines given in chapter II and that the hydrographic surveys of the affected river reach extending upstream and downstream as per requirement and hydraulic model studies and geo-morphological studies of the area/river reach have been conducted, considered and specific notes included.

   (ii) The Basic Planning & Flood Routing Studies relating to design flood have been carried out by the respective specialized units established in the State Irrigation/Water Resources Department so as to avoid major changes in the project features at a later date on appraisal by Central Water Commission. For this purpose the State Department shall also get the aspects of Basic Planning and Design Flood Calculation etc. vetted by Central Water Commission before preparing the D.P.R.

   (iii) The views of the State Agriculture, Planning, Revenue, Environment, Forest, Ground Water, Tribal Welfare and Roads Departments and of the Railways have been taken, considered and incorporated in the D.P.R.

2) D.P.R prepared by the field unite shall be submitted to the Central Design and Planning Organisation of the State Govt., if existing, for technical examination & scrutiny in its various specialized units.

3) Based on the technical examination & scrutiny in the specialized units of CDO the detailed project report may be amended/modified wherever necessary & cost estimates finalised.

4) The concurrence of the State Planning Department & Finance Department shall be obtained for the project estimate finalized after scrutiny by the CDO.

5) The project shall be discussed and considered from techno-economic aspects and recommended by the State Technical Advisory Committee and then approved by the State Flood Control Board.

6) The DPR so prepared may be submitted to the Chief Engineer (FM) Central Water Commission if the scheme is purely on flood control and to Chief Engineer (PAO) if the scheme is relating to multipurpose.

7) Sufficient No. of copies (at least 10 to 12 Nos.) of DPR shall be furnished by the State Govt.

(B) Appraisal at Centre

1) In Central Water Commission, the copies of the D.P.R shall be distributed to the relevant directorates for technical/economical examination.

2) Central Water Commission will send copies of the project reports & relevant proforma to the Union Ministry of Environment & Forest, if the estimated cost exceeds Rs. 100 crore. However, the State Govt. will directly take up the matter with the Ministry of Environment & Forest for obtaining clearance from the environment and forest angle.

3) The scrutiny of the project costing between Rs.7.5 crore and Rs. 15 crore the Central Water Commission shall be completed in 6 months and for projects with estimated cost over Rs. 15 crore, in a period of 9 months as per the flow chart enclosed vide Annex III & IV

4) For the projects where these issues have remained unsettled even after 9 months, the project shall be returned to the State Govt. for carrying out necessary modifications. After the issues are settled and the project is re submitted with updated cost estimates , such projects will be reprocessed afresh by Central Water Commission.

5) After the appraisal of the project at centre is completed, TAC note shall be prepared by the concerned Directorate of Central Water Commission & put up to the Advisory Committee of Ministry of Water Resources for its consideration & recommendation to the Planning Commission.

(C) Consideration by Advisory Committee of MoWR

1) The State Engineers at the level of the Chief Engineer/Superintending Engineer associated with the project formulation/design will be invited to attend the Advisory Committee so as to furnish information/clarification, if any, sought by the members of the Technical Advisory Committee.

2) The Advisory Committee of the Ministry of Water Resources shall consider the scheme in its meeting and recommend to the Planning Commission for investment clearance, if found acceptable.

3) The DPR cleared by Advisory Committee will be recommended for approval by Planning Commission and inclusion in the Five Year Plan/Annual Plan of the State.

(D) Procedure in respect of schemes costing more than Rs. 7.5 crore but less than Rs. 15 crore

1) State Level Appraisal
Same as described in the Chapter IV(a).

2) Appraisal at centre.

Same as described in the Chapter IV(b) except that Central Water Commission will submit the note on the scheme along with statement in annexure – II directly to Planning Commission after detailed examination.

Annexure-I

Proforma for information to be furnished in respect of Flood Management, Drainage, Anti-river erosion and Anti-sea erosion costing Rs 7.5 crore or less each sanctioned by the States

1. Name of the Scheme (Attach Location map and Index map).

2. Name of 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 or drainage channels.

5. Estimated cost.

6. Area benefited.

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.

Annexure-II

Proforma for information to be furnished in respect of Flood Management, Drainage, Anti-river erosion and Anti-sea erosion costing Rs 15 crore or less but more than Rs 7.5 crore each sanctioned by the States

1. Name of the Scheme (attach location map and Index
2. Abstract of cost, including foreign exchange components, if any.
3. Skeleton reports.
4. Area and population which will get protected by the project.
5. i) Betterment levy or flood cess, if any, proposed for the 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 hectares of area protected.
7. The extent to which people's participation is envisaged for the execution of the schemes and in what form.
8. Whether inter-state/International aspect of scheme, if any, has been examined by the State Technical Advisory Committee and, where necessary, clearance of the CWC/Ganga Flood Commission and the Ministry of Water Resources has been obtained.
9. Status of requisite administrative/statutory clearance.

Annexure-III

Flow Chart for Examination of Flood Management Projects at the Centre Costing between Rs. 7.5 crore and Rs. 15.0 crore

Date of Receipt of Proforma Report in Central Water Commission
(--------------------------------)

Examination in CWC and transmission of comments to the State
(1 month)

Submission of State comments including further studies and investigation/surveys.
(3 months)

Examination of the State's replies and discussions with the project engineers for finalisation in Central Water Commission.
(1 month)

Preparation of the note on the scheme also with Statement "B" for the Planning Commission and approval of the same to be forwarded to Planning Commission for their acceptance.
(1 month)

Total : 6 months

Annexure-IV

Flow Chart for Examination of Flood Management Projects at the Centre Costing more than Rs. 15.0 crore

Date of Receipt of D.P.R. in Central Water Commission

Preliminary Examination in the Flood Management Directorate and Circulation to appraisal agencies.
(1 month)

Examination in the various specialized Directorates of CWC, Ministry of Water Resources and Ministry of Agriculture and transmission of first set of comments to State.
(2 months)

Forwarding Report to the Ministry of environment and Forest.

Submission of State's replies to comments raised by the Appraisal Agencies including further studies and investigation/surveys etc.
(2 months)

Clearance to be obtained from the Ministry of Environment and Forests by the State Govt. and communicated to CWC.

Examination of State replies and transmission of second set of comments to the State.
(1 month)

Submission of State's final replies to second set of comments to Central Water Commission including further investigation and surveys.
(1 month)

Examination of State's final replies and discussion with the project engineers for finalization in the Central Water Commission.
(1 month)

Preparation of Note by the Flood Management Directorate for the Advisory Committee. (1 month)

Total : 9 months

Annexure-V

MODEL BILL FOR FLOOD PLAIN ZONING

A BILL

to provide for the zoning of flood plains of rivers in the State of ___________ Be it enacted by the legislature of the State of ______________________ in the Twenty ____________ Year of the Republic of India as follows:

CHAPTER 1- PRELIMINARY

Short title extent and commencement

(1) This Act may be called the Flood Plain Zoning Act.

(2) It extends to the whole State of _____________

(3) This section shall come into force at once and the remaining provisions of this Act shall come into force on such date as the State Government may, by notification in the Official Gazette, appoint:

Provided that the different dates may be appointed for different provisions of this Act and for different areas or different rivers.

Definition

(2) In this Act, unless the context otherwise requires –

(a) 'flood plain' includes water channel, flood channel and that area of nearby low land susceptible to flood by inundation.

(b) 'flood plain zoning' means restricting any human activity in the flood plains of a river where the plains are created by overflow of water from the channels of rivers and streams;

(c) 'flood zone' means the area which is required to carry the flow of the maximum probable floods;

(d) 'Flood Zoning Authority' in relation to a river, means the authority appointed by the State Govt. under section 3;

(e) 'land' includes interest in lands, benefits arising out of lands and things attached to the earth or permanently fastened to anything attached to the earth;

(f) 'occupier' in respect of any land, means any person who has an interest in the land and cultivates the land himself or by his servants or by hired labour and includes a tenant;

(g) 'owner' in relation to any land includes any person having interest in such land;

(h) 'prescribed' means prescribed by rules made by the State Govt. under this Act;

(i) 'river' includes its tributaries;

(j) 'water channel' means the channel in which the flows of a river are generally confined.

CHAPTER II- FLOOD ZONING AUTHORITY AND ITS POWERS

Declaration of flood plain zoning

(1) where the State Government considers it necessary or expedient so to do, it may, by notification in the official Gazette and in the Gazette of every District in which any part of a river flows, declare that flood plain zoning shall be made in the manner hereinafter specified.

(2) The State Govt. may direct that a survey be made of a river for the purpose of determining the limits within which the provisions of the Act are to be applied and that proper charts and registers be prepared specifying all boundaries and landmarks and any other necessary matter for the purposes of ascertaining such limits.

(3) The State Govt. may by notification in the Official Gazette, appoint the Collector of the District or such other authority as that Government considers necessary, as the Flood Zoning Authority for the purposes of making a survey of the area as required under sub section (2) and may specify in such notification, the duties to be discharged by such authority.

Powers and functions of the Flood Zoning Authority.

4. The Flood Zoning Authority shall exercise the powers and discharge the duties in accordance with the provisions of this Act and the terms and conditions specified in the notification under sub-section (3) of Section 3.

CHAPTER III- SURVEYS AND DELINEATION OF FLOOD PLAIN AREA

Survey

5. (1) The Flood Zoning Authority shall carry out surveys of flood plains of the rivers and determine the nature and the extent of flood plains of the rivers.

(2) The Flood Zoning Authority shall, on the basis of the survey carried out under sub-section (1), establish flood plain zones and delineate the areas which are subject to flooding including classification of land with reference to relative risk of flood plain use intended to safeguard the health, safety and property of the general public.

(3) The Flood Zoning Authority shall prepare charts and registers indicating the areas delineated under sub-section (2).

Power to take up survey

6. It shall be lawful for the Flood Zoning Authority or any of the officers generally or specially authorized by it in this behalf.

(a) to enter upon and survey and take levels of any land within its or his jurisdiction;

(b) to mark such levels, boundaries and lines by placing marks or boundary stones;

(c) to measure the land;

(d) to do all other acts necessary for the purposes of ascertaining the limits referred to in sub-section (2) of section 3;

(e) where otherwise the survey cannot be completed and the levels taken, to cut down and clear away any part of standing crop, fence or judge;

Provided that no Flood Zoning Authority or any other officer shall enter into any building or open any enclosed court or garden attached to a dwelling house (unless with the consent of the occupier thereof) without previously giving such occupier atleast seven days notice in writing of its or his intention to do so.

Payment of damages

7. (1) The Flood Zoning Authority or any other officer generally of specially authorized by it in this behalf, who has entered upon any land under section 5 shall, before leaving, tender compensation to the owner or occupier of such land for any damage which may have been caused and in case of dispute as to the sufficiency of the amount so tendered, the Flood Zoning Authority or such officer shall refer the matter to the __________ for his decision.

(2) The decision of the officer under sub-section (1) shall be final and no suit shall lie in a civil court to have it set aside or modified.

CHAPTER IV- NOTIFICATION OF LIMITS OF FLOOD PLAINS

Declaration of intention of State Govt. to demarcate flood plain areas

8. The State Govt. may, on the basis of a report from the Flood Zoning Authority or otherwise, by notification the official Gazette, declare its intention to demarcate the Flood Plain areas and either prohibit or restrict the use of land therein.

Public Notices

9. (1) The Flood Zoning Authority shall, on the issue of notification under Section 8, cause public notice of the substance of such notification to be given at convenient places in the area.

(2) The Flood Zoning Authority shall also give notices individually to the owners of the lands situated in the area.

(3) The Flood Zoning Authority shall exhibit records, charts, maps, registers and such other documents showing the river channel.

flood channel and the flood plain area, specifying the nature and extent to which the use of limits of the area is either prohibited or restricted, in the office for inspection by the general public at the timings specified therein.

Objections

10. (1) Any person who desires to raise any objection to the limits and either the prohibitions or restrictions specified in the public notice referred to in section 9, may, within a period of sixty days from the date of publication of the notification in the official gazette, forward to the Flood Zoning Authority a statement in writing setting forth his objections.

(2) After the expiry of the period aforesaid, the Flood Zoning Authority shall issue a notice in the manner prescribed and consider the objection after giving the party concerned a reasonable opportunity of being heard in the matter.

(3) The Flood Zoning Authority shall forward to the State Govt. its or his proposals together with the records referred to in sub-section (3) of section 9.

Decision of the State Government

11. (1) The State Govt. shall, after considering the report of the Flood Zoning Authority, order such alterations in the limits of the areas as it considers necessary.

(2) The decision of the State Govt. shall be final.

(3) The State Govt. shall, by notification in the official Gazette, declare that the provisions of this Act shall apply to the said river with boundaries and limits as specified.

(4) The areas delineated and approved by the State Govt. shall be deemed to be the flood plain and the limits shall, where necessary, be marked either by boundary stones or other suitable marks.

(5) The Flood Zoning Authority shall maintain the charts and registers of such areas so delineated and such charts and registers shall form part of the permanent records of the office.

(6) The charts and registers maintained under sub-section (5) shall be furnished to the Collector of the District in which any part of the river is situated and shall be open for inspection by the general public at such times as may be prescribed.

CHAPTER V - PROHIBITION OR RESTRICTION OF THE USE OF THE FLOOD PLAINS

Powers to prohibit obstruction, etc. in the flood plain area

12. (1) Where the State Govt. is satisfied that it is necessary to do so in the interest of public health, safety, or property in the interest of reducing the inconvenience to the general public or that it is necessary to prohibit or restrict the activities in the flood plain, that Government may, by notification in the official Gazette, specify the area where such prohibition or restriction is to be enforced and the nature and extent of such prohibition or restriction.

Provided that no notification under this sub-section shall be issued after the expiry of six months from the date of publication of notification under section-8.

(2) Upon the publication of a notification under sub-section (1) not withstanding anything contained in any law, custom, agreement or instrument for the time being in force, the prohibition or restriction specified in such notification shall prevail.

