WORKING GROUP REPORT

GUIDELINES FOR PREPARATION OF DETAILED PROJECT REPORTS OF IRRIGATION AND MULTIPURPOSE PROJECTS

GOVERNMENT OF INDIA
MINISTRY OF IRRIGATION
1980

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MULTIPURPOSE PROJECTS

VOLUMES I, II & III

GOVERNMENT OF INDIA
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VOLUME I

REPORT

CHAPTER I

INTRODUCTION

1.1 Present status of preparation of project report

1.1.1 A large part of the outlay under the Five Year plans in the country has been in the field of Irrigation and Multipurpose Projects. These projects are investigated, formulated and implemented by the concerned State Governments. However, these are required to be accepted by the Planning Commission for inclusion in the plans before they are taken up for implementation by the concerned States.

1.1.2 The procedure for the formulation 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 in the Project Reports.

1.1.3 The Central Water Commission which has been entrusted with the responsibility of examination of technical and economic feasibility of Multipurpose and Major and Medium Irrigation Projects has issued to the States Guidelines for investigation of Major Irrigation and Hydro-electric Projects and Guidelines for preparation of Project estimates for Major and Multipurpose Projects. The Water Management Division of the Ministry of Agriculture has brought out technical bulletins for evaluating the water requirements of crops. The environmental and ecological aspects which have to be covered in the Project Reports have been outlined by the Department of Science and Technology.

1.1.4 Apart from the above the Indian Standards Institute has also prepared a number of Standards and Codes of Practices for carrying out investigations of projects and preparation of Detailed Project Reports. These cover a number of subjects such as, details of topographical surveys to be carried out, organisational set up required for carrying out investigations and methodology for preparation of Project Report.

1.1.5 However, it is observed that by and large, the Project Reports prepared are not inconformity with the guidelines and procedures and do not contain the data and details required for a proper appreciation of the project proposals and technical and economic assessment of the project. The extent and quality of investigations carried out are not upto the required standards. The Project Reports prepared are not satisfactory and the estimated costs are not realistic. This has often been the cause of frequent exchange of correspondence between the states and the various agencies charged with the task of techno-economic scrutiny of the project.

1.1.6 Experience of large number of Irrigation and Multipurpose Projects implemented so far shows that :

(i) In a number of cases the time taken for completion is considerably more than initially estimated and consequently benefits have been realised much later than expected.

(ii) The costs have been appreciably more than originally estimated and the returns have been smaller than anticipated.

While it is to be conceded that there has been a general escalation of prices of materials and wages, the extent of increase of project costs has exceeded the general price rise. Incomplete investigations, analysis and deficiency in the initial project planning are largely responsible for this state of affairs.

1.1.7 The present position in the country in respect of planning for water resources and preparation of Project Reports for approval of the Government of India were highlighted in the report of the Expert Committee on rise of costs of Irrigation and Multipurpose Projects, 1973. The Committee observed that there is no uniformity in the approach towards preparation of the Project Reports in the state. The paterns differ in detail.

One of the recommendations by this Committee was that the guidelines laid down by the CW&PC for the investigations to be carried out and preparation of the Project Report for approval of the Planning Commission should be strictly followed for preparing the reports of all Major Irrigation and Multipurpose Projects in the country.

1.1.8 Even though a large number of projects have been formulated and implemented during the last 30 years, as stated earlier, there is still no uniformity of views among the various states and Central agencies regarding the requirements of proper investigations of projects and preparation of project reports. There is often wide variations in the quality of investigations and project reports prepared even by the same agencies.

1.2 Constitution of the Working Group

1.2.1 The tempo of Irrigation and Multipurpose Projects has to be increased considerably to achieve higher targets of irrigation and power necessitated by the increase in population and developmental activities. The projects to be formulated and undertaken in the future will be more and more complex. In order to enable the scrutinising agencies to examine the techno-economic viability of these projects, it is

necessary that the projects should be well investigated and the Project Reports are prepared on a systematic basis incorporating all the requisite data, studies, designs and estimates.

1.2.2 For laying down comprehensive guidelines for the preparation of Project Reports, the Department of Irrigation of the Government of India constituted a Working Group vide their letter No. 4|6|77-DW-II dated 24-10-1977 & 8-2-1978 (Annexure-1). The composition of the Working Group was as follows :—

1. Shri A. S. Kurpad,
Chief Engineer (TE),
Central Water Commission,
New Delhi. — Chairman

2. Shri B. S. Kapre,
Chief Engineer (WR) & JS,
Govt. of Maharashtra,
Irrigation Department,
Bombay. — Member

3. Shri A. V. Shankar Rao,
Chief Engineer (WARDO),
Govt. of Karnataka,
Bangalore. — Member

4. Shri B. N. Aich,
Chief Engineer,
Govt. of West Bengal,
Calcutta. — Member

5. Shri K. M. Maheshwari,
Joint Adviser (I&CAD),
Planning Commission,
New Delhi. — Member

6. Sh. G. N. Kathpalia,
Chief Engineer, Minor Irrigation,
Ministry of Irrigation,
New Delhi. — Member

7. Shri M. M. Shah,
Superintending Engineer,
Narmada Project Circle (HW),
Vadodara — Member

8. Shri K. Krishnamurthy,
Director (Hydrology-I),
Central Water Commission,
New Delhi. — Member

9. Shri J. R. Khanna,
Director FA-II,
Central Water Commission,
New Delhi. — Member

10. Shri W. M. Deshpande,
Director (C.P.),
Central Water Commission,
New Delhi. — Member

11. Shri B. M. Hukku,
Director (GSI),
E.G. Division (Central),
Lucknow. — Member

12. Shri G. V. Ramanamorty,
Joint Commissioner (CC),
Agriculture Production Division,
Deptt. of Agriculture,
New Delhi. — Member

13. Dr. R. K. Rajput,
Project Coordinator (WM).
C.S.S. Research Instt.,
Karnal — Member

14. Shri A. M. Krishna,
Director (TE),
Central Water Commission,
New Delhi. — Member-Secretary

The following were the terms of reference :

1. To review the Guidelines and Norms prescribed for preparation of Project Reports including circulars, letters and other communications addressed to the State Government in this respect and prepare uptodate Guidelines for—

(a) Preparation of Detailed Project Reports for projects costing less than Rs. 30 crores and

(b) Preparation of Feasibility Reports as well as Detailed Project Reports for projects costing Rs. 30 crores and more ;

2. The norms and manner for preparation of a project report for Command Area Development which has to form integral part of the project according to the directions of the Government of India ;

3. To suggest norms for assessment of benefits and costs for analysis regarding cost effectiveness of the project ;

4. Recommend the quantum and content of the infrastructure work which should be undertaken for the purposes of preparing Feasibility and Detailed Project Reports, as well as enabling construction works such as haul roads, colonies etc., for undertaking the projects actually sanctioned.

1.3 Changes in membership and terms of reference

1.3.1 Changes in membership :

Subsequent to the issue of the O.M. dated 24-10-77, the following additions/changes were made in the membership :

Department of Irrigation vide O.M. No. 4/6/77-DW-II dated 21st January, 1978 authorised the Chairman of the Working Group to co-opt such Specialists as considered necessary during the deliberations of the Working Group.

Accordingly, the following were co-opted as members :—

1 Shri S. P. Bhat,
Chairman (CAD)
Ghataprabha Malaprabha Project,
Belgaum.

2. Shri N. L. Shankaran,
Joint Secretary (GB),
Ministry of Irrigation,
New Delhi..

3. Shri B. D. Pathak,
   Chief Hydrogeologist,
   Central Ground Water Board,
   New Delhi.
4. Sh. K. B. Singh,
   Dy. Commissioner (WMS),
   Ministry of Irrigation,
   New Delhi.
5. Dr. P. C. Sah,
   Economic Adviser,
   State Planning Institute, U.P.,
   Lucknow.
6. Shri. G. V. Rao,
   Dy. Secretary,
   Ministry of Irrigation,
   New Delhi.

Shri K. Ramesh Rao, Chief Engineer (TE), was nominated as Chairman of the Working Group in December, 1979 in place of Shri A. S. Kurpad. Shri J. R. Khanna, member of the Working Group was nominated as Member-Secretary in place of Shri A. M. Krishna, Member-Secretary, in April, 1978.

Shri N. L. Shankaran, Director, CWC, presently Joint Secretary (GB) in the Department of Irrigation coopted member till April, 1978 was nominated as member in April, 1978. Shri B. Ramachandran, Director (GSI) was nominated member from May, 1978 in place of Shri B. M. Hukku, Director (GSI)

1.3.2 Changes in terms of reference

In the title of the Ministry of Irrigation O.M. No. 4|6|77-DW-II, dated 24-10-1977 a mention of flood control projects has been made. The Working Group considered this and in view of the setting up of the Rashtriya Barh Ayog for a comprehensive study of the flood problem in the country, felt that the present Working Group may not go into Guidelines for preparation of the Flood Control Projects. The Working Group also examined whether Hydro-Electric Projects should be brought within its purview. It was considered that the Guidelines for Irrigation and Multi-purpose Project would, by and large, also cover the general planning and civil works of such projects and the special aspects relating to these projects should be left to the Central Electricity Authority. These views of the Working Group were conveyed to the Department of Irrigation vide No. 6/CE(TE)-77-854 dated 7-12-77.

In view of the need for modernisation of the old Irrigation Projects and for ensuring the optimum utilisation of available water resources, the Working Group felt that it should also formulate the Guidelines for Modernisation schemes including conjunctive use of ground water. A reference in this regard was, therefore, made to the Department of Irrigation. An addition in terms of reference was made vide Department of Irrigation O.M. No. 4|6|77-DW-II dated 21-1-78 as follows :—

> "To prepare Norms for preparation of Project Report of 'Modernisation Schemes' including the conjunctive use of surface and ground water."

1.3.3 The latest constitution and terms of reference to the Working Group are given in Annexure-2.

1.4.. Meetings of the Working Group

1.4.1 The Working Group held meetings as per details given below :—

Meeting	Date	Venue
1st	26th November, 1977	New Delhi
2nd	17th to 19th January, 1978	Bangalore
3rd	17th & 18th February, 1978	New Delhi
4th	14th & 15th April 1978	New Delhi
5th	4th to 6th May, 1978	Gandhinagar
6th	24th & 25th July, 1978	New Delhi
7th	28th & 29th August, 1978	Bombay
8th	7th & 8th November, 1978	New Delhi
9th	6th & 7th December, 1979	New Delhi
10th	16th to 18th July, 1980	New Delhi

The final meeting was held on 5-8-1980 at New Delhi where the report was signed.

1.4.2 Discussions were held in these meetings on the various terms of reference to the Working Group and also the manner in which the deliberation of Working Group should be carried out. The contents of the Guidelines for Irrigation and Multi-purposes Projects, Command Area Development and Modernisation Schemes were discussed in detail and finalised for incorporation in the report. The general recommendations of the Working Group relating to the various terms of reference were also discussed in detail and finalised.

1.5 The format of the report

1.5.1 The report of the Working Group has been prepared in three volumes. Volume-I of the report deals with the various aspects relating to the terms of reference to the Working Group and also contains the general recommendations for the proper implementation of the suggestions/Guidelines stipulated in the Working Group Report. Volume-II of the Report deals with the Guidelines for preparation of the Detailed Project Report of Irrigation and Multi-purpose Projects and Volume-III of the Report deals with the Guidelines for the preparation of reports on Command Area Development and Modernisation Schemes.

1.5.2 The Guidelines included in Volume-II & Volume-III of the report have been formulated in such a manner as to facilitate not only the agency formulating the projects but also the agencies charged with the responsibility of the techno-economic scrutiny of the project.

1.5.3 The Guidelines presented in Volume-II & Volume III have been further divided into five sections.

(a) Section-I presents the Check List which outlines the points that have to be covered in the project report and therefore will enable the agency preparing the project report to verify whether all the features that are required to be incorporated have been dealt-with. This Check List will also enable the scrutinising agencies to have a picture of the contents of the report and whether all the points that are required to be dealt with in a project report have been reasonably covered.

(b) Section-II deals with the salient features and indicates the relevant details that have to be listed for giving comprehensive idea and information on the project. This information will not only be useful for the project authorities to have important details of the schemes for reference but also the agencies concerned with statistics of Irrigation and Multipurposes Projects to extract such details as are required for statistical studies.

(c) Section-III gives the details which are to be incorporated in each chapter of the Detailed Project Report.

Section-IV & V given respectively the list of drawings and appendices that are required to be incorporated in their part.

1.6 Acknowledgements

1.6.1 The Working Group has made use of a number of documents while preparing the Guidelines. These are tabulated in Annexure-3.

1.6.2 The Working Group records its appreciation and gratitude to all the Secretaries of the Public Works/Irrigation Departments of the State Governments of Gujarat, Karnataka and Maharashtra for making all the necessary arrangements ter holding of the Working Group meetings in their States, and allowing few senior officers to participate during deliberations of the Working Group. The Working Group acknowledges the assistance it received from the various officers of the Central Water Commission, Ministry of Irrigation and Bharat Earth Movers' Limited. Special mention is made of the Hydrology Directorate of Central Water Commission and the Water Management Division of Ministry of Irrigation for furnishing valuable material on hydrology and Command Area Development respectively.

1.6.3 The Working Group also appreciate the continuous assistance it received from Shri B. S. Kapre, Member in the framing of the guidelines.

1.6.4 The Working Group would like to place on record its appreciation of the strenuous efforts and hard work put in by Shri J. R. Khanna, Member-Secretary in organising the meetings, preparing and taking follow up action on the minutes of the meetings, analysis of data received, preparation of the Report etc., involving considerable work which had to be done in addition to his normal duties and with the meagre staff provided. The appreciation of the Working Group is also due to S/Shri H. K. Babbar and P. R. Chopra, Deputy Directors for their part in assisting the Member-Secretary in organising the meetings, processing of the data, and completion of the report. Thanks of the Working Group are also due to Shri Ram Prakash, Personal Assistant and other staff of the Foreign Assistance-II Directorate for rendering stenographic and other assistance in compilation of the Report of the Working Group.

CHAPTER 2

PREPARATION OF PROJECT REPORTS

2.1 The Working Group is required to review the guidelines and norms prescribed for preparation of Project Reports including circulars, letters, and other communications addressed to the State Governments in this regard from time to time and prepare guidelines for detailed Project reports for projects costing than Rs. 30 crores and feasibility and detailed project Reports for projects costing Rs. 30 crores and more.

2.2 The categorization of projects costing less than Rs. 30 crores and more than Rs. 30 crores was first made by the Expert Committee for "Rise in costs of Irrigation and Multipurpose Projects (1973)". This Committee observed that very big projects costing over Rs. 30 crores would require adequate attention in the investigations and preparation of reports. Subsequently, at a Seminar organised by the Central Board of Irrigation & Power in October, 1977 on "Evolving the strategy for Irrigation Development in the Sixth Plan", the project formulation by the States was discussed in detail. One of the recommendations that emerged was that the reports of all major projects having a utilisation greater than 1000 M cum or commending an area of more than 50,000 ha should be presented to the Central Water Commission in two stages namely : (i) Feasibility Project Report stage (ii) Detailed Project Report stage.

2.3 While the Expert Committee categorised the size of the projects on the basis of cost, the criterion suggested subsequently was based on the culturable Command Area. When the Expert Committee made its recommendations, the cost per hectare was about Rs. 6,000. On this basis, for a project costing Rs. 30 crores are would have been 50,000 ha which is the same as laid down by the Seminar.

2.4 The Working Group is of the view that the basis for categorization of the projects should be on the basis of Culturable Command Area.

2.5 According to the procedure laid down, projects with a culturable command area between 2000 ha and 10,000 ha are treated as medium projects and are examined on a Proforma basis in the Central Water Commission. Projects with culturable command area of more than 10,000 ha are required to be examined in the Central Water Commission in detail. However, even for the projects which are examined on Proforma basis, the information that is to be furnished by the State on the Prescribed Proforma, should be based on a detailed Project Report. Thus, whatever be the nature of the project, the report that is to be prepared by the State Government, should be in detail so that examination in the Central Water Commission can be fruitful and the projects can be cleared expeditiously. In fact a Detailed Project Report will also be required by the State Government for its own use.

2.6 The "Expert Committee" mentioned earlier had made a study of the Project Reports that are being received in the Central Water Commission and have observed that in most cases, the usual procedures for the preparation of project reports are not followed. Many important aspects of the projects are not dealt with in sufficient detail. The deficiences in data, information etc. mostly relate to :—

1. Submergence, rehabilitation, compensation, etc.
2. Design assumptions criteria, data and investigations carried out;
3. Geological Investigations of the foundations of the various structures;
4. Contour Plans of the commanded area;
5. Ground water levels and possibilities of water-logging, arrangements for drainage;
6. Soil surveys and suitability of soil for irrigation;
7. Conjunctive use of ground water and surface water for optimum use of available waters;
8. Transmission losses in canals;
9. Agreements on inter-state aspects on utilisation of waters, submersion, etc.

The Committee had also observed that the preparation of Project Reports with greater care and after adequate investigations and studies, will considerably help in the expeditious clearance by the Centre.

2.7 Considering all aspects, the Working Group is of the view that the Project Reports prepared by the States irrespective of their categorization, should be in detail and such reports should be sent to the Central Water Commission for examination and clearance according to procedures laid down. The Guidelines have accordingly been prepared by the Working Group for the preparation of such reports are included in Vol. II.

2.8 In the case of projects with culturable command area of more than 50,000 ha (which will be comparatively few) the Working Group connsiders that it would be appropriate to prepare a further report which would supplement and up-date the original report and incorporates the results of further investigations and studies made.

In case the further investigations and studies indicate that change in scope and cost would be necessary (which should not arise in case the original report has been well prepared), the modifications and amplifications subsequently found necessary should be explained in detail in the further report. This report should also include a plan for the regulation of reservoirs and methods of project operation keeping in view the inter-state agreements and other agreements relating to various aspects of projects. This report should also be furnished to the Central Water Commission and in cases where the scope has been changed considerably and the cost estimates are substantially revised, examination and fresh clearance at the centre would be called for.

CHAPTER 3

COMMAND AREA DEVELOPMENT

3.1 Most of the large pre-independence projects served alluvial plains with alluvial soils. The requirement of on-farm activities including provision of field channels was considered necessary mainly in wheat growing areas, where these were provided by the farmers themselves with encouragement from the Government. In the case of rice growing areas, the field channels were not considered necessary and field to field irrigation by flooding was practised.

3.2 Under these conditions, after the completion of such irrigation works, the State's responsibility was limited to the maintenance of head-works, canals and distributaries, the supply and distribution of water at the outlet and the assessment and collection of water charges. For all other requirements, the farmer was left to his own initiative and efforts. The development of irrigation was, therefore, slow and often took a decade or more on a project. Consequently, proper regulation and distribution of water to the farmer's fields was not adequately achieved and the areas in the vicinity of Government channels suffered from over-irrigation and those in the tail-reaches were usually in short supply.

3.3 With great spurt in the construction of major and medium irrigation schemes after Independence and consequent increase in the irrigated area, attention was drawn to the need for faster utilisation of the created irrigation potential. The frequent scarcity conditions in various parts of the country in 1972-73, coupled with power shortage and non-availability of regular and adequate irrigation supplies, resulted in a shortfall in the food production. Attention was focussed on the imperative need towards optimising the agricultural production from irrigated areas by planned command area development. This has been stressed by the Ministers' Committee on Under-utilisation of Irrigation potential, the National Commission on Irrigation and the National Commission on Agriculture.

3.4 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, communication roads, other infra-facilities, major drainage, laterals etc. The on-farm works include land levelling and shaping, construction of water courses field channels (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.

3.5 According to the term of reference No. 2 the Working Group is required to prepare Guidelines for command area development. The Working Group has formulated the guidelines for various aspects of command area development. These have been covered in Vol. III.

CHAPTER 4

MODERNISATION OF IRRIGATION SYSTEMS

4.1 There is an urgent need for increasing the pace of irrigation development to meet the rising demands for food and fibre and to provide employment opportunities for the growing population in the country. Most of the sites having no major problems and which could be developed expeditiously and economically for construction of storage reservoirs have already been utilized. With the present technology, it might be possible to develop the available limited sites for storage but the unit cost of the irrigation and benefits under these projects is bound to be considerably more than in the past. In this context, exploring the possibility of improving operational efficiency of existing irrigation systems so as to economise on the use of water and thereby intensify or extend irrigation under these projects calls for urgent attention.

4.2 Most of the existing irrigation systems in the country have unlined canal systems in which considerable wastage and loss of water takes place. The introduction of high yielding varieties of crops since 1965 requires a review of canal capacity since the yield from these crops are adversely affected if application of right quantities of water is not provided at the right time.

4.3 The deficiencies in the existing systems such as seepage losses wastage of water and inadequacy to meet the requirements of high yielding varieties can be corrected by modernising the systems. Such modernisation can not only lead to considerable economy in water use and extension of irrigation but also lead to other benefits by way of minimising problems of water lagging and soil salinity, etc.

4.4 Modernisation of irrigation systems does not involve merely improvement in the engineering aspect of the systems such as lining of canal and distribution system and improvements and modifications to the structures but also application of a complex combination of several different disciplines to irrigated agriculture. As such modernisation covers not only, engineering aspects of Irrigation system but also agronomic and management aspects. Modernisation of irrigation systems is a comprehensive term which includes a review of the crop pattern and crop calendar to make the best use of the soil in command with regard to their suitability for different crops to avoid excessive losses in the distribution system and field channel, a reappraisal of the irrigation water requirements and the frequency of water application, the conjuctive use of ground water to the extent possible, improvements in the drainage conditions of the command area, modifications to canal structures and construction of new structures as necessary, adequate on farm development, proper water management and provision for satisfactory maintenance of the system in terms of money and time etc.

4.5 The Central Water Commission prepared a note on Modernisation of Irrigation Systems indicating particularly the lines on which schemes of modernisation of an existing irrigation system should be formulated. It also high-lighted the importance of other related aspects such as command area development, proper soil, water and crop management practise, the provision of efficient comunication facilities in the canal systems etc. This note along with the guidelines for the preparation of the modernisation schemes were forwarded to the State Governments in June, 1978. The guidelines as finalized by the Working Group are included in Volume III.

CHAPTER 5

BENEFIT-COST RATIO

5.1 Before independence, the financial productivity test was the criterion for the sanctioning of irrigation projects. The financial results of irrigation projects were tested as follows :—

(i) by considering the capital cost of any work as simply the sum actually spent on its construction ;

(ii) by debiting the revenue account yearly with—

(a) the simple interest on the capital cost of the works at the commencement of the year ; and

(b) the working expenses of the year ;

(iii) by crediting the revenue account yearly with :

(a) direct receipts ; and

(b) indirect receipts

The difference between (ii) and (iii) for one year showed the profit or loss for that year. Schemes were sanctioned only if they satisfied the test of financial productivity arrived at in terms of the rate of returns calculated as suggested in (i), (ii) and (iii) above ; the test of financial productivity being that the project should be able to show a certain percentage return on the sum-at-charge in the 10th year after its opening, the sum-at-charge being the capital cost plus the arrears of interest upto that year.

The financial productivity test as indicated above, was rigidly applied to all irrigation projects but protective irrigation works which did not satisfy the financial criteria were taken up from time to time but these were few and far between.

5.2 The earlier large irrigation schemes were mostly diversion works and were relatively inexpensive. But later on when new schemes were taken up, it was felt that the development of irrigation was being held up by the rigid application of the financial criterion, namely 6 per cent between 1921 and 1949. Noting that apart from direct irrigation revenues, other benefits accrued to the Government in the shape of increased revenue from excise duties, income-tax, sales tax, transport, etc., the Central Board of Irrigation passed a resolution at its annual meeting held in 1936 stating "that as the expansion of irrigation is seriously handicapped by the restricted view taken of the value of irrigation, an economic survey should be carried out with a view to estimating the direct and indirect financial benefits accruing to the Central and Local Governments from irrigation Projects". However, the financial criterion continued to be applied even if studies showed that the indirect benefits of irrigation projects were substantial. But a view was taken that if a project did not fulfil the financial criterion, but was still considered necessary in the public interest, it could be sanctioned as a protective work.

5.3 After Independence, irrigation was stepped up considerably. The return in the productivity test was reduced from 6 per cent to 3.75 per cent. Consequently, a large number of projects could be accepted for construction. Even then, there was a feeling that the indirect benefits of irrigation should also be taken into account.

5.4 In 1958, the Planning Commission initiated studies of some of the major projects to assess the overall benefits and to find a better criterion for deciding whether various irrigation projects should be undertaken. These studies which were completed in 1961 showed that large benefits accrued from irrigation in terms of double cropping, diversification and better quality crops, higher yields, larger income and greater opportunities of employment for hired labour. Indirect benefits that accrued were the establishment of processing industries, the expansion of consumer industries, retail trade and transport and communications. The total benefits from irrigation were far larger than the direct financial returns accruing to Government from irrigation rates. The Committee, therefore, recommended that in future the benefit cost ratio should be used for assessing the feasibility of new projects instead of the traditional criterion of the direct financial return to Government. For simplicity, it was also considered that the indirect or secondary benefits need not be taken into account. The benefit was to be worked out as the difference between the value of the total annual agricultural production and the cost of cultivation before and after the introduction of irrigation. The cost should be taken to comprise the annual interest on capital, depreciation and expenditure on maintenance and operation.

5.5 In 1964, the "Committee to Suggest Ways and Means of Improving the Financial Returns from Irrigation Projects" recommended that the economic benefit criterion should be adopted for sanctioning irrigation projects in stead of the financial criterion. The Government accepted this recommendation and since then the benefit cost ratio criterion has been adopted.

5.6 The Irrigation Commission (1972) observed that the economic benefit criterion is more suitable than the financial return criterion. Financial return

depends upon the charges levied for the water supplied and these charges could be altered at will and arbitrarily but not so, the components of the benefit-cost ratio which denotes the economic worth of a project.