(3) No person shall undertake any activity within the prohibited area or restricted area except with the previous permission of the Flood Zoning Authority.

Provided that where a person makes an application to the Flood Zoning Authority for permission under this sub-section to undertake any activity and the Flood Zoning Authority does not, within a period of ninety days from the date of receipt of such application, communicate to the person that permission applied for has been refused, it shall be presumed that the Flood Zoning Authority has grant such permission.

Penalty

13. If any person commences or carries on or attempts to carry on any activity in the area specified in the notification under sub-

section (1) of section 12 contrary to the terms and conditions specified in such notification, he shall be punishable.

(a) With fine which may extend to five hundred rupees or in default, of payment of fine, to simple imprisonment for a term which may extend to two months; and

(b) With further fine which may extend to one hundred rupees for each day after the conviction under clause (a).

Power to Compound

14 (1) Subject to such conditions as may be prescribed, any officer authorized by the State Govt. by a general or special order in this behalf may, either before or after the institution of proceedings under this Act accept from the person who has committed or is reasonably suspected of having committed an offence, a sum of money not exceeding ____________rupees.

(2) On the payment of such sum of money, such person shall be discharged and no further proceedings shall be taken against him in respect of such offence.

Appeal.

15 (1) Any person aggrieved by any decision of the Flood Zoning Authority may refer an appeal to the prescribed authority within a period of ninety days from the date on which such decision was communicated to him;

Provided that the prescribed authority may entertain the appeal after the expiry of the said period of ninety days if it is satisfied that the appellant was prevented by sufficient cause from filling the appeal in time.

(2) The prescribed authority may after giving a reasonable opportunity to the appellant of being heard in the matter, make such orders as it deems fit and the decision thereof shall be final.

Revision.

16. (1) Where no appeal has been preferred under section 15, the state Govt. may, for the purpose of examining the legality, properiety or correctness of any inquiry or proceedings of the Flood zoning Authority, call for the records of any inquiry or proceedings of the Flood Zoning Authority and make such order in the case as it thinks fit;

Provided that no such record shall be called after the expiry of six months from the date of such order.

(2) No order of the Flood Zoning Authority shall be varied by the state Govt. so as to prejudicially affect any person without giving such person a reasonable opportunity of being heard in the matter.

CHAPTER VI- COMPENSATION

Payment of compensation

17. (1) Where any permission to undertake any activity in the flood plain has been refused to any person or whereas a result of prohibition or restriction imposed on any person under this Act, such person suffers any damage, he shall be entitled to the payment of compensation not exceeding the difference between the value of the land as determined under section 23 or section 24 of the Land Acquisition Act, 1894 and the value which it would have, had the permission for carrying on any (Central Act 1 of 1894) activity had been granted or the prohibition or restriction had not been imposed.

(2) In determining the amount of compensation under sub-section (1), any restriction to which the land is subjected to under any other law for the time being in force in regard to the right of the person claiming compensation to carry on any activity on the land or otherwise to the use of the land shall be taken into consideration.

Determining the compensation and apportionment by consent

18. (1) The person to whom the compensation under section 17 is to be paid and the apportionment of such amount among the persons interested

therein shall be determined by agreement between the Flood Zoning Authority and the person or persons claiming interest therein.

(2) In default of any such agreement, the Flood Zoning Authority shall, after holding such enquiry as it considers necessary, make an award determining:-

(a) the amount of compensation to be paid under section 17 and

(b) the apportionment, if any, of such compensation among persons known or believed to be interested therein;

Provided that where the amount of compensation exceeds Ten thousand rupees, no award shall be made without the previous approval of the state Govt. or such other officer as the state Govt. may authorise in his behalf.

Compensation not admissible

19. (1) No compensation shall be awarded.

(a) if and in so far as the land is subject substantially similar restriction in force under some other law in force on the date on which the restrictions were imposed by or under this act; or

(b) if compensation in respect of the same restrictions imposed by or under this Act or substantially similar restrictions in force under some other law has already been paid in respect of the land to the claimant or any predecessor in interest of the claim; or

(c) for removal of any encroachment.

(2) If any person has unauthorisedly undertaken any activity, then any increase in the value of land from such activity shall not be taken into account in estimating the value of land.

Application against award

20. (1) Any person aggrieved by the Award of the Flood Zoning Authority under sub-section (2) of section 18 may by an application in writing, apply to the state Govt. or such other officer as the state Govt. may authorise in this behalf.

(2) Any application under sub section (1) shall be made in such form and in such manner as may be prescribed and shall be made within forty five days from the date of communication of the award.

(3) The application under this section shall be disposed of in such manner as may be prescribed.

Procedure & Powers of authorities in deciding applications

21. (1) An application under section shall be deemed to be proceedings within the meaning of section 141 of the code of civil Procedure, 1908 and in the trial thereof, the authorities empowered to decide reference may exercise on the powers of civil court. (Central Act 5 of 1908).

(2) The scope of inquiry shall be restricted to the consideration of the matter referred to the state. Govt. or such other officer as the state Govt. may authorise in this behalf.

Decision enforceable as decree of civil court

22. The decision under section 21 shall be enforceable as a decree of civil court.

Payment under award

23. On the determination of the compensation under sub-section (1) of section 18, or on the making of an award under sub-section (2) of section 18 or if an application is made under section 20 against such award after decision of the authority, the compensation shall be paid by Flood zoning Authority and the provisions of section 31 to 35 (both inclusive) of the land Acquisition Act, 1894, shall apply to such payment (Central Act 1 of 1894).

CHAPTER VII - POWER TO REMOVE OBSTRUCTIONS AFTER PROHIBITION

Power to remove obstructions.

24. (1) The Flood Zoning Authority may, in accordance with the provisions of this Act, within such time as may be specified by it direct any owner or occupier of land to do any act or remove any unauthorised obstruction within such time as may be specified by it and such owner or occupier shall do such act or remove the obstruction.

(2) If the owner or occupier fials to comply with the order of the Flood Zoning Authority within time specified under sub-section (1), the Flood Zoning Authority may cause the act to be performed or cause the obstruction to be removed.

(3) All expenses incurred by the Flood Zoning Authority under this section shall be recovered from such owner or occupier as arrears of land revenue.

CHAPTER VIII - MISCELLANEOUS

Preventing Flood Zoning Authority from doing an act to be offence

25. Any person who prevents the Flood Zoning Authority in discharging any act imposed on such Authority by or under this Act, shall be deemed to have committed an offence under section 186 of the Penal Code. (Central Act 45 of 1860).

Flood zoning Authority and other officers to be public servants

26. The Flood Zoning Authority and other officers and employees authorised under this Act shall be deemed to be public servants within the meaning of section 21 of the Indian Penal Code (Central Act 45 of 1860).

Protection of action taken in good faith

27. (1) No suit, prosecution or other legal proceeding shall lie against the state Govt. or any authority or person exercising any power or performing any duty under this Act for anything which is in good faith done or intended to be done in pursuance of this Act or order made thereunder.

(2) No suit or other legal proceeding shall lie against the state Govt. for any damage caused or likely to be caused for anything which is in good faith done or intended to be done in pursuance of this Act or any rule or order made thereunder.

Recovery of fine

28. All fines imposed under this Act shall be recovered in the manner provided in the Code of criminal Procedure, 1898. (Central Act 5 of 1890).

Power of court

29. A civil court shall have jurisdiction to settle, decide deal with any question which is by or under this Act required to be settled, decided or dealt with by the Flood Zoning Authority or such other officer authorised by the state Govt. in this behalf.

Power to make rules

30. (1) The State Govt. may, by notification in the Official Gazette, make rules to carry out the purposes of this Act.

(2) In particular and without prejudice to the generally of the foregoing provisions, such rules may provide for.

(a) The manner in which charts and records shall be maintained.

(b) The form and manner in which application under section 20 shall be made and the manner in which such application shall be disposed of;

(c) any other matter which has to be, or may be, prescribed.

(3) Every rule made under this Act shall be laid, as soon as may be after it is made, before each House of the state Legislature while it is in session for a total period of fourteen days which may be comprised in one session or two or successive sessions and if before the expiry of the session immediately following the session or the successive sessions aforesaid both Houses agree that the rule should not be made, the rule shall, thereafter, have effect only in such modified form or be of no effect, as the case may be, so, however, that any such modification or annulment shall be without prejudice to the validity of anything previously done under that rule.

GUIDELINES ON FLOOD PLAIN REGULATIONS

CONCEPT OF FLOOD PLAIN ZONING:

The basic concept of flood plain zoning is to regulate the land use in the flood plains to restrict the damage caused by floods which are bound to occur from time to time. Flood Plain Zoning, therefore, aims at determining the locations and the extent of areas in such a fashion that the damage is reduced to the minimum. It, therefore, envisages limitations on indiscriminate development of both the unprotected as well as protected area. In the former case, boundaries of forbidden areas are to be established to prevent indiscriminate growth while in the protected areas development can be allowed which will not involve unduly heavy damage in case the protective measures fail. Zoning cannot remedy existing situations. However, it can definitely help in minimizing flood damage in new developments.

Flood Plain Zoning is not only necessary in the case of floods by rivers but is also useful in reducing the damage caused by drainage congestion particularly in urban areas where on grounds of economy and other considerations urban drainage is not designed for the worst conditions and presupposes some damage during storms whose magnitude exceeds that for which the drainage system is designed.

Basic criteria for zoning:

The basic criteria to be followed in implementation of flood zoning are as follows:

(i) Broad demarcation of areas vulnerable to floods.

(ii) Preparation of detailed contour plans of such areas to large scale (preferably 1 in 15,000) showing contours at an interval of 0.3 metres or 0.5 metres.

(iii) Fixation of reference river gauges with respect which the areas likely to be inundated for different magnitudes of floods will be determined.

(iv) Demarcation of areas liable to flooding by floods of different frequencies like once in two years, five years, ten, twenty, fifty and hundred years. Similarly, areas likely to be affected on account of accumulation of rain water for different frequencies of rainfall like 5, 10, 25 and 50.

(v) Making of likely submersion contours for different flood stages or accumulation of rain water on the maps.

Regulating Land Use in Different Flood Zones:

There can be different considerations for such regulation. For example, the area likely to be affected by floods upto a 10 year frequency should be kept reserved only for the gardens, parks, playgrounds, etc., prohibiting any residential or public building, prohibition of any commercial buildings, industries, public utilities in area liable to flooding by a 25 year frequency flood. In the latter case, residential buildings could be permitted with certain stipulation of construction on stilts (columns), minimum plinth levels, prohibition for construction of basements and minimum levels of approach roads, etc. In urban areas there should be double storeyed buildings. Ground floors could be utilised for schools, libraries and other non-residential I purposes.

Specific suggestions for Flood Zoning:

In regulation of land use in flood plains, different types of buildings and utility services can be grouped under priorities indicated below from the point of view of the damage likely to occur.

Priorities

Priority-l

Defence installation, industries, public utilities like hospitals, electricity installations, water supply, telephone exchange, aerodromes, railway stations, commercial centres, etc.

Priority-2

Public institutions, Government offices, universities, public libraries and residential areas.

Priority-3

Parks and play grounds.

The following regulations in respect of the above can be considered.

(a) Buildings for priority-1 should be located in such a fashion that they are above the levels corresponding to a 100 year frequency or the maximum observed flood levels. Similarly they should also be above the levels corresponding to a 50 year rainfall and the likely submersion due to drainage congestion.

(b) Priority-2 should be for a 25 year flood or a 10 year rainfall with stipulation that all buildings in vulnerable zones should be constructed on columns or stilts as indicated above.

(c) Play-grounds and parks can be located in areas vulnerable to frequent floods.

Since every city needs some open areas and garden, by restricting any building activity in vulnerable area, it will be possible to develop parks and play grounds, which would be in the interest of providing a proper environment for growth of the city.

On the same analogy, certain areas of either side of the existing and proposed drains (including rural drains) should be declared as green belts where no building or other activity should be allowed. This will not only facilitate improvement of these drains in future for taking discharges on account of growing urbanisation, but will also help in minimising the damage due to drainage congestion whenever rainfall of higher frequency than designed is experienced. These green belts at suitable locations can also be developed as parks and gardens.

In the existing developed areas, possibilities of protecting/relocation/exchanging the sites of vital installation like electricity sub-stations/power houses, telephone exchange, etc., should be seriously examined, so that these are always safe from possible flood damage. Similarly, the pump station of tubewells meant for drinking water supply should be raised above the high flood levels corresponding a 100-year flood.

Similarly, possibility of removing buildings/structures obstructing existing natural drainage lines should be seriously considered. In any case, with immediate effect unplanned growth can be restricted so that no construction obstructing natural drainage or resulting in increased flood hazard is allowed.

In future buildings, the following regulations may be stipulated:-

(a) Plinth levels of all buildings should be 2 feet above the drainage/flood submersion lines.

(b) In the areas liable to floods, all the buildings should preferably be double and multiple storeys.

(c) Wherever there are single storey buildings, a stairway, should invariably be provided to the roofs so that temporary shelter can be taken there. The roof levels of the single storey buildings and the first floor level in double storey buildings should be above 100-year flood levels so that the human lives and the movable property can be temporarily sheltered there during the periods of danger on account of floods.

Annexure-VI

No.16(12)/1/99-WR
Planning Commission
(WR Division)

Yojana Bhawan,
Sansad Marg,
New Delhi
Dated 09.09.2003

To
The Chief Secretary,
Government of . . . .

Subject: Enhancement of powers of the State Governments for the sanction of flood control, drainage and anti-water logging scheme.

Sir,

As the State Governments are aware, the investment approval of the Planning Commission to new flood control and drainage schemes having inter state/international ramifications has been a pre-requisite for their inclusion and funding in the States' Plan. The Planning Commission's letter no.16(12)/1/99-I&CAD, dated 18.06.99 lays down the procedure for submission and examination of such flood control, drainage and anti-water logging projects.

With a view to delegate more powers to the State Govts., it has been now decided that 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 cost upto 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 Rs.15.00 Crore.

Accordingly and in supersession of the relevant instructions contained in the letter dated 18.6.99 cited above, 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 the Advisory Committee) will be with immediate effect as follows:

2.1 Schemes costing upto Rs.7.5 Crore

2.1.1 The schemes proposed by the Flood Control Department will be sanction 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.

2.1.2 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 sanction by the State Govt. 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 the State Govt.

2.1.3 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-soil 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 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.

2.1.4 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.

2.1.5 All emergent schemes costing upto Rs. 25 lakhs each to be carried out during the flood season which do not have inter-department/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.

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

2.2.1 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.

2.2.2 Schemes with international implications will follow similar procedure as in para 2.2.1 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 2.2.1 (iii).

2.2.3 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.

2.2.4 The following categories of embankment schemes 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.

2.2.5 The following categories of schemes in the Ganga and Brahmputra 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.

2.3 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 2.2 above and, thereafter, the project reports 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.

3.0 Modification and Revision of Schemes

3.1 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.

3.2 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 revised cost of the scheme still continues to be Rs. 15 Crore or less, such modifications should be intimated by the State Government to 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 2.3 above for consideration of the Technical Advisory Committee of the Ministry of Water Resources and investment approval by the Panning Commission.

3.3 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 to 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 Rs. 1.5 crore, whichever is less, the revised estimate should be processed in the manner as indicated in Section 2.3 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.

3.4 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.

3.5 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 Govertments 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 3.0 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.

Yours faithfully

Sd/-
(Avinash Mishra)
Sr. research Officer (WR)

<u>Encl. Proforma "A" & "B"</u>

STATEMENT "A"

PROFORMA IN WHICH INFORMATION IS REQUIRED TO BE FURNISHED BY THE STATE GOVERNMENT IN RESPECT OF FLOOD CONTROL, DRAINAGE, ANTI-WATER LOGGING AND ANTI-SEA EROSION SCHEMES COSTING LESS THAN RS.7.5 CRORE EACH SANCTIONED BY THE STATES

1. Name of the Scheme (attach index map)
2. Name of the river, river basin and district in which the scheme is situated.
3. Name of scheme- whether new embankments, raising and strengthening of existing embankment, drainage, anti-erosion town protection etc.
4. Length of embankment or drainage channels.
5. Estimated Cost.
6. Area benefited.
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/GFCC and the Ministry of Water Resources has been obtained.
9. Status of requisite administrative/statutory clearance.

STATEMENT "B"

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

1. Name of the Scheme (attach index map)
2. Abstract of cost, including foreign exchange components, if any.
3. Skeleton reports.
4. Area and population which will get protected by the project
5. (i) Betterment levy or flood cess, if any, proposed for the area to be protected from floods or water logging or sea erosion.
   (ii) Anticipated revenue therefrom.
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 form.
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/GFCC and the Ministry of Water Resources has been obtained.
9. Status of requisite administrative/statutory clearance.

Copy forwarded for information and necessary action to:

1. Secretary (WR)
2. Secretary, Deptt. of North East Region, Vigyan Bhawan.
3. Commissioner(ER)/Indus/Projects/PP
4. Chairman, CWC
5. Member(RM)/Member(WP&P)
6. CE, PAO/CE,FM/CE, FCD
7. Chairman, GFCC : 3 copies
8. Ministry of Finance, Deptt. of Expenditure, Plan Finance Section, New Delhi : 5 copies
9. Ministry of Railways : 10 copies
10. Ministry of Transport (Roads Wing) : 10 copies
11. Chairman, Brahmaputra Board, Guwahati : 10 copies
12. <u>All State Governments/UTs.</u>
(a) Secretary, Planning : 5 copies
(b) Secretary, Water Resources/Flood Control Deptt. : 5 copies
(c) Chief Engineer, Water Resources/Flood Control Deptt, : 5 copies

Copy also for kind information to

13. PS to DCH/PS to MoS (Plg.)/PS to all members.
14. PS to Secretary (Planning Commission)
15. Adviser(PAMD)/Adviser(SP-NE)

Sd/-
(Avinash Mishra)
Sr. research Officer (WR)

REFERENCES

1. MoWR Guidelines for providing Central Assistance to State Govts. for the schemes/proposals of Flood control of River Management works under Flood Management Programme, 2007 – 12 December, 2007.

2. Govt. of India, Planning Commission, water Resources Divn., Office Order No. 16(12)/99, WR dt. 30.11.2000.

3. Report of Rashtriya Barh Ayog – March, 1980.

4. River Management Wing, Central water Commission – Embankment Manual.

5. IS Code 14262 : 1995 – Indian Standard for Planning and Design of revetments – Guidelines.

6. IS Code 8408 : 1994 - Indian Standard for Planning and Design of Groynes in Alluvial River – Guidelines.

PART-III

GUIDELINES FOR PREPARATION OF DETAILED PROJECT REPORTS OF MODERNISATION OF IRRIGATION PROJECTS

MODERNISATION OF IRRIGATION PROJECTS

Section-1

CHECK LIST

Sl. No.	Item

1. Was the original project given investment clearance by Planning Commission?

2. Has the performance evaluation of the existing project been carried out?

3. Have the salient features of the project as envisaged at the time of execution of project and as at present, been indicated ?

4. Have the irrigation potential of the existing project as originally envisaged, potential created and utilised and reasons for variations been indicated?

5. Has the culturable command area been actually assessed and compared with that at the time of planning of the project and shortfalls/excesses, if any, discussed?

6. Has the hydraulic survey of canal/distribution system been carried out?

7. Have the deficiencies in the existing irrigation system been identified?

8. Has the need for modernisation been justified?

9. Have the hydrological studies been reviewed, compared with those made at the time of preparation of the original project if available and reasons for variations recorded in respect of:

   (i) rainfall
   (ii) runoff
   (iii) flood
   (iv) sediment
   (v) ground water
   (vi) Evaporation

10 (a) Have changes in the upstream withdrawals/diversions for industrial use, power generation, drinking requirement and other developments in the upper catchment to the extent

which can be collected with reasonable efforts been described?

(b) Have the changes in power generation/consumption in power for the lift irrigation scheme been described?

11. Have the semi-detailed soil surveys been carried out for the entire command (if not entire command then extent covered) and soil and land irrigability classification brought out in the report? (For the Project to be acceptable, semi detailed soil survey in at least 50% of command should have been carried out.)

12. Is the Crop Water Requirement determined by the modified Penmen method?

13. Have water requirements for other uses been worked out ?

14. Has justification for the proposed cropping pattern been furnished?

15. Have the cropping pattern & proper cropping calendar been devised with a view to maximise the production and canal closures for maintenance etc. ensured? Have these been concurred by the Agriculture Department ?

16. Are the areas and percentage of CCA that will be irrigated during Kharif, Rabi, two seasonal, hot weather and perennials been indicated and compared with cropping pattern as existing prior to taking of the project, originally envisaged and actually developed after completion of the project ?

17. Is the justification furnished for continuing with/or taking up perennial and hot weather crops from the reservoir?

18. Have the most suitable depths and frequencies of irrigation to be adopted, based on the characteristics of the soil and crops been worked out ?

19. Have the values of conveyance efficiency, field application efficiency and overall water use efficiency been indicated with basis thereof?

20. Has the pattern of releases (10 daily/monthly) from the diversion/storage headworks been worked out & compared with those envisaged originally?

21. Has the canal been redesigned to cater for peak requirement with 10 percent increase (20% for small reservoirs) for rush

irrigation. If not, have the alternative proposals for carrying the required discharge been discussed?

22. Whether supplementation from ground water has been considered?

23. Are the supplies available sufficient to meet the requirements for ensuring 75 per cent dependability ? If not, have the possibilities of augmenting the supplies been discussed either by increasing the storage or supplementing by ground water etc.? Have the revised reservoir operation tables been furnished?

24. Has a study of the ground water potential of the command area, the present level of the ground water use and the scope of future ground water utilisation, been carried out and included in the project report?

25. Have the economics of ground water development been studied?

26. Has the possible impact on ground water recharge on account of lining of the system been kept in view in the scheme of ground water utilisation ?

27. Has the possibility of the ground water for irrigating areas not commanded by the canal system been considered?

28. Has the quality of surface water as also ground water & drainage water, if intended for irrigation use, been tested?

29. Have the requirements of drainage in the command area, been studied and a suitable integrated drainage plan drawn up and provided for in the cost estimate?

30. Have the arrangements for the following been considered and provided for?

    (a) Execution of OFD works
    (b) Training programmes for field staff and farmers – existing position and proposals for strengthening
    (c) Participatory Irrigation Management (PIM), Water Users Associations (WUA), and turnover of the system to WUAs.
    (d) Provision of extension services
    (e) Providing important inputs like seeds, fertilizers etc.

31. Have adequacy of road communication facilities and if not, the necessity of improvements been discussed and provided for?

32. Have matters about the improvement in reliability/dependability of the annual irrigation in the existing/proposed command area been discussed in the light of modernisation?

33. Have the net benefits due to the project been estimated and concurred by the Agricultural Department?

34. Has the concurrence of the State Finance Department been obtained for taking up the project at the estimated cost?

35. Whether the scheme has already been started? If so, is the present stage of construction indicated?

36. Is the scheme included in the plan? If not, what is the present position regarding its inclusion in the plan?

37. Have the year wise requirement of funds been indicated?

38. Is the scheme covered under state sector or Central sector?

39. Is the scheme covered or proposed to be covered under any foreign assistance/aid agreement?

40. Are the detailed cost estimates included in the Report?

41. Has the benefit-cost ratio been worked out? Whether depreciated cost of completed works has been included in the calculations?

42. Whether Internal Rate of Return (IRR) has been worked out?

43. Are the financial returns attached ?

44. Are there any special reasons to undertake the project if it is unproductive and whether these have been recorded in the Report?

45. Have the rates of betterment levy proposed, the period of recovery and the estimated total recovery been indicated?

46. Are there any charges levied for irrigation facilities as distinct from water charges?

47. Are the water rates for different crops indicated ?

48. Have the rates of betterment levy, water charges, etc. been compared with those obtained in other regions of the State ?

49. Has the concurrence of the State Revenue Department been obtained for these rates ?

50. Have the O&M aspects (both financial as well as management) been discussed? How are the O&M costs proposed to be met?

51. Have the programme of construction and the expenditure involved been furnished ?

52. Has the requirement of staff been estimated and furnished with justification?

53. Has the adequacy of the existing irrigation laws and revision, if any, considered necessary been discussed ?

54. Has the impact of the scheme on the overall development of water resources in the basin/state been discussed?

55. Whether views of water users about proposed works in modernisation project been obtained and described in the Report?

56. Have environmental/ecological aspects been discussed in the Report & environmental clearance obtained from MOEF?

57. Does the project involve acquisition of forest land? Has the MOE&F been approached for clearance under Forest Conservation Act 1980?

58. Does the project involve any re-settlement? Whether rehabilitation of PAPs provided for?

59. Does project involve rehabilitation of SC/ST population? Has the rehabilitation package for them been cleared by Ministry of Social Justice & Empowerment?

60. Have the socio economic studies (bench mark surveys) been carried out?

61. Have the interstate aspects been examined & discussed?

62. Have the list of ongoing programs of Agriculture Department in Command Area been given?

63. Have the provisions of Indus Water Treaty, 1960 for schemes on western rivers of Indus Basin been examined and discussed?

MODERNISATION OF IRRIGATION SCHEMES

Section-2

SALIENT FEATURES

1.0 Name of the project

2.0 General data

2.1 District(s)

2.2 Tehsil(s) / Taluka(s)

2.3 River / tributary

2.4 Location of dam / diversion structures

2.5 Name of river/basin

2.6 Longitude & Latitude (at dam site)

3.0	Socio-economic aspects	Original /Revised
3.1	District(s) benefited	
3.2	Income	
3.3	Land holdings	
3.4	Population benefited	
	(a)Total	
	(b)Scheduled cast	
	(c)Scheduled Tribe	
	(d)Other backward castes	

4.0 Hydrological data

4.1	**Catchment area at dam site (ha)**	
4.2	**Rainfall (mm)**	**Original/Revised**
	(a) Maximum annual rainfall	
	(b) Minimum annual rainfall	
	(c) Mean annual rainfall	
	(d) 75% dependable annual rainfall	

4.3 Annual runoff (M cum) Original/Proposed

(a) Average

(b) Maximum

(c) Minimum

(d) 75% dependability

4.4 Design flood Original /Revised

5.0 Water utilisation (M cum) Present/Proposed

(a) Reservation for upstream use

(b) Reservation for downstream use

(c) Utilisation through the project

(i) Irrigation

(ii) Power Generation

(iii) Drinking water

(iv) Industrial Use

(v) Others

(d) Water saved through modernisation

6.0 Ground water (M cum)

(a) Potential

(b) Present use

(c) Proposed use after modernisation

(d) Balance for future utilisation after modernisation

7.0 Reservoir data Existing/Proposed

(a) Storage (M cum)

(i) Gross storage

(ii) Dead storage

(iii) Live Storage

(iv) Annual carry over

(b) Elevation (El-m) Original/ Proposed

- (i) Maximum water level (MWL)
- (ii) Full reservoir level (FRL)
- (iii) Lowest water level (LWL)
- (iv) Dead storage level (DSL)
- (v) River bed level (RBL)
- (vi) Irrigation outlet level (IOL)

(c) Water spread area (sq.km) at Original/ Proposed

- (i) Dead storage level
- (ii) Full reservoir level
- (iii) Maximum water level

(d) Water Quality Reservoir/Canal/River (downstream)

- (i) Physical
- (ii) Chemical
- (iii) Bacteriological

8.0 Canal system (Irrigation) – Information to be furnished for each Main/Branch canal separately

Existing /Proposed

- (a) Length of canal (km)
- (b) Full supply level at canal head (m)
- (c) Full supply discharge at canal head (m^3/sec)
- (d) Length of complete distribution system upto minors
- (e) No. of villages served
- (f) Areas (ha)
  - (i) Gross command area (GCA)
  - (ii) Culturable command area (CCA)
  - (iii) Annual Irrigation (AI)
  - (iv) Intensity of Irrigation (% age of CCA)

9.0 Power

(a) Existing/Proposed

(i) Installed capacity (MW)

(ii) Unit size

(iii) Size of power house

(iv) Type of turbine

(v) Rated head

(vi) Rated/Design Unit discharge

(vii) Specific speed

(viii) Generator type

(ix) Capacity

(x)Voltage

(b) Power Benefits

(i)Firm Power

(ii)Energy

(c) Evacuation System

10. Cropping pattern (crop wise) – Season wise

Name of crop season-wise	Pre-project (ha)	Planned originally (ha)	Actual achieved (ha)	Proposed (ha)
	% of CCA	% of CCA	% of CCA	% of CCA
1.				
2.				
3.				
4.				