5.7 In the benefit-cost ratio, the benefit represents the total gains accruing from a project and the cost represents the expenditure involved in producing them, all in terms of current values. The "Rate of Return" criterion used by the World Bank deals with a different aspect as it connotes a ratio between the current annual net benefits from a project and the capital investment on the project. The inter-se ranking of two projects can be different with these two criteria. The Irrigation Commission observed that the rate of return method which is more suited as a basis for making a choice between two investments and where financial return is the dominant consideration and no constraints are imposed by national goals and recommended the continued use of the benefit cost ratio for irrigation projects not only because it is simpler but also because it is used in most countries.

5.8 The application of the benefit-cost ratio criterion has, however, had undesirable effects. It minimises the importance of securing an adequate return from investments on irrigation projects. The Irrigation Commission, therefore, recommended that at the time of considering a project for acceptance, the financial return of the project should also be carefully examined. If the return does not cover working expenses and interest charges on capital, the impact of the project on the irrigation revenues of the State should be examined to see if an upward revision of the water rates in the States, would be necessary.

5.9 The Working Group have considered a suggestion that the Benefit Cost Ratio should be calculated with the discounted cash flow techniques or by the Internal Rate of Return method. The Working Group felt that if these are to be followed there would be difficulties in working out economic prices of materials and crops. It was also considered that the calculation of benefit cost ratio involved multi-disciplinary approach and a review should, therefore, be made by a team consisting of engineers, agronomists, economists, etc.

5.10 The Working Group, therefore, recommends that the Planning Commission might consider the constitution of a committee consisting of representatives of all the concerned disciplines to make a review of the existing method of calculating the benefit cost ratio and to indicate whether any changes in the present method are necessary after a detailed examination of the methods used elsewhere, such as discounted cash flow or internal rate of return methods.

5.11 Pending such a review, the Working Group recommends that the existing procedure of benefit cost computation should be continued but the cost of land development in the command area development estimates should be included in the cost element. The procedure has been outlined in Chapter 3.18 of Vol. II on the Guidelines for preparation of Project Reports.

CHAPTER 6

INFRASTRUCTURE

6.1 The aim of water resources planning is to ensure the most effective use of the available water resources to meet the immediate and long-term needs. Such planning involves the following:—

(a) Basic data which includes stream flow, geophysical aspect covering the topography, soils, geological formations, minerals, etc. and economics covering population and production;

(b) Projection of population and the economy in the area in the near and distant future;

(c) Water requirements for various uses, such as irrigation, navigation, domestic and industrial use, power generation, etc.;

(d) Development of a plan to achieve maximum efficiency indicating priorities of water used, if any.

6.2 A plan for conservation, use and development of water resources will be successful if it is based on knowledge and interpretation of relevant facts and conditions. Optimum development at minimum cost may not be possible if appropriate data are not collected for preparing a Project Report.

Therefore, in the first instance it is necessary to identify the type of essential data for the preparation of a Project Report. These can be broadly grouped as physical and socio-economic.

The physical data will include topography, regional geology, vegetation, fish and wild life, hydrology covering meteorology, surface and ground water and quality of water and sedimentation.

The socio-economic data includes population, income, employment, production, etc., in the region and the sectoral data relating to the various departments, such as agriculture, forestry, industry, power, mining, etc.

The above data have to be collected continuously by the various concerned agencies at the national as well as regional levels, analysed and stored so that they are available whenever necessary.

6.3 For proper collection of the data, close cooperation between the data collecting agencies and the resources development agencies, is essential. The aspect of data collection had been examined in detail by the Export Committee on "Rise in Cost of Irrigation and Multipurpose Projects", Ministry of Irrigation & Power—1973 (Naegamvala Committee). This committee had made the following recommendations :—

(a) to set up a Standing Committee for development of basic data, required for planning water resources projects. This Committee should establish liaison with the appropriate Governmental agencies engaged in the development of data. The Committee should prepare annual programmes for data collection and analysis ;

(b) to set up a minimum standard for a factual information which a Project Report must make before it can be considered for acceptance ;

(c) research should be continued to improve techniques of data analysis. Programme on in-service training to impart recent technical know-how in this subject should be developed.

6.4 **Agencies for collection of data**

It will be useful to make a brief review of the agencies that are presently engaged in the data collection programme.

The Survey of India is responsible for carrying out all topographic surveys as well as special surveys for the production of maps. As a part of their general programme, maps to the scale of 1 : 50,000 are being prepared by them. Specific jobs of mapping to larger scales for the projects are carried out by them on payment by the concerned project authorities. The survey work for the irrigation and multipurposes projects done by the Survey of India is coordinated with the Central Water Commission and the annual programmes are prepared by the Survey Priorities Committee.

The Geological Survey of India prepares the geological maps of the country. They also provide information on structural aspects of various rock types, their disposition, faults, etc. and occurrence of mineral deposits, their quality and extent. Systematic geological mapping on a 1″=1 mile scale is being done by them on a regional basis. Specific investigations are, however, required to be done by the Engineering Geologists of this organisation in close association with the investigating agencies on aspects relating to geological factors affecting design, location and planning of large projects.

Correlation and collection of soil data are mainly done by the National Bureau of Soil Surveys and Land Use Planning, Nagpur. Soil surveys have been carried out in the catchment areas of some river valley projects for classification of soils and grouping

them in connection with planning of soil conservation measures. Some work has also been done on survey of agricultural land and preparation of land use classification maps.

The meteorological data, such as rainfall, temperature, evaporation, sunshine, wind speed, humidity, etc., is being observed by the India Meteorological Department at number of selected stations all over the country. The observations are also made by the State authorities at the stations maintained by them. This data is supplied to the India Meteorological Department for processing and publication. At present this published data covers nearly 3000 stations. There are, however, a number of deficiencies in the data collected by the States which can be stated as follows :—

(a) Recording in most of the stations are done by part-time observers over whom it is not possible to maintain effective supervisions ;

(b) Raingauges are not maintained properly ;

(c) Compilations and despatches of monthly and annual data are not made regularly and systematically ;

(d) Statistical activities are not planned by trained and experienced personnel at supervisory level.

The available data may not specifically cover the catchment area of particular projects. In such cases, it will be necessary to set up raingauges stations and observatories in the catchment-2 command of the project and the data collected on a regular basis as per prescribed standards of India Meteorological Department.

Stream flow data covering gagues and discharges and observations in some places are being collected at a number of stations in the country by Central and State Governments. The stations maintained by the Central Government are principally key gauging station. When the programme is fully implemented, the data of these stations will give representative data for a general assessment of the water resources as well as to make any adjustments in the data collected by agencies. The inventory of the stream flow data in many cases is not complete and has to be brought up-to-date. Where machinery exists at present for the collection of the gauge and discharge and sediment data, some improvements may be required in the measurement, collection, storage, retrieval and analysis of hydrological data, and wherever the machinery does not exist, it has to be suitably created. Arrangements are presently existing for the compilation of data of the stations maintained by the Centre and in some of the States. However, these have to be made in all other states as necessary. The data is to be compiled and published on a uniform basis so that it is readily available to the users connected with the planning of water resources projects.

A review should be made of the existing network and wherever inadequate, it should be strengthened and observations made systematically on a continuous basis as per the prescribed standards of the Indian Standards Institution. The short interval data during the flood season are very important in flood studies. Such observations are being made at some of the stations. These should be systematically compiled in a suitable form and should be readily made available to the project authorities. It is also necessary that complete details such as reservoir levels, inflows, outflows, withdrawals, diversions, etc. at headworks, storages, barrages and weirs shall be collected, processed and compiled regularly on systematic basis as the data will facilitate utilisation and surplus flows available at specific point.

Sediment carried by the streams adversely affects the construction and operation of water retaining structures. Reliable data are required on the quantity and quality of sediment transported by streams in different parts of the country. This data is especially required during the monsoon season when the concentration of silt is very high. While arrangements have been made for the collection of sediment data at the stream gauging stations, especially those maintained by the Central Water Commission, the present status of data is far from satisfactory. Improvements are required in the collection, processing, storage and analysis of such data.

In the project planning, apart from the surface water data, data relating to hydrological formations, ground water recharge from sources, such as seepage from canals, ponds, tanks, etc. are required. Scientific assessment of ground water resources is possible only when proper studies are carried out. The Central and State Ground Water Boards are at present engaged in such studies and the collection of data for improving the resources estimation of ground water.

Although a number of agencies have been set up for collecting and coordinating the data relating to soil moisture, chemical quality of water, vegetal cover, fish and wild life and environmental aspects, at present very little data is available in these respects.

A number of governmental, semi-governmental and private agencies have been engaged in the collection of socio-economic data which are essential in the preparation of project reports. The availability of such data is generally satisfactory.

6.5 In India, water resources development is essentially a State subject and, therefore, difficulty is often experienced not only in setting up of proper organisation for collection of data but also in organizing the Central Data Bank from where the requisite information could be obtained by the concerned agencies. This has been responsible for deficiencies in respect of plans drawn up for water resources development in the country.

6.6 While the data availability for preparation of Project Reports is not at all satisfactory, the agency with the necessary expertise for collection and processing of data is equally inadequate. Further, field work has to be carried out to ascertain in detail and compile the data on various aspects.

Investigations of projects are generally the responsibility of the states. The nature and quantum of investigation vary according to the data available and the magnitude of the project. Barring a few States, no separate set up is available for carrying out field investigations and preparation of Project Reports. Generally this work is entrusted along with other routine jobs to a Division of Circle functioning under the overall supervision of a Chief Engineer of the State. Also it is observed that only officers with a lesser experience or those not considered desirable in the Department, are posted to investigation work. Most of the senior officers are pre-occupied with administration or other technical work, and therefore, the work of investigations receives very little attention from them. Consequently, there is neither any direction nor any guidance at the higher technical level to the junior officers who actually carry out the investigations. The importance of associating specialists in the fields like Engineering Geology, Hydrology, etc. in drawing up proper schemes is rarely appreciated.

The multipurpose and irrigation projects are mostly located in remote far flung and often inhospitable reaches in the mountains which are far away from civilized habitations and lack amenities and facilities. There are no approach roads to the area to be investigated. Housing and transport facilities do not exist. As such, the investigation and preparation of the project reports are to be carried out under difficult and trying circumstances. As a result, the right talent is not attracted to carry out the investigation works and preparation of project reports which are very imporant aspects of developmental activity.

There is in general an apathy towards the work of investigations and preparation of detailed reports and adequate funds are rarely provided for these works. The time allotted for carrying out the requisite surveys, collection of data and investigations for the preparation of the report is often insufficient. Obviously, the project reports prepared under these conditions can never be satisfactory, complete and realistic. The report will not be able to bring out the major problems of engineering, geology and hydrology which are essential in the design and implementation of works. Some of the important items having substantial implications on time and cost of construction, may not be dealt with at all.

Some of the major deficiencies noticed in the Project Reports which can be attributed to lack of proper directions, expert advice during the period of investigation and personnel with requisite experience and preparation of Project Reports can be stated as follows :—

(a) Construction programme ;
(b) Construction planning and plant lay out ;
(c) Construction equipment planning ;
(d) Organisational set up for construction ;
(e) Programme for creation of infrastructure ;
(f) Cost Estimates not supported by rate analysis even for major items.

6.7 The Working Group has considered the inadequacy of the data and also the organisation available at present for surveys, investigation, collection of data and preparation of the Project Report. It is of the view that certain basic improvements are essential in regard to surveys, investigation and preparation of project report, which shall cover both the collection of data and organisation. The suggestions for improvement have been made keeping in view the recommendation made by the sub-group of the "Seminar for Evolving the Strategy for Irrigation Development in the Sixth Plan—October 1977" held under the auspicious of Central Board of Irrigation and Power at New Delhi. The improvements needed are as follows :—

6.7.1 Improvement in the data

(a) Adequate steps shall be taken for collection of field data required for technical and economic feasibility of the project. The basic information required includes hydrological and meteorological data, topographical surveys, geological data, soil surveys, agricultural data and socio-economic statistical data of the command, ecological and environmental data for the project area etc.

(b) There shall be adequate arrangement for coordination and collection of these data between the various Central and State organisation concerned. Wherever necessary these organisations shall be adequately strengthened for timely collection and analysis of the data so that when a project is identified, the required data is readily available.

(c) In the collection of data, modern techniques such as remote sensing, satelite imageries etc. shall be utilised. Wherever necessary aerial surveys shall be carried out for better appreciation of the project area and to study possible alternative.

(d) Wherever called for, ground surveys shall be organised by the agency charged with the survey work to adhere to the time schedule for preparation of the project report.

(e) The network for collection of hydrological and meteorological data shall confirm to the standards laid down by the "World Meteorological organisation" and "Indian Standards Institute". Wherever required, additional meteorological and hydrological observation sites shall be set up by the project authorities to meet the specific requirement of the project.

(f) Water Data Bank shall be set up at National and State levels. The data shall be processed and stored on a uniform basis and shall be made available to the users. The State Data Bank shall also make available to the Central Data Bank the data of the specific stations required by it.

(g) The State governments shall estimate their requirements of topographical surveys and geological surveys and shall intimate the same to the Survey of India and Geological Survey of India well in advance (say 3 to 5 years) to enable them to draw their physical performance and estimate the staff requirements for strengthening these organisations for keeping the project data.

6.7.2 Improvement in Organisation

6.7.2.1 A committee for "Development of Water Resources" shall be set up at the state level. This committee shall be headed by the State Chief Engineer, in charge for Investigations of Projects. All the disciplines involved in the development of River Valley Project such as Engineering, Agriculture, Agronomy, Economics, Geology etc. shall be represented by the senior Officers of the concerned State department. Officers from Geological Survey of India and Survey of India shall also be represented on the committee. The committee shall consult as and when necessary, the Central Water Commission during the investigations of the project. The committee shall meet once in three months and review the entire state programme for investigations and its implementation. The committee shall look after the following :—

(a) Planning schedule for investigations and preparation of project reports of the various projects under investigations and advise the State for timely allocation of funds required to carry out the investigations.

(b) Review and guide the work being done in the state in respect of surveys, investigations, collection of hydrological, meteorological, socio-economic, agricultural data etc. required for preparation of the reports of different projects under investigations.

(c) Assess the potentialities of each project/site based on the available data to ensure right type of planning keeping in view the needs of the region, social and political implications, ecological and environmental problems resulting from the altered surface water flow pattern etc.

(d) Ensure that the project reports are complete in all respect as per guidelines before these are put up to competent authority.

6.7.2.2 The organisation charged with the work of investigations of the project shall be headed by an officer of suitable rank depending upon the quantum of investigation work in the State.

The broad frame work of the investigation set up shall be as under :—

(a) Each investigation sub-division shall have three to four investigation/survey units.

(a) Each investigation division shall have three sub-divisions. An additional cell shall be attached to the division for collection, analysis and compilation of socio-economic, population, agricultural, hydrological, meteorological etc. data available with the various government agencies.

(c) Each investigation cricle shall have three divisions. An additional division shall be attached to the circle for initial planning, preliminary designs, and coordination of the work among the various disciplines involved in the development of the River Valley Project viz. agriculture, power, geological, drilling, collection of other data, designs etc., for preparation of the project report.

(d) Each Chief Engineer, Incharge of the Investigation shall look after the work of three investigation circles.

An additional circle entrusted with the work of planning, design and monitoring of investigation relating to the three circle and preparation of the basin-wise master plan shall be attached to the Chief Engineer Office. The circle will form the secretariat to the State Committee on Water Resources Development and assist in formulation of investigation programmes and ensure their timely implementation. This circle shall also be charged with the responsibility of maintaining liasion between the 'State Committee for Water Resources Development', Central Water Commission and other central organisation.

An economist shall be attached to the Chief Engineer Office with other supporting staff for economic studies including benefit-cost ratio.

The requirement of the staff for investigation work will largely depend upon the investigation programme of the State. Suitable adjustments in the staff pattern suggested above shall be made to suit the State requirements.

(e) The following organisations shall be created or strengthen as necessary to cater for the growing needs :

(i) State organisation responsible for drilling.

(ii) State organisation engaged in collection of hydrological and meteorological data.

(iii) State Engineering Research Institute.

(iv) State Department of Geology.

(v) State organisation responsible for agriculture, agronomy and soil surveys (it will be desirable as far as possible if this could work directly under the Chief Engineer in Charge of Investigations).

6.7.3 The Engineering Officers who are posted on the investigation work shall have proper training and experience and officers with proper capability shall be assigned to such jobs.

Regular refresher courses shall be arranged for the officers engaged in investigation work. Planning of geological investigation in a systematic manner is necessary. These investigations are of a highly complex nature and as such are to be carried out by well-trained engineering geologists conversant with the latest techniques. These techniques are rapidly advancing and very limited facilities exist within the country for training in these methods. However, endeavour shall be made for training the personnels in the institutions which have requisite know how.

The investigation posting shall be made attractive taking into account the following :—

(a) As far as possible the head quarters of the staff shall be kept at the nearest town where

facilities for education, medical treatment etc. are available.

(b) The staff is required to stay at the project site normally during the working season (October to May). The staff shall be adequately compensated by payment of daily allowance on the pattern followed by Geological Survey of India/Survey of India.

(c) Incentive in form of special pay shall be granted.

(d) Government accommodation wherever available shall be given to such staff members on priority basis.

(e) Adequate facilities such as communication, transport camping etc. shall be provided to the staff for carrying out the field work efficiently.

6.8 The exact requirements of field staff for carrying out the investigations would largely depend upon the size of the project, quantum of data available and to be collected, and the extent of field studies depending upon the geology, hydrology, sediment and construction materials. It is not possible to lay down any specific yardstick for this purpose. However, for a major multi-purpose project costing over Rs. 60 crores, it would be necessary to employ at least one circle of pattern suggested above for about 5 years. This will be in addition to the assistance that could be obtained from organisation like the Survey of India, Geological Survey of India, etc. For major projects costing over Rs. 100 crores, it may be necessary to further increase the staff by provision of an additional circle or divisions.

The Design staff for preparation of the Report and drawings shall, however, be centralised in the office of the Chief Engineer, Incharge of the Investigations.

6.9 The Working Group considers that project reports prepared in conformity with the guidelines could be cleared at the centre in a period of about 6 months. Taking this into account, it is the considered view that infrastructure facilities such as haul roads, colonys etc. shall be taken up only after the acceptance of the Project Report by the Central Government.

CHAPTER 7

RECOMMENDATIONS

7.1 In the Preamble to the office memorandum constituting the Working Group, the importance of having properly prepared Project Reports, has been stressed. It has been stated that the reports should be based on uniform norms so that all vital components are well investigated, studied and designs & estimates are prepared on a realistic basis to enable early scrutiny and approval to the projects. It has been mentioned that the Report should contain as much technical data as possible to enable the scrutinising agencies to examine techno-economic viability of the projects quickly. Expeditious processing of projects is required in the context of the need for increasing the tempo on various irrigation projects to achieve higher targets of irrigation contemplated.

7.2 The Working Group has framed comprehensive Guidelines to provide all the requisite information in a project report for facilitating quick clearance of the projects. Emphasis has been laid particularly on investigations, hydrology and the preparation of estimates which have to be covered in detail to ensure that the Planning and designs are sound and the costs as indicated are realistic and firm.

7.3 As mentioned elsewhere in the Report, the data base for the preparation of project reports is at present inadequate. The Working Group has made recommendations to the creation of adequate infrastructure facilities and strengthening of the field units and other state and central agencies connected wtih the work of project investigations for this purpose. The Working Group recommends that this should be done in the next five years. The Project Reports prepared thereafter should cover all the details as indicated in the Guidelines before they are forwarded to the Centre for clearance. In the intervening period, the State Governments should ensure that all the data as available, is collected and analysed and used in the preparation of the Project Reports in addition to the data collected during the investigations. Such reports could be considered for clearance by the Centre on merit.

7.4 Considering the importance of hydrology in planning of the project and their operation, the Working Group recommends that the arangements of the collection, processing and publication of data shall be strengthened both at the Central and State levels. Wherever necessary advance action shall be taken for setting up additional hydrometric stations for specific project planning. The hydrological data shall be made available to all investigating agencies unless there are any specific constraints.

7.5 The Working Group is of the view that clearance of the projects at the Centre should be on the basis of a single Report prepared in conformity with the Guidelines. The State Governments, if they so desire, can have an intermediate report prepared on the basis of the available data for taking a view on the merits of the project and further investigations that should be carried out. Similarly, in the case of projects having Culturable Command Area of 50,000 ha or more or costing more than Rs. 60 crores, a further report shall be prepared on the basis of subsequent investigations, if any, done and incorporating changes made in the scope of the project either for their own record or for submission to the Centre for a revised sanction.

7.6 In the case of all projects approved by the Centre, revision of cost necessitated due to rise in prices or minor modifications made during actual execution, should be done as necessary, for obtaining the approval of the Planning Commission according to the procedure prescribed from time to time.

7.7 The Working Group has indicated the Guidelines for preparation of Report on Command Area Development which have been incorporated in Vol III. The Report dealing with Irrigation and Agriculture aspects should be prepared and furnished simultaneously with the report of the project. The report for auxiliary works should be prepared by the concerned Departments for compilation and submission to the Centre within a period of one year of the submission of the main report.

7.8 In Chapter-5, the Working Group has recommended the continuance of the existing procedure for evaluation of the benefit cost ratio with some modifications relating to the cost element. A recommendation has also been made that a Committee consisting of representatives of the various disciplines, such as engineering, economy, agriculture, etc., should be set up by the Planning Commission for making a detailed review of the existing procedures and suggesting improvements in the light of the practices that are being adopted elsewhere. Action may be taken on this recommendation as early as possible.

7.9 The environmental aspects of the projects are assuming greater and greater importance. The Working Group, therefore, emphasises the need for making a detailed analysis of the environmental aspects after collecting the requisite data from the concerned disciplines. The Guidelines in this regard have been given in Chapter 3.19 of Vol. II.

7.10 Another aspect to which attention is frequently drawn is that of submersion and consequent displacement of the people inhabiting these areas arising as a result of the implementation of the river valley projects. The Working Group is of the view that the data relating to the submersion and its effects should be

collected and analysed in detail and incorporated in the Report comparing the same with the overall benefits that will accrue from the project. The measures proposed for compensation and rehabilitation should be discussed in detail in the Report in the light of any policy adopted in the State. It is necessary that there shall be uniform norms fixed in this regard by the State. This will help in giving a clear picture of the likely effects of the projects, their magnitude compared with the overall benefits of the project and the steps that the Government propose for proper rehabilitation of the affected people.

7.11 The Working Group has considered the importance of soil conservation measures in the catchments of river valley projects, and is of the view that they should be implemented as a complement to the river valley projects. They should not form part of the projects but adequate funds shall be allocated by the Agriculture Department for execution of such measures to protect the valuable land from erosion, etc., and reduce the problems of siltation. Such measures normally can be justified on their own instead of being tagged on to the project.

7.12 With the introduction of the Guidelines and adequate basin-wise plannig rise in cost due to inadequate investigations, inadequate provisions and changes in scope resulting in consequent changes in design will largely reduce. To check the rise due to other causes such as land rates, rehabilitation measure, paucity of funds, poor performance of equipment and procurement problems, the project authorities have to ensure realistic provision, selection of proper equipment and timely action for the procurement in consultation with the Central Water Commission.

Regarding price escalation, it is recommended that this item though may not be provided in the estimate should be taken into account while planning the year-wise phasing of funds to ensure timely completion of the project.

7.13 The Working Group wishes to make the following general recommendations :

7.13.1 Classification of irrigation channels :

These shall be classified as under:

(a)	Field channel/water course	less than 50 lits/sec
(b)	Sub-minor	50 to 200 lits/sec
(c)	Minor	200 to 1000 lits/sec 1 cumec
(d)	Distributaries	1 – 5 cumec
(e)	Branch Canal	5 – 50 cumec
(f)	Main Canal	More than 50 cumec

Note : Canals off-taking from the headworks shall be classified as main canals irrespective of discharge at head.

7.13.2 Sub-head in estimates

The sub-heads presently adopted do not include the following :

(a) u—Distributaries, minors and sub-minors

(b) v—Water courses

(c) w—Drainage

(d) x—Environment and ecology

(e) y—Losses on stock

Note : These have been included in Chapter 3.16 Estimates—Vol. II. It is recommended that these may be considered for inclusion IS 4877-1968 and Guide for Preparation of Estimates of River Valley Projects.

7.13.3 Drainage and roads in the command area :

(a) Drainage

Improvement of existing drains and construction of new drains carrying a discharge of 50 litres/sec and above should be planned and executed by the Irrigation Department and the cost thereof should form a part of the estimate. The other drains should form a part of the Command Area Development programme.

(b) Roads

Improvement of the existing roads and construction of new roads connecting each village to the nearest market centre for a distance of 3 km or more should be planned and executed in collaboration with the State PWD and the cost thereof should be charged to the State Road Sector.

Criteria and specifical of the roads shall be as recommended by the Technical Group to go into the norms and specifications for Ayacut Roads constructed by the Ministry of Irrigation. The extracts from the draft report of the technical group are given in Annexure 6 (CAD report volume III).

Other roads shall form a part of the Command Area Development and shall be constructed as per criteria and specification recommended by Technical Group.

ANNEXURE I

No 4 6/77-DW. II
GOVERNMENT OF INDIA
MINISTRY OF AGRICULTURE AND IRRIGATION
(Department of Irrigation)
New Delhi the 24th October, 1977

OFFICE MEMORANDUM

Subject : Setting up of a Working Group to formulate guidelines for the preparation of Feasibility and Detailed Project Reports of Irrigation and Flood Control Projects.

It has become necessary to base the Feasibility and Detailed Project Reports submitted by State Governments on uniform norms so that all the vital components are well investigated, studied and designs and estimates prepared on realistic basis to enable early scrutiny and approval to the projects. The Feasibility and Detailed Project Reports should cover as much technical date as possible to enable the scrutinizing agencies to examine the techno-economic viability of the projects quickly. This has become all the more necessary in view of the fact that the tempo on various Irrigation Projects has to be increased to a great extent to achieve the higher targets specified.