11. Benefits (Additional – annual)

	Amount)Rs.)
(a) Food grains	
(b) Commercial crops	
(c) Others	

12.0 Revenue (Rs) Existing/proposed

12.1 Revenue from water rates

(a) Irrigation

(b) Domestic Water Supply

(c) Industrial Water Supply

(d) Power

(e) others

12.2 Revenue from Irrigation cess other than water rates

12.3 Recovery of betterment levy

12.4 Other source of revenue, if any.

13.0 Cost

13.1 Estimated cost of modernisation Works (Rs. lakhs)

(a) Irrigation

(b) Doestic water supply

(c) Industrial water supply

(d) Power

(e) Others

13.2 Cost of completed works (Rs lakh) - original & depreciated

13.3 Annual Cost

14.0 Benefit Cost Ratio

15.0 Internal Rate of Return

16.0 Financial Return

MODERNISATION OF IRRIGATION PROJECTS

Section-3

REPORT

1. Introduction

The following points and additional points, if any, as relevant to the project shall be discussed in details under this chapter.

1.1 Brief description of major components of the project as formulated/conceived originally/ completed

1.2 Salient features/aspects

(a) Envisaged at the time of approval of the project
(b) As completed
(c) As proposed
(d) Comparison between the existing and proposed features

1.3 Present performance of various components of the project

1.4 Irrigation potential envisaged originally/created on completion of project and its utilisation year to year (indicate what changes have taken place in the development of irrigation potential during the operation of the project).

1.5 Deficiencies in the existing Irrigation System

(a) Engineering
(b) Agronomical
(c) Administrative
(d) Legislative

1.6 Justification/need for modernisation
1.7 Dove-tailing of the project in the basin plan/master plan.

2. Hydrology

The following points and additional points, if any, as relevant to the project shall be discussed in details under this chapter.

2.1 Original studies made at the time of preparation of the project in respect of

(a) Rainfall
(b) Runoff

(c) Flood
(d) Sediment
(e) Ground water
(f) Evaporation
(g) Any other

2.2 Additional data collected after approval and during the operation of the project in respect of

(a) Rainfall
(b) Runoff
(c) Floods
(d) Sediment
(e) Ground water
(f) Evaporation
(g) Any other

2.3 Review of all studies under 2.1 in the light of new information collected under 2.2.

2.4 Gross/net 75% dependable annual flow available at the site.

2.5 Balance groundwater availability.

3. Reservoir

Original studies made at the time of preparation of project for fixation of MWL, FRL, LWL, DSL, RBL, IOL and revised studies as a result of studies made at paras 2.3 and 6 to 9.

4. Dam/Barrage/Weir

Dam/Barrage/Weir and appurtenant structures should be reviewed with regards to the adequancy of design, performance and safety.

4.1 The following records of the dam are required to be reviewed.

(a) Completion Report
(b) Operation & Maintenance Mannual
(c) Instrumentation Details of the dam
(d) Installation of Standard Meteorological Instruments
(e) Emergency Action Plans, including inundation maps
(f) Determination of hydrological safety of dams
(g) Checking the dams against maximum credible earthquake

4.2 The following components are to be checked during the inspection of the dams:

Masonry/Concrete Dams

1. Upstream and downstream faces
2. Drainage Gallery
3. Seepage from foundations
4. Seepage from body wall
5. Structural performance
6. Spillway Gates
7. Spillway bridge, hoist bridge, Catwalks and other bridges where applicable
8. Energy dissipation arrangements
9. Walls
10. End Weir
11. Hydraulic performance of energy dissipation arrangements
12. Instruments installed and observations
13. Outlets
14. Outlet Gates
15. River outlet/river sluice and gates
16. Power outlet
17. Emergency preparedness
18. Access roads
19. Communication facilities
20. General assessment of condition of the dams

Earth Dams

In addition to the above aspects, the following need to be seen:

1. Downstream drainage
2. Surface drainage of downstream slopes
3. Seepage measurements
4. Earth dam section crest
5. Earth dam section - u/s and d/s slopes
6. Junction earth work with masonry/concrete sections and outlets
7. Relief walls
8. Breaching Section(if provided)

4.3 Remedial measures proposed as a part of modernisation of project should be described.

5. Land Potential

The following points and additional points, if any, as relevant to the project shall be discussed in details under this chapter.

5.1 Culturable Command Area (C.C.A.)

(a) Originally adopted with basis
(b) Basis for fixing
  (i) Based on general topographical maps of Survey of India (Scale 1 : 50000)
  (ii) Survey conducted to a scale 1 : 15000 confirm availability of land
  (iii)Based on village maps
  (iv)Actual attained at present under the outlets
(c) Area that will be attained in the post modernisation stage, the basis thereof, (Refer item (b) (i), (ii) and (iii) above).

5.2 Soil Survey

(a) Pre-irrigation (at the time of original project formulation stage), if any.
(b) Post-irrigation (after appraisal of the original project and/or during its operation)
(c) Latest surveys carried out for formulation of the modernisation scheme

5.3 Soil Capability classification based on the latest soil survey

5.4 Land Irrigability classification based on the latest soil survey

6. Cropping pattern and crop water requirement

The following points and additional points, if any, as relevant to the project shall be discussed in details under this chapter.

Note :- Where the information is asked in form of table(s) it will be followed by discussions of a tabulated data

6.1 Details of pre-project cropping cropping pattern, crop calendar (Annexure 1).

6.2 Details of original cropping pattern, crop calendar (Annexure I) and basis for its adoption i.e:

(a) Soil surveys and agroclimatic conditions
(b) Ad-hoc (based on information from similar projects in the vicinity)
(c) Experimental farm results

6.3 Studies carried out and data collected in respect of crops since operation of the project
(a) Details of crop season
(b) Availability and use of
  (i) Seeds, high yielding varieties etc
  (ii) Fertilisers
  (iii)Pesticides
  (iv)Weedicides

(a) Net irrigation and field irrigation requirements crop-wise
(b) Assumed field application efficiency with basis
(i) Paddy
(ii) Upland crops

6.4 Cropping pattern (details of crop to be discussed Annexure 1) suggested on the basis of latest available data in respect of
(a) Land
(b) Soil
(c) Availability of water, improved implements and other inputs, like improved seeds, fertilisers, weedicides, pesticides etc.
(d) Agroclimatic conditions
(e) Existing Irrigated Agricultural practices
(f) Farmers attitude towards new practices

6.5 Estimation of effective rainfall (fortnightly) in different periods of crop season with basis (Fortnightly rainfall & climatic data to be given as per Annexures 6 & 7, Part-II and calculation of effective rainfall may also be given)

6.6 Assessment of crop water requirements (As per Annexure-8 Part-II)

(a) Based on actual experimental farm data or field plot experiments conducted on different crops.

Note:- This data would directly give the field water requirement (including losses due to deep percolation and for the effective rainfall, these values directly give field irrigation requirements at the outlet).

(b)Consumptive use based on Modified Penman method

6.7 Assumed conveyance efficiencies with basis

Kharif
Rabi

6.8 Irrigation water requirement (at canal head)

(a)Crop water requirement (refer Annexure-8 Part-II)
(b)Irrigation Demand Table at (refer Annexure-9 Part-II)
(i) Kharif
(ii) Rabi
(iii) Two Seasonal
(iv) Perennials
(v) Hot weather

7. **Pisciculture**

(a) Details of pre project pisciculture activities (area & varieties cultured)
(b) Details of originally planned pisciculture activities (area, varieties and monthwise water requirement).
(c) Details of existing pisciculture activities (area, varieties and monthwise water supplied).
(d) Details of proposed pisciculture activities (area, varieties, monthwise water requirement).

8. **Horticulture**

(a) Details of horticulture crops grown in pre-project conditions.
(b) Details of horticulture crops as originally planned with monthwise/seasonwise water requirement.
(c) Details of horticulture crops grown at present and water supplied (month wise / seasionwise)
(d) Details of horticulture crops proposed as a part of modernisation alongwith water requirement (monthwise/seasonwise)

9. **Others** – Like Domestic & industrial water supply, power generation, navigation etc. Similar details as in 7 and 8 may be furnished.

10. **Demand Table** - The demand table covering the water requirement in para –6, 7, 8 & 9 may be prepared as per Annexure-10 Part-II.

11. **Impact of modernisation proposal on existing, ongoing and proposed projects in the basin.**

(a)Upstream projects
(b)Downstream projects

12. **International/interstate aspects**

1(a) Impact on international agreements/tribunal awards
1(b) Impact on interstate agreements/tribunal awards
1(c) Impact on existing/ongoing/proposed projects in the other states/countries to the extent information can be collected with reasonable efforts.
2. In respect of Irrigation Projects on western rivers of Indus Basin, the following shall be necessary and followed :-
   (a) Every efforts shall be made to harness the potential of the water resources and hydropower to the maximum extent permissible under the treaty.
   (b) The design, construction, initial filling and operation of projects shall conform to the provisions of the Indus waters treaty, 1960.
   (c) A chapter showing compliance to this effect shall be included in the detailed project report (DPR).

(d) In irrigation schemes, the irrigated cropped area (ICA) shall conform to the provisions of Indus Waters Treaty, 1960.

13. Canal system

The following points and additional points, if any, as relevant to the project shall be discussed in details under this chapter.

Note:- Where the information is asked in form of table(s), it will be followed by discussions of tabulated data.

13.1 Hydraulic Survey of the Canal System.

13.2 Field measurement of seepage losses in main/branch/distributary/minor/sub-minor/water courses (Annexure-2)

13.3 Review of the capacity of existing canals (Annexure-3)

(a) Original design capacity
(b) Present capacity
(c) Its sufficiency or otherwise for the proposed peak requirement including rash irrigation
(d) Design of revised section (lined/unlined)

13.4 Identification of the reaches needing improvements (Annexure-2 & 4)

(a) Lining
(b) Re-sectioning
(c) Strengthening/stabilisation of banks

13.5 Preparation of capacity statement showing discharges from main canal, each branch canal worked out from tail to head taking into account transmission losses as per IS 5968-1970 (Annexure-11 Part-II)

13.6 Need for remodeling and extension of existing canal system/new canals and distribution system.

13.7 Review of the existing canal structures and needs for additional structures and/or remodeling.

(a) Head works
(b) Outlets (number, size, location, command area)
(c) Cross regulators
(d) Escapes including terminal
(e) Cross drainage works
(f) Conversion of inlets into cross drainage works

(g) Bridges
(h) Water measuring devices.

13.8 Estimation of conveyance (canal and distribution system) efficiency

13.9 Gross Water requirements at the canal head (Annexure-10 Part-II)

(a)Irrigation crop-wise, season-wise (para-6)
(b)Pisciculture (para-7)
(c)Horticulture (para-8)
(d)Domestic water supply (para-9)
(e)Industrial water supply (para-9)
(f)Power generation (para-9)
(g)Navigation (para-9)
(h)Others (para-9)

13.10 Availability of river supplies and storages

(a)Their efficiency to meet diversion requirements based on ten daily/monthly reservoir operation tables, for sufficient number of years (Annexure-12 Part-II).

(b) If the available supplies are not adequate and the head-works not capable to divert the peak requirements into the canal system, the head-works, may be redesigned suitably based on proper investigations after examining the possibility of

(i) Raising the F.R.L. of the reservoir.
(ii) Providing back-up storage for diversion structures.
(iii) Raising the pond level of the diversion works by installing mechanically/electrically operated gates on the diversion weir.
(iv) Supplementing water supply by exploitation of ground water

(c) If there is no possibility of increasing storage/pondage to the required extent or providing the necessary back-up storage or supplementary water supplies by ground water, the cropping pattern/irrigation intensity/area to be irrigated may be suitably adjusted to match the availability of the supplies and the pattern of diversion requirements.

13.11 Details of land-water budgeting showing whether land available is more than corresponding quantity of water or vice-versa.

13.12 Intensity of irrigation crop-wise (season-wise)

(a) Pre project
(b) As originally proposed
(d) As actually attained
(e) As proposed in post-modernisation stage.

Note : Irrigation includes pisiculture, horticulture and others.

13.13 Water Quality

(a) Period of study
(b) Physical, chemical and bacteriological

(i) Salinity
(ii) pH
(iii) SAR
(iv) Boron, Phosphorus, Fluoride

Studies should be made for upstream, reservoir and downstream areas.

Reasons for variation in water quality parameters should be studied and described. Measures for improvement in water quality should also be described and provided for in the project.

14. Power

14.1 Present Status

If there is any installed capacity in the project proposed to be modernised, its details i.e. installed capacity, unit size, load factor, type & size of power house, type of turbines, rated head, rated/design unit discharge, specific speed generator type, capacity, voltage, power benefits & firm power/Energy generation, type of station i.e. peaking or non-peaking etc. may be discussed.

14.2 Modernisation / Uprating proposal

Impact of modernisation proposal on the existing power generation may be discussed and alternative arrangements for power generation, if any, in case of adverse impact on existing power generation, may be discussed. If there is any proposal for modernisation of the power plant, that may also be discussed here. Details of power evacuation arrangement and adequacy of the existing evacuation system to evacuate the enhanced power may be given.

Detailed information also to be furnished for existing/proposed system for lift canal or other pumping system for drinking water supply system including power requirements & sources of power for lift/pumping schemes.

15. Navigation

Impact of modernisation proposal on navigation may be discussed. Remedial measures, if any, may also be discussed and provided for.

16. Ground Water

The following points and additional points, if any, as relevant to the project shall be discussed in details under this chapter.

16.1 Depth of ground water level — Present

(a) Pre-monsoon

(b) Post-monsoon

16.2 Assessment of the Ground Water potential in the Command Area :

(a) Total potential

(b) Present use

(c) Balance for future utilisation

16.3 Quality of Ground Water (Salinity, P, SAR, B,F, etc.) - Suitability for Irrigation & drinking.

16.4 Assessment of possible impact on Ground Water recharge due to canal lining and ground water utilisation and action taken for its replenishment.

16.5 Identification of areas where ground water

(a) Can be exploited economically

(b) Cannot be exploited due to non-availability of ground water aquifer or the quality being not suitable.

16.6 Conjunctive use of surface and ground waters -identification of areas where this is possible, such as areas of rising water table and detailed proposals may be formulated as per CWC guidelines for planning conjunctive use of surface and groundwaters in irrigation projects (see Annexure-7 part-II).

16.7 Possibility of ground water utilisation for irrigation areas not commanded by the canal system.

17. Drainage and land reclaimation

The following points and additional points, if any, as relevant to the project shall be discussed in details under this chapter.

17.1 Review of existing drainage system

(a) Maximum 1, 2 and 3 day rainfall in the command.

(b) Assessment of water logging, soil salinity, alkalinity.

(c) Identification of areas needing drainage and reclamation.
(d) Length of the existing drains and its intensity per sq.km of GCA.

17.2 Type of drainage needed with proposals
(a) Surface drainage
(b) Sub-surface drainage
(c) Vertical drainage (tubewells).

17.3 Type of reclaimation needed with proposal
(a) Soil salinity
(b) Alkalinity
(c) Sodicity

18. Land acquisition, rehabilitation and resettlement

18.1 Land acquisition category-wise i.e. Government, forest, private land proposed to be acquired may be furnished for various components of the project as under:

(a) Dam /Reservoir
(b) Main canals/branch canals
(c) Distribution System
(d) Drainage improvement
(e) O.F.D. Works

18.2 Rehabilitation/resettlement

(a) No. of villages affected (partly / fully)
(b) No. of families/population affected
(c) Proposals for R&R - Definition of family and R&R package are to be in accordance with the State Government's policy on R&R/National policy on R&R (as & when finalised). Detailed breakup of families / population in the ST/SC/OBC and general categories be given.

19. Water management and maintenance

The following points and additional points, if any, as relevant to the project shall be discussed in detail under this chapter.

19.1 Review of existing system of operation, maintenance and distribution.(CWC's Guidelines issued in March, 1997 may please referred to).

19.2 Water Users Associations (WUA)/Participating Irrigation Management (PIM).

The existing set up, if any may be described. The proposals for formation of WUAs alongwith their constitution, powers, functions etc. may be described.

19.3 Water supplied

Existing/Proposed

(a) Irrigation
(b) Drinking Water
(c) Industrial
(d) Power Generation
(e) Others

19.4 Improvements proposed

(a) Scope of introduction of modern technology like sprinkler, drip irrigation etc. specially in lift schemes
(b) Ground water recharging/conjunctive use
(c) Use of poor quality water
(d) Recycling of drainage water
(e) Instrumentation for assessing day to day canal requirement accurately.
(f) Canal automation
(g) Any other improvements.

20. On farm development works

The following points and additional points, if any, as relevant to the project shall be discussed in detail under this chapter.

20.1 Review of the present on-farm development works and proposed improvements
(a) Water courses, field channels and field drains
(b) Land leveling and land shaping

20.2 Status of individual holdings
(a) Land holdings
(b) Land consolidation (past efforts)
(c) Deficiencies and proposals for improvements.

20.3 Extension services – Details of existing and proposed services under different ongoing programmes of agriculture and other departments and those proposed under modernisation proposal should be furnished.
(a) Trial-cum-demonstration farms, demonstration on farmer's fields, package programs etc.
(b) Dissemination of information to the farmers through audio-visual media, like radio, television, films etc.

(c) Farmers' Training
(d) Others

20.4 Facilities for input supplies – Details of existing and proposed facilities under various ongoing schemes/programmes and proposals under modernisation proposals may be furnished.
(a) Institutional finance
(b) Agricultural credit
(c) Seeds
(d) Fertilizers
(e) Pesticides
(f) Weedicides

20.5 Infra-structural facilities-existing and proposed
(a) Roads including ayacut and farm roads.
(b) Railways
(c) Navigable water ways
(d) Airfields
(e) Grain stroage
(f) Agro-processing
(g) Agro-servicing
(h) Animal husbandry
(i) Poultry
(j) Dairying
(k) Markets (mandis)
(l) Any other

20.6 Communieation facilities-existing and proposed
(a) Telephone
(b) Telegraph
(c) Wireless
(d) E-Mail, Internet, NIC NET

21. Construction programme

Works should be planned for a period of 5 years. If required the project can be taken up in stages & phases rather than planning completion of the project over a long period. Detailed construction programme split into different packages may be given

21.1 Physical
21.2 Financial

22. Construction organisation

22.1 Organisation set-up for execution (including quality control) of the modernisation works with justification.

22.2 Organisation set-up for execution of OFD works with justification.

23. Environment, Ecology and Forest aspects
(details as per Para 17 Section-3 Part-II)

As per MOEF's notification, environmental clearance is required if the project is estimated to cost more than Rs. 50 crores. Forest clearance would be required if diversion of forest land is envisaged. Clearance of R&R Action plan is required if population affected/displaced is tribal.

24. Economic evaluation

Guidelines for economic evaluation of projects as given in Chapter-7 Part-I & Para 21 Section-3 Part-II applicable for modernisation projects as well.

The following points and additional points, if any, as relevant to the project shall be discussed in details under this chapter.

24.1 Cost Estimates
(a)Modernisation Works (Details as per para 18, Section-3, Part-II)
(b)Existing Works

24.2 Benefits.

24.3 Operation and maintenance charges
(a)Present
(b)Proposed

24.4 Water rates from irrigation, drinking water, industrial water supply, power generation etc.
(a) Present
(b) Proposed

24.5 Betterment Levy
(a) Present
(b) Proposed

24.6 Assessment of crop yields Quintals Quintals/M Cum. Quintals/ha
(a) Pre project
(b) Pre-modernisation
(c) Post-modernisation

24.7 Benefit Cost Ratio

24.8 Internal Rate of Return (IRR)

24.9 Financial Return.

24.10 Baseline survey & development of parameters for evaluation of the performance of the project at regular intervals say 5 years after completion of the project.

25. Administrative and legislative provisions

The following points and additional points, if any, as relevant to the project shall be discussed in details under this chapter.

25.1 Measures and procedures
(a) Deficiencies in existing measures and procedures
(b) Proposed measures to overcome or remove the deficiencies.

25.2 Assessment and mode of collection of revenue
(a) Existing
(b) Modification proposed, if any

25.3 Assessment and mode of collection of betterment levy
(a) Existing.
(b) Modification proposed, if any.

26. Facilities for training the operational and maintenance personnel

The following points and additional points, if any, relevant to the project shall be discussed in details under this chapter.

26.1 Existing.

26.2 Proposals for improvement and extension.

Annexure – 1

CROPPING PATTERN

(i) Pre-project Cropping pattern
(ii) Cropping pattern as provided in the original project
(iii) Cropping pattern as developed at present
(iv) Proposed cropping pattern under Modernisation Scheme

Crop with variety	Growing period		Area in hectares Percentage of CCA			
	Optimum sowing Date	Optimum maturity date	Pre-project	As provided in the original report	As developed at present	Under modernisation
1	2	3	4	5	6	7
Kharif						
i)						
ii)						
iii)						
Sub Total						
Rabi						
i)						
ii)						
iii)						
Sub Total						
Summer						
i)						
ii)						
iii)						
Sub Total						
Perennial and other Crops						
i)						
ii)						
iii)						
Sub Total						
Grand Total:						

Annexure-2

Results of experiments of seepage losses from unlined/lined canals

S.No.	Name of channel	Site of experi-ment	Type of soil	Dates of observations	Discharge in cubic meter		Testing method	Seepage losses in cum/million sq. meter of wetted surface	Remarks
					At head	At site of test			
1	2	3	4	5	6	7	8	9	10
							Ponding method/ inflow-outflow method		

$$\text{Average seepage losses} = \frac{\text{Total of seepage losses}}{\text{No. of observations}}$$

Annexure-3

Particulars of Canal System

Sl. No.	Canal System	Length in km.	Lined or Unlined	Designed Capacity as originally provided (m3/sec.)	Designed Capacity as at present m3/sec.	Designed Capacity as envisaged under modernisation scheme m3/sec.	Remarks
1	2	3	4	5	6	7	8
(I)	Main Canal (s)						
(II)	Branches						
(III)	Distributaries						
(IV)	Minors						
Total (where applicable)							

Note: Information to be furnished for each main/branch canal/distributary separately for different reaches

Annexure-4

Statement showing water saved due to lining

Sl. No.	Name of Channel	Reaches to be lined		Total length to be lined	Discharge in the beginning of the reaches in $m^3/sec.$	Channel Dimensions before lining			Losses actually observed in unlined state	Channel dimension after lining			Losses in the lined state (based on other observed data)	Total water saved due to lining (col..9-13) in cumec
		From	To			Bed width **B** (meter)	Water Depth **D** (meter)	Wetted peri-meter with side slopes		Bed width **B** (meter)	Water Depth **D** (meter)	Wetted perimeter with side slopes		
1	2	3		4	5	6	7	8	9	10	11	12	13	14
1.	Main Canal													
2.	Branches													
3.	Distributaries													
4.	Water courses													

LIST OF DRAWINGS

1. Existing layout plan of the headwork and appurtenances with super imposed proposed changes.

2. Existing cross-section of earth / rockfill dam, non-overflow concrete/masonry power dam section, spillway, regulator etc. with super imposed changes in these sections.

3. Existing power generation/transmission network with super imposed changes in these sections, if any.

4. Contour plan of the sample command (scale 1: 10,000 contour interval 0.5 m) showing the existing alignment of existing canal, location of structures, off-taking channels with details of discharge, bed level, FSL, both of the canal and the off-taking channel at the point of off-taking culturable command area under each channel etc.

5. Contour plan of the sample command (scale 1:10,000 contour interval 0.5 m) showing the proposed alignment of the canal, location of structures off-taking channels with details of discharge, bed level, FSL both of the canal and the off-taking channel at the point of off-take, culturable command area under each channel etc.

6. Condensed existing L-Section of the canal showing the location of the existing structures, off taking channel, bed level, full supply level, bed slope and condition thereof.

7. Condensed L-Section of the canal showing the location of the proposed structures, off-taking channel, bed level, full supply level, bed slope etc.

8. Typical cross-section of the existing canal super-imposed with the proposed section.

9. Contoured layout plan, L-Section and Cross Section of major new/proposed to be remodeled canal structures with location of the bore hole drilled, pits excavated shown on the plan and the log on the cross-sections.

10. Plan showing the classification of soils available in the command.

11. Land capability classification map of the command

12. Land irrigability classification map of command with boundaries of the area having different constraints and pre and post monsoon ground water contours.

13. Map showing existing area under irrigation and additional area proposed through modernisation.

14. Map showing the ground water potential areas.

15. Map showing the water logged and other problematic areas indicating the problems.

16. Map showing the sub-surface water quality in the command

17. Map showing depth to ground water in the Command Area (These maps are available with State/Central Ground Water Boards).

PART – IV

COMMAND AREA DEVELOPMENT

FORMAT FOR SUBMISSION OF DETAILED PROJECT REPORTS (DPRs)

For a systematic development of the Command Area, it is essential to prepare a comprehensive project report of all the activities to be taken up under the Command. Earlier this Ministry had issued guidelines for formulation of project reports for inclusion of new projects vide letter no. 15-1/90-CAD dated 19th April 1990. Under the restructured CADWM Programme, it has been decided that with effect from FY 2004-05 for a period of three years during X plan and beginning each future Five Year Plan, all State Governments will be required to submit a fresh project report in respect of all continuing or new projects as the case may be for assessment of the works already completed and left out, assessment of the physical and financial progress made so far, availability of financial resources during the Plan Period, prioritisation of the works proposed to the taken up during the Plan period, status and extent of the Participatory programme in the State/Projects, level of involvement of the WUAs in paying requisite contributions for execution of works, and possibility of handing over of the system to them.

The objective of the detailed project report shall be:

a. To provide in-depth analysis of the past efforts,

b. To evaluate the works done so far and to identify the constraints,

c. To adopt a holistic approach to the future development of the CAD infra-structure

d. To involve farmers at all levels,

e. To complete all CAD activities in only those outlet commands where WUAs have been formed and are effective,

f. WUAs are willing to take over the system - MOU signed in this regard

g. Willingness of the State irrigation Departments to hand over the system to the Distributaries Committees after completion of corrective measures in distributaries,

h. Evolution of suitable and sustainable measures for O&M of the distributaries and the micro level infrastructure

i. All activities under the outlet command to be taken up in an integrated manner and release to be made only after all the works in the outlet are completed.

The format Project Report shall be as under:

I. CONTENTS OF THE PROJECT REPORT

This should have three columns viz.; Serial No., Particulars and page No.