2. It has, therefore, been decided to constitute a Working Group with the following composition :—

(i) Shri A. S. Kurped, C.E. (T.E.), Central Water Commission, New Delhi. — Chairman

(ii) Shri B. S. Kapre, C.E. (WR) & J.S., Govt. of Maharshtra, Irrigation Department, Bombay. — Member

(iii) Shri A. V. Shankar Rao, C.E. (WR), Govt. of Karnataka, Bangalore. — Member

(iv) Shri B. N. Aich, C.E., Government of West Bengal, Calcutta. — Member

(v) Shri K. M. Maheshwari, Joint-Adviser I&CAD Planning Commission New Delhi. — Member

(vi) Shri G. N. Kathpalia, Chief Engineer Minor Irrigation Ministry of Irrigation. New Delhi. — Member

(vii) Shri M. M. Shah, Superintending Engineer, Narmada Project Circle (HW) Vadodara. — Member

(viii) Shri K. K. Krishnamurthy, Director (Hydrology-I), Central Water Commission, New Delhi. — Member

(xi) Shri J. R. Khanna, Director (R& C-II), Central Water Commission, New Delhi. — Member

(x) Shri W. M. Deshpande, Director (CP), Central Water Commission, New Delhi. — Member

(xi) Shri B. N. Hukku, Director, Engineering Geology Division, GSI, Lucknow. — Member

(xii) Shri A. M. Krishna, Director (IE-II), Central Water Commission, New Delhi. — Member-Secretary

3. The terms of reference of the Committee are :—

(1) To review Guidelines and Norms prescribed for preparation of project reports including circulars, letters and other communications addressed to the State Government in this respect and prepare up-to-date guidelines for—

(a) Preparation of Detailed Project Reports for project costing less than Rs. 30 crores ; and

(b) Preparation of Feasibility Reports as well as Detailed Project Reports for projects costing Rs. 30 crores and more ;

(2) The Norms and manner for preparation of a Project Report for Command Area Development which has to form integral part of the project according to the directions of the Government of India ;

(3) To suggest Norms for assessment of Benefits and Costs for analysis regarding cost effectiveness of the project ;

(4) Recommend the Quantum and Content of the Infrastructure work which should be undertaken for the purposes of preparing Feasibility and Detailed Project Reports, as well as enabling works such as haul-roads, colonies etc. for undertaking the construction before the project is actually sanctioned ;

5. Any other recommendations regarding formulation, and scrutiny of the project.

The Working Group will submit its report within 6 months. The expenditure on TA/DA etc. of the officers on account of the meetings of the Working Groups will be borne by the concerned State Governments/Departments.

Sd/-
S. B. KHARE
24-10-1977
Jt. Secy. to the Govt. of India

No. 4/6/77-DW-II
GOVERNMENT OF INDIA
MINISTRY OF AGRICULTURE AND IRRIGATION
(Department of Irrigation)
New Delhi, the 8th February, 1978

OFFICE MEMORANDUM

Subject : Setting up of a Working Group to formulate guidelines for the preparation of Feasibility and Detailed Project Report of Irrigation and Flood Control Projects.

In partial modification of this Department's Office Memorandum of even number dated 24th October, 1977 as amended from time to time on the subject mentioned above the following officers are nominated as Members of the Working Group in addition to the existing Members :—

1. Dr. G. V. Ramanamurthy, Joint Commissioner (CC), Agricultural Production Division, Department of Agriculture, Krishi Bhavan, New Delhi.
2. Dr. R. K. Rajput, Project Coordinator, Water Management, Central Soil Salinity Research Institute, Karnal.

Sd/-
(K. R. S. ACHARYA)
Under Secy. to the Govt. of India
(TEL : 381459)

1. Chairman of the Working Group [Shri A. S. Kurpad, C.E. (TE), Central Water Commission, New Delhi].

2. Chairman, Central Water Commission, New Delhi.

3. Members of the Working Group

(i) Shri B. S. Kapre, C.E. (WR) & J.S., Government of Maharashtra, Irrigation Department, Bombay.

(ii) Shri A. V. Shankar Rao, C.E. (WR), Govt. of Karnataka, Bangalore

(iii) Shri B. N. Aich, C.E., Government of West Bengal, Calcutta.

(iv) Shri K. M. Maheshwari, Chief (Irrigation) Planning Commission, New Delhi.

(v) Shri G. N. Kathpalia, Chief Engineer, Minor Irrigation, Ministry of Irrigation, New Delhi.

(vi) Shri M. M Shah, Superintending Engineer, Narmada Project Circle (HW) Vadodara.

(vii) Shri K. Krishnamurthy, Director (Hydrology-I), Central Water Commission, New Delhi.

(viii) Shri J. R. Khanna, Director (R&C-II), Central Water Commission, New Delhi.

(ix) Shri W. M. Deshpande, Director (CP), Central Water Commission, New Delhi.

(x) Shri B. N. Kukku, Director, Engineering Geology Division, GSI, Lucknow.

(xi) Shri A. M. Krishna, Director (TE-II), Central Water Commission, New Delhi.

(xii) Dr. G. V. Ramanamurthy, Joint Commissioner (CC) Agricultural Production Division, Deptt. of Agriculture, Krishi Bhavan, New Delhi.

(xiii) Dr. R. K. Rajput, Project Coordinator, Water Management, Central Soil Salinity Research Institute, Karnal.

Sd/-
(K. R. S ACHARYA)
Under Secy. to the Govt. of India
(TEL : 381459)

Copy forwarded for information to :—

1. Shri S. S. Dhanoa, Joint Secretary, Deptt. of Agricultural Research and Education, Ministry of Agriculture and Irrigation, New Delhi with reference to his D.O. Letter No. PS/465/Secy/ICAR dated 24-1-1978.
2. Dr. G. S. Kalkat, Agricultural Commissioner, Ministry of Agriculture and Irrigation, Department of Agriculture, Krishi Bhavan, New Delhi with reference to his D.O. No. PA/AC/78/348 dated 28-1-1978.

Sd/-
(K. R. S. ACHARYA)
Under Secy. to the Govt. of India
(TEL : 381459)

ANNEXURE 2

LATEST CONSTITUTION OF THE WORKING GROUP AND TERMS OF REFERENCE

CONSTITUTION

1. Shri K. Ramesh Rao
   Chief Engineer (TE)
   Central Water Commission
   New Delhi. — Chairman
2. Shri B. S. Kapre
   Chief Engineer (WR) & JS
   Govt. of Maharashtra
   Irrigation Department
   Bombay. — Member
3. Shri A. V. Shankar Rao
   Chief Engineer (WARDO)
   Govt. of Karnataka
   Bangalore. — Member
4. Shri B. N. Aich
   Chief Engineer
   Govt. of West Bengal
   Calcutta. — Member
5. Shri K. M. Maheshwari
   Joint Adviser (I&CAD)
   Planning Commission
   New Delhi. — Member
6. Shri N. L. Shankaran
   Joint Secretary (GB)
   Deptt. of Irrigation
   New Delhi. — Member
7. Shri G. N. Kathpalia
   Chief Engineer Minor Irrigation
   Ministry of Irrigation
   New Delhi. — Member
8. Shri M. M. Shah
   Superintending Engineer
   Narmada Project Circle (HW)
   Vadodara.
9. Shri K. Krishnamurthy
   Director (Hydrology-I)
   Central Water Commission
   New Delhi. — Member
10. Shri W. M. Deshpande
    Director (C.P.)
    Central Water Commission
    New Delhi. — Member
11. Shri B. Ramachandran
    Director (GSI)
    Geology Division
    Geological Survey of India
    Raipur — Member
12. Shri G. V. Ramanamurthy
    Joint Commissioner (CC)
    Agriculture Production Division
    Deptt. of Agriculture
    New Delhi. — Member
13. Dr. R. K. Rajput
    Project Coordinator (WM)
    C.S.S. Research Instt.
    Karnal. — Member
14. Shri J. R. Khanna
    Director FA-II
    Central Water Commission
    New Delhi. — Member—Secretary
15. Shri S. P. Bhat
    Chairman (CAD)
    Ghataprabha Malaprabha Project
    Belgaum. — Co-opted Member
16. Shri B. D. Pathak
    Chief Hydrogeologist
    Central Ground Water Board
    New Delhi — Co-opted Member
17. Shri K. B. Singh
    Dy. Commissioner (WMS)
    Ministry of Irrigation
    New Delhi. — Co-opted Member
18. Dr. P. C. Sah
    Economic Adviser
    State Planning Institute
    U.P. Lucknow. — Co-opted Member
19. Shri G. V. Rao
    Deputy Secretary
    Ministry of Irrigation
    New Delhi. — Co-opted Member

TERMS OF REFERENCE

1. To review the Guidelines and Norms prescribed for preparation of Project Reports including circulars, letters and other communications addressed to the State Government in this respect and prepare uptodate Guidelines for—

   (a) Preparation of Detailed Project Reports for projects costing less than Rs. 30 crores and

   (b) Preparation of Feasibility Reports as well as Detailed Project Reports for projects costing Rs. 30 crores and more;

2. The norms and manner for preparation of a project report for Command Area Development which has to form integral part of the project according to the directions of the Government of India ;

3. To suggest norms for assessment of benefits and costs for analysis regarding cost effectiveness of the project ;

4. Recommend the quantum and content of the infra-structure work which should be undertaken for the purposes of preparing Feasibility and Detailed Project Reports, as well as enabling construction works such as haul roads, colonies etc., for undertaking the projects actually sanctioned.

5. To prepare Norms for preparation of Project Report for "Modernisation Schemes" including the conjuctive use of surface and ground water.

ANNEXURE-3

LIST OF REFERENCES

1. Circulars issued by Planning Commission on the preparation and procedure for preparation of Irrigation and Multi-purpose project reports from time to time.
2. Broad guidelines for preparation of "project estimates for major irrigation and multi-purpose projects, July-1976" issued by Central Water Commission.
3. Guidelines for "Investigation of major irrigation and hydroelectric projects, August-1975" issued by Central Water Commission.
4. A note on the "Modernisation of irrigation systems, February-1978" issued by Central Water Commission.
5. Guide for "Estimating irrigation water requirement, July-1971" issued by the Water Management Division, Deptt. of Agriculture, New Delhi.
6. Hand-book "Irrigation Water Management September-1971" issued by the Water Management Division, Department of Agriculture, New Delhi.
7. Report of the Committee to examine procedures of Investigations and implementing Multi-purpose and Hydro-electric projects constituted in September-1976.
8. Report of the "Expert Committee to study the rising cost of irrigation and multi-purpose project, April-1973" issued by Ministry of Irrigation & Power , New Delhi.
9. Report of the "Irrigation Commission-1972".
10. "Soil Survey Mannual, August-1971" issued by Indian Agriculture Research Institute, New Delhi.
11. "Crop water requirement—Irrigation & Drainage paper—24, FAO Publication-1977"
12. CBIP-Technical Report No. 19.
13. Draft Report of Technical Group to go into norms of specifications for Ayacut Roads in the command Area in the Irrigation Projects.
14. IS No. 1192—1959 —Velocity Area method for measurement of flow of water in open channel.
15. IS No. 3918—1966 —Use of Current Meter.
16. IS No. 4987—1968 —Recommendation for establishing network of raingauge stations.
17. IS No. 4890—1968 —Method for measurement of suspended sediment in open rivers.
18. IS No. 4453—1967 —Code of Practice for Exploration by pits, drifts & shafts.
19. IS No. 4464—1967 (Part III) —Code of practice for presentation of drilling information and core description in foundation investigation.
20. IS No. 5510—1969 —Guide for soil survey for River Valley Projects.
21. IS No. 8835—1978 —Guidelines for Planning and design of surface drains.
22. IS No. 4877—1968 —Guide for preparation of estimate for river valley projects.
23. IS No. 2132—1972 —Code of Practice for thin walled tube sampling of soils.
24. IS No. 8763—1978 —Guide for undisturbed sampling of soils.

VOLUME II

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

DETAILED PROJECT REPORT

SECTION—1

Check List

Name of the project

Location :

(a) State(s)

(b) District(s)

(c) Taluka(s)

Category of the project :

(a) Irrigation or Multipurpose

(b) Storage or diversion

Sr. No.	Item	Reference
1	2	3
	Planning	
1	Has the Master plan for overall development of the river basin been prepared and stages of basin development discussed briefly?	
2.	Have the alternative proposals been studied and their merits and demerits discussed ?	
3.	Does the scheme fit in the overall development of the river basin and its priority in the overall development of the basin discussed?	
4.	Are there any features which are not likely to fit in the overall development of the basin? Have the other Departments concerned with the development been anformed.	
5.	Is the present scheme proposed to be executed in stages? If so, are its various stages of execution and development discussed in the report?	
6.	Are the effects of the scheme on the reparian rights existing upstream and downstream projects etc. discussed?	
	Interstate and International Aspects	
7.	Are there any International/Interstate issues involved? If so, have these issues been identified and present status of agreement indicated specially in respect of (a) Sharing of water (b) Sharing of cost (c) Sharing of benefits (d) Acceptance of the submergence by the upstream state(s). (e) 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 item above.	
	Surveys	
8.	Have the detailed topographical surveys been carried out for the following items and maps prepared as per prescribed scales (Refer Annexure-I) (a) River surveys (b) Reservoir surveys	

1	2	3

(c) Head-works surveys (dams, dykes, barrages, weirs etc. and auxiliary components)

(d) Plant site and Colonies

(e) Canals, branch canals and water conductor system.

(f) Major canal structures.

(g) Power house, switch-yard, surge shafts, tailrace.

(h) Tunnel (s), adits, penstocks etc.

(j) Surveys (Detailed and sample) of areas of the command for OFD and drainage works.

(k) Soil surveys

(l) Surveys for soil conservation.

(m) Any other surveys i.e. Archeological, Right of way, Communication etc.

Geology

9. Have the geological surveys for the following items been carried out (Refer Chapter 3.4.2 and Annexure II) and report on geology appended?

(a) Regional geology

(b) Reservoir

(c) Headworks and energy dissipation area

(d) Power house and appurtenances

(e) Intakes and regulators

(f) Major canal structures

(g) Tunnel(s), Penstock hill etc.

(h) Communication routes

(j) Any other

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

(b) Has the approval of the Standing Committee for recommending design of seismic co-efficient for River Valley Project been obtained?

Foundation Investigations

11. Have the detailed foundation investigations (including insitu tests and laboratory tests) for the following structures been carried out (Refer Chapter 3.4.3 and Annexure-II) and detailed report(s) appended?

(a) Earth and rockfill dam/barrage/weir etc.

(b) Masonry/concrete dam/weir etc.

(c) Canal

(d) Power house, tunnel(s) cannal structures etc.

(e) Any other

12. Are there any special features affecting the designs?

Material Surveys

13. Have the surveys and laboratory tests for the following construction materials been carried out (Refer Chapter 3.4.4 and Annexure III) and report(s) appended?

(a) Soils for impervious, semipervious and pervious zones of earth dam.

(b) Sand

(c) Rock and aggregate

(d) Bricks and tiles

1	2	3

(e) Pozzolana

(f) Cement and lime stone

(g) Steel

(h) Other scarce materials:

(i)

(ii)

(iii)

(j) Any other

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

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

Hydrological And Meteorological Investigations

16. Have the hydrological and meteorological investigations been carried out and status of data discussed in report?

(a) Rainfall

(b) Gauge

(c) Discharge

(d) Sediment

(e) Water quality

(f) Evaporation and whether the above data has been appended?

Hydrology

17. Is the hydrology dealt with in detail in a separate volume (attached as appendix-B)?

(a) Have the brief details been included in this Report?

(b) Is an index map and bar chart showing locations of various hydrometric, climatic and rainfall stations and the data availability at those stations been attached ?

(c) Are brief notes about quality, consistency, processing and gap filling of the data included?

18. 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).

19. Have the analysis for the water flows sediment flows, evaporation and command area rainfall been discussed?

20. Have the studies regarding reservoir sedimentation been carried out and revised Elevation—Area Capacity Curves been used in the simulation studies (Working Table)?

21. Have the other requirements such as low flow augmentation, water quality control etc. been included in the Project Report and incorporated in the simulation studies?

22. (a) 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?

(b) Have the number of failures for different aspects been indicated.

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

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

25. Is the basis for fixing up the storages discussed?

26. Have the flood routing studies been carried out?

27. Have the back water studies been carried out?

1	2	3

Land acquisition and resettlement of oustees

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

29. Is the basis for provision for land acquisition indicated?

30. Have the rehabilitation measures, amenities and facilities to be provided to the oustees been discussed specially for the oustees from the upstream State?

31. Are the basis of land acquisition of the submerged area upon FRL/MWL etc. discussed?

Design

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

33. Has the layout of the project area viz., location of headworks, work-shop, sheds, offices, colonies, etc. been finalised and discussed?

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

35. Have the designs been prepared for the following components and appended (Chapter 3.6)?

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

(b) Energy dissipation arrangements, training wells etc.

(c) Opening through dams—galleries, head regulators, penstocks other outlets, sluices etc.

(d) Regulators.

(e) Canal and water conductory system.

(f) Canal structures.

(g) Power House, tunnels, surge shaft.

(h) Instrumentation.

36. Have the assumptions made in the design of above components of the project been indicated and basis of assumption discussed?

37. 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?

38. Has the final alignment of canal(s) and branch canal(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?

39. Is the canal and distribution system being lined and if so what is the minimum capacity of the channel proposed to be lined?

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

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

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

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

1	2	3

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

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

Irrigation and Command Area Development

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

47. Have the weekly/fortnightly Crop water requirements at the canal had been worked out?

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

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

50. Are the particulars for minor irrigation projects existing/proposed in the command been indicated?

51. Are there potential areas, indicating the potential where ground water is available? If so, has the quality of the ground water been indicated?

52. Has the quantum of available ground water been assessed indicating the basis for conjunctive use with surface water discussed?

53. Have the semi-detailed soil surveys been carried out for the entire command and soil and land irrigability classifications brought out in the report?

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

55. Has the pre-project cropping pattern and justification for the proposed cropping pattern been furnished?

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

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

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

59. 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?

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

61. Have the arrangements for financing the OFD works and proposals for strengthening the same been discussed?

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

63. Has the yearwise phasing of irrigation development as a result of the project been discussed?

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

65. 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?

1	2	3

Flood Control and Drainage

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

67. Have the damage areas been identified and flood intensities worked out at each of the damage centre(s) which gets affected?

68. Have the following aspects been discussed?

(a) Flood cushion in the reservoir.

(b) Maximum moderated flood out flows over the spillway etc. and its frequency.

(c) Safe carrying capacities of the channel below the dam existing and after construction of flood embankment, channel improvement, river diversion etc.

(d) Syncronized 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.

69. Have the following aspects of drainage been discussed?

(a) Surface and sub-surface drainage problems of the Command Area with details of studies on sub soil water table.

(b) Maximum intensity of 1, 2 & 3 day rainfall.

(c) Deficiencies in farm drains.

(d) Deficiencies in existing natural drains.

(e) Proposal for improvement of drainage/water logging of the area with criteria.

(f) Identification of the area in Command which will get benefited due to execution of drainage net-work and benefits thereof in terms of relief from crop damage, increased yields etc.

Navigation

70. Is the present scheme for remodelling of the existing facilities and/or extension of the Navigable reach or New proposals?

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

72. Have the traffic surveys been carried out and discussed in respect of present and projected:

(a) Goods traffic.

(b) Passenger traffic.

(c) Existing traffic in the area and its comparison with the other modes of transportation.

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

73. Have the main goods that are being carried and/or proposed to be carried been indicated?

74. Are the canal sections and canal structures designed from Navigation considerations or irrigation considerations?

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

76. 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 (sizewise);

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

1	2	3

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

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

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

78. Has economic justification and viability of the Navigation component of the multipurpose project been discussed?

Power

79. Have the following points been discussed?

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

(b) Total energy available and peaking capacity of the system.

(c) Integrated operation of the system and present status of utilisation.

(d) Surpluses and shortfalls in the system.

(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 connecting to the existing system/grid.

(j) Cost of generation per kwh installed and per kwh generated as compared to the different hydro-electric projects and different sources in the State/region to justify the power component of the project.

Construction Programme and Plant and Manpower Planning

80. Are the major components of work proposed to be done departmentally or through contractor?

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

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

83. Have the yearwise quantities of the following materials of construction been worked out for various components of the project :

(a) Excavation—soft and hard strata.

(b) Earthwork infilling—impervious semi-pervious and pervious.

(c) Rockfill—dam, toe, riprap etc.

(d) Stone for masonry.

(e) Coarse aggregate for concrete.

(f) Sand—filter, masonry, concrete.

(g) Gravel—filter.

(h) Steel of various sizes and type-reinforcement.

(j) Cement-normal, quick/slow setting with or without pozzolana.

(k) Lime—surkhi—pozzolana.

(l) Scarce material—special steel.

(m) Other material—fuel, electricity, explosive etc.

84. Have the yearwise quantities to be executed by machine/labour for each of the major component been worked our for each of the above material?

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

1	2	3

Foreign Exchange

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

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

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

Financial Resources

89. (a) Has the concurrence of the Finance Department been obtained ?
    (b) Whether the scheme has already been started ? If so, is the present stage of construction indicated ?

90. Is the scheme included in the plan ? If not what is the present position regarding its inclusion in the plan?

91. Have the yearwise requirement of funds been indicated ?

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

93. Is the scheme covered under any foreign assistance/aid agreement ?

Estimate

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

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

96. Have the analysis of rates for various major items of work for the major components of the project been furnished, with basis for analysis ?

97. Are the provisios 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

Revenues

98. 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) Cropwise water rates
    (e) Sale of water for village water supply
    (f) Miscellaneous

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

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

101. Have the organizational set up for the collection of revenue been indicated ?

1	2	3

B. C. Ratio

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

103. Have the various departments State agreed to the sharing of the above allocated cost ?

104. Have the cropwise benefits been worked out for irrigated and unirrigated crops being grown before project in consultation with the agriculture department and statement furnished ?

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

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

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

108. Have the following financial return statements been furnished keeping in view the phasing of development :
   (a) Irrigation
   (b) Power

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

Ecological aspect

109. (a) Is the area likely to have any of the following environmental and ecological problems due to the altered surface water pattern and preventive measures discussed ?
   (i) Excessive sedimentation of the reservoir
   (ii) Water logging
   (iii) Increase in salinity of the ground water
   (iv) Ground water recharge
   (v) Health hazard—water borne diseases, industrial pollution etc.
   (vi) Submergence of important minerals
   (vii) Submergence of monuments
   (viii) Fish culture and aquatic life
   (ix) Plant life—forests
   (x) Life of migratory birds
   (xi) National park and sancturies
   (xii) Seismicity due to filling of reservoir
   (xiii) Any other
   (b) Has the concurrence of the Environmental Appraisal Committee been obtained.

Colonies and Buildings

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

1	2	3
111.	Has an estimate of the extent of higher cost involved been made and details discussed ?	
112.	Are the permanent buildings being constructed required for maintenance of the project only ?	
113.	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 ?	
114.	Have the interested agencies been consulted in planning of the buildings to suit their requirements later on ?	
115.	Have the proposals for disposal of temporary buildings been discussed ?	
	Public participation and Cooperation	
116.	Are the possibilities of these been discussed in : (a) Planning (b) Construction (c) Improved agricultural practices (d) Any other	
	Soil Conservation	
117.	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 :

2.1 Name of the project

2.2 General

2.2.1 River Basin

(a) Name

(b) Located in

(i) State

(ii) States (if interstate river)

(iii) Countries (if international river)

2.2.2 Name of

(a) River

(b) Tributary

(c) State(s)

(d) District(s)

(i) Reservoir

(ii) Headwork

(iii) Command Area

(iv) Power house

(e) Taluka(s)/Tehsil(s)

(i) Reservoir

(ii) Headworks

(iii) Command Area

(iv) Power house

(f) Village near the Headworks

2.2.3 Location of

2.2.3.1 Headworks

(a) Longitude

(b) Latitude

2.2.3.2 Project area reference to :

(a) Degree Sheets

(b) Index Plan

2.2.4 Access to the project

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

2.2.5 Estimated Life of the project (years)

2.3 Type of project (Irrigation/multipurpose)

2.3.1 Irrigation (ha)

	By flow	By lift
(a) Gross commanded 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 $\left(\frac{GIA}{CCA} \times 100\right)$ %		

**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)

2.3.2 Power

(a) Installed capacity (mw)

(b) Firm power (mw) load factor per cent

(c) Seasonal (maximum) power (mw)

(d) Annual energy (M kwh)

(i) Firm

(ii) Seasonal.

(iii) Total

(e) Cost per kw installed

(f) Cost per kwh at the bus bar

2.3.3 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)

(c) Safe carrying capacity of the river down stream (cumec)

(i) Without project

(ii) With project

2.3.4 Navigation

(a) Length of the navigable reach

(b) Minimum draft

(c) Total tonnage of goods to be carried annually

(d) Expected passenger traffic (annual)

2.3.5 Water Supply

2.3.5.1 Domestic

(a) Names of towns/villages served

(b) Size of population served

(c) Quantum of water made available (1000 cum)

(d) Quantum of water per capita (litre)

2.3.5.2 Quantum of water for industrial use (1000 cum)

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

2.4 Hydrology

2.4.1 Catchment

2.4.1.1 Catchment area at headwork site (km²)

(a) Gross

(b) Intercepted :

(i) By existing projects

(ii) By ongoing projects

(iii) By contemplated projects

(c) Unintercepted

Note :—In case of a downstream weir/barrage regulating the supply to the canal(s) similar details shall be furnished for the catchment between headworks and the weir/barrage.