II. CHECK LIST

To be given at the beginning of the project report after index

a) Whether salient features of the project have been enclosed at the beginning of the report

b) Whether details of the canal Command viz; distributory-wise /minor-wise details of outlets to be covered under the programme together with relevant maps and other details have been included under salient features of the project

c) Whether the project has been cleared by the Planning Commission (except in case of minor irrigation schemes)

d) Whether more than 60% irrigation potential has been created in the project

e) Whether the State Government has approved the project for inclusion under CADWM Programme (Applicable in case of new projects being proposed for inclusion under CADWM programme) -

f) Whether Plan provision has been made in the State budget for providing matching share-

III. SALIENT FEATURES OF THE IRRIGATION PROJECT SHALL INCLUDE:

1	Location - Name of River basin, Tributary, Irrigation project headwork..	
	Type of dam, barrage etc.	
2	Canal Network:	
	A. Main and Branch Canals	

Canal	Name	CCA (Th. Ha.)	Disch - area at head (Cum-ecs)	No. of direct outlets	Length (Km.)	Portion lined (km.) (%)	Portion unlined (km.) (%)	No. of days of running on full discharge	Weather volumetric devises/- discharge measuring structures exist on the canals
Main	1. 2.								
Branch	1. 2. 3. 4.-								

B. Distributaries/ Minors/ Sub-minors

Canal	Total Length in Km.	Portion \lined (km.) (%)	Portion unlined (km.) (%)	Weather volumetric devises/discharge measuring structures exist
Distributaries				
Minors				

3	Hydrology of Catchment:							
	Catchment Area (Sq. Km.)	Average Rainfall. (mm)	Average Annual flow with years of assessment MCM	75% dependable yield(Design) MCM	75% yield (present MCM)	catchment Ground water yield (MCM)	Total yield MCM	Has the yield been affected due to upstream development- if so details.
4	storage:							
	Year of first impounding	Gross (MCM)	Dead MCM	Live (MCM)	FRL (m)	Extent of Evaporation losses MCM (%of present yield)	Average Rate of siltation MCM/year	Weather rules of operation exists

5	Give details of rules of operation:	
6	Give no. of structures provided at the time of construction on all canals.	
7	Has the project been revised at any time: Give details	
8	Has modernisation of the project/ canal been under taken at any stage/ give details.	
9	If yes, repeat information 1to 5 for the modernisation project.	

IV. SALIENT FEATURES OF THE CAD PROJECT.

1	Name of the CAD project. (Whether new/continuing - Year of inclusion if continuing).	
2	Name of State and CADA implementing the Project.	
3	Name of State, Districts and Blocks served by the Project Command. District wise area served by the Command in thousand hectares.	
4	Name, designation, address, phone, fax and e-mail of: a. Secretary level b. Chief Engineer level c. Administrator CADA d. SE level officers e. Organizational Structure	
5	Financial source of the project at State level - Whether State funds or through loans or through corporations.	
6	Estimated cost of the CAD project as originally envisaged at the time of inclusion under CAD programme,	
7	Has the CAD project executed through Foreign assistance at any stage wholly or partly? If yes details.	
8	Area served by the Command in Th. Ha.:	
	Gross Area of the Irrigation Project (Design)	
	CCA of the Irrigation project (Design)	
	Ultimate Irrigation Potential (Design).	

	Irrigation Potential created at the time of Inclusion under CADP								
	Irrigation Potential utilised at the time of inclusion under CADP								
	CCA/IP	At Inception	Area covered upto end of IX plan	CCA covered during 2002-03	CCA covered during 2003-04	Target 2004-05	Target 2005-06	Target 2006-07	Target 2004-07
	CCA included under the CADP								
	Irrg. Potential created								
	Irrigation potential utilized								
	Approximate year during which the irrigation potential is likely to be fully utilized.								
9	Physical Progress/Targets detail (Th. Ha):								
	Activity	As per Design Report	CCA covered upto end of IX Plan	CCA covered during 2002-03	CCA covered during 2003-04	Target 2004-05	Target 2005-06	Target 2006-07	Target 2004-07
	Field Channel (at least 20% lined)								
	Field Drain								
	Wara-bandi								
	Land leveling								
	Correction of system Deficiencies								
	Rehabilitation of existing MI tanks								
10.	Financial Progress/Targets (Rs. Lakh) :								
	Estimated Cost (latest) with year	Expenditure incurred upto end of IX Plan	Expenditure incurred during 2002-03	Expenditure incurred during 2003-04	Estimated Cost of Balance CAD Works and Likely year of Completion	Cost 2004-05	Target Cost 2005-06	Target Cost 2006-07	Target Cost 2004-07
	State								
	Central								
	Total								
11.	Intensity of irrigation (Crop season wise and annual)								

	(a) As project in Project Report (b) As envisaged after CAD	
12	Cropping pattern (Area/Percent of CCA) :	

Crop name	As envisaged in the Project Report				Present			
	Kharif	Rabi	Perennial	Total	Kharif	Rabi	Perennial	Total
Total								

13.	Whether consolidation of holdings would be necessary, if so, is there an enabling/ compulsory legislation. Status of consolidation of holdings in the State.	
14	Is it proposed to set up a new Command Area Development Authority (for new projects), if so. (a) The year by which this would be done. (b) What is likely level of appointment to the post of Administrator/Chairman. (c) Proposed Organisation structure.	
15	Area affected by water logging (ha.)/ salinity/alkalinity and indicate the norms for taking areas under water logging (enclose depths to groundwater map) a. any projects been taken up in the past? If so provide details of works included and completed, estimated cost and present expenditure. b. Extend of balance area to be covered. c. Area to proposed be covered during X Plan (2004-07).	
16	(a) Range of other activities to be undertaken under the CAD programme (please indicate yes or no) i. Consolidation of holding ii. Roads iii. Regulated markets iv. Modernisation of the system v. Processing industries vi. Change in cropping pattern/ practices vii. Intensive Agriculture Extension viii. Other (Specify) (b) Present status of above CAD activities.	
17	Information regarding small/marginal farmers: a. Total CCA b. Area held by marginal farmers (upto 1 .00 ha.) c. Area held by small farmers (upto 1.01 to 2.00 ha.) d. Percentage of marginal holdings to total number of holdings e. Percentage of small holdings to total number of holdings.	
18	i) What is the percentage (of total population of Scheduled Tribes in the command area ii) What is the percentage (of total population of /Scheduled Castes in the command Area.	
19	Whether irrigation component of the Project has been cleared by Planning Commission, if so the letter no. and date of clearance.	

20	Whether CAD component of the Project has been cleared by Planning Commission if so date of clearance.	
21	Whether provision for taking up of the project has been made in the 10^{th} Jan.	
22	Whether the project report along with the related maps has been enclosed or not along with above data.	
23	Total time required for completion of CAD Project	
24	Cost of the CAD Project as proposed and year-wise and Plan-wise has in of expenditure.	

V. TEXT OF THE REPORT

Chapter-1

INTRODUCTION

Introduction would cover broadly the location of the project area. The general topographical details relating to hilly areas or rivers or the drainage lines may also be included. This chapter would also highlight in brief the need of taking up the particular activity and the overall cost estimates and phasing of works.

Chapter-2

PROJECT DETAILS

This Chapter would briefly give the data on the following aspects:

i) General details of the area viz. geographical area district-wise gross area and culturable command area, etc.
ii) Physiography covering (a) climate, rainfall, location of rain gauge stations, equipments installed (b) temperature - maximum, minimum of all zones of project area with data (c) mean wind speed and their variations and (d) mean relative humidity. Other specific data relating to physiography may also be included.
iii) Rivers, drainage systems and other details of relief of command area. The availability of outfalls may be discussed in detail.
iv) Topography giving general details of country slopes as related with the irrigation slopes for flow or lift irrigation, land Specific features of general topography.
v) Soil survey details as per available data, methodology used for soil surveys, soil series, soil irri-gability and land-capability classification, soil maps as available. The suitable details indicating the fertility status of the soils and remedial measures for covering their deficiencies. Number and location of soil testing laboratories as available may also be given.
vi) General water availability giving hydrological conditions of the area, ground water, monitoring details such as depth of ground water, ground water fluctuation maps indicating the position obtained before the introduction of irrigation, /analysis of data for the assessment of rising/depleting trends of ground water, quality of ground water

along with details of the area under various limiting values of salinity and alkalinity indicators. Number and locations of water testing laboratories may also be given.

vii) Socio-economic status covering data on population, households, workers - rural/urban and literacy status etc.

viii) Land holding, land tenure and farm economy giving details of land holding series, frequency distribution, land values and tenures; and farm budget analysis dealing with farm income and expenditure on irrigated and un irrigated holdings.

Chapter 3

AVAILABLE WATER RESOURCES AT PROJECT HEAD

This chapter should give details of usual water availability at the project head in Kharif and Rabi seasons in normal rainfall year and the deficit rainfall year, the average and 75% annual and monsoon dependable flows as given in the project report and at present. Canal-wise details of allocation of water for irrigation at the head may be given.

Chapter 4

STATUS OF CONVEYANCE SYSTEM

This chapter should contain details relating to status of the existing conveyance system giving inter-alia details of existing deficiencies, which are hindering the water use efficiency, frequency of the O&M works, availability of funds for O&M, participation of Water Users' Associations etc. in the O&M activities. Details of potential created and utilized, other performance indicators, existing and proposed benchmarks may be given. Information on volumetric assessment of water at prominent points along with a map may also be provided. Has any study on seepage and other losses been made in the past, if so, provide details.

Chapter 5

IRRIGATION DEVELOPMENT OF COMMAND AREA

This chapter would highlight the project provisions in the sanctioned project estimate with reference to the intensity of irrigation to be achieved, cropping pattern adopted and the operation plan. Also it will discuss the development of irrigation in the command during the period of construction till its proposed inclusion, cropping pattern adopted and operation plan being followed. This chapter would broadly cover: -

i) Source of irrigation available in the command area,
ii) Details of irrigation network,
iii) Design/envisages flows in the system,
iv) Details of the network and gross area and culturable command area covered under each system,

v) Distributory-wise name of the outlet and their discharge and CCA.
vi) Status of linking of channel and construction of structures such as head works. bridges. escapes etc. on the alignment.
vii) Operational details of the system including rotational programme of various channels with discharges,
viii) Water account of all the distributaries/minors and its comparison with the design data. discussing the designed and achieved intensity of irrigation.
ix) Deficiencies in the supplies.
x) The system constraints and proposed action for taking remedial measures; and
xi) Cropping pattern designed in the Project estimate Region-wise.

Chapter 6

STATUS OF ON-FARM WATER MANAGEMENT SYSTEM

This chapter should contain details of prevailing On-Farm Water Management practices, need and the strategies to be adopted to bring about a switch over from the traditional and less efficient water management practices to improved and better water management practices in the command area.

Chapter 7

CROPS AND CROPPING PATTERN

This chapter would give the details of pre-project cropping pattern, present cropping pattern and cropping patterns to be promoted in future with a view to improve water use efficiency and increase production, productivity and income of the farmers.

Chapter 8

PROJECT OBJECTIVES AND PROPOSED WORKS

This chapter would highlight the details of the potential creation and utilisation with future targets. The details of the works proposed to be taken up for optimum utilisation of created potential and increase in agricultural productivity may be detailed. The works may include:

i) Correction of system deficiencies
ii) Construction of field channels/full package OFD works/ Underground pipeline
iii) Field drainage
iv) Warabandi
v) Ground Water Development/conjunctive use
vi) Adaptive trials and demonstrations and other agricultural extension activities
vii) Renovation Minor irrigation Tanks
viii) Formation of Water Users' Associations

ix) Monitoring and Evaluation
x) Training of fanners and technical staff
xi) Mechanism for maintenance of OFD works
xii) Any other work considered essential for development of command area including infrastructural facilities such as rural roads, market centres, rural go downs etc. through convergence with other schemes

All the items taken up for execution should be documented in details covering total assessment of work and line of action for taking up these activities in a systematic manner.

Chapter 9

STATUS OF DRAINAGE SYSTEM - WATERLOGGED AND SALINITY/ ALKALINITY AFFECTED AREAS AND CONCEPT OF BIO DRAINAGE

This chapter would identify all the areas affected with Water logging land salinity/alkalinity/proper assessment of these areas and their remedial measures may be given in details. This chapter may also include the findings of research institutions or agriculture universities and pilot studies as related with this subject.

Chapter 10

STATUS OF EXISTING MINOR IRRIGATION TANKS WITHIN THE COMMAND

This chapter should give complete status about Minor Irrigation Tanks including irrigation system and control structures existing within the command such as area originally commanded by the MI tank, area under irrigation now, status of conveyance system, the benefits that are likely to accrue as a result of renovation, whether farmers are willing to form Water Users' Associations and contribute 10% of the total estimated cost of renovation towards maintenance fund.

Chapter 11

ORGANISATION MANAGEMENTAND EXECUTION

a) Organizational Set up

This part would cover the proposals of the State Government for setting up the suitable CAD Authorities with the details of its Board of Directors (if not already done). The organizational set up at both State level and Project level may be given in detail.

b) Implementation schedule and cost estimates

This part would cover the assessment of workload under each activity to be taken up, specification of all the works in brief and cost estimates of the works and their phasing. The phasing should cover both the physical and financial aspects.

Chapter 12

TECHNICAL DETAILS OF THE WORKS TO BE CARRIED OUT – ACTIVITY WISE AND DETAILS

This chapter should cover design aspects of OFD works and other activities such as design details of field channels including regulatory structures under a given soil and topographic situation, O&M works to be carried out for correction of system deficiencies, design details of works for reclamation of water logged areas, renovation work to be done in case of MI tanks etc.

Chapter 13

PARTICIPATORY APPROACH TO IMPLEMENT THE PROGRAMME

This chapter should give salient features of PIM Act if already enacted in the State, the Status of formation of water Users' Associations, their viability and whether they are functional or not. If not functioning, reasons thereof and strategies being thought of for their revival.