2.4.1.2 Catchment area

(a) Rainfed

(b) Snowfed

2.4.2. Precipitation

2.4.2.1. Catchment—Period of record 19—— to 19——

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

2.4.2.2. Command

	Cropping season			
	Annual	Kharif (June-Oct.)	Rabi (Nov-Feb.)	Hot-weather (Mar-May).
(a) Average				
(b) 80 per cent dependable				
(c) ETO (mm)				

2.4.3. Annual yield calculated at the proposed site (M cum) period of record 19—— to 19——

	Gross	Net
(a) Maximum		
(b) Minimum		
(c) Average		

(d) Dependable (per cent)

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

2.4.4. Climatic data

2.4.4.1. Command—names of stations and period of record 19—— to 19——

	Normal	Max.	Min.
(a) Air temp. (°C)			
(b) Humidity (per cent)			
(c) Wind (km/hr)			

2.4.5. Utilisation within the State (M cum)

2.4.5.1. States share in case of interstate river

2.4.5.2. Committed Utilisation

(a) Up Stream	Major	Medium	Minor
(i) projects completed			
(ii) Project under construction			
(iii) Future projects			
(iv) Any other			

(b) Down-stream Major Medium Minor

(i) Projects completed

(ii) Projects under construction

(iii) Future projects

(iv) Any other

2.4.5.3. Proposed utilisation by the project

(a) Kharif

(b) Rabi

(c) Total

2.4.6. Floods near the headwork site

2.4.6.1. Historical—period of record 19———to 19———

Location

(a) Maximum water level (El-m)

(b) Maximum Dishcarge estimated (cumec)

(c) Year of occurrance, date

2.4.6.2. Observed—period of record 19———to 19——

Location

(a) Maximum water level (El-m)

(b) Maximum Discharge (cumec)

(c) Year of occurrance, date

2.4.6.3. Standard project flood (cumec)

2.4.6.4. Maximum probable flood (cumec)

2.4.6.5. Flood

Frequency	Magnitude (cumec)
(a) 50 year	
(b) 100 year	
(c) 1000 year	

2.4.6.6. Design flood (cumec)

(a) Dam

(b) Weir/Barrage

(c) Flood Control Works/Construction Diversion.

2.4.6.7. River flows (minimum observed)

(a) Water level (El-m)

(b) Discharge (cumec)

(c) Months of 'nil' flow

2.5 Reservoir

2.5.1 Water Levels (El-m)

(a) Maximum water level

(b) Full Reservoir level

(c) Minimum draw down level

(d) Dead Storage Level

2.5.2 Free board (m)

2.5.3 Wave height (m)

2.5.4 Live storage (M cum)

2.5.5 Capacity at (M cum)

(a) Maximum water level

(b) Full reservoir level

(c) Minimum draw down level

(d) Dead storage level

2.5.6 Flood absorption capacity (M cum)

(a) Below FRL

(b) Between FRL & MWL

2.5.7 Sedimentation after

	Year	
(a) Above MDDL	50	100
(b) Below MDDL		
(c) Encroachment of live storage (per cent)		

2.5.8 Assumed Annual losses Evaporation from the reservoir

	Average (M cum)
(a) Quantum	
(b) Depth (m)	

2.6 Submergence

2.6.1 Land and property submerged

	Level	
	Maximum water (1)	Full Reservoir (2)
(a) Villages affected (No.)		
(i) Full		
(ii) Partial		
(b) Land affected (ha)		
(i) Gross		
(ii) Culturable		
(iii) Irrigated		
(c) Building/houses (No.)		
(i) Private		
(ii) Communities		
(d) Wells (No.)		
(e) Road/rail (km)		
(f) Transmission lines		
(g) Any other		

2.6.2 Submergence ratio (with reference to culturable command areas)

2.6.3 Number of families affected

2.6.4 Number of persons affected

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

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

2.7 Headworks

2.7.1 Dam

2.7.1.1. Earth and Rockfill Dam

(a) Type of dam (Homogenous/zoned/Rock-fill)

(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 cutain/combination of alternatives)

2.7.1.2 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)		

2.7.1.3 Spillway (overflow section)

(a) Type of spillway (Ogee/chute/side channel/tunnel/syphon/any other type)

(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 (m)

(j) Maximum discharging capacity (cumec) at FRL and MWL

(k) Flood lift (m)

(l) Tail water level (El-m)

(i) Maximum

(ii) Minimum

(m) Type of energy dissipation arrangement

NOTE :— Similar details shall be furnished for subsidiary spillway, if any.

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

(a) Purpose

(b) Number

(c) Size (m)

(d) Sill level (El-m)

(e) Discharging capacity at (cumec)

(i) Full reservoir level

(ii) Minimum draw down level

NOTE :— The above detail shall be furnished for all the sluices provided for different purposes.

2.7.2 Barrage

2.7.2.1 Location with respect to dam, if any

2.7.2.2 Length (m)

2.7.2.3 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 gate

(j) Size of gate (m)

(k) Type of energy dissipation arrangement

(l) Maximum discharging capacity (cumec)

(m) Tail water level (El-m)

(i) Maximum

(ii) Minimum

2.7.2.4 Under Sluice Bays

	Left side	Right side
(a) Total length (m)		
(b) Maximum height of under sluice (crest above deepest foundation-m)		
(c) Length of bay (m)		
(d) Sill level (El-m)		

(e) Number of gates

(f) Type of gate

(g) Size of gate (m)

(h) Type of energy dissipation arrangement

(j) Maximum discharging capacity of under-sluices (cumec)

(k) Silt excluder tunnel (s)

(i) Number

(ii) Length

(iii) Size (m)

(iv) Floor level (El-m)

2.7.2.5 Guide bunds/Afflux bunds

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

2.7.3 Weir

2.7.3.1 Details of weir

(a) Type of weir

(b) (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 (cumec) capacity

NOTE :— For gated weir information as asked under 2.7.1.2 Masonry/Concrete dam shall be furnished.

2.7.4 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) Size of gates		
(g) Number of silt excluder bays		
(h) Type of energy dissipation arrangement		

2.8 Canal System

2.8.1 Main Canal

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

2.8.1.2 Type

(a) Flow/lift

(b) Lined—unlined

(c) Discharging capacity of the channel above which lining is proposed.

(d) Type of lining

2.8.1.3 Main Canal data

(a) Length (km)

(b) Full supply level at head (El-m)

(c) Full supply depth at head (m)

(d) Bed width at head (m)

(e) Side slope at head

(f) Bed slope (range)

(g) Maximum discharging capacity at head (cumec)

(h) Total number of canal structures on main and branch canals

(j) Total assumed losses across the structure (m)

(k) Gross Command Area (ha)

(l) Culturable Command area

2.8.1.4 Branch canal(s)	Flow canal	Lift canal
(a) Number		
(b) Total length (km)		

2.8.1.5 Total length of distribution system upto minimum discharge capacity of 24 cusec

Note: Similar information shall be furnished for all canals, off taking from headworks.

2.8.2 Efficiencies (percent)

(i) Conveyance

(ii) Field application

2.9 Cropping pattern

	Percentage area (CCA)	
	Existing	Proposed
2.9.1 Name of crop (season-wise)		
(1)		
(2)		
(3)		
(4)		
(5)		

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

2.10 Power

2.10.1 Head Race

	Canal	Tunnel
(a) Length (m)		
(b) Shape		
(c) Size (m)		
(d) Thickness of lining (m)		
(e) Designed discharge		
(f) Invert level at (El-m)		
(i) Inlet		
(ii) Outlet		
(g) Free flow/pressure (m)		

2.10.2 Balancing Reservoir :

(a) Capacity (1000 cum)
(b) Full reservoir level (El-m)
(c) Maximum reservoir level (El-m)
(d) Live Storage (1000 cum)
(e) Balancing periods (hrs)

2.10.3 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) Number of off takes :
(i) Size (m)
(ii) Invert level (El-m)
(iii) Capacity (cumec)
(f) Maximum discharging capacity (Cumec)

2.10.4 Surge tank/shaft :

(a) Type
(b) Size (m)
(c) Height above foundation level (m)
(d) Top level (El-m)
(e) Capacity (1000 cum)
(f) Surge level (El-m)
(i) Maximum
(ii) Minimum

2.10.5 Penstocks/pressure shafts:

(a) Number
(b) Diameter (m)
(c) Length (m)
(d) Size of gate (m)
(e) Bifurcations, if any, at lower end
(f) Invert level (m)

to paste

2.10.6 Power House :

(a) Type : (Surface-underground)
(b) Head(m) :
(i) Maximum
(ii) Minimum
(iii) Average
(iv) Design
(c) Dimensions(m)
(d) Installed capacity (mw)
(e) Tarbine(s) :
(i) Type
(ii) Number
(iii) Capacity (hp)
(f) Type of generator
(g) Number of standby unit(s)

2.10.7 Tail Race :

	Canal	Tunnel
(a) Length (m)		
(b) Water level (El-m)		
(i) Maximum		
(ii) Minimum		
(c) Size of draft tube gates (m)		

2.11 Cost

2.11.1 Cost of the project (Rs. lakhs) (unitwise) (Refer Chapter 3.16 Estimates)

2.11.2 Allocated cost. (Rs. lakhs)

(a) Irrigation

(b) Power

(c) Flood control

(d) Navigation

(e) Water Supply

(f) Any other

2.12 Benefits/Revenue

	Annual Estimated		
	Quantity	Value (Rs. lakhs)	Revenue (Rs. lakhs)
(a) Food Production (Tonne)			
(b) Power (kwh)			
(c) Flood Protection (ha)			
(d) Navigation (Tonnage)			
(e) Water supply (Population served)			
(f) Any other (fisheries)			

2.13 Benefit cost ratio

(a) B.C. ratio

(i) Irrigation component

(ii)Flood control component

(iii) Power

(a) No. of years when accumulated deficit is wiped out.

(b) percentage return per annum after the deficit is wiped out (shall not be less than 11.5 percent)

SECTION 3

REPORT

3.1 INTRODUCTION

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

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

3.1.2 Location of project area including longitude and latitude, and district(s) & tehsil/taluka(s) affected/ benefited.

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

3.1.4 General climatic conditions of the state and project area in particular.

3.1.5 General description of topography, physiography and geology of the area.

3.1.6 Population

(a) Affected and benefited

(b) Occupation

(i) Agriculture

(ii) Other than agriculture etc.

3.1.7 Natural resources

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

3.1.9 History

(a) Earlier proposal(s)

(b) Present proposal

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

3.1.11 Stages of development of the project

3.1.12 Fitment of the scheme in overall development of the river basin-intimation to the other development authorities regarding this Scheme.

3.1.13 Inter-linking of the scheme with neighbouring basin schemes.

3.1.14 Interstate/International aspect(s)

3.1.15 Cost and Benefits of the scheme

3.1.16 Public cooperation and participation

3.1.17 Public views on benefits and proposed levies

3.2 PHYSICAL FEATURES

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

3.2.1 Geographical disposition

3.2.2 Topography of the basin, reservoir and command area

3.2.3 Geology of the basin, reservoir and command area

3.2.4 River system and basin characteristics

3.3 INTERSTATE/INTERNATIONAL ASPECT(S)

Details of the following importatnt items and additional item, if any, as relevant to the project shall be discussed under this chapter.

3.3.1 State/countries traversed by the river.

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

3.3.3 Effect of the following on project

(a) Interstate/International agreements, on sharing of waters, sharing of 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, oustee's rehabilitation, compensation, etc.

(d) Any other aspect of the project involving Interstate/International problems.

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

3.4 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 Annexure-I unless otherwise stated in the text).

3.4.1 **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 Annexure-1.

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

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

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

The contour interval for slopes less than 10° to the horizontal shall be 0.15 or 0.25 or 0.5 or 1 m depending upon the purpose of surveys. For slopes 10°—30° the contour interval shall be 2 m and more than 30°—3 m or more depending upon the steepness of the slopes.

3.4.1.1 River

3.4.1.2 Reservoir

3.4.1.3 Headworks (Dams including Dykes, Barrages, weirs etc.)

3.4.1.4 Plant and Colony, layout

3.4.1.5. Canal and Water Conductor System and Canal Structures.

3.4.1.6 Power-house, switch-yards, surge-shaft, Tail race, etc.

3.4.1.7 Tunnel, Adits and Penstocks

3.4.1.8 Command area (detailed and sample)

3.4.1.9. Soil Conservation

3.4.1.10. Any other

3.4.2 **Other Surveys**

3.4.2.1 Archaeological surveys in the reservoir area

3.4.2.2 Mineral, (useful and harmful) surveys in the catchment reservoir areas

The nature of such minerals, quantum and location in the reservoir area and its vicinity shall be indicated.

3.4.2.3 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 FR.

3.4.2.4 Communication Surveys

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

3.4.2.5 Drainage Surveys

This shall cover surveys for existing status and future requirements of drainage system (surface and sub-surface as necessary) in the command area

3.4.2.6 Soil surveys for details refer volume-III Command area development. section-5.

3.4.3 Geology, geotechnical features and seismicity

Detailed report on Geology 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.

For projects envisaging irrigation of 50,000 ha and above or having gross utilization of 1000 M cum and above, additional investigations required, shall be carried out in consultation with the project geological organisation, Geological Survey of India 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 Annexure-1 unless otherwise stated in the text.

The location and depth of exploratory holes/pits/drifts shall be as in Annexure-2).

3.4.3.1 Geology and Geotechnical Features :

(a) Regional geology, geomorphology structure and techtonics of the project areas and its 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, Landsat 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 investigations (pitting, drilling, drifting, geophysical probing, rock mechanics etc.) in the project area.

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

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

Result of the explorations and tests shall include details of the observations in the field as well as the results 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 affect 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.

The structurally weak zones like faults, shear zones joint planes and fracture zones. Their pattern, with relating to structure, etc. shall be demarcates 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 tests. 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 neotectonic activity.

-Geo-thermal gradient

Where underground works (cavities and tunnels) are proposed and high temperatures are anticipated, an estimation of underground canditions 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 occurance 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 reservior impoundment, its implications shall be discussed.

(iv) Construction materials

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

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

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

(i) Reservoir

(ii) Headworks

(iii) Energy dissipation devices

(iv) Power Houses & appurtenances

(v) Intake

(vi) Head regulators

(vii) Major canal structures

(viii) Tunnel(s), penstock hill etc.

(ix) Communication routes etc.

3.4.3.2 Seismicity

(a) History of earthquakes in the area with details of epicentre(s), date(s) of occurrance 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 stuctures

3.4.4.—**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 Investigations 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 exploratory holes/pits/drifts shall be as in Annexure-2.)

3.4.4.1 Earth and rockfill dam/barrage/weir etc.

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

(b) Logging of the auger/drill holes, pits and drifts, description of the 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 insitu tests (density, shear, permeability, bearing capacity, penetration, etc.) conducted at 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 insitu and laboratory tests data, evaluation of the design parameters and treatment proposed.

3.4.4.2 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) and insitu tests conducted for foundation investigations including other locations.

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

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

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

(e) Details and results of the insitu 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 insitu rock mechanic tests carried out in the foundation/drifts/other locations.

(g) Summary of the field investigations/observations, insitu and laboratory test data, evaluation of the design parameters and treatment proposed.

3.4.4.3 Canal

(a) Detail and logging of the auger holes/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) Details and results of the samples collected to confirm the field classification.

(c) Details and results of the insitu density tests, conducted, if necessary.

(d) Summary of the field investigations/observations, laboratory and insitu tests data and general recommendations regarding evaluation of design parameters and treatment proposed.

3.4.4.4 Power house tunnels, and canal structures

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

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

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

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

3.4.5. **Construction Material Investigations:**

Detailed report on the investigations 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 to 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.)

3.4.5.1. Soils—Location(s) of different types of soils in the borrow area—quantities, properties lead etc.

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

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

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

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

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

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

3.4.5.8. Scarce Materials—Source, quantities required and procedures for procurement etc.

3.4.5.9. Any other material

3.4.6. Hydrological and Meteorological Investigations

Hydrological data requirement for project planning have been indicated in Chapter-II of the detailed guidelines for Hydrology—(Annexure 44)

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

Constraints of time and money

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

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 correlated with the relevant phenomenon are not available in the general region, 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	2	3
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.
2. River Flows Discharge	10 years	Weekly during low flow season daily during high flow season. For rivers with stakle 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- along with 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 raingauge and observation measuring temperature (maximum and minimum dry and bulb) wind velocity, sunshine etc.	3 years	Daily

1	2	3
8. Rainfall (ordinary raingauge) as necessary for strengthening existing network	10 years concurrent with flow observations for rainfall—runoff corelation and longer period as available for hind casting	Daily
9. Self Recording Raingauges	10 years 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 ISI/IMD Standards where these are not available the location/methodology adopted shall be described.

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 has 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 rainguage 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 raingauge station shall preferably be equipped with a self recording rainguage, with a minimum of the 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 end in the irrigation command areas keeping in view the availability of such stations.

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

3.5 HYDROLOGY

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

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.

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

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

3.5.1.2 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.

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

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

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

3.5.2.1 Details of the system configuration for each alternative tested.

3.5.2.2 Period of simulation and operational policies used.

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

3.5.2.4 External constraints on the system

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

3.5.3. Effect of project development on hydrologic regime (Chapter VII)

3.5.3.1 Changes in hydrologic regime (desirable/ undesirable)

(a) reduction in low flows.

(b) changes in flood hydrology.

(c) changes in total runoff.

(d) changes in river hydraulics (short and long terms).

(e) changes in sediment yields and sediment carrying capacities.

(f) aggradation and degradation at various locations.

(g) changes in water quality.

(h) changes in water demand.

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

3.5.4.1 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 (supported by hydrograph or hydrographs of the design flood and frequency curve of annual maximum peak discharges).

(c) Comparison of flood estimates with the estimates of existing projects in the vicinity.

3.5.4.2 Design flood for design of flood control component

(a) Criteria adopted for flood storage and specified flood control structures discussing studied made.

(b) Flood discharge for 'without project' and 'with project' conditions.

(c) Results of alternative T-year of SPF flood situations and present results as discussed in para 3.5.4.1.

3.5.4.3 Hydrologic design of surface drainage

Design criteria for hydrologic design of drainage and give details of different studies made. Refer IS : 8835—1978 and Chapter 3.10 "Flood Control and Drainage" of the Detailed Project Report.

3.5.4.4 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 plan—the studies made to determine the flood intensity.

3.5.4.5 Determination of floods levels for structures 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.

3.5.4.6 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.

3.5.4.7 Tail Water rating curves

Points at which these are required Approach assumptions and results used in development of these curves, Assumption regarding long term changes in river regime near these points.

3.6 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, 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 Annexure 1, 2 *and* 3.

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

3.6.1 Structure and layout

3.6.1.1 General—Brief

(a) Headworks its site and vicinity—stage of the river (Mountain/submountain/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/Rockfill/Masonry/Concrete/Barrage/Weir).

(d) Layout of the Dam and Spillway/Barrage/Weir and appurtenants/auxiliary works, reasons for choice of site.

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

3.6.1.2 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—1975, clearance by the Standing Committee for recommending design of Seismic, Co-efficient for River Valley Project.

(d) Log of bore/drill holes, pits, drifts, geophysical data etc.

(e) Evaluation of foundations 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 etc. and evaluation of design parameters.

3.6.1.3 Alternative studies carried out for selection of site and type of structures/Dam (Earth/Rockfill/Concrete/Masonry)/Barrage/Weir Regulators, Outlets, Power House and appurtenances etc. and alignment of main and branch canals/Water Conductor system.

3.6.1.4 Choice of final layout of all major components of the project and reason—Details

3.6.1.5 Design Flood and Sediment Studies—Brief.

(a) Design flood its frequency, stage discharge curve at the proposed site with supporting data etc.

(b) Yield and sediment studies (Moody's/Area Reduction method)—Basis for fixing reservoir and other control levels (MWL, TRL, DSL/LWL and Tail Water Level (maximum and minimum).

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

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

3.6.1.6 Free Board

Free board calculations by Seville's method for FRL and MWL conditions in the Reservoir to fix the top elevation of the structure.

3.6.1.7 River Diversion arrangements—choice of design flood with Hydrographs.

(a) Coffer dam(s)

(b) Tunnel(s), Construction Sluices etc.

3.6.1.8 Construction materials—Brief

(a) Qualitative and quantitative assessment of availability of construction material for core and casing (borrow area) sand, transition filters, aggregate, rockfill (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.

3.6.1.9 Details of the model studies for important structures

3.6.2 Dam

3.6.2.1 Earth and/or Rockfill 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 and factor of safety for checking the stability of the earth/rockfill dam/natural slope (a closed grid pattern of centres of slip cilrcles tested, shall be followed).

—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 tailwater level with and without earthquake.

—Heavy downpour condition.

3.6.2.2 Concrete/Masonry Dam/Weirs

(a) Non-overflow section-design criteria

(i) Section.

(ii) Stresses allowed (Masonry/Concrete/Steel/Foundation.

(iii) Grout curtain 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) Mean shear friction factor.

(x) Sliding factor.

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

(b) Spillway section—design criteria.

(i) Spillway profile.

(ii) Capacity of spillway.

(iii) Energy dissipation arrangements and protective works down stream.

iv) Spillway gates, type, size and hoisting arrangements and stop-logs.

(v) Spillway bridge.

(vi) Scouring/river sluice(s), Gates stoplogs etc.

(vii) By pass arrangements—Sluices.

(viii) All items under 3.6.2.2(a) (i)—(xi).

3.6.2.3 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) Special problems of design, if any.

(b) Outlet/sluices.

(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.

3.6.3 Barrages/neir and Head regulator

3.6.3.1 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.

3.6.3.2 Assumed retrogression at maximum and minimum discharges.

3.6.3.3 Loosenees factor.

3.6.3.4 Scour factor.

3.6.3.5 Intensity of discharge under design/super flood conditions.

(a) Spillway

(b) Under sluice

3.6.3.6 Co-efficient of discharge.

3.6.3.7 Exist Gradient Value.

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

3.6.3.9 Type (concrete/Masonry)/Profile cut offs, upstreams and downstream aprons, uplift pressure relief arrangements etc.

3.6.3.10 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.

3.6.3.11 Gates, type of gate and hoist bridge and stoplogs.

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

3.6.4. Canals

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

3.6.4.2 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.

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

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

3.6.4.5 Details of lining if provided.

3.6.4.6 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.

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

3.6.4.8 Design calculation for adequacy of canal sections adopted indicating

(a) Formula used and values of constants, bed slopes.

(b) Design of canal side 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.

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

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

3.6.5 Canal Structures (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/borehole data for deciding the nautre 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 etc.

(iii) percentage of fluming proposed.

(h) Regulators—cross regulators (specing etc.)—basic design criteria.

(j) Escapes, folls, road bridge standing wave flumes—basic design criteria.

(k) Conditions assumed to check the stability of the structure.

3.6.6 Power House—Layout of intake, power channel, Tunnel, Balancing Reservoir, Forebay, penstock, power house, Tail-race and Switchyard.

3.6.6.1 Intake

(a) Stability of the slopes/cuts around intake.

(b) Velocity through trash rack and bell mouth adopted.

(c) Submergence of the entry below water level.

(d) Intake Gates.

3.6.6.2 Power Channel

(a) Capacity (cumec).

(b) Bed slope.

(c) Side slopes and bed width.

(d) Lined/unlined.

(e) Length.

(f) For design detail refer item 3.6.4. Canals.

3.6.6.3 Tunnel(s)/Pressure shaft

(a) Type of tunnel (Pressure/non-pressure). pressure intensity transfer of stress to rock etc.

(b) Nature of overburden/rock.

(c) Minimum cover of overburden/rock (vertical and horizontal).

(d) Shape and size of tunnel.

(e) Velocity in the tunnel.

(f) Friction Factor.

(g) Lost of head.

(h) Lining including steel lining for pressure shaft.

(j) Supports temporary and permanent.

(k) Stability of slopes in the portal areas and along the alignment.

(m) Grouting.

3.6.6.4 Balancing Reservoir

(a) Capacity (storage-cum).

(b) Duration for which the storage is sufficient.

3.6.6.5 Forebay

(a) Description

(b) Gates, types of gates and hoist bridge

(c) Number of openings

(d) For other details refer item 3.6.6.1—Intake

3.6.6.6 Penstocks and surge shaft

(a) Types of steel/material used, maximum thickness

(b) Economic studies for diameter

(i) Velocity adopted

(ii) Stress adopted

(c) Design criteria for water hammer

(d) Type of surge shaft shape and size

(e) Surge shaft criteria for

(i) Maximum surge

(ii) Minimum surge

(iii) Area of surge shaft/tank

(iv) Structural design

(f) Stability of slopes in the penstocks area

(g) Ancher blocks, chain valves, manholes, expansion joints

(h) Bifurcation and other special provisions

(j) paints

3.6.6.7 Power House

(a) Details of civil structures of

(i) Power House and appurtenances (Sur face/underground)

(ii) Tail Race

(iii) Switch yeard

(b) Stability of power house & slopes around power house area

3.6.7 Instrumentation

Details of proposed instruments for various structures (Dam/Barrage/Weir/Power House, Tunnels penstocks etc.) and location

3.7 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 discussion of tabulated data*

3.7.1 Fixation of Storage and Reservoir Levels—Approach—Criteria (Refer para 3.7.2 & 3.7.4)

3.7.1.1 Dead storage Level (El-m)

3.7.1.2 Low Water (Minimum draw down) Level (El-m)

3.7.1.3 Full Reservoir Level (El-m)

3.7.1.4 Maximum Water Level (El-m)

3.7.1.5 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

3.7.1.6 Fetch

3.7.1.7 Direction of wind—velocity of wind—wave—height—Free board—Top of dam

3.7.2 Sedimentation data and studies

3.7.2.1 Rates of sedimentation (Tonnes or ham/sq 1 km of catchment per year) with basis

3.7.2.2 Sedimentation fractions expected : (Tonnes/ham) fraction

	Load	
	Suspended	Bed
(a) Coarse		
(b) Medium		
(c) Fine		

3.7.2.3 Quantity of sediment (Tonnes or ham during the life of the Reservoir)

3.7.2.4 Type and shape of Reservoir

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

3.7.2.6 Sedimentation in the reservoir after 50 and 100 years (ham)

(i) Below MDDL

(ii) Above MDDL

(iii) Percentage encroachment of live storage during the anticipated life of reservoir

(iv) New Zero Elevation (El-m)

3.7.3 Life of Reservoir in years with basis

3.7.4 Capacities

3.7.4.1 Capacities (M cum) :

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

3.7.4.2 Storage (M Cum)

(a) Storage capacity provided with basis for different uses (supported by simulation studies)

(b) Annual Carry over capacity provided, if any, with basis

(c) Gross annual utilisation and dependability (M cum) for each use

3.7.4.3 Water tightness of the reservoir

3.7.4.4 Annual Losses (M cum) and basis

(a) Evaporation

(b) Seepage in the reservoir

3.7.4.5 Flood Absorption (M cum)

(a) Below FRL

(b) Between FRL and MWL

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

3.7.6 Reservoir rim stability

3.7.7 Area of submergence at (ha) :

3.7.7.1 Maximum Water Level

3.7.7.2 Full Reservoir Level

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

3.7.8 Land Acquisition—property submerged—Rehabilitation

3.7.8.1 Land Acquisition (ha)

(a) Quantum of Land :

(i) Upto Full Reservoir Level

(ii) Between maximum Water Level and Full Reservoir Level

(iii) Criteria followed for acquisition of land above Full Resovoir Level and Maximum Water Level

(b) Classification of land

(i) Forest

(ii) Cultivable

—Irrigated

—Unirrigated

—Pastures & Orchard etc.
—Fallow

(iii) Cultivable Waste

(iv) Waste Land

(c) Any other peculiar problem

3.7.8.2 Details of property submerged (no.)

(c) 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

(e) 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) Historical/archaeological monuments

(f) Any other peculiar problem

3.7.8.3 Rehabilitation of Oustees (Descriptive)

(a) Number of villages affected

(b) Number of families affected

(c) Number of persons affected :

(i) Agriculturists

(ii) Agricultural labour

(iii) Artisans

(iv) Ordinary labour

(v) Others

3.7.9 Recreation facilities

3.7.10 Pisciculture

3.7.11 Need and recommendation for soil conservation measure in the catchment.

3.7.12 Any other relevant information

3.8 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*

3.8.1 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	Kharif	Rabi	Hot weather	Two seasonal	Perennial
1	2	3	4	5	6	7	8	9	10
Canals name(s)									
Tanks name(s)									
River lift(s) location(s)									
Open wells No.									
Tubewells No.									