Chapter 14

OPERATION AND MAINTENANCE

This chapter would highlight the existing set up dealing with operations and maintenance of the main canal system and delivery arrangements upto farmers holding and other OFD works. Legal status of provisions of regulatory Acts, methodology of achieving farmers' participation and collection of water charges etc. may also be detailed. Chapter may also provide details of rationalized structure of water charges as existing on date.

Chapter 15

AGRICULTURAL PRODUCTION AND INCOME, INFRASTRUCTURAL FACILITIES, FINANCING AND AGRICULTURAL CREDIT

This chapter would give the status of crop-wise areas irrigated being irrigated during pre-project and post- project periods. On development of irrigation shifts in areas from rain-fed areas to irrigated conditions may be given. The data on crop wise yields for pre-project/post-project should be utilised for working out the additional production and benefits that would accrue on full irrigation development. Methodology of crop cutting experiments to be conducted in the irrigated agriculture be also discussed.

The portion on infrastructural facilities shall include:

(i) Agricultural supporting services, (a) inputs viz seeds, fertilizers, pesticides etc. (b)T&V system of agricultural extension and (c) Agricultural Research indicating the list of Agriculture Universities, other research demonstration Institutions and extension education facilities as available
(ii) Roads
(iii) Market centers.
(iv) Other miscellaneous services such as plant protection, horticulture, soil and water testing, agro industries and other small/marginal farmers development agencies etc.
(v) Liaison with allied departments/institutions like WALMIs, Agriculture Universities and Departments, Research Institutes like ICAR and other rural development institutes in the area be discussed.

The portion on financing shall include details of mode of financing of the project. This will include the funds as made available by State, Centre and other Institutions. The details of accounting procedure to be adopted may also be indicated.

The portion on Agricultural Production - shall include the information on facility available for agricultural credit from various banks for proposed activities etc. The mechanism for arranging short and long term loans/credit to small/marginal farmers and other fanners may also be detailed.

Chapter 16

CONVERGENCE OF THE CADWM PROGRAMME WITH PROGRAMMES OF OTHER MINISTRIES

Various other Ministries of Government of India such as Ministry of Agriculture and Ministry of Rural Development are operating programmes/schemes, which have components relating to on-farm water management, ground water development, renovation of tanks etc. The provisions of such schemes can be used/dovetailed to benefit the farmers. Some of the schemes are mentioned below:

Schemes of Ministry of Agriculture:
a) <u>On-Farm Water Management</u> for Increasing Crop Production In Eastern India
b) <u>Development of Horticulture</u> through Plasticulture Interventions

Schemes of Ministry of Rural Development

a) <u>Swajal Dhara</u>- Drinking Water Sector and Hariyali - initiative in watershed development to strengthen role of Panchayati Raj Institutions in development process.

b) 2.Safe Drinking Water to all in rural sector by 2004 plan -outlay - Rs.14200 crores, 12.80 lakh habitations already covered. Only 15444 (1.09%) rural habitations yet to be covered.

c) 3.Desert Development Programme (DDP), Drought Prone Area Programme (DPAP)and Integrated Wasteland Development Programme (IWDP) – Area Under Treatment - 87.12 Lakh Hectares.

d) 4.Central Rural Sanitation Programme (CRSP)

Chapter 17

MONITORING AND EVALUATION

This chapter should contain details of the State level Committee set up by State Government in accordance with the provisions of the guidelines so as strengthen the monitoring of the CADWM Programme and thereby bring about a qualitative improvement in the implementation of the programme. It may also include details of information being compiled and mechanism of dissemination. This chapter may also include all evaluation studies done so far, whether for the project as a whole or for Specific component of the project with details of the findings thereof.

Annexure to DPRs

The Project Report should be accompanied by suitable annexure to each chapter and data/drawings relating to canal irrigation system, project areas, annual, rainfall and coefficient of variations, soil maps, ground water quality and fluctuation maps and other typical designs and specifications.

VI. ATTACHMENTS

1	Please attach the following on a suitable scale:- a. Catchment Area map of the Project showing all upstream works affecting the flow into the reservoirs. b. Attach full command Area maps showing all details of canals, branches, distributaries, Minors and outlets c. Attach maps in parts if the command is too large.
2	Provide a map of canal, branches, and distributaries, outlets with area commanded by each up to outlet level. Clearly indicate the outlets already saturated.
3	A map showing water logged areas within the command

PART – V

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   (c) Planning Commission's letter No. 16(12)/96-I&CAD dated 17.11.1997 and dated 7.1.1998, regarding investment clearance of medium projects.
   (d) Planning Commission's letter No. II-16(12)/1/90-I&CAD dated 10.10.1991 regarding procedure for submission and examination of flood control, drainage, anti-river erosion and anti-sea erosion projects.
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List of Abbreviations

CAD	- Command Area Development
CADA	- Command Area Development Authority
DPR	- Detailed Project Report
B.C. Ratio	- Benefit Cost Ratio
OFD	- On Farm Development
FRL	- Full Reservoir Level
MWL	- Maximum Water Level
MDDL	- Minimum Draw down Level
CDO	- Central Design Organization
CGWB	- Central Ground Water Board
CWC	- Central Water Commission
MoWR	- Ministry of Water Resources
CCA	- Culturable Command Area
GCA	- Gross Command Area
CPM	- Critical Path Method
PERT	- Program, Evaluation Review Technique
GIA	- Gross Irrigation Area
PCC	- Plain Cement Concrete
RCC	- Reinforced cement concrete
HRT	- Head Race Tunnel
TRT	- Tail Race Tunnel
RMR/Q	- Reach wise Rock properties
GPS	- Global Positioning System
DGPS	- Differential Global Positioning System
GIS	- Geological Survey of India
CSMRS	- Central Soil and Material Research Station
SAR	- Sodium Alkali Ratio
TWL	- Tail water Level
DSL	- Dead Storage Level
HFL	- Highest Flood Level
NIR	- Net Irrigation Requirement
FAO	- Food and Agricultural Requirement
WMD	- Water Management division
CSSRI	- Central Soil Salinity Research Institute
NIH	- National Institute of Hydrology
MW	- Mega Watt
KWH	- Kilo Watt Hour
RM&U	- Renovation, Modernization and Up gradation
IRR	- Internal Rate of Return
PVC	- Poly Vinyl Chloride
R/M	- Running & Maintenance
T&P	- Tool and Plants
PWD	- Public Works Department
COT	- Cut off Trench
IMD	- India Meteorological Department

GLOF	- Glacier Lake Outburst Flood
AR	- Autogressive
ARMA	- Autogressive Moving Average
WUA	- Water Users Associations
PIM	- Participatory Irrigation Management
R&R	- Resettlement & Rehabilitation
DRDA	- District Rural Development Agency
ICAR	- Indian Council of Agricultural Research
SAU	- State Agriculture University
ARDC	- Agricultural Refinance and Development Corporation

GLOSSARY

Afflux - The rise in the maximum flood level (HFL) upstream of the weir, caused due to construction of the weir across the river.

Alignment of Canal - (i) Watershed canal; (ii) Contour canal; (iii) Side slope canal

Aqueducts - Structure constructed when the HFL of the drain is sufficiently below the bottom of the canal so that tne drainage water flows freely under gravity.

Average yield of reservoir - The arithmetic average of the safe yield and the secondary yield over long period of time.

River Banks- The primary purpose of banks is to retain water.

Barrage - Most of the Ponding is done by gates and a smaller or nil part of it is done by the raised crest.

Basin Flooding - This method is a special type of check flooding and is adopted specially for orchard trees.

Benefit cost ratio - The expenditure on a project is justified if the annual benefits exceed the annual costs (including interest on the capital expenditure) i.e. B.C. ratio is more than one, normally, 1.5

Branch Canal - When a main canal bifurcates into branches covering the whole tract to be irrigated.

Canal falls - Whenever the available natural ground slope steeper than the designed bed slope of the channel, the difference is adjusted by constructing canal falls or a canal drop.

Canal Head Regulator - Provided at the head of the off-taking canal.

Canal Outlets or Modules - Small structure built at the head of the water course to connect it with a minor or distributory channel.

Cash Crop - Crop which has be en-cashed in the market for processing etc. e.g. jute, tea, cotton, tobacco, sugarcane etc.

Cattle Crossings - Arrangements for cattle, bullock carts etc. to swim across the canals.

Compacted Earth Lining - Soil is compacted at optimum moisture content (OMC). Use of this type of lining is restricted to the availability of suitable soils in the area.

Cement Concrete Lining - Made from selected aggregates are considered a high quality type of lining.

Consumptive Irrigation Requirement (CIR) - Amount of irrigation water required in order to meet the evapo-transpiration needs of the crop during its full growth.

Cross Drainage Works - Structure which is constructed at the crossing of a canal and a natural drain.

Culturable Command Area (CCA) -The total area on which cultivation is possible.

Dams - An obstruction or a barrier built across the stream of a river.

Dead Storage - Water stored in the reservoir below the minimum pool level.

Distributaries - Smaller channels, which take off from the branch canals and distribute their supply through outlets into water courses.

Duty of Water - Relationship between the volume of water and the area of crop it matures.

Effective rainfall - Precipitation falling during the growing period of a crop that is available to meet the evapo-transpiration needs of the crop.

Flood control reservoir - Stores a portion of the flood flows in such a way as to minimize the flood peaks at the areas to be protected down-stream.

Gravity Dam - Designed in such a way that its own weight resists the external forces.

Gross Command Area (GCA) - Total area which can be economically irrigated without considering the limitations of quantity of available water.

Hydro-electric Power - Energy of the flowing water is used to run the turbines.

Hydrology - The science that deals with depletion and replenishment of our water resources.

Inlets - Constructed in order to allow the drainage water to enter the canal.

Installed Capacity - The total capacity of all the turbine generator units installed in a power house.

Intensity of irrigation - The percentage of CCA proposed to be irrigated annually.

Jump - Hydraulic jump is the jump of water that takes place when a super – critical flow changes into a sub-critical flow.

Kharif-Rabi ratio or Crop ratio - Ratio of proposed areas to be irrigated in kharif season to that of in Rabi season (generally 1:2).

Launching apron - Stone pitching to protect sloping face extended beyond the toe on the bed.

Level Crossing - Canal water & drain water are allowed to intermingle with each other.

Lift Irrigation - Water is lifted up by some mechanical or manual means and then supplied for irrigation.

Lining of Canal - The channel earthen surface is lined with stable lining surface such as concrete, tiles, asphalt etc. to reduce the seepage losses.

Main Canal - Water from reservoir is taken into the main canal through the outlet sluices. There are generally two main canals which off-take from the reservoir, Left Bank Canal and Right Bank canal.

Minors - Small channels taken off from the distributaries, so as to supply water to the cultivators at a point nearer to their fields.

Multipurpose Reservoir - Planned & constructed to serve various purposes together.

Net Irrigation Requirement - Amount of irrigation water required in order to meet the evapo-transpiration needs of the crop as well as other needs such as leaching.

Optimum Utilization of Irrigation Water - Generally means getting maximum benefits with any amount of water.

Outlets - Constructed to escape out the additional discharge at suitable site.

Penstocks - Huge diameter pipes which carry water under pressure from the storage reservoir to the turbines.

Precipitation - The evaporated water comes back to the surface of the earth in its various forms of precipitation like rain, snow, hail etc.

Quality of Irrigation water - Water containing impurities, which are injurious to plant growth is not satisfactory for irrigation.

Rabi Crops - From 1st October to 31st March e.g. Wheat, Barley, Gram, Mustard, Potato etc.

Reservoir - When a barrier is constructed across some river in the form of a dam, water gets stored up on the upstream side of the barrier, forming a pool of water.

Rock filled Dam - Characteristics lying somewhere between gravity dams and those of earthen dams.

Run Off - The portion of the precipitation that makes its way towards rivers or oceans, etc as surface or sub-surface flow.

Secondary Yield - Water available in excess of safe yield during periods of high flows.

Spillway - Structure constructed at a dam site, for effectively disposing of the dam surplus water from upstream to downstream.

Storage Capacity - This is the most important physical characteristics of a reservoir and determined from the contour maps of the area.

Tail race - The channel into which the water is discharged after passing through the turbine.

Useful Storage - The volume of water stored in the reservoir between the minimum pool and normal pool levels.

Valley Storage - Variable amount of water stored in the stream channel.

Water courses - Small channels excavated by cultivators so as to take water from the govt. owned outlet point provided in the distributory or the minor.

Water requirements of a crop - Total quantity and the way in which a crop requires water, from the time it is sown to the time it is harvested.

Weir - Major part or the entire ponding of the water is achieved by a raised crest and a smaller part or nil part it is achieved by the shutters.

Yield of reservoir - Amount of water that can be drawn from the reservoir in a certain interval of time.

Zoned Embankment - Usually provided with a central impervious core, covered by a comparatively pervious transition zone, which is finally surrounded by a much more pervious outer zone.

Conversion Factors

LENGTH

1 Inch (in)	= 25.4 Millimeter (mm)
	= 2.54 Centimeter (cm)
1 cm	= 0.394 Feet (ft)
1 Meter (m)	= 3.281 Feet (ft)
1 ft.	= 30.48 cm
1 Kilometer (km.)	= 0.621 mile
1 mile	= 1.61 km.