Notes :— 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.

3.8.2 Existing crop pattern

3.8.2.1 Existing area under rainfed cultivation

(a) Rainfall during Monsoon (Max., Min., & Average)

(b) Rainfall during non-monsoon (Max., Min. & Average)

(c) Area under rainfed cultivation.

3.8.2.2 Area under each crop

	Rainfed	Irrigated
— Kharif crop		
(i)		
(ii)		
(iii)		
(iv)		
(v)		
— Rabi crop		
(i)		
(ii)		
(iii)		
(iv)		
(v)		

— Hot weather crop
(i)
(ii)
(iii)
— Two seasonal crop
(i)
(ii)
(iii)
— Perennial
(i)
(ii)
(iii)

3.8.3 Soil Surveys

3.8.3.1 Soil capability classification

3.8.3.2 Land Irrigability classification

3.8.4 Proposed Cropping Pattern

3.8.4.1 Proposed irrigation facilities indicating G.C.A., C.C.A., area proposed for irrigation under Kharif, Rabi, hot weather, two seasonal, perennial, crop calender, intensity of irrigation, extent of stabilization to the existing irrigation facilities, if any.

3.8.4.2 Scope for double and multiple cropping pattern; suggested cropping pattern on the basis of latest available data in respect of—

(a) Soil

(b) Agroclimatic conditions

(c) Water and other inputs like fertilisers, weedicides and pesticides

(d) Irrigated crops in the adjoining area Attitude of farmers towards modern irrigated agricultural practices.

3.8.5 Crop-water requirements for the crops proposed by the Agronomist. Crop-water requirements 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, 1971.

3.8.6 Water Planning

3.8.6.1 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 (SAR), PH, Boron, flourine etc.]—Suitability for irrigation and drinking

(d) Efficiencies assumed with basis

(i) canal & distribution system

(ii) Field application

3.8.6.2 Ground Water (Support)

(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 assessed, status of present utilisation and possibility with proposals for future utilisation

(c) Anticipated behaviour of ground water on downstream after creation of the reservoir based on the experience in the similar project(s)/area(s)

(d) Quality of ground water (salinity, PH, SAR. Boron, flourine etc.)

(d) Proposals of conjunctive use of surface and ground water.

3.9 COMMAND AREA DEVELOPMENT

The National Commission on Agriculture in its report, (1976) recommended that an Irrigation project Report should be prepared in three parts viz.,

PART—1 All engineering works from source of supply upto outlet

PART—2 All engineering work in Command Area comprising of land levelling and shaping construction of water courses lined or unlined, field channels, field drains and field roads

PART—3 All other items pertaining to agriculture, forestry, animal husbandry, fishery, communication and co-operation

While Detailed Project Report (Part I) and Command Area Development Report (Part 2) shall be submitted together, the report for other items pertaining to agriculture, forestry, animal husbandry, fishery, communication and co-operation (Part 3) shall be submitted within one year of the submission of the Detailed Project Report. The State Irrigation Department shall co-ordinate the work between various departments connected with the various aspects of this report (Part 3) and shall be responsible for its timely submission.

The Command Area Development Report (Part 2) shall be prepared in accordance with the guidelines prescribed in Part III (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.*

3.9.1 Command Area

3.9.1.1 Command Area Details

(a) Location

(b) Classification of land (Forest, Grass land, Cultivated land, Cultivated follow, Culturable waste, Barren

(c) Size of land holding

Name of District		Name of Taluka				
Sl. No.	Size of holding (ha)	Farmers		Area held by each category		Remarks
		No.	Percentage of the total farmers (No.)	Area	Percentage of total area	
	0—1					
	1—2					
	2—4					
	Above 4					

Note : — Information to be furnished Talukawise for the Project Command Area.

3.9.1.2 Climate of Command Area

(a) Average Annual Rainfall (weighted)

(b) Seasonal distribution (Monsoon & non-monsoon)

(c) Co-efficient of variation

(d) Temperature (maximum, minimum and average)

(e) Humidity (maximum, minimum & average)

(f) Evapotranspiration (ETO)—annual

3.9.1.3 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

3.9.1.4 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

(e) Availability of agriculture labour and wages

(f) Bench mark Sample surveys for a representative area in the command

3.9.1.5 Infrastructure facilities

(a) Railways and roads (villages, district, etc.)

(b) Marketing facilities

(c) Agro-industries

(d) Banks; credit; societies, etc.

3.9.2 Topography and Soils

3.9.2.1 Topography and relief (gentle, rolling, steep)

3.9.2.2 Land slopes

3.9.2.3 Soils

(a) Origion

(b) Texture

(c) Depth

(d) Infiltration and drainability

(e) Salinity

(f) Base-exchange and p^H

(g) Fertility status

3.9.3 Ground water and drainage

(a) Depth of ground water and seasonal fluctuations (pre-monsoon and post-monsoon)

(b) Quality of ground water (salinity, p^H, SAR etc.) and suitablility for irrigation and drinking

(c) Density of natural drainage (km per sq. km of the command area)

3.9.4 Agriculture

3.9.4.1 Present land use

3.9.4.2 Cropping pattern followed with average yield of 3 years irrigated and rainfed crops separately for each crop

(a) Kharif

(b) Rabi

(c) Summer

(d) Two seasonal

(e) Perennials

Cropwise information to be furnished (source of information to be indicated)

3.9.4.3 Agriculture practices adopted-use of

(a) Improved implements and seeds

(b) Fertilizers, insecticides, pesticides, etc.

(c) Extension services

3.9.4.4 Farmers' attitude towards improved agricultural practices

3.9.5 Identification of problems in command area

3.9.5.1 Physical problems (including hazards)

(a) Land slopes

(b) Soil depth

(c) Salinity/alkalinity

(d) Soil erosion

(e) Water logging

(f) Drainage

(g) Any other

3.9.5.2 Financial problems

(a) Socio-economic conditions

(b) Availability of improved implements/machines and other inputs

(c) Credit facilities

(d) Infrastructure facilities

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

3.9.7 Land Development Works (proposals)

3.9.7.1 Area involved

(a) Land levelling/shaping

(b) Field channels

(c) Field drainage

(d) Farm roads

3.9.7.2 Measures proposed

3.9.7.3 Agency responsible for survey planning and execution of land development works and proposals

3.9.7.4 Cost estimates and cost per ha for land development

3.9.7.5 Financing arrangement for execution of works

3.9.7.6 Schedule for completion of land development

3.9.7.7 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.

3.9.8 Ayacut roads

3.9.9 Benefits

3.9.9.1 Cropwise increase in yield per ha and total expected output from the command

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

3.9.9.3 Likely socio-economic impact

(a) Increase in employment

(b) Agriculture based industry

(c) Any other

3.10 FLOOD CONTROL AND DRAINAGE

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

3.10.1 Flood Control

3.10.1.1 Description of the flood problem in the tributary/basin in which the reseservoir proposed as well as in the main river basin with particular reference to the command area of the project

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

3.10.1.3 Flood Data

(a) Historical floods

(i) Source of information.

(ii) Years of occurrence

(iii) Estimated peak discharge

(iv) Gauge (Correlated to 'b' below)

(v) Area affected

(vi) Historical records, if any, (floods, damages etc.)

(b) Observed floods (yearwise) :

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

(i) Year

(ii) Duration of peak, above normal (dominant) flood

(iii) Observed/estimated peak discharge

(iv) Maximum gauges in each year

(v) Area affected with average depth of flooding during flood peak(s)

(c) Catchment area at damage centre(s)

3.10.1.4. Flood damage (yearwise)

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

(a) Village, Taluk or Tehsils/Towns/Distiricts etc. affected

(b) population affected

(c) Area affected (in the proposed project)

(i) Gross area

(ii) Culturable area

(iii) Cultivated area

(d) Damage/loss

Physical and monetary yearwise (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

3.10.1.5 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

3.10.1.6 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 for sychronizable contribution of the controlled catchment upto the dam site and the uncontrolled catchment between the dam and the damage centres

(iv) Syncronization/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.

3.10.1.7 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

3.10.2 Drainage

3.10.2.1 Basin Characteristics

(a) Geological history/geology of the command

(b) Physiography

(c) Existing Drainage lines

(d) Farm drainage

(e) Rainfall in the command, its distribution over space and time (give 1, 2 and 3 days rainfall of 5 years frequency)

3.10.2.2 Investigation—Brief

(a) Water-table investigations and Artesian conditions, if any

(b) Soil surveys-texture and permeability

3.10.2.3 Cultivation practices

(a) Existing cultivation pattern

(b) proposed cropping pattern

(c) Existing drainage

(d) Drainage deficiencies

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

NOTE :— For B.C. Ratio of "Flood Control" component of the Multipurpose project, refer Annexure—

3.11 POWER

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

3.11.1 Present status of power development in the State/region.

3.11.1.1 Available generating capacity in the State/region from different sources with location, category-wise:

(a) Hydro power
(b) Thermal power
(c) Diesel power
(d) Gas turbines
(e) Atomic power
(f) Tidal power
(g) Solar power
(h) Geothermal power
(j) Any other

3.11.1.2 Present status of utilisation of power produced for:

(a) Agriculture
(b) Industry
(c) Domestic
(d) Any other

3.11.1.3 Energy availability (kwh) and peaking capability Monthwise on a dependable year baiss (90%) category-wise:

(a) Hydro power
(b) Thermal power
(c) Diesel power
(d) Gas turbines
(e) Atomic power
(f) Tidal power
(g) Solar power
(h) Geothermal power
(j) Any other

3.11.1.4 Shortages/surpluses and import/export of power from/to the neighbouring States/region.

3.11.1.5 Transmission system—layout of transmission network and operation voltages.

3.11.2 Power requirements.

3.11.2.1 Existing

(a) Energy and peak load requirement—daily and seasonal variations

(b) Daily monthly and annual load factor in the State/region

3.11.2.2 Anticipated requirements of energy and peak load with daily, monthly and annual variations upto the likely year of completion of project report say 10-15 years.

3.11.3 Future plans of power development in the State/region

3.11.3.1 Schemes under construction/expansion with location

3.11.3.2 New schemes sanctioned—brief

3.11.3.3 Month-wise energy and capacity contribution from the schemes existing under construction/ expansion and new for a design year.

3.11.3.4 Integrated operation studies of the regional power system—shortfall/surplus, if any and proposals, to meet the shortfall/disposal of surplus energy.

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

3.11.4 Assessment of power benefits of the proposed project

3.11.4.1 Nature of Multipurpose project viz., runoff of the river, storage, based with and without carry over—brief.

3.11.4.2 Hydrology, sedimentation studies and criteria for fixing up full reservoir level and minimum draw-down level—brief.

3.11.4.3 Mode of operation of reservoir depending-upon the requirement of irrigation power, flood control, water supply reparian rights etc.

3.11.4.4 Water power studies depending upon the nature of project (3.11.4.1) above. The period of simulation for the studies shall be as indicated in Annexure—4.

3.11.4.5 Month-wise availability of firm and seasonal power

3.11.5 Installed capacity

3.11.5.1 Anticipated load factor of operation of the power house

3.11.5.2 Total installed capacity to be provided based on the power benefits and anticipated load factor of operation

3.11.5.3 Size and type of generating units, their designed and rated head with justification for selection of the type and size of unit

3.11.5.4 Number of generating units including stand by units to be installed

3.11.5.5 Layout of the power generating units, including auxiliary equipment and switch-yard, choice of step up voltage transformers.

3.11.6 Annual energy generated (firm, seasonal and total) in dependable/lean year

3.11.7 Cost of generation—per kwh installed and per kwh generated in dependable year

3.11.8 Proposal for transmission of power from the power station to the existing system/grid

3.11.9 Allocated cost of head works

3.11.10 Comparison of the total cost of the Hydro-electric components of the project with any other viable category viz. Thermal, Atomic, tidal etc.

NOTE:—For financial return statements of "Power" component of Multipurpose project refer Annexure

3.12 NAVIGATION

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

3.12.1 Traffic surveys:

(a) Existing transport system of the region
—Road
—Railways
—River
—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

(j) Feasibility of Inland Water Transport
(i) Technical
(ii) Socio-economic

3.12.2 Navigability of the waterways

3.12.2.1 Existing system

(a) Rivers

(b) Canals

Discuss the following items in respect of existing system 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 nevigability

(vi) Indicate whether canal is lined or unlined

(vii) Location and size of navigation lacks, 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-sheals)

(xii) Towns connected

(xiii) Industries served

(xiv) Traffic catered
—Passenger (numbers)
—Goods—commodities-wise (tonne)
—General
—Specific

(c) Conservancy measures

(i) Periodical Hydrographic surveys and hydrological observations

(ii) Nature of conservancy and other river training works.
—Temporary:
—Bandalling
—Bottom panelling
—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

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

(l) Maximum flood discharge/level upto which the system can work

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

3.12.2.2. Future Planning of Waterways in the basin/region

(a) Possibility of interlinking 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

3.12.2.3 Present Proposal

(a) Broad details of the present proposals in the light of para 3.12.2.2—Discuss items under para 3.12.2.1 above as relevant to the present proposal

(b) Provision, location and design of navigation lacks in headworks and other structures with data of 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 transhipment of passengers and cargo

(d) Effect of withdrawal of water for irrigation, power etc. on the existing navigation on the main river and the miner 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 along with multipurpose development by the construction of series of dams, provision of navigation lacks 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 clearance and draft available/required.

(i) Bridges
(ii) Aqueducts
(iii) Super passages
(iv) Spurs
(v) Cuays, 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.

3.13 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-6 shall be referred to Construction programme.

3.13.1.1 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.

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

3.13.2 Key Materials Planning

3.13.2.1 Special Materials — year-wise requirement

(a) Cement
(b) Steel
  (i) Structurals
  (ii) Plates
  (iii) Bars & rounds
  (iv) Special Steels, if any
(c) Explosives
  (i) Gelatine
  (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

3.13.2.2 (a) Suggested source of supply for each key item and availability Irrigation proposed mode of transportation and constraints/limitation if any.

(b) Distance from nearest railway station to worksite

(c) Mode of handling including railway siding and transportations

(d) Road Transport.

3.13.3 Plant/Equipment Planning

For working out detailed quantities of equipments required refer Annexure-6. Give separate justification for auxiliary equipment such as loading/unloading cranes, trailers etc. Planning should normally be on two shift working basis.

3.13.3.1 Quantities of excavation involved

Proposed excavation ('000 cum)

Item	Manually			By Machine		
	Qty.	Lead	Lift	*type	Qty.	Lead
	1	2	3	1	2	3
(a) Levels and Approaches						
(i) Soft Strata						
(ii) Hard Strata						
(iii) Rock						
(b) Headworks 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 shift.						
Soft strata						
Hard Strata						
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, Scraper-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 upto 0.3 m.

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

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

For the purposes of manual excavations the materials shall be classified in thre ecategoires viz., soft strata, hard strata and rock. For the purposes of excavation by Machine, the materials 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.

3.13.3.2 Dewatering

(a) Expected quantity to be dewatered (HP/hour)

(b) Nature of Strata

3.13.3.3 Dredging to be done, if any

3.13.3.4 Drilling & Grouting

(a) Depthof 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) Qty. of material(s) required

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

3.13.3.5 Earth Works and Rock Filling

	Usable Qty. available from excavation ('000 cum)				Qty. to be available from Borrow areas/ quarries ('000 cum)			
	Manual		Machine		Manually		By Machine	
	Qty	Lead Lift	Type	Qty Lead Qty	Lead	Lift	Type	Qty Lead
(a) Levels and approaches								
(i) Soft Strata								
(ii) Hard Strata								
(iii) Rock								
(b) Headworks & appurtenant works								
(i) Soft Strata								
(ii) Hard Strata								
(iii) Rock								
(c) Canals								
(i) Soft Strata								
(ii) Hard Strata								
(iii) Rock								

3.13.3.6 Concreting/masonry

	Total Qty. involved	Manual			Machine		
		Qty.	Lead	Lift	Type	Qty	Lead
	1	2	3	4	5	6	7
(a) Dam and Appurtenant works							
(i) Concrete							
(ii) Stone Masonry							
(b) Tunnels							
(i) Lining							
(ii) Supports							

1	2	3	4	5	6	7
(c) Shot-creting						
(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/Any other						

3.13.3.7 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 calculations 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, efficincy factor etc. shall be furnished.

Yearwise scheduling of procurement of equipment including stand by equipment and/or induction replaceemnt 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	

3.13.3.8 Workshop and stores facilities to be provided.

3.13.4 Manpower Planning

3.13.4.1 Yearwise 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

3.13.4.2 Facilities and amenities proposed to be provided to :—

(a) Regular Staff

(b) Workcharged Staff

(c) Daily wages Staff

(d) Contractor's staff and Labour

3.14 FOREIGN EXCHANGE ELEMENT

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

3.14.1 Plant, Machinery, Instruments etc. to be imported including the details of spare parts.

3.14.2 Justification for importing the plant Machinery, Instruments etc. supported with details.

3.14.3 Name of the countries where available.

3.14.4 Estimate of cost and its basis.

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

3.14.6 Programme for import and yearly requirement of Foreign Exchange.

(a) Aid/loan agreements

(b) Govt. resources of foreign exchange.

3.15 FINANCIAL RESOURCES

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

3.15.1 Total resources of the state and their utilisation for developmental activities—sectorwise resources for the last 5 years.

3.15.2 Present position of the scheme regarding its inclusion in the plan—concurrance of the State Planning finance department.

3.15.3 Provision for the sector/for the scheme in the plan

3.15.4 Central/foreign aid contemplated, if any

3.15.5 Commitment on the work in progress in the plan and allocations available for starting new scheme

3.15.6 Effect of inclusion of the scheme in the plan on the schedule of other works in progress—budget staff etc.

3.15.7 Requirement of funds for the scheme and its yearly phasing as in project report.

3.15.8 Adequate/strengthening of organisational set up for execution for all projects together as contemplated.

3.15.9 Advance action proposed for starting the preliminaries of the project, if any

3.16 ESTIMATES

The Central Water Commission issued broad Guidelines for preparation of project estimates for Major Irrigation and Multipurpose Projects in July 1976. These were based on the IS : 4877-1968 and have now been updated with explanatory notes for each unit/minor head/sub-head

Detailed estimates shall be prepared based on the items listed under 3.16.3 to 3.16.8 and shall form a separate volume. The approach for the provision made under various units/minor heads/sub head as per items 3.16.1 & 3.16.2 shall be discussed *in details* in the *volume.*

In this Chapter, the approach for provisions made under various units/minor heads/sub heads as per details under item 3.16.1 & 3.16.2 shall be discussed *briefly.* Sub head-wise abstract of the estimate shall be included.

3.16.1 Classification of Units

The project works shall be grouped into the following units :

3.16.1.1 Unit I—Headworks including main dam and auxiliary dam, dykes, spillway, outlet works, energy dissipation devices, barrage, weir, regulator including intake structures and diversion works.

3.16.1.2 Unit II—Main Canals, branches, distributaries, and channels upto strata works inclusive of all pucca works, flood embankments, drainage works etc.

3.16.1.3 Unit III—Hydroelectric installation

(a) Power House and Appurtenant works :

(i) Civil works

(ii) Power Equipment

(b) Transmission lines

(c) Sub-stations

3.16.1.4 Unit IV—Navigation works

3.16.1.5 Unit V—Water Supply works

3.16.1.6 Unit VI—Command Area Development works.

3.16.2 Classification of minor heads/sub-heads

Works [illegible] if necessary each sub-unit shall be covered under the following minor heads classified as direct and indirect charges

3.16.2.1 Direct Charges

(a) I-Works

(b) II—Establishment

(c) III—Tools and Plant

(d) IV—Suspense

(e) V—Receipts and recoveries on capital account

3.16.2.2 Indirect charges

(a) Capitalized value of abatement of hand revenue.

(b) Audit and account charges

3.16.2.3 The provisions under the minor head I—Works shall be further subdivided into the following subheads :

A—Preliminary
B—Land
C—Works
D—Regulators and measuring devices
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 appurtenances (Civil works)
K—Buildings
L—(for canals only)
(i) Earth work
(ii) Lining
M—Plantations
N—Tanks and reservoirs
O—Miscellaneous
P—Maintenance
Q—Special Tools and Plants
R—Communications

S—Power Plant and electrical system
T—Water supply works
U—Distributaries Minors and subminors
V—Water course
W—Drainage
X—Environment and ecology
Y—Losses on stock and unforeseen

3.16.3 Requirements under different sub-heads.

(The important items for which the provisions shall be made under the sub-heads are indicated hereunder. Additional items, if any, can be also included and justified).

3.16.3.1 A—Preliminary

Important items to be considered

(a) Expenditure incurred on previous investigations.
(b) Detailed surveys for final location
(c) Contour survey for reservoir basin (including establishment of permanent bench marks)
(d) Geological surveys and geophysical surveys
(e) Hydrological & meteorological surveys including establishment of raingauges, river gauge and discharge sedimentation stations and their running charges
(f) Investigations for foundations and rock mechanic testing
(g) Investigations for availability of construction materials
(h) Construction of access roads to facilitate investigations
(j) Model experiments
(k) Preparation and printing of project reports
(l) Vehicles for inspecting officers for site investigations
(m) Camp equipment
(n) Preliminary soil tests, establishing soil testing laboratory
(p) Charges for preliminary design work including consultant's fee or advice
(q) Environmental and ecological studies
(r) Training of engineers

NOTE : 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 provision under 'A' Preliminary in the project estimate amounts to about 1% of the total cost of I—Works.

The Expert Committee to study the 'Rise in Cost of Irrigation and Multipurpose Project' in April 1973 has recommended a provision of 3-5% of I—Works under 'A' Preliminary. The Working Group recommends that the provision under 'A' Preliminary shall be made keeping in view the actual requirement of detailed surveys and investigations required for the preparation of a sound project report. It is essential that preliminary designs are made for all important structures and quantities taken out, proper preliminary construction planning including equipment planning is carried out, the sources of materials indentified and the analysis of rates for all important items prepared for the local conditions, if the project estimate is to be realistic.

It is for guidance that provision for this sub-head could be 1—2 percent for a diversion scheme and 2—4 percent for a storage scheme. Provisions less than 1% and more than 5% under this sub-head shall be fully justified.

3.16.3.2 B : Land

Important items to be considered

(a) Acquisition of private and Government land.
(b) Compensation for property i.e., houses, wells, trees etc.
(c) Compensation for standing crops
(d) Rent for use of land
(e) Interest charges on the amount of award for the period between taking over possession of land and date of award
(f) Legal charges
(g) Relocations of communication system like roads, railways, telegraphs lines etc.
(h) Staff for demarcation/measurement of land
(j) Solatium charges
(k) Staff for acquisition
(l) Rehabilitation measure:
    (i) Acquisition of lands for new village site and allotment of plots for housing the villagers at suitable rates.
    (ii) Making the acquired land fit for habitation and providing facilities such as village roads, wells, school building, post offices, dispensaries, panchayat ghars etc.
    (iii) Providing free transport for conveyance of dismentaled materials and household articles from old place to new sites
    (iv) Development of lands (including reclamation if needed) to be allotted to for agricultural purposes to displaced persons.

NOTE : Policy of the state relating to payment of compensation and rehalibitation of the affected persons shall be discussed in details. Manner in which this policy is proposed to be implemented in the project shall also be explained.

The cost per unit of land of different types to be acquired shall be adopted in consultation with the concerned revenue, forest of other competent authority, and preferably after obtaining a certificate from them to that effect and appending the same 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.

The cost of wells could be based on their numbers and evaluation of present day costs, but the cost of structures such as buildings, temples, etc. shall be based on plinth area and the type of construction rates at present day cost less value of usable materials.

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 of a percentage of cultivated land being acquired. Crop compensation is generally provided for 25 to 50 percent of the agriculture land to be acquired.

The interest charges on compensation may also be necessary in view of thelikely time lag in taking possession of the land and actual payment of compensation.

Solatium charges and land acquisition establishment charges are generally provided at 15 and 6.25 percent of the cost of land respectively. In addition to Land Acquisition establishment charges, provision is also required for labour and materials for demarcation and measurements for land and properties. Provision for legal charges may also be necessary, as requirements on this account have been on the increase.

The provision for rehabilitation would depend on the number of persons displaced and the rehabilitation measures proposed to be adopted which shall be clearly indicated in the project report. It is generally observed that the provision for rehabilitation is made on a lumpsum basis and the scope of rehabilitation measures vaguely discussed. This leads to substantial revision in the cost, when the work is executed. This obviously soalls for a realistic assessment with reference to the rehabilitation policy to be followed.

3.16.3.3 C-Works

Important items to be considered

(a) Earth dam and rockfill dam

(i) Care of the river during construction including such items as coffer dams and diversion tunnels

(ii) Foundation—this shall include the following :

—Excavations—the excavations included are for

—Stripping for dam seat

—Stripping for blanket

—Cut-off trench

—Longitudinal, cross and toe drains

—Dewatering arrangements

—Foundation treatment (drilling and grouting)

—Drilling in rock or in soil with casing

—Grouting (cement, bentonite, chemicals)

—Cement concrete pad for grouting or for cut off walls or for both

—Other treatments

—Pile driving

Foundation drainage—this shall consist of :

—Drilling drainage holes

—Making drainage and grouting tunnels

—Filling cut-off trench with selected improvious material

—From excavated material

—From borrow area

(iii) Dam (Structure)

—Earthwork (in core, shell, random zones and upstream blanket)

—Impervious

—Semi-pervious

—Pervious (Total to be indicated separately for excavated material and borrow areas)

—Filter (sloping and horizontal at downstream toe or hearting) of selected media

—Filling longitudinal, cross and toe drains, etc. with drainage materials, like sand, gravel or spalls and rubble

—Downstream rock toe

—From excavated material,

—From quarries

—Upstream slope protection

—Downstream slope protection

—Relief wells, drainage blanket, etc.

—Parapet wall

—Masonry or concrete with coping

—Railing

—Wheel guard stones

—Roadway over top of dam

—Gauge posts

—Instrumentation

—Laying open jointed pipes

—Manholes

NOTE : Rock-fill dam will include dumped rockfill of different grades and in different zones.

(b) Masonry and concrete dam

(i) Diversion works during construction, such as coffer dams and tunnels

(ii) Foundations :

—Clearing site

—Dewatering in foundations

—Excavation for approach and tail channels divide walls, guide walls and main dam, in :

—Overburden of soft strata

—Overburden of hard strata

—Hard rock

—Preparation of dam seat

—Cement grouting including curtain and consolidation grouting

—Drilling holes

—For grouting

—For drainage, and

—For Anchor Rods
—Anchor Rods

(iii) Dam

—Masonry/concrete for

NOTE:—Concrete item rate shall be inclusive of Form work
—Hearting
—Upstream face
—Down-stream face (non-overflow section and overflow section)
—Divide walls
—Parapets and
—Galleries, adits and other openings
—Cement Concrete in
—Foundation
—Divide Wall
—Parapets
—Galleries, adits and other openings
—Griniting upstream face
—Instrumentation
—Reinforcement steel
—Joints and seals
—Drilling and grouting of masonry
—Porous pipes for drainage
—Ventilation

(c) Spillway

(i) Cement concrete for
—Bridge piers
—Bridge beams and slabs
—Tunnel lining
—Miscellaneous items of bridge like bearings
—Tunnel excavation
—Crest gates with hoisting equipment and hoist bridge
—Stop logs for crest gates, and lifting arrangement.

Energy dissipation works

—Same items as for concrete/masonry dam with the addition of cement concrete or masonry for:
—Apron
—Floor blocks
—End sills and chute block
—Training wells

(d) Outlets

(i) Excavation

(ii) Cement concrete
—In foundations
—For conduit bottom slabs, walls and top slab or arch, cut-off, collars, etc.
—For hoist tower walls, beams, floor slabs etc.
—For blockouts

(iii) Intake structures
—Excavation
—Foundation treatment
—Cement concrete for foundation, and for piers and abutments
—Masonry for guide walls of approach channel
—Trash rack including raking arrangement
—Gates with auxiliary equipment
—Reinforcement Steel

(iv) Joints and seals

(v) Drilling and grouting

(vi) Gates and hoisting arrangement

(vii) Steel lining

(viii) Miscellaneous items, such as air vent, operating cabin, ladder, flooring etc.

NOTE:—It shall be mentioned in the estimate that the costs pertain to the rates on..... (month and year).

The following points shall be kept in view while framing the estimate under sub-head C-works.

The latest labour rates for unskilled, semi-skilled and skilled labour shall be furnished.

It shall be indicated clearly whether the work(s) is/are to be executed departmentally or through contractor(s)

The contemplated extent of manual and mechanised construction for major components of the project shall be indicated and separate analysis of rate (manual/machine) furnished for each item of work.

The latest basic cost of material such as steel (reinforcement/structural) cement (at rail head/stockyard) soil(s) (borrow area) sand, aggregate, rock (quarry) shall be indicated and supported with the analysis of rates wherever necessary. The distance from the rail head/stockyard/quarry/borrow area etc. to the site of work shall be indicated

In some project estimates, the provisions are based on the District/State schedule of rates duly modified for extra leads and lifts. The River Valley Projects are generally to be constructed in the out of way places. No standard or schedule of rate of a District/State can therefore be applied for working out the provisions under various items of work. Thus the practice of applying District or State schedule of rates shall be avoided as firstly the project rates have their own structure different from normal work i. e. buildings, roads, irrigation maintenance etc., and secondly the schedule of rate in the area may not have been updated and the escalation to be considered for updating the rates may pose a problem. It is therefore, essential that the item rates shall be based on the detailed analysis prepared for principle items of work, keeping in view the local conditions for the purposes of estimation. The analysis of rates worked out for the major items of work shall be enclosed with the estimate.

The actual rates obtained for the major items of work at the project constructed in the nearby areas could also be used with advantage with necessary modification while framing the estimate. It shall however be ensured and justified that the working site conditions at the two projects are similar and if so, the rates can be modified keeping in view the difference in lead, lift and escalation wherever necessary for adopting the rates for the new project. The name of the project from which the actual rates are taken and the year in which these rates were realised shall be specified.

Lumpsum provision for other items of work shall be avoided as far as possible and efforts shall be made to assess such items by working out in detail to the maximum possible extent. The cost of some of such items duly modified, if required, can be based on the experience of nearby works.

For working out the use rates of machinery the norms for life, depreciation, repair provision etc. shall be taken as given in the 'Guide-book on transfer of used equipment May, 1975' issued by the Central Water Commission, New Delhi. This guide-book is based on the recommendation made by the 'Select Group' constituted to examine the report of the second Construction Plant and Machinery Committee approved by the erstwhile Ministry of Irrigation and Power.

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 macadum, murum, katcha etc.).

Contingencies and workcharged establishment shall be provided at 5 per cent of the cost of all items excluding lumpsum items. Similar provisions for contingencies shall be made under other sub-heads concerning works pertaining to canals, canal structures, buildings, power house, navigation, communications etc. where the estimates/sub-estimates are based on the basis of item rates and quantities of works to be executed.

For excavated materials to be used in the body of the structure, separate item rate excluding the cost of excavation shall be worked out and provided.

3.16.3.4 D — Regulators

3.16.3.5 E — Falls

3.16.3.6 F —Cross Drainage Works

3.16.3.7 G — Bridges

3.16.3.8 H —Escapes

NOTE:—The following points shall be considered while framing the estimates for canal structures (mentioned above)

Where there is a big range in the discharging capacity of the structures typical structures of different capacity two or more in number shall be analysed to form the basis of provision for each type of structure.

OR

The provision shall be made on the basis of actual cost of structures constructed on similar project(s) by applying premium to update the cost. It shall be ensured and justified that the projects considered are similar in nature.

The basis for premium applied shall be indicated. The reference to the project where such costs were realised and the year of work shall also be indicated.

OR

The provision shall be made on the basis of cost curves updated based on the quantities of different items of work of old similar structures and applying current item rates (analysed).

The analysis of rates for major items of work shall be in line with procedure discussed under C—works and finished.

The sub-estimates for the structure analysed/prepared on the basis of modifications of tendered rates/analysis of rates shall be appended.

3.16.3.9 Navigation Works

Important items to be considered

(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.

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 shall be made in consultation with the State Inland Water Authorities.

3.16.3.10 Power Plant/Appurtenances (Civil Works)

Important items to be considered

(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 rocks including raking arrangement

(vi) Gates with auxiliary equipment

(vii) Reinforcement steel

(b) Tunnels (including cut and cover section)
  (i) Excavation
    Open cut
    Tunnel including temporary supports
  (ii) Rock bolts etc.
  (iii) permanent supports, ventilation
  (iv) Drainage
  (v) Cement concrete for lining
  (vi) Steel lining
  (vii) Drilling and grouting
  (viii) Gates and ancillaries where required
  (ix) Reinforcement steel

(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

(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

(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

(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, griting etc.

NOTE: The provision shall be made in line with the procedure discussed under C-Works and analysis of rates for major items of work shall be furnished.

3.16.3.11 K— Buildings

Important items to be considered

(a) Residential buildings

Buildings for the various categories of the staff

(b) Non-residential buildings
  (i) Office buildings
  (ii) Testing laboratories
  (iii) Rest houses and Field hostels
  (iv) Workshops
  (v) Stores
  (vi) Sheds
  (vii) Other Service Buildings
    —Hospitals/dispensaries
    —Welfare Centres
    —Police Station
    —Schools
    —Post Offices, Telegraphs and Telephone offices
    —Community Centre
    —Generating House or sub-stations
    —Canteens
    —Co-operative stores and markets
    —Bus Stops
    —Other public utility services bank and treasury

(c) Provision for other items
  (i) Land development
  (ii) Colony Roads
  (iii) Fencing
  (iv) Service connections for Water Supply, Sanitation, Electrification etc.
  (v) Lawns and gardens

NOTE : The buildings, both residential (including workcharged staff) and non-residential shall be divided in two categories i.e., permanent and semi-permanent/temporary. Permanent buildings shall be provided on the basis of post construction/maintenance requirement of the project. The provision for the various categories of building shall be made on the basis of plinth area and prevailing market rate per unit area of the different categories which shall be indicated in the estimate.

While planning temporary buildings, the scope of their use after the project shall be considered in consultation with the other departments of the State especially Industries Department and the extra cost if any, on the account shall be clearly spelt out. The proposal for the disposal of such buildings shall be discussed.

It is for guidance that the provision under this sub-head is normally made at 3-5 percent of I-Works. Exceptionally higher/lower provisions shall be justified.

15 percent of the cost of temporary/semi permanent building is shown under V-Receipts and Recoveries (Item 3.16.7)

3.16.3.12 L-Earthwork :

Important items to be considered

(a) Excavation

(b) Embankment from

(i) Excavated material

(ii) Borrow areas

(c) Lining

(d) Pitching

(e) Miscellaneous items, such as construction of drains inspection and service road/path etc.

NOTE : 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.

3.16.3.13 M—Plantation

The cost depends upon the plantation programme including Gardens etc. required for beautification as considered necessary downstream of Dam and appurtenances around power house and other important structures.

For headworks, the provision shall be made on lump sum basis keeping in view the experience of other projects. 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.

3.16.3.14 N—Tanks and Reservoirs

Important items to be considered

(a) Earthwork

(i) Excavation

(ii) Filling

(b) Repair of the spillway portion

(c) Repair of outlets

(d) Repair of the channels

(e) Any other work

This sub-head shall 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.

The procedure for analysing the item rates shall be in line with that described under C-Works.

3.16.3.15 O—Miscellaneous

Important items to be considered

(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 Offices and Wireless

(vi) Medical equipment for hospital/dispensary(s) etc.

(vii) Any other such as fountains, recreation facilities, special lighting arrangements for beautification of areas in the project

(b) Maintenance and service

(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) Ambulance

(xiii) Pay van

(c) Other items

(i) Visits of dignitaries

(ii) Technical record, photographic record

(iii) Inaugural ceremonies

(iv) Compensation to workmen

(v) Boundary pillars and stones, distance marks and bench marks

(vi) Power supply

(vii) Anti-malaria measures

(viii) Model and exhibits

(ix) Testing laboratory and exhibits
(x) Publicity and information centres
(xi) Subsidy for school bus
(xii) Publications, Pamphlets
(xiii) Running of transit camps/rest sheds guest houses/Inspection bungalow
(xiv) Training of Engineers
(xv) Canteen facilities
(xvi) Co-operative stores
(xvii) Library facilities
(xviii) Time keeping cabin
(xix) Wireless communication system
(xx) Providing flood warning system
(xxi) Retrenchment compensation
(xxii) Seismological observation
(xxiii) Police station
(xxiv) Community Centre
(xxv) Photographic and cinematographic equipment establishment and running/ maintenance charges
(xxvi) Creches
(xxvii) Railway Siding
(xxviii) Writing of completion report and history of project.

NOTE : The above list is illustrative and not exhaustive. Provision shall be made for all the items, which are relevant to the project.

The total provision under this sub-head is generally of the order of 4 per cent of I-Works. It is however, not unsual to have provisions working out to more than 4 percent also. Provision in excess of 4 persons shall be justified. The R & M Inspection/ Transport Vehicle (Ref. 3.16.3.15—b items-viii-xiii) hall be provided on per vehicle per year basis.

Credit on account of resale of electric installations, water supply fittings etc. after completion of the project if anticipated shall be shown under item 3.16.3.17-V Receipts & Recoveries.

3.16.3.16 P Maintenance

The usual norm for provision under this sub-head is 1 percent of the cost of I—Works less A—preliminary, B—Land and Q—Special T & P, and covers maintenance of all works during the construction period.

3.16.3.17 Q—Special T & P

Important items to be considered

(a) Drilling and grouting equipment
(i) Compressed air distribution system
(ii) Diamond drills
(iii) Core drilling machine with prime mover
(iv) Wagon drills
(v) Jack hammers
(vi) Pavement breakers
(vii) Grouting equipment like grout mixers, pumps, etc.

(b) Transport Equipment
(i) Trucks of 3 to 20 tonne capacity
(ii) Motorized tanker (3636 to 9090 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

(c) Water Supply Works and Dewatering Arrangements :

(d) Electrical Equipment
(i) Generators
(ii) Motors
(iii) Flood lights

(e) Compaction Equipment
(i) Road rollers (8 to 12 tonne)
(ii) Sheep foot rollers
(iii) Pneumatic tyred rollers (20 to 50 tonnes)
(iv) Vibratory rollers

(f) Construction Plant
(i) Crushers, classifiers
(ii) Washing and cleaning plants for aggregates
(iii) Batching plants
(iv) Refrigerating plants
(v) Screening plants
(vi) Reclaiming plants
(vii) Belt conveyor
(viii) Cranes, wagons, cement silos and cement pumping plant
(ix) Surkhi/pozzolana manufacturing plant
(x) Concrete mixer
(xi) Mortar mills
(xii) Portable vibrators (Pneumatic, diesel, petrol, etc.)
(xiii) Tram lines and related equipment

(g) Earth Moving Equipment
(i) Shovels and draglines
(ii) Scrapers (moterizes and tractor drawn)
(iii) Overhead and crawler front-end loaders (tyred and tractor type)
(iv) Crawler tractors, dozers and rippers
(v) Wheeled tractors, dozers and rippers

(vi) Motor graders

(vii) Carriers, such as bottom dumpers, rear dumpers and side dumpers

(viii) Belt loaders, elevating grader

(ix) Tippers trucks

(x) Trenchers

(xi) Wheeled excavators

(xii) Dredging equipment

(h) Miscellaneous Equipment

(i) Hoists

(ii) Pulley block, lifting tackle, gantries

(iii) Winches

(iv) Mobile cranes

(v) Other lifting machines

(i) Workshop and ancillary equipment

(i) Foundary Shop

(ii) Smithy Shop

(iii) Machine shop

(iv) Structural shop

(v) Welding shop

(vi) Fitting and assembling shop

(vii) Tyre retreading shop

(viii) Carpentry shop

(ix) Paint shop

(x) Millwright shop

(xi) Galvanizing shop

(xii) Field repair shops, such as carrier repair shop, tractor shop, auto shop, pipes and pumping shop and drill and bit repair shop

NOTE :—The capital cost of the equipment shall 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 machinery shall generally be so planned that it spends 75 percent of its life at project i.e., 75 percent of its cost is recovered from the works as hourly use rates. The provision under this head therefore shall be 25 percent of the capital cost of the Special T&P and 75 percent of this provision (25 percent) shall be shown under V—Receipt and Recoveries towards resale/transfer value. Loss of the project on this account is not expected to be more than 10 percent of the capital (purchase) cost.

For highly specialised Capital Intensive Equipment like Aerial Cableways, Moles, etc. which cannot be planned on the criteria under para above the anticipated cost chargeable to the sub-head C-Works shall be calculated and the residual value shall be shown under V—Receipt and Recoveries. Justification shall be furnished for calculating the charges debitable to ub-head C-Works.

For inspection, transport (other than required for material transportation) etc. vehicles 100 percent of the capital cost shall be provided under this head. 20 percent of the value shall be considered as resale, transfer value of the vehicle(s) and shown under V—Receipts and Recoveries.

Higher/lower provisions for special T&P other than specified above shall be justified.

No provision shall be made for the items normally covered under III T&P i.e., furniture for office, Camp equipage Surveys and Mathematical equipment and any other instrument etc.

No provision shall be made for spares as they are directly covered under the hourly rate chargeable to the items of work.

All the equipment required inclusive of capital intensive equipment shall be provided on the basis of the latest rates including transport cost and other (insurance taxes etc.) and initial requirement of funds worked out but the provision for this sub-head shall be worked out as under :

Capital cost of Special T&P (other than specialised capital intensive equipment)	— P
Cost recoverable as hourly use rate (debitable to works)	— 0.75 P
Capital cost of inspection/ transport vehicles	— Q
Capital cost of specialised Capital Intensive Equipment	— R
Cost 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+ Ra
Recoveries to be shown under V-Receipt and Recoveries (Item 3.16.7)	— 0.75 (0.25 P) +(R-Ra)+ 0.2Q

3.16.3 18 R—Communications

Important items to be considered

(a) Construction of the main approach road to dam site

(b) Construction of quarry roads

(c) Construction of temporary roads in the works area

(d) Construction of temporary or permanent river crossing

(e) Railways, bridges, connecting roads, waterways and air strips/halipad

The cost for each type of road shall be provided on the basis of calculated a road length and rate per km. Major items on this account shall be supported by sub-estimates

For road bridges the provision shall be made in line with the canal structures

For railway siding and railway bridges the provision shall be made in consultation with the Railway Authorities

For provision of air strip/halipad, Civil Aviation Authorities shall be consulted

For provision of water-ways State Inland Water Authority shall be consulted

3.16.3.19 S—Power Plant and Electrical System

This sub-head shall cover the provision required for the equipment for Power Plant Switchyard etc. and other items connected with the installation

The provision to be realistic shall be based on the latest market rates and year for which the rates are applicable shall be indicated .

3.16.3.20 T—Water Supply Works

This item shall cover works required for delivering water to a point beyond which the supply system will be taken over by the Public Health Department. This shall normally consist of water conductor system and pucca structures on open channels. The provision for various items of work shall be made in line with the procedure discussed under various sub-heads i.e. C-Works D-Regulators etc. I.-Earthwork etc.

3.16.3.21 U—Distributaries, Minors and Subminers

Cost shall be indicated on the basis of rate per hectare of CCA for distributaries, miners etc. For the estimates to be realistic, the rates shall be based on a detailed sub-estimate for a typical block of command area of size of about 10 percent of the CCA after detailed contour surveys.

3.16.3.22 V—Water Course/field channels

The provision for water courses/field channels serving upto 5 to 8 ha block the block of about 40 ha is indicated on the basis of rate per hectare of CCA. The rates per hectare shall be arrived at on the basis of a sub-estimate of a representative sample area surveyed to cover about 10 per cent of the Culturable Command Area.

3.16.3.23 W—Drainage

Provision for drainage in the command area shall also be indicated on basis of rate per hectare of CCA. The rates per hectare shall be arrived at on the basis of sub-estimates of a representative sample area surveyed to cover about 10 percent of the culturable Command Area.

3.16.3.24 X—Environment and Ecology

Important items to be considered

(a) Compensatory afforestation (To be implemented by forest department)

(b) Measure in construction area to minimise land erosion, stagnation of water and health hazard.

(c) Removal of trees including stumps and roots (depth to be specified) before reservoir is filled.

(d) Control of aquatic weeds in submerged areas to provide improved habitate for aquatic life (fisheries depratment)

(e) Measures to salvage/rehabilitate any rare or endangered species of flora and fauna found in the affected area (Zoological survey of India wield Life Department and Botanical Survey of India.)

(f) Measures to salvage monuments from inundation and their relocation (Archaeological Department.)

(g) Enforcement of anti-poaching laws (forest department) in and the construction area during the conrtruction.

(h) Measures to prevent forest fires/over grazing of areas etc. (forest department) in and near the construction area during the construction.

(j) Establishment of fuel depots etc. to meet fuel requirements of labour force to prevent in discriminate felling of trees.

(k) Public health measures to control spread of water and soil borne diseases (health department).

NOTE:—Provision shall be made in consultation with the departments indicated in brackets.

3.16.3.25 Losses on Stock and Unforeseen.

It is for guidance that the provision under the said sub-head is generally made at 0.25 percent of the cost of I-works less A-Preliminary B- Land and Q-Special T & P.

3.16.4.11 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 percent to 12 percent for scattered works like canals.

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

Since land acquisition staff is separately provided under the sub-head B-Land. the percentage provision for II-Establishment shall be considered on the cost of I-Works less B-Land.

3.16.5.II— T& P

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. It shall generally be provided at 1 percent of the cost of I-works.

3.16.6 IV—Suspense

Provision made shall be justified.

NOTE:—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.

3.16.7 V—Receipts & Recoveries on Capital Account.

Under this head estimated recoveries by way of resale or transfer of temporary buildings and special T & P shall be accounted for. Miscellaneous receipts likely from rent charges of buildings, electricity charges etc. shall 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 tubelar construction, vicinity to an industrial undertaking etc.) Such special reasons shall be indicated in the Report. The recoveries on account of Special T & P shall be indicated as explained in item 3.16.3.17 Credit on account of resale of electrical installations, water supply fittings etc. after execution of the project if anticipated, shall also be shown.

3.16.8—Indirect charges.

The provision for these shall be made for two items as under. :

3.16.8.1 Audit & Accounts Charges.

This is generally taken at 1 percent of the cost of I-works.

3.16.8.2 Abatement of land Revenue.

The provision for this is generally made at either 5 percent of the land cost or 20 times the annual revenue lost.

3.17 REVENUES

The following points and additional points, if any, shall be discussed under this chapter :

Where information if asked in a tabular form, it shall be followed by the discussion of the tabulated data.

3.17.1 Yearly programme of development w.r.t. 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) Any other						

3.17.2 Sources of revenue.

3.17.2.1 Water rates-irrigation cess—betterment levy—pisciculture-sale of fishing rights etc.

3.17.2.2 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.

3.17.2.3 Power rate

3.17.2.4 Navigation—Cargo rates, passenger rates

3.17.2.5 Other sources

3.17.2.6 Basis for levy of various rates for above items and comparison with existing rates and concurrence from the concerned department.

3.17.3 Concession in water rates (irrigation) Cargo and passenger rates etc. (navigation) as incentives during first few years of introduction of irrigation and navigation.

3.17.4 Administrative charges for supply of water and collection of revenues etc.

3.17.5 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.

3.17.6 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).

3.17.7 Total income from the various sources indicated, 3.17.2.

3.17.8 Details of staff proposed for collection of revenues and its basis.

3.17.9 Net revenue expected from different components of project.

3.17.10 Productivity of the project in terms of percentage financial return at

(a) 10 Year after completion.

(b) Full development.

(c) Where betterment levy proposed is anticipated to be realised.

3.17.11 Justification for sponsoring an unproductive project with concurrence of the finance department

3.18 BENEFIT—COST RATIO AND FINANCIAL RETURN

This chapter shall contain details in respect of the assessment of Benefit-Cost Ratio(s) and Financial Return(s) of the Irrigation and 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.

—Views of this Working Group on Command Area Development cost.

The suggested procedure shall be followed till such time the revised instructions are issued by the Planning Commission.

3.18.1 Irrigation Projects.

3.18.1.1 Estimation of annual benefits.

Annual Benefits shall be computed as under :

(a) Agriculture production in the area to be irrigated under pre-project conditions.

(b) Agriculture production in the area after completion of the Irrigation Projects.

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. The Department of Agriculture shall also furnish the basis for recommending the cropwise yields/ha under pre and post project conditions and prices to be used.

3.18.1.2 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 at Rs. 50 per ha. of the Gross Irrigated Area or culturable Command Area, whichever is more.

(c) Depreciation of the project based on the assumed life of the project e.g. 1 per cent of the total cost (excluding land development) for 100 years life of the project.

(d) Maintenance of the Headworks 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

3.18.1.3 Benefit Cost Ratio & financial return B.C. Ratio = Annual Benefits/Annual Cost, Typical B.C. Ratio calculations of an Irrigation Project are given in Annexure-7 and proformae for financial return statement is given in Annexure-8.

3.18.2 Multipurpose Projects

3.18.2.1 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 beadworks shall be shared by the concerned departments on mutually agreed basis.

3.18.2.2 B.C. Ratio and financial return for Irrigation component of the Multipurpose Project

The B.C. Ratio and financial return statements for the Irrigation component of the Project shall be prepared as per item 3.18.1 above.

3.18.2.3 Financial Return for Power component of Multipurpose Project

The Financial Return statements shall be prepared for the power component of the project as per proforma given in Annexure-5.

3.18.2.4 B.C. Ratio for flood control component of the Project.

(a) Estimation of annual benefits

Annual benefits shall be computed as under :

(i) Average annual damage computed.

NOTE :—This shall be based on at least last 10 years data.