AREA

1 Square Meter (m^2)	= 10.764 Square Feet (ft^2)
1 ft^2	= 0.093 m^2
1 Hectare (ha)	= 2.47 Acre
	= 10,000m^2
1 Acre	= 0.405 ha
	= 43,560 ft^2
1 Square Kilometer (km^2)	= 0.386 $mile^2$
	= 100 ha
1 $mile^2$	= 2.59 km^2
	= 259 ha
	= 640 Acres

VOLUME

1 Cubic Meter (m^3)	= 35.315 Cubic Feet (ft^3)
	= 1 Kiloliter
	= 1,000 litres
1 ft^3	= 0.0283 m^3
	= 28.32 litres
	= 6.23 UK Gallons
1 UK Gallon	= 4.564 litres
	= 0.1605 ft^3
1 Acre Feet (Acre ft)	= 1233.48 m^3
1 m^3	= 0.00081 Acre ft
1 Hectare Meter (ha m)	= 8.10 Acre ft
	= 10,000 m^3
1 Acre ft	= 0.1233 ha m
	= 43,560 ft^3
1 Million Cubic (Mn^3)	= 810.71 Acre ft
1 Million Acre Feet (MAF)	= 1233.48 Mm^3
1 Mm^3	= 0.00081 MAF

1 Million Cubic Feet (Mft^3)	= 0.0283 Mm^3
1 Mm^3	= 35.315 Mft^3
1Thousand Million Cubic Feet (TMC)	= 28.317 Mm^3
	= 22956.87 Acre ft
1 Mm^3	= 0.0353TMC
1 Cubic Kilometer (km^3)	= 1 Billion Cubic Meter (BCM)
	= 0.81 MAF
	= 10^9 m^3
	= 1 million m^3
	= 0.10 Million ha m
1 MAF	= 1.233 km^3 or BCM
	= 43.56 TMC

ENERGY

1 Kilowatt hour (kWh)	= 1.341 Horse Power hour (hph)
	= 3.6 x 10^6 Joules (J)
	= 859.85 kilo-calories (kcal)
1 J	= 2.778 x 10^7 kWh
1 kcal	= 1,000 calories
	= 0.001163 kWh
	= 4186.8 J
1hph	= 0.746 kWh
	= 2544.43 British Thermal Units (Btu)
1Btu	= 1055.06 J
1 Gegawatt hour (GWh)	= 10^6 kWh.
	= 10^3 Megawatt hour (MWh)

POWER

1 Horse Power (hp)	= 0.746 kW
	= 550 ftlb/sec
1 Kilowatt (kw)	= 1000 Watts (W)
1 Mega Watt (MW)	= 1000 KW
1Gega Watt (GW)	= 1000 MW

DENSITY

1 Gram per Cubtc Centimeter (g/cm^3)	= 1000 kilograms per Cubic Meter (kg/m^3)
	= 0.0361 Pound per Cubic Inch (lb/in^3)
1 lb/in^3	= 27.7g/cm^3
1 Tonne per Cubic Meter (t/m^3)	= 0.361 lm/in^3
1 lb/in^3	= 27.7 t/m^3

TEMPERATURE

1 Fahrenheit (°F)	= 1.8 °C +32
1 Celsius (°C)	= 0.56(°F-32)
1 Kelvin (°K)	= °C +273.15
	= 0.56 (°F+459.67)
1 °C	= °K – 273.15
1 °F	= 1.8 °K – 459.67

DISCHARGE

1 Cubic Meter per sec (m^3/sec.)	= 35.315 Cubic Feet per sec (ft^3/sec)
	= 1000 liters/sec
1 ft^3/sec	= 0.0283 m^3/sec
1 ft^3/sec per day	= 1.984 Acer ft per day
1 Million Gallons per day	= 1.858 ft^3/sec

VELOCITY

1 Meter per second (m/sec)	= 3.281 Feet per second (ft/sec)
1 ft/sec	= 0.3048 m/sec
1 Kilometer per hour (km/hr)	= 0.621 Mile per hour (mph)
1 mph	= 1.61 km/hr

WEIGHT

1 Gram (g)	= 1,000 Milligrams (mg)
1 Kilogram (kg)	= 1,000 g
	= 2.205 Pounds (lb)
1 lb	= 0.454 kg
1 Tonne (T)	= 0.9842 Tons
	= 1,000 kg
1 Ton	= 1016 kg
	= 2240lb

No. 27/6/98-P.I
Government of India
Ministry of Water Resources
(Project-I Section)
....

New Delhi, the 12th May, 1999

OFFICE MEMORANDUM

SUBJECT : SETTING UP OF A WORKING GROUP TO UPDATE THE "WORKING GROUP REPORT GUIDELINES FOR PREPARATION OF DETAILED PROJECT REPORTS OF IRRIGATION AND OF IRRIGATION 1980.

Guidelines for preparation of detailed project reports of irrigation and multipurpose projects were brought out issued by the then ministry of Irrigation, Government of India during 1980 on the recommendations of Working Group constituted vide letter No. 4/6/77-DW-11 dated 24.10.1977 and 8.2.1078. In view of the various changes that have taken place in the project formulation, funding and execution of the projects in the last 17 years, it has become necessary to review and update these guidelines.

2.0 It has therefore been decided to constitute a Working Group with the following composition :-

SI. No.	Name, Designation and Address	
1.	Chief Engineer (PPO) Central Water Commission 801(SW), Sewa Bhawan, R.K. Puram, New Delhi	Chairman
2.	Shri D.R..Chakraborty, Chief Engineer (I) Irrigation & Waterways Dept. Govt. of West Bengal Jalsampad Bhavan, Salt Lake, Calcutta-700091	Member
3.	Chief Engineer, Investigation I&CAD Department, Govt. of Andhra Pradesh, Errammanzil, Hydrabad	Member

4. Shri V.K. Sarvaiya, — Member
Chief Engineer (Irrg.Projects) & Joint Secretary,
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Narmada, Water Resources and
Water Supply Department,
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5. Er. S.K. Mohanty, — Member
Chief Engineer,
Project Planning & Formulation,
Orissa, Secha Sadan, Bhubneswar

6. Shri S.V. Sodal, — Member
Chief Engineer (WR) & Joint Secretary,
Irrigation Department
II Floor, Mantralaya, Mumbai-400 032

7. Engineer-In-Chief — Member
Water Resources Development Organisation,
Govt. of Karnataka,
Ananda Rao Circle,
Bangalore – 560 009

8. Engineer-In Chief — Member
Water Resources Organisation
Public Works Department,
Chepauk, Chennai – 600 005

9. Shri K.K. Narang — Member
Director (I&CAD),
Room No. 446, Yojana Bhawan,
Sansad Marg, New Delhi-110 001

10. Dr. S. Bhaumik, — Member
Addl. Director,
Ministry of Environment & Forest
Paryavaran Bhawan, CGO Complex,
Lodhi Road, New Delhi

11. Shri S.C. Awasthi — Member
Sr. Joint Commissioner (CAD),
Ministry of Water Resources,
Room No. 107, B-Wing, Shastri Bhawan,
New Delhi – 110 001

12.	Shri N.B.G. Tilak, Deputy Director General, Operation: M.P. GSI, E/5 Area Colony, Bhopal – 462 016	Member
13.	Shri M.M. Rawal, Director (HP-I), Central Electricity Authority, Room No. 403 (N), Sewa Bhawan, R.K. Puram, New Delhi – 110 066	Member
14.	Shri Lokesh Jha, Deputy Secretary, Ministry of Social Justice & Empowerment, New Delhi.	Member
15.	Shri K.P.S. Verma Deputy Commissioner, Water Management, Ministry of Agriculture & Cooperation Room No. 300-A, Krishi Bhawan, New Delhi	Member
16.	Shri A.D. Joseph, Scientist – D, Central Ground Water Board, New CGO Complex, NH-IV, Faridabad – 121 001	Member
17.	Dr. B.R. Sharma, Asstt. Director General (IWM), Indian Council of Agriculture Research, Room No. 222-A, Krishi Bhawan, New Delhi – 10 001	Member
18.	Director (FM-I), CWC	Member
19.	Director BCD (N&W&NWS), CWC	Member
20.	Director (Cost Appraisal Irrigation), CWC	Member
21.	Director (Economics), CWC	Member
22.	Director (Hydrology NE), CWC	Member
23.	Director (Irrigation Planning)	Member
24.	**Shri B.G. Kaushik, Director (PP-Central)**	**Member Secretary**

3.0 The terms of reference of the Committee are:

(a) To review the guide-lines brought out in 1980 on the basis of experience gained in the use of the guidelines by State Government and scrutiny of the project reports in CWC for the last 17 years.

(i) To suggest / review the norms for assessment of benefits and cost for analysis regarding cost effectiveness of the project.

(ii) To prepare the norms for preparation of project report for modernization schemes including the conjunctive use of ground and surface water.

(iii) To review the norms and manner for preparation of a project report for command area development which have to form an integral part of the project.

(iv) To review the recommendation regarding the quantum and content of the infrastructure work which should be undertaken for the purposes of the preparing feasibility and detail project reports as well as enabling construction works such as haul roads, colonies etc. for undertaking the projects actually sanctioned.

(b) To review/update these guidelines and norms based on the latest circulars, letters and other communications issued by planning commission, ministry of water resources and CWC.

(c) To make the guidelines more comprehensive by incorporation the details required by the Ministry of Environment and Forest for clearance of the projects from environmental/forest angle and by Ministry of Welfare for clearance of resettlement and rehabilitation plans for the project affected persons.

(d) Any other recommendation regarding formulation and scrutiny of the project.

The working group will submit its report within six months. The expenditure on the TA/DA of the officers on account of the meetings of the working groups will be borne by the concern state government/departments.

Sd/-
(J.L. CHUGH)
UNDER SECRETARY TO THE GOVERNMENT OF INDIA

No. 27/6/98-P.I
Government of India
Ministry of Water Resources
(Project-1 Section)

New Delhi: the 3rd March, 2000

To

Shri B.G. Kaushik
Director PPO(c)
Central Water Commission
New Delhi.

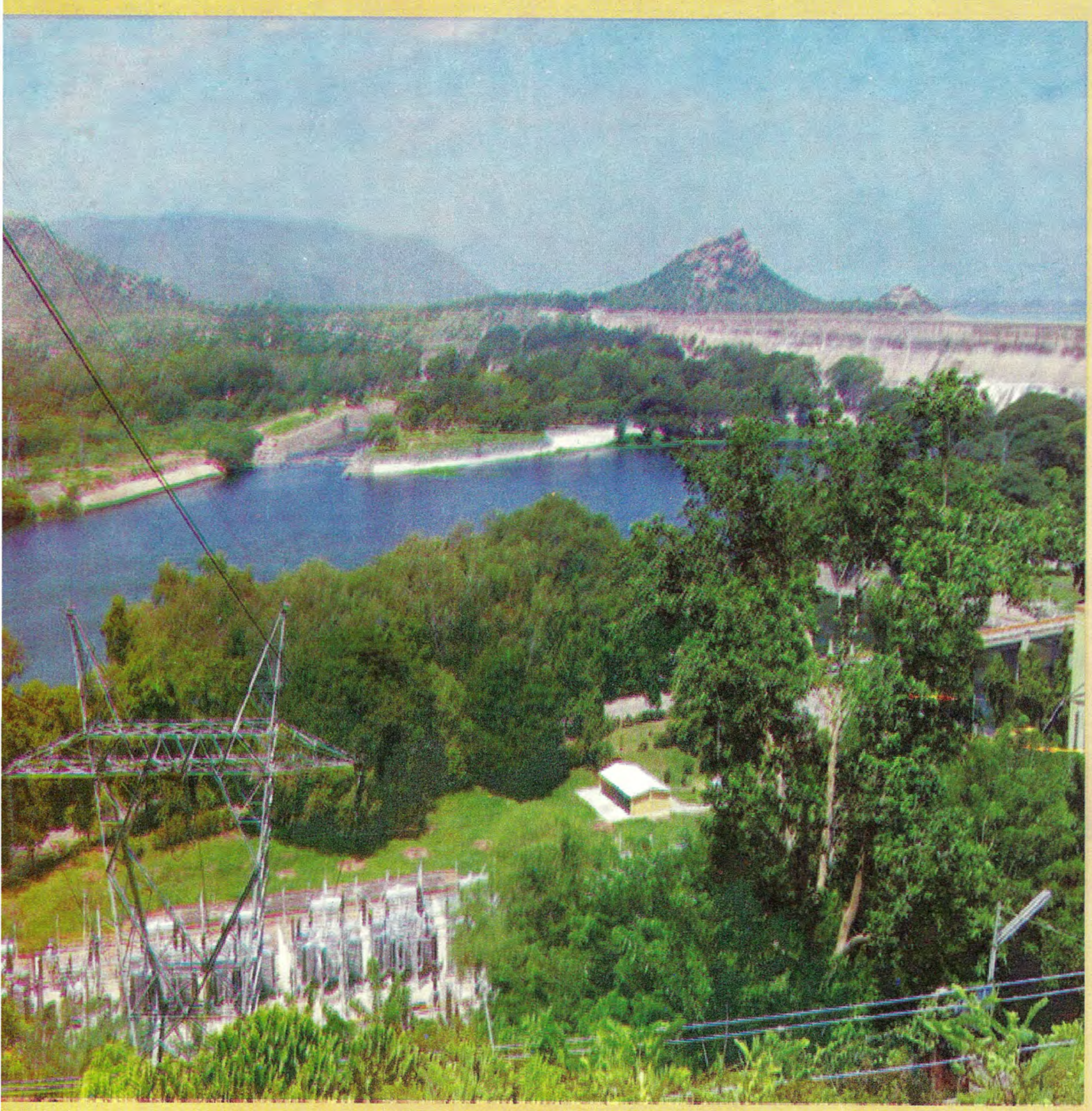
Subject : Updating of "guidelines for preparation of detailed project Reports of Irrigation and Multipurpose projects"- extension of time limit for submission of the Report.

Sir,

I am directed to refer to your I.D. Note No. 2/265/96-P/P/0/361 dated 16.11.1999 on the above - mentioned subject and to say that the Secretary (WR) has agreed for constituting the Working Group by designation and extending the time limit by April. 2000 for submitting the Working Group Report.

Further, it is also intimated that Chairman Working Group has also been authorized to invite/coopt officers of any other concerned specialized organizations.

Sd/-
(R.C. MEENA)
Under Secretary to the Govt. of India



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