(ii) Average annual damage anticipated after the completion of the project.

(iii) Net benefits (i—ii)

(b) Estimation of annual cost

Annual cost shall consist of the following :

(i) Interest at the rate of 10 per cent on the allocated cost of the dam and estimated cost of the flood embankment.

(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 percent 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 at 4 per cent.

(c) B.C. Ratio = Annual Benefits/Annual costs
For sample proforma refer Annexure-9.

3.18.3 Benefits other than those considered in the B.C. ratio and financial ai return.

3.19 ENVIRONMENTAL AND ECOLOGICAL ASPECTS OF THE PROJECT

Following aspects of environment and ecology of the project shall be considered while preparing this chapter (on the lines suggested by the Deptt. of Science & Technology)

Site Selection

Major environmental and ecological components that need to be kept in view during site selection include :

Immediate and long term impact on population in the surrounding human settlements, both in the inundated and surrounded areas.

Impact on flora and fauna (plant life) in the vicinity.

Impact on national parks and sanctuaries—both existing and potential

Impact on wild life (including birds) breeding area/feeding area/migration route

Impact on sites and monuments of historical, cultural and religious significance

Impact on forests, agriculture, fishery and recreation etc.

Requisite data for impact assessment, if not already available, may be generated through field surveys such as

Census of flora and fauna in submergence area, particularly rare and endangered species.

Census of animal population and available grazing areas

Land-use pattern in the area with details of extent and type of forest in catchment and submergence areas

Pre-impoundment survey of fish habitat and nutrients levels

Ground water levels, quality and existing water use pattern

Mineral resources including injurious minerals in the impoundment

Living conditions of affected tribals/aboriginals etc.

Physical aspects

The impoundment will create altered surface water patterns that may have for reaching impact on underground acquifers and their recharge. Major aspects to be considered include;

Land slides periphery of the reservoir siltation or sedimentation expected in the reservoir Identification of critical area of erosion and methods of possible treatment.

Ground recharge or other ground water changes

Expected water quality (salinity) changes over time and their effect on riverine eco-system both in impoundment and downstream

Land use patterns and practices in the vicinity of waterspread that would affect acquatic vegetation growth patterns

Potential seismic impact of reservoir loading

Favourable aspects of impoundment on project area.

Resource linkages aspects

Creation of an impoundment cause considerable disruption and results inevitably in the adoption of alternative land uses. Careful evaluation of the impact should be undertaken of factors as :

Resource trade-off, such as less of optional land uses due to impoundment, mineral deposit less, loss of forest reserves etc. monuments inundated, recreational facilities lost, dislocation of existing settlements because of submergence etc.

Compatibility of dam's presence and operation, including the impoundment, with present or planned development of the region

Effect on resident and migrating fish and other acquatic life and assessment of new fishing potential

Likely increase in production

Socio-cultural aspects

Since, relocation may strain/disrupt the social fabric of the affected population, efforts should be directed towards enhancing their quality of life and preserving, to the extent possible, the special characteristics of their life-style.

Population relocation requirements in inundated as well as watershed areas. This aspects has special bearing on the relocation of Tribals and Advasis etc.

Resettlement area planning for housing and other amenities of community life (water supply sanitation, schools, health services etc.) to be provided at resettlement sites.

Likely improvement in the life style of the area benefited.

Public health aspects

New health problems or vector patterns that may arise due to changes in water velocities, temperature, quality or other physical change factors caused by water impoundment

Adequate public health planning to create facilities for migrant construction workers and immigrant influx.

Possibility of disease aggravation or new public health problems introduced due to changes in population density and distribution should be looked into.

The following data shall be collected to study the above aspects of the environment and ecology of the project. The source from where the data is to be collected and whose opinion is to be sought and incorporated within the project report are listed below :

Notation	Department
1	Forest Department
2	Indian Meteorological Department
3	State Fisheries Department
4	Zoological Survey of India
5	State Wild Life Department
6	State Health Department/State Public Health Department
7	Botanical Survey of India
8	Geological Survey of India

NOTE :— For preparation of this Chapter, Department of Science and Technology (Environmental Cell) shall be consulted as and when required.

3.19.1 Basic information

3.19.1.1 Existing land use in the catchment upto the source of the river or 100 km upstream of the structure whichever is less (ha)

(a) Agricultural land

(b) Forests

(i) Reserved

(ii) Unreserved

(c) Barren land etc.

3.19.1.2 Submerged Area (ha)

(a) Cultivated land

(b) Forest

(c) Shrubs and fellow

(d) Wet lands

(e) Area under ponds and tanks etc.

(f) Other uses

(g) Total

3.19.1.3 Forests types in the catchment and submerged area (types of trees, sporse or thickly populated and other details)

(ii) Area proposed to be cleared for construction of roads, colonies and other uses of the project.

3.19.1.4 Proposed period of construction

19.1.5 Labour

(a) Estimated strength (peak)

(i) Total

(ii) Skilled and semi skilled (separate)

(iii) Unskilled

(b) Availability of labour from the affected area

(i) Total

(ii) Skilled

(iii) Unskilled

3.19.1.6 Population density (per sq km)

(a) Catchment

(b) Submerged area

(c) Command

3.19.1.7 Villages affected and population displaced

(a) Number of villages

(b) Population

(a) Scheduled Caste

(b) Scheduled Tribe

(c) Others

(d) Occupation of the affected working force

(i) Agriculturists

(ii) Agricultural labour

(iii) Industrial labour

(iv) Forest labour

(v) Artisans

(vi) Any other

(e) Land Owner

(i) Marginal farmers

(ii) Small farmers

(iii) Medium farmers

(iv) Big farmers

3.19.1.8 Resettlement

(a) Details of rehabilitation committee, if any

(b) Existing status' guidelines for resettlement, compensation cash and/or kind, if any

(c) Compensation proposed to be paid

(d) Resettlement plans of oustees (number of persons and families)

(i) In existing villages

(ii) At new village site and its distance from the present habitation

(iii) Plan of the new village

(iv) Facilities being provided (school, post office, bank, panchayat ghar, police station, roads, drainage, water supply, vocational training etc.)

(e) Proposals to provide employment to oustees.

3.19.1.9 Details of development activity in the affected area

(a) Drought-prone Area Programme

(b) Small Farmer Development Agency

(c) Rural Development

(d) Tribal Development

(e) Other programmes.

3.19.1.10 Sedimentation of the reservoir

(a) Expected rate of siltation

(b) Proposed/existing soil conservation programmes/measures in the catchment

(c) Problems of slips and slide on the periphery of the reservoir and proposed remedial measures.

3.19.1.11 Present flood situation in the command.

3.19.1.12 Wind rose diagram, wind speed (maximum average) direction (seasonal) etc. at the headworks site 2

3.19.1.13 Frequency of occurance of tornadoes, cyclones, hurricane (maximum and minimum wind velocity) 2

3.19.1.14 Ground water (command)

(a) Depth and seasonal variations (pre and post monsoons)

(b) Quality-potable, fit for irrigation/industry

(c) Present use

(i) Area under irrigation

(ii) Extent of industrial use

(d) Interaction between the altered surface water patterns and under ground water recharge etc. (based on the experience of similar projects)

3.19.2 Environmental status

3.19.2.1 Known sources of pollution

(a) Industry
(b) Thermal power House
(c) Mining operation etc.

3.19.2.2 Industrial development in project area

(a) Present status
(b) Future plans (10 years)

3.19.2.3. Broad details of the aquatic life (fish, crocodiles etc.) supported by the area. If economically viable indicate the breeding grounds in the river/tributary (s) area (s) coming under submergence 3

3.19.2.4 Wild animals and birds 4 & 5

(a) Existance in the area
(b) Rare/dying species (number)
(c) Breeding/feeding area(s)
(d) Migration routes
(e) Is the area a Potential wild life sanctuary

3.19.2.5 Flora, fauna in the submerged area 5 & 7

(a) Broad details of the rare/dying species
(b) Number species
(c) Measures to salvage/rehabilitate

3.19.2.6 Tourism

(a) Is the area a tourist resort
(b) Broad details of religious, archeological and recreational centre, wild life sanctuaries, national parks/likely to be affected by the project etc.

3.19.2.7 Broad details of endemic health problems due to soil and water borne diseases 6

3.19.3 Environmental impact

3.19.3.1 Proposals to develop the site to attract tourism (recreation, water sport, picnic sites etc.)

3.19.3.2 Effect of the storage in flood mitigation

3.19.3.3 Changes in salinity of underground water expected and remedies, if required

3.19.3.4 Expected Waterlogging problems and remedies

3.19.3.5 Aquatic life

(a) Existance of migratory fish life and proposals for fish ladder/lift, if any
(b) Proposals for fisheries development and crocodile farming, if any
(c) Loss in aquatic production up or downstream, if any

3.19.3.6 Broad details of mines, mineral, commercial timber and other natural resources coming under submergence with estimated loss 1 & 8

3.19.3.7 Broad details of injurious minerals coming under submergence.

3.19.3.8 Effect of water body in enhancement of water borne diseases 6

3.19.3.9 Broad details of likely growth of weeds (salvinia, water hya nith etc.) intermittent host (vectors like snails, mosquitoes) and proposed remedial measures 3 & 7

3.19.3.10 Effect of project on climatalogical changes (temperature, humidity, wind and precipitation including modification to micro and macro climate) 2

3.19.3.11 Measures to prevent animal over grazin and cultivation of fore-shore of reservoir to prevent premature silting.

3.19.3.12 Likely impact of reservoir loading on seismicity

3.19.3.13 Likely impact of population pressure on (during construction)

(a) Felling the trees for fire wood
(b) Forest fires
(c) Overgrazing leading to depletion of pasture lands
(d) Visual pollution and damage to scenary

3.19.3.14 Arrangement made for

(a) Fuel requirement for the labour force during construction period to prevent indiscriminate felling of trees for fire wood (fuel depots)
(b) Compensatory afforestation
(c) Enforcing of antipeaching laws
(d) Central of Sediment and pollution

3.19.4 Proposals for observance and monitoring of suggested safe guards and mitigative measures etc. during and after construction of the project.

3.20 FUTURE UTILISATION OF THE FACILITIES CREATED (BUILDINGS)

A provision of 3 to 5% of I-works is normally made in the estimate of River valley Project. Hiher provisions depending upon the location of site, though not common, have also been made in the estimates and accepted. This investment in the housing sector can be considered substantial. If proper care is taken, it can meet the ever increasing need for accommodation to some extent.

Normally two categories of buildings i.e. permanent and semi-permanent/temporary are constructed at the various activity centres of the River valley project. Generally the permanent buildings are planned from the consideration of the requirement for maintenance of the project after its completion. The quantum of such buildings is substantially less than the requirement of the buildings during the

peak construction period and to meet the peak requirement, construction of semi-permanent/temporary buildings is resorted. In case there is not much use for the temporary/semi-permanent buildings, after completion of the project, a recovery of 15% is shown under the head V-Receipt and Recoveries and the rest is considered as a loss to the project.

If the colonies are located near the railway stations, or the state and National highways or in the proximity of the existing township etc. these can go a long way in reducing the pressure on the development areas.

Major users of these buildings could be the Government, Industry, Educational Institutions, Department of Tourism, Public etc. So while constructing such Colonies the whole problem needs to be viewed from the overall needs of development of the area. A close coordination amongst the various development agencies is, therefore, essential while planning such colonies.

While planning the buildings the requirement of the other Government agencies which might be interested in development of the area shall be kept in view so as to decide upon the category of the buildings to be constructed. The proposed layout of each category/type may be discussed with the interested parties to incorporate their requirements in the design, if any, as far as possible.

Wherever it is not possible to dispose of the buildings to the Government and other agencies due to the remoteness of location of the project or some other reasons the material used for construction shall be such that it has maximum salvage value. Construction material at such location like Tublar Trusses, A.C. sheets or any other local cheap construction material having better salvage value could be considered for construction of temporary/semi-permanent buildings to reduce the loss to the project.

As a rule the buildings shall be transferred to the Government and semi-Government bodies at the residual value and when required by the private agencies the prices could be negotiated. The buildings could also be disposed to the interested individuals inline with the Government policies. The following points and additional points, if any, regarding the disposal of the buildings shall be discussed under this chapter.

3.20.1 Details of building to be constructed to meet the peak requirements of the project.

Details shall be furnished separately for each category i.e. permanent and semi-permanent/temprorav building with the basis for construction of each category in respect of the following types of buildings:

(a) Offices, rest houses, hostels etc.

(b) Residential

(c) sheds and stores etc.

NOTE:—information shall be furnished for each type of building indicating the plinth area of each type and total.

3.20.2 Departmental requirement of buildings of each category and type after completion of the project for the purpose of maintenance of the project.

3.20.3 Requirement of the surplus buildings by the then agencies as a result of dialogue while planning the buildings and how their special requirements have been taken into account at the planning stage along with the phasing.

3.20.4 Buildings likely to be rendered surplus after taking into account item 3.20.1.b, categorywise and typewise and phasing of availability of such accommodation after the peak requirement.

3.20.5 Proximity of the accommodation to the Railway Station National/State Highway, Industrial and other townships etc.

3.20.6 Important archeological and other places of interest near the project Area, communication routes with distances from the important places and possibility/proposal for development of facilities including beautification of the area to attract tourist traffic by the concerned departments.

3.20.7 Details of recovery due to disposal of building with basis;

DETAILED PROJECT REPORT

SECTION-4

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 a ea, location of the IMD stations rain-gauge 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 depest 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 barage 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 transmission lines etc.

27. Plan of the command area (scale 1:10,000 contour interval .5 m) 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 stratification 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 structure 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 furture projections.

41. Bar charts showing the construction programme and programme of development of benefits (irrigation, power etc.)

NOTE:—All drawings shall be prepared to the scale indicated in chapter 3.4.1. and annexure—1 unless and otherwise stated.

SECTION 5

List of Appendices

Appendix-1	Report on geology and seismicity of the project area, and site geology of major components of the project including major canal structures. (Refer Chapter 3.4.2.).
Appendix-2	Report on the foundation investigations of the major components of the project including major canal structures. (Refer Chapter 3.4.3.).
Appendix-3	Report on the material investigation for headworks and canal system (Refer Chapter 3.4.4.).
Appendix-4	Report on hydrology and water planning (Refer Chapter 3.5).
Appendix 5	Report on the design of major components of the project (Refer Chapter 3.6).
Appendix 6	Estimates.

All appendices shall have the necessary supporting tables and drawings.

ANNEXURE—1

SURVEYS : Extent, Scales, Contour intervals, etc. (Refer Chapter 3.4.1)

Sl. No.	Description	Area to be covered/Extent of Surveys	Scale		Contour Interval	Remarks
			Horizontal	Vertical		
1	2	3	4	5	6	7
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 far these point affected by fack 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 the L-Section (i) Date of survey of the particular reach and water level on that day (ii) Deep pools and rapids, rock outcrops etc. (iii) Maximum Historical observed HFL
		(ii) Downstream 10km from the axis of the structure or upto nearest headwork whichever is less.	1:10000	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.	1:2500	1:100	—	Levelling at 50m or less intervals. Following items shall be shown on the cross sections : (a) Date of survey and water level on that day (b) Minimum Water Level (c) Maximum historical/Observed HFL (d) Rapids & Rock outcrops etc.
		(ii) Down Stream X-Section @ 200 m interval upto historical/observed HFL+1m on either side of firm bank for a distance of 2 to 5 km from the axis of the structure depending upon the mandearing nature of the river.	1:2500	1:100	—	-do-
		(iii) Along the axis of the structure	1:2500	1:100	—	-do-
2.	Reservoir	Contour Plan covering an area upto an elevation of MWL+5m.	1:2500	—	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	Grid plan with contours of the site covering the area upto 250m upstream and 500m downstream of the axis extending upto an elevation of MWL+5m or more depending upon the site conditions. (tail channel area shall be adequately covered).	1:2500	—	0.5 to 1 m	Contour intervals as per item 2 above. Block levelling to be on 10m grid basis.
4.	Barrage/Weir	Grid plan with contours of the site covering an area upto 1 km on either side of the firm bank and 100m from the upstream/down stream tip of the guide bunds, parallel to the flow (tail channel area shall be adequately covered)	1:2500	—	0.05 to 1m	Block levelling on 50m or less grid basis depending upon the slope of the land.

1	2	3	4	5	6	7
5.	Canal & Water Conductor System	(i) L-Section (ii) Cross-section at 50m interval	1:2500 1:2500	1:100 1:100		Levelling at 50m or less interval -do-
		(iii) Strip Contour Plan cover 150m on either side of the centre line of the canal or depending upon the requirement whichever is more.	1:1500	—	0.5	Block levelling as per Item 4 above.
6.	Canal Structures	(i) Grid plan with contours of the site to cover an area upto 300m on either side of the centre line of the canal--100m downstream of the point of exit of water and 100m upstream of the point of water inlet.	1:2500	—	0.5	Block levelling as per Item 4 above
		(ii) Cross-section of the drain along the centre line of the canal.	1:2500	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	1:10,000			Refer Item 1 also
		Longitudinal and Cross-sections	1:2500	1:100		Refer Item 1 also
7.	Power House, Switch Yard Surge Shaft, Tailrace etc.	Contour plan of the site to cover full area of the component(s) alternative layouts.	1:2500	—	0.5 or 1 or 2 or 3 m	Contour intervals as per Item 2 above. Block level as per Item 4 above.
8.	Plant & Colony	Contour Plan of required area	1:2500	—	0.5	Block levelling as per Item 4 above.
9.	Tunnel & Adit	(i) Contour plan of the area covering the length of the tunnel & 500 m on either side of the centre line of the tunnel/adit including approach, portal and dump areas.	1:2500	—	1 or 2 or 3m	Contour interval as per Item 2 above Block levelling as per Item 4 above in case of ground surveys.
		(ii) L-Section	1:2500	1:100 or 1:200 or 1:500 or 1:1000		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.	1:2500	—	1 or 2 or 3m	Contour interval as per Item 2 above. Block levelling as per Item 4 above.
		(ii) L-Section	1:2500	1:100 or 1:200 or 1:500 or 1:1000		Vertical scale depending upon steepness of the slope.
11.	Command area survey including survey for drainage system.	(i) Contour plan of the area	1:10,000 or 1:15000		0.5m	
		(a) Plains and Plateau OFD works	1:2500		0.15or 0.25	Block levelling on 50m 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	1:1250 or 1:625		0.25 or 0.5 or 1 m	-do-
12.	Soil Conservation Survey	Plan of area subject to erosion, slides and slips	1:10000 or 1:50000	—	10m or less	Depending upon the location of the area
13.	Geological Maps	Reservoir and river valley structures (Dams, Barrage, Tunnel, Power House, Penstocks important structures on canal and water conductor system)	Same as recommended under each item above or otherwise stated in the text.			

1	2	3	4	5	6	7
14	Foundation Investigation Maps	Plan	1:2500	—	As specified above for the corresponding structure.	Showing location of structures, boreholes, trialpits, drifts and points where in situ tests were conducted etc.
		Gross Section	1:2500	1:100	—	Showing logs of boreholes, trialpits, drifts etc. and other features of the foundation.
15	Borrow Area and Quarries	Plan	1:2500	—	0.5 or 1 m	Location of different materials of construction pit/drill holes.
		Sections	1:2500	1:100	—	Showing profile along the grid lines upto the depth explored.
16	Soil Surveys	Plan	1:10000 or 1:15000			

ANNEXURE - 2

Location and Depth of Exploratory Holes/Drifts/Pits etc.

(Refer Chapter - 3.4.2. and 3.4.3)

Structure	Minimum Pattern of Drilling	
	Spacing of Drill Holes/Pits/Drifts	Depth of Drill Holes/Pits/Drifts
(a) Earth and rockfill dam	Drill holes along the axis 150-m or less apart, with intermediate pits to delineate weak and vulnerable strata with a minimum number of three to five 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 5m 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 elevations), in the gorge portion and one each in abutments.
	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	Drill holes along the axis at 100m interval or less apart to delineate weak and vulnerable strata with a minimum number of three to five holes in the gorge portion and additional two on each abutment parallel to the flow.	10 m in fresh rock (proved by geophysical or any other suitable method) About two holes to be extended deep (equal to the maximum height of the Dam in the absence of rock of higher elevation) in the gorge portion, and one each in abutment.
	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	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 5-10m 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.
	Drift, one each at the portal and adit sites.	Drifts shall be extended upto 10m in fresh rock or upto tunnel face.
(d) Barrage and Weirs	Drill holes along the axis, 150m or 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 two maximum head of water below the average foundation level or 5 m 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 structures or 5-10m 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 the 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 500 m or less apart to 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. Additional holes shall be drilled and pits/drifts excavated in consultation with the Geologist/Research laboratory to bring out clearly the foundation and abutment characteristics especially the weak zones requiring special treatment.

2. Disturbed and/or undisturbed soil samples, foundation of 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. 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.

3. 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.

4. 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.

5. The logs of the holes/pits/drifts shall be prepared as per I.S. Nos. 4453— 1967 and 4464-1967 (codes of practice)

ANNEXURE—3

MATERIAL SURVEY

(Refer Chapter—3.4.4)

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 15 to 30 cm) 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 of 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 includd 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 indicated.

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 materials shall be indicated.

10. Any other material

Required details as indicated in the earlier items shall be indicated.

ANNEXURE—4

GUIDELINES FOR PREPARATION OF HYDROLOGY, VOLUME OF DETAILED PROJECT REPORT

CHAPTER 1

1.0 General climate and hydrology

This chapter shall provide sufficient information about climate 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 E 13 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.

The above details shall be supported by the following maps and tables :

(a) One or more small index maps of size 25 × 20 cm (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 : 1,000,000).

(c) Tables or bar charts showing monthly normals and extremes of rainfall—number of rainy days—temperature, humidity—wind speed—pan evaporation—potential evapotranspiration (ETO) etc. for observatories (at least two in and around areas of interest); at least one 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/CWC/GBWRO/other agencies (include stations with long period data).

1.2 Specific Information

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 per cent.

(ii) Present land use classifying land under forest cultivated area, fallow land, land under urban and other uses.

(iii) Soil types

NOTE :—In preparing the above maps information available in the revenue records District Gazetteers, Census report, Irrigation Commission's report 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 show/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) Area altitude curves for orographic region having sizeable area above El 1000 m.

(d) Water quality data depending upon the nature of development.

1.2.2. Command area (Refer E2 of Enclosure-A)

(a) Table or charts presenting monthly normal rainfall and coefficient of variation for a few stations in or near command area.

(b) Monthly normal evaporation for few stations in or near the command.

(c) Infiltration characteristics of soils.

(d) Ground water behaviour supported with data of fluctuation (maximum, minimum and average over a period).

1.2.3. Floods and drainage (Refer E3, E4 & E10 of Enclosure 3-A)

(a) River profile showing flood levels and river cross-section.

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 L-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 spacings can be adopted.

(b) Information of past floods and past events of drainage congestion giving levels, discharge flooded areas and depth and 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)

(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)

(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)**

(a) Water quality data indicating both chemical and biologic 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—drainage area where appropriate—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

(b) 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 : 1,000,000 depending upon the size of the area involved showing the location of relevant meteorological and hydrological stations shall be furnished.

CHAPTER II

2.0 Hydrological Data Requirements

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 utilising the information classified in Enclosure-B and Enclosure-C

2.2 Inputs

2.2.1. Type of inputs

The inputs required for simulation and other studies for the development in question shall be discussed.

The nature of inputs required has been grouped as C-I 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.

2.2.2 Time unit for simulation studies

The time units applicable to the various type of projects are given in Enclosure-C. The information given in this Enclosure shall be utilised in deciding the time units of the hydrological inputs for particular type of development.

2.2.3 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 data required is given below :

Type of project (Enclosure-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)

2.3 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 required for simulation, flood studies and sedimentation) for the various components/at various control points shall be determined and discussed in details.

CHAPTER III

3.0 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 Chapter 3.4.5 of the Detailed Project Report shall be discussed. The details of the specific data collected 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 itemwise viz., flow, sedimentation, gauging, temperature, humidity, evaporation etc.

(b) Details of history of station, shifts in the location, shifts in the rate 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. The following or some of the techniques which can be used for gap filling :

(a) Random choice from values observed for that period.
(b) Interpolation from adjoining values by plotting a smooth hydrograph (for runoff alone).
(c) Using the average proportion with normals for the adjoining stations.
(d) Double mass curve techiques.
(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) Any other.

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 substracted.

NOTE:— (1) The adjustment of the observed flows/sediment data may not be nesessary if

(a) The utilisation by upstream projects has been same throughout the period of observation of flows and sediment
(b) If the pattern and quantum of usage has not changed appreciably or with a definite trend

(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, if any, made shall be checked and discussed

The check can be done by study of stage discharge relationship, and sedimentation rating curves for different periods Large veriations, if any, shall be investigated, corrected and explained suitably, if required.

3.5.2 External

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 runoff.
(b) Comparing average annual specific flow experessed as ham/sq km with corresponding figures at other sites of the same river or adjacent basins.
(c) By comparing the hydrograph of daily discharge at the control point with adjacent sites etc.
(d) 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/GBWRO/States and other agencies shall be summarised and presented as follows :

(a) Average annual/seasonal/monthy flow volumes 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 he compiled for appropriate time unit (Refer Enclosure-G).

NOTE :—

(1) The avearge for each time unit and totals and averages for months/seasons/year (June to May) shall be furnished.

(2) Where gap filling has been carried out and basic data adjusted, suitable footnotes to the effect 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.

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

4.0 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

4.1.1 Storage projects

The overall approach whether historical for generated sequences of flow volumes used shall be indicated.

4.1.1.1 Data Extension

The studies and methodology used for extending short-term runoff series to desired length of time (Chapter-II Para 2.2.3) shall be discussed covering details of type(s) of correlation transformation of data, correlation coefficient, standard error, etc. These studies can be done as follows:—

(a) Correlating runoff data with concurrent data on rainfall of long term stations in the same catchment or data of runoff of adjacent long-term station and applying these correlations developed to past data of long-term stations of rainfall/runoff.

(b) Such correlations shall be developed for each time unit selected.

NOTE :—

(1) Rainfall/runoff correlation may not be feasible or nessary for non-monsoon period.

(2) Overall Acceptability of correlation shall be checked.

(3) Random components may be considered where Correlations are not very strong.

4.1.1.2 Data generation

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 modelling (Time series)

(b) Conceptual modelling

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-correlation in data, its physical explanation, need for modelling autocorrelation, 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, correlation between random error components of different series and method of flow generation at different sites

For data generation by conceptual Modelling, details of modelling input data (e.g. rainfall) may be includied together with compilation of output data in appropriate time units.

4.1.2 Diversion and small pondages

4.1.2.1 Extension of data

The studies and methodology used for extending short-term runoff series to the desired length of time (Chapter-II Para 2.2.3) shall be discussed covering details of type(s) of correlations, transformation of data, correlation co-efficient, standard error, etc.

Techniques as suggested under 4.1.1.1 are also generally applicable for extension of data but the time unit shall be of shorter duration (refer Enclosure-G).

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 par evaporation or climatological data of a station close to the reservoir after adjusting the same 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 reservoirs' 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 : 5477 (Part-II & III) 1969 & CBI&P Publication No. 89 and 19).

NOTE :—

(1) The studies may not be necessary for diversion structures/works and for storages where the ratio of annual sediment volume as compared to the gross storage is less than 0.1 percent

(2) Studies have to be carried out where the ratio of annual sediment volume to the gross storage is more then 0.1 percent and with percesion for rate exceeding 0.5 percent. In such cases, more than one (depending upon the seriousness of the sedimentation problem) revised adjusted area capacity curves may be required.

(3) Usually for irrigation projects while working out the adjusted area capacity curves a time period of 50 years is used. In case a different time period is used the same shall be justified.

4.3.2 Rate of sedimentation

Annual rate of sedimentation shall be estimated from the historical data by analysis of the sediment discharge observations adjusted to long-term conditions where necessary by means of sediment rating and flow duration curves and or hydrographic surveys of the nearby existing storage(s) in similar catchment(s).

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 and discussed. The methodology for computing ETO shall also 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 may 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-efficients 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.

4.6 Inputs for water quality

The water quality problems in the various reaches such as salinity control and other aspects for preservation of fish and wild life shall be indicated and details of the water quality characteristics and the water flows or 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 extensioning 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 these 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

5.0 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" shall be referred to).

5.1.1 The criteria for selection of design flood for each structure taking into account the importance of each structure shall be discussed. The selected floods may be.

(1) 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 unit hydrograph) approach.

(b) Frequency approach (including conversion of storm frequencies into flood frequencies).

5.1.2.1 Hydrometeorological approach

(a) Design storms

The details of the transposed storms/Depth Area Duration obtained from the storms considered transposable from those discussed in Chapter-I shall be included alongwith details of moisture adjustment and 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 positionings of storm centre will be required to work out sub-area-wise depth—duration curves in each case.

(b) Unit hydrographs

Details of analysis of 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 hydrographs shall be given.

NOTE : Averaging and selection of unit hydrographs including maximization of unit hydrograph peak for increase of hydraulic efficiency shall be indicated.

Transfer of unit hydrographs to desired locations wherever made and details of synthetic unit hydrographs for ungauged area shall be included.

(c) Infiltration loss rates, runoff co-efficients:

Selection of infiltration loss rates, runoff co-efficient etc. shall be given based on information drived from observed flood hydrographs.

(d) Design flood hydrographs :

The synthesis of the flood hydrographs shall be indicated giving details of critical sequence of storm rainfall and antecedent storms, runoff and base flows adopted.

NOTE:—In very large catchments (say exceeding 5,000 sq km) the areas may be sub-divided and unit hydro-graphs/flood hydrographs prepared for each sub area by the procedure mentioned above and synthesised to the desired location by channel routing. Where upstream reservoirs exist, reservoir routing shall also be necessary.

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) Details of regional flood frequency study, if any.

(c) Reliability and consistency of frequency estimates, confidence intervals.

(d) Method adopted to draw the T-year flood hydrographs, where necessary.

Where long-term flood data are not available, storm frequencies are converted to flood frequency—details of compilation and frequency analysis of maximum rainfall series, infiltration rates and unit hydrographs, short period distribution of storm rain-fall and general flood synthesis criteria shall be furnished.

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 known historical flood, a flood of specified return period, depending upon the assets protected. However, in case of protection of important, cities, vital installations etc. are involved, Standard Project Flood may be considered.

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 floods 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. above the flood storage dam) 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(s) 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 channle 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 enfluence 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 to 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 considerations, 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

The points at which rating curves are required and the approach adopted—hydrologic or hydraulic, shall be discussed.

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 or basin.

NOTE :— Such of the projects which will not have serious impact on the availability of flows can be ignored.

If necessary, allowances (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:

(i) 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.

(ii) 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 procedures 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.

(iii) The series used in the simulation—single historical, many likey historical or synthetic—shall be indicated with reasons.

(iv) 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.

(v) If control of quality of water etc. is involved in the studies, the manner in which this has been provided for has to be discussed.

(vi) 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.

(vii) 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.

(viii) 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:

(a) Sanctioned or approved utilisations and legal right demands or

(b) historical actual use

(c) demands if any, based on reassessment of requirements of the existing projects.

(ix) The operation policies (priorities etc.) for different uses considered in the simulation studies, shall be indicated with reasons.

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.

(x) In the 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 the spillway design flood, it can be negotiated safely without endangering the structure.

(xi) 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:

1. 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.
2. Number of failure years compared with the total years considered in the studies by neglecting the failure of quantum below a particular quantity of failure for short periods or both.
3. Number of crop seasons in which failure takes place compared with total crop seasons, as in (a) and (b).
4. The number of succesive 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:

(a) Average and annual quantum of shortages for use over the period of simulation.

(b) 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

7.0 EFFECT OF PROJECT ON HYDROLOGIC REGIME

The following aspects shall be discussed under this chapter:

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 runoff

The likely decrease in the total runoff yield of the basin due to increased evaporation from the altered water surface and evaporation in the command area.

7.4 Effect on sediment flows

Likely changes (quantitatively) on sediment flows downstream of the project and its effects on downstream structures, land fertility etc.

ENCLOSURE A

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 (another structure of a natural hydraulic control 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 sustenance 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 systems involving combinations of 1 to 4 above mentioned.

ENCLOSURE C

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—TYPES OF HYDROLOGIC INPUTS REQUIRED

C-1	For simulation studies
C-1.1	Water inflows
C-1.2	Lake evaporation
C-1.3	Potential evapotranspiration 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

ENCLOSURE E

TYPES OF HYDROLOGICAL INPUTS REQUIRED FOR SIMULATION (CLASSIFIED AS PER CONTEMPLATED USE)

Use	Inputs
B 1*	C 1.1 C 1.2 (if storage is involved) C 1.3
B 2* and B 3*	C 1.1 C 1.2 (if storage is involved)
B 4 * to B 7*	C 1.1 C 1.2 (if storage is involved) C 1.7
B 8*	C 1.5
B 9*	C 1.5
B 10*	C 1.1 C 1.8
B 11*	All depending on individual uses

*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 a '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 I

TYPE OF HYDROLOGICAL INPUTS REQUIRED FOR STUDIES OTHER THAN SIMULATION (CLASSIFIED AS PER STORAGE TYPES AND USE)

Storage	Use	Hydrologic inputs required
A 1	All	C 2.1 C 2.4 C 2.5 C 2.6
A 3, A 4 & A 5	B 1 to B 7, B 10 and B 11	-do-
A 3, A 4 & A 5	B 8	Same as above Also C 2.2
Any	B 9	C 2.3

ENCLOSURE G

TIME UNITS REQUIRED FOR SIMULATION (CLASSIFIED AS PER STORAGE TYPE AND USE)

Type of Storage	Type of Use	Time unit required for simulation studies (except for studies of sediment inflow and deposition)
A 1	B 2 to B 7 & B 10	Instantaneous discharges every day, or at smaller units.
A 2	B 2 to B 7	1 day to 10 days depending on the extent of pondage.
A 2	B 1	3 days for upland crops, 10 days for paddies. If extra pondage at headworks in addition to natural storage on field is provided, larger units can be used.
A 3/A 2	B 8	1 hour to 24 hours depending on the damping provided by the drainage basin to the storage.
A 2	B 10	1 day to 10 days depending on the pondage.
A2	B 11	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.
A 3	B 1 to B 3	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.
A 3	B 4 to B 7	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.
A 3	B 10	Same as A 3 —B 1 to B 3 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.
A 3	B 11	Minimum of individual time units for each type of use. However, shorter time units required for use B 4 to B 7 or for B 8 will apply only during critical low flows or floods.
A 4	B 1 to B 3	Bi-seasonal (i.e. year divided in two blocks say monsoon and non-monsoon) or shorter blocks.
A 4	B 4 to B 7 B 10 or B 11	Same as above, but during critical low flows, short time operation as indicated for storage type A 3 and corresponding type of use may be adopted.
A 5	All uses	Adopt the minimum of the time unit required by each of the component storages involved in the compled system, after considering the type of use through that storage. However, structures or uses of minor importance in the overall system may not dictate the choice of time used to be adopted in total simulation of the system.

ANNEXURE—5

Financial return for Power

Component

(Refer" Chapter 3.11)

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	19					
2	19					
3	19					
4	19					
5	19					
6	19					
7	19					
8	19					
	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 etc.				
2. Surge shaft, pressure shaft				
3. Power House building machine foundation and tail race etc.				
4. Permanent Buildings				
5. Roads				
6. Other items prorate				
Total for Civil works				
B—*Hydraulic and Electrical Engineering Works*				
7. Penstock lining				
8. Generating plants				
9. Power Transformers and control equipment				
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 Rs. in lakhs

Sl. No.	Year	Capital outlay upto the commencement of the year	Expenditure during the year	Simple interest & % p.a. on col. 3 & @—% p.a. on col.	Depreciation charges @—% on Col. 3.	Operation & Maintenance charges @ 1 % p.a. on ol. 3	Total working expenses col. 6+7
1	2	3	4	5	6	7	8
1	19						
2	19						
3	19						
4	19						
5	19						
6	19						
7	19						
8	19						
9	19						
10	19						

Energy generated per annum M. Kwh.	Gross Revenue per annum @ paise per KW Hrs.	Net Revenue Col. 10(10—8)	Surplus (+) or deficit (—) Col. (1-5)	Cummulative Surplus (+) or deficit (=)	Sum at charges at the end of the year (3+4+13)	Percent return Col. $\frac{11 \times 100}{\text{Col. } 14}$
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 and 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 19..... viz., during the —the year commencement of preliminary works and the second Unit—months later etc.

6. The accumulated deficit (Cl. 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 accumulalated deficits.

8. Any other assumption.

ANNEXURE—6

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 utilisasion of equimpents, 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 :

(a) (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	1200 Hrs (25 × 8 × 6)
Two shift work/day	2000 Hrs (25 × 8 × 10)
Three shift work/day	2500 Hrs (25 × 8 × 12.5)

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. per M³ lbs/cu. yd. Bank	Loose	Percent Swell	Swell Factor
Clay, dry	1605	1189	35	0.74
	2700	2000		
Clay, wet	1783	1308	35	0.74
	3000	2200		
Earth, Dry	1665	1332	25	0.80
	2800	2240		
Earth, Wet	1902	1534	25	0.80
	3200	2580		
Earth & Gravel	1902	1581	20	0 83
	3200	2660		
Gravel, dry	1665	1480	12	0.89
	2800	2490		
Gravel, wet	2021	1772	14	0.88
	3400	2980		
Lime-stone	2615	1635	60	0.63
	4400	2750		
Rock, well blasted	2497	1569	60	0.63
	4200	2640		
Sand, dry	1545	1344	15	0.87
	2600	2260		
Sand, wet	1605	1403	15	0 87
	2700	2360		
Shale	2081	1474	40	0.71
	3500	2480		

(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* (Excavator)

Shovel Dipper capacity in cu. m. (cyd) (bank measure)

	0.57 (3/4)	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)	3.44 (4-1/2)	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)	119 (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)	126 (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)

(*g*) *Factor for Depth of cut and angle of swing (Shovels)*

Per cent of optimum depth	Angle of Swing (deg) 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

(*h*) *Ideal Output of Loaders*

(i) 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 per cent and an average load equal to 90 per cent 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 per cent and an average load equal to 90 per cent 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*

Per cent of optimum depth	Angle of swing in degrees							
	30°	45°	60°	75°	90°	120°	150°	180°
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, antifraction 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(220–160)
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)

(*p*) *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.	
(O)	(O)	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)

(*q*) *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
O	(O)	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

(r) *Blade Capacities and Bulldozer output*

Blade length m (ft)	Blade height cm (in)	Tractor drawbar hp	Forwarded speed in per minute (fpm)	Reverse speed in per minute (fpm)	Blade capacity cum (cu. yd)	Output cum (cu. yd) per hr. 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.

(s) *Typical Air Consumption of various pneumatic tools*

Equipment	Cu.m. per minute (cfm) per unit at 5.62 kg/sq cm (80 p.s.i.)
Air track drills	16.99(600)
Drifter 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)

(t) *Fixed Time Elements for Wheel Scrapers in minutes*

Element	Hauling speed ranges, kph								
	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.

(u) *Load Time*

7 cu.m	Elevating Scraper	.80 Min
8 cu.m	Elevating Scraper	1.00 Min
17 cu.m	Elevating Scraper	1.00 Min.
21 cu.m	Elevating Scraper (Twin Power)	.70 Min.
24 cu.m	Elevating Scraper (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 equipments to be used for this purpose has been given in Part IV of this annexture.

(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 equipment 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 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

Sl. No.	Equipment		Life of Equipment		Repair Provision (%age of cost equipment)	Remarks
	Category	Capacity	Year	Hours		
1	2	3	4	5	6	7
1. Excavators						
	Shovels & Draglines	Upto 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 & above (Electric)	20	40,000	150	
	Walking Draglines		20	30,000	150	
	Bucket wheeled Excavators		20	40,000	150	
	Dredger In	Hull	25	—	60	
	Fresh Water	Machine	10	—	60	
	Barges	Hull	16	—	60	
		Machine	10	—	60	
	Tugs	Hull	16	—	60	
		Machine	10	—	60	

1	2	3	4	5	6	7
2. **Dumpers**						
	Bottom Dumpers	Upto 20 T	8	10,000	140	
		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 T to 50 T	12	15,000	140	
		above 50 T	15	20,000	140	
	Highway Dumpers		8	10,000	140	
3. **Scrapers**						
	A. Motorised					
	Push Loaded	Upto 10 cyd	8	9,000	150	
		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		20	40,000	75	
	(ii) Ice Plant					
9. Water Sprinklers			10	16,000	100	
10. Canal Trimmer and Lining Equipment above 200 cyds/hr.			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 Cmpressors					
	(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		10	10,000	120	
	(iii) Agitating Cars					
	(iv) Portable Concrete Mixers		5	6,000	80	

1	2	3	4	5	6	7
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) Mabile (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 Equipment					
	A. Heavy Transport Vehicles					
	(a) Trucks & Highway Dumpers	(i) Diesel upto 3 T Diesel 3 to 5 T 5 T and above	10	2,00,000 km	140	
	(b) Tractor Trailers	Upto 5 T 5 T to 10 T	10	2,50,000 km	140	
		10 T and above	12	20,000 Hrs.	140	
	B. Light Transport Vehicles	(i) Jeeps (ii) Station Wagons (iii) Cars (iv) Ambulance Cars		1,60,000 km	140	
	C. Aerial 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 Above 50 Kva	10 15	20,000 30,000	100 120	

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EXAMPLE NO. 1

Hydraulic Excavator (Back-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 $3 m^3$ 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	$= 390 \times 0.84 \times 0.83 \times 0.9$ $= 245\ m^3$
∴ No. of excavators required	$= 4.705$
	$\frac{}{245} = 1.92$
Add 20% stand by	(+).35
	2.30
	say 2 Nos.

2. TRANSPORTATION TO SITE:

Quantity available per hour for handling	$= 245\ m^3$
Taking swell factor	$= 0.75$
Quantity per hour to be handled by Dumpers	$= \frac{245}{0.74}$
	$= 326.66\ m^3$
Select 18.12 m^3 31.75 (tonnes) capacity Dumpers Lead	$= 3.75$ K.M.
Dumper Cycle Time :	
(a) Loading time	$= \frac{18.12 \times 60}{326.66}$
	$= 3.32$ Minutes
(b) Dumping turning & spotting time	= 3 minutes
(c) Speed of loaded Dumper	= 22.5 K.P.H.
Speed of empty Dumper	= 27.5 K.P.H.
∴ Haul time	$= \frac{7.5 \times 60}{25}$
	= 18 Minutes
(d) Total cycle time	= 24.32 Minutes
No. of trips per hours of 50 Minutes	$= \frac{50}{24.32} = 2.06$
Quantity carried by one dumper	$= 18.12 \times 2.06$ $= 36.25\ m^3$
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 dumpers required	= 22

3. SPREADING :

Total quantity for spreading	$= 37.67 = 10^5\ m^3$
Programme	= 5 years
Work load per season	$= \frac{37.67 \times 10^5 m^3}{5}$
	$= 37.67$
Peak work load per season	$\frac{}{5} \times 1.25 \times 10^5$
	$= 9.41 \times 10^5\ m^3$
Output required per hour	$= \frac{9,41,000}{2,000}$
	$= 471\ m^3$ (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	$= 500 \times 0.75 \times 0.75$ $= 281 m^3$ (b.m.)
∴ No. of dozer required	$= \frac{629}{281} = 2.2$
Stand by	(+).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 $629 m^3$ (loose)

Taking Double Drum Sheep foot Roller of 1.5m dia of 1.2 m width with 900–100 HP 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

$= \frac{\text{Efficiency} \times \text{wi} \times \text{th} \times \text{speed} \times \text{dept of layer} \times \text{effective width}}{\text{No. of passes}}$

$= \frac{.83 \times 2.4 \times 4 \times 1000 \times .25 \times 0.85}{12}$

$= 141\ m^3$ /hour

= No. of Double Drum Sheep foot rollers required

$= \frac{629}{141} = 4.4$

Say 4 numbers

Stand by +1 number

Total : 6 numbers

EXAMPLE No. 2

Scraper—Pusher Combination

Total earth work to be handled $= 16 \times 10^5$ m³

The earth work is proposed to be completed by Scraper—Pusher Combination and is to be completed in three years as below :

1st year $= 6 \times 10^5$ m³
2nd year $= 6 \times 10^5$ m³
3rd year $= 4 \times 10^5$ m³

The peak quantity to be handled in one season $= 6.00 \times 10^5$ m³

Quantity to be handled/hr $= \frac{6,00,000}{2,000}$
$= 300$ m³

1. SCRAPERS:

Selecting scraper of 11.50 m³ capacity

Average lead = 3 K.M.
speed of loaded scraper = 22.5 K.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 $\frac{6 \times 60}{25}$ = 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 $= \frac{50}{17}$
$= 3$

∴ Production of scraper/hr. $= 11.50 \times 3$ m³
$= 34.5$ m³ (loose)
or $= 34.5 \times 8$ m³ (b.m.)
$= 27.6$ m³

Therefore No. of scrapers required $= \frac{300}{27.6}$
$= 11$ 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 Pushers 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 m³
Adopting dozer of 180 H.P. and taking spread area of 30.48 m (100 ft.)
Ideal Production per hour = 300 m³
Considering :
Load factor = 0.8
Job & management factor = 0.75
Therefore output per dozer per hour $= 300 \times 0.8 \times 0.75$
$= 180$ m³
∴ 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 m³
Weight of earth placed per hour $= 375 \times 1661$
$= 6,22,875$ kg.
Water to be added by weight = 12% — 6% = 6%
Weight of water required per hour $= 6,22,875 \times 0.06$
$= 37,370$ kg.
or 37,370 litres

Using water tanker of 10,000 litres capacity and water pump of 2,275 litres 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 litres at the rate of 1,000 litres/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 $= 10,000 \times 2$
$= 20,000$ 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 m³
Selecting self-propelled vibrators Tampering foot compactor with efficiency factor = 0.83
Width = 2.1 m
effective width = 0.85
speed = 3 K.M./hour
Depth of layer = 30 cm
No. of passes = 4
∴ Progress of compaction per hour $= \frac{0.83 \times 2.1 \times 0.85 \times 3000 \times .3}{4}$
$= 335$ m³/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. Whereaver 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 = 58.28×10^5 m³

Type of material

= To be completed in 5 years.

Programme

Shift working = Double shift

Work load per season $= \frac{58.28}{5} \times 10^5$

Peak work load $= \frac{58.28}{5} \times 1.25 \times 10^5$

—Work load per hour $= \frac{14.5 \times 10^5}{2{,}000}$

= 728.5 m³

1. Excavation :

Select 2.3 m³ capacity loader (Crawler)

Considering one-way haul distance of 25 ft.

Ideal production per hour = 164.6 m³ (b. m.)

Actual estimated output per hour = $164.6 \times 0.76 \times 0.75 \times 0.83$

= 78.38 m (b. m)

or $\frac{78.38}{0.8}$ (loose)

= 98 m

∴ No. of loaders required $= \frac{728.5}{98}$

= 7.43

Stand by (+) 1.48

8.91

Say 9 Nos.

Provide 9 Nos. of loaders of 2.3 m³ capacity

2. Transportation :

Quantity per hour available for handling = 98 m³

Lead = 2 K.M.

Select 18.12 m³ (31.75 tonnes) capacity rear Dumpers.

Dumper cycle time :

(a) Loading time $= \frac{18.12 \times 70}{98} = 11.00$ min

(b) Dumpting, 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 $= \frac{50}{23.6} = 2.12$

Quantity carried by one dumper = 18.12×2.12

= 38.38 m³

—No. of Dumpers required/loader $= \frac{98}{38.8} = 2.55$

Total No. of Dumpers required for 7 loadrers = $2.55 \times 7 = 17.8$

Say 18 Nos.

Stand by (+) 4

22

—Total No. of 18.12 m³ 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 m³

Peak requirement in a season = 2,85,000—1.25 m³

= 3,56,400 m³

= 3,56,400

Output required per day $= \frac{3{,}56{,}400}{200}$

= 1782 m³

1. Drilling Operation :

Estimated average progress of 120 cfm capacity heavy du v Jack hammer = 4 holes of 1.5 metre per hour i.e. 6 m per hour.

Estimated average progress per day (considering single shift working i.e. for 5 production hours) = 6. × 5m

= 30 m/day

For 1 cu. m. of meterial 1 m of drilling is achieved

—For 1982 m³ of material per day drilling at rate of 30 meter per day, No. of Jack hammers required $= \frac{1782}{30}$

= 59.4

Say 60 Ms.

Stand by at 30% (+) 18 ms

78 Ms.

—Total No. of Jack hammers required (120 cfm capacity) —78 mr.

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 = $2{,}85{,}000 \times 1.25$ m³

= 3,56,400 m³

Requirement per hour $= \frac{3{,}56{,}400}{2000}$

—178.2 m³

Select Tippers of 4.5 m³ (6.5T) capacity . Lead = 5 K.M.

Cycle Time :

(i) Spotting time = 1.5 minutes

(ii) Loading time (Manually) = 15.0 minutes

(iii) Haul time = 20.0 minutes
(average speed of 30 KMPH)
i.e. $\frac{10\times 60}{30}$ = 20 min.

(iv) Dumping time = 2.5 minutes

(v) Total cycle time = 39.0 minutes
= Say 40 minutes

∴No. of trips per hour = $\frac{50}{40}$ = 1.25

∴Output per tipper per hour = 4.25 × 1.25
= 5.625 m³

∴No. of tippers required = $\frac{178.2}{5.625}$
= 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 m³ : to be completed in 4 years. Peak qty. in 2nd year is 2,10,000 m³. 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, 75-40 mm, 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 m³

Period = 4 years

Average quantity = 1,40,000 m³

Peak quantity in 2nd year = 2,10,000 m³

Schedule in working hours in a year in double shift working. = 2000 hrs.

Rate of concrete placement required = $\frac{210000}{2000}$ = 105 m³/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 = $\frac{105\times 105}{100}$ = 110 m³/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. = $\frac{50}{2.7}$ = 18.5

Hourly production = 18.5 × 2.5 = 46.2 cu. m.

No. of mixers required = $\frac{110}{46.2}$ = 2.38 say 3 Nos.

Provide 1 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 × 2314 = 5785 kg.

Weight of coarse aggregate = $\frac{5785\times 7}{1+2.5+7}$ × 3857 kg

or volume of coarse aggregate = $\frac{3857}{1780}$ = 2.17 cum. m.

weight of sand = $\frac{5785\times 2.5}{1+2.5+7}$ = 1377 kg.

or volume of sand = $\frac{1377}{1542}$ = 8.9 cu. m.

weight of cement = $\frac{1\times 5785}{1+2.5+7}$ = 550 kg

weight of water required per batch = 550 × 0.6
= 330 kg
= 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 × .35 = 1350 kg
= 0.76 cu.m.

75 to 40 mm „ — 3857 × .30 = 1157 kg
= 0.650 cu. m.

40 to 20 mm „ — 3857 × .25 = 964 kg
= 0.54 cu. m.

20 to 6 mm „ — 3857 × .10 = 386 kg
= 0.22 cu. m.

The batcher may be sized for an additional 33% capacity so we provide as under

Sizes of Batcher required for aggregate	Provided
1350 × 1.33 = 1805 kg 1157 × 1.33 = 1538 kg	2 batches of 1800 kg each +1 stand by
964 × 1.33 = 1287 kg 386 × 1.33 = 513 kg	2 batchers of 1300 kg each +1 stand by
For Sand size required 1337 × 1.33 = 1831	Provided 1 Batcher of 1800 kg cap.
For Cement size required 550 × 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-a-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 hrs. 3×110 cu. m. concrete M.T.	Recommended Bin. size M.T.
Coarse aggregate				
150—75 mm	1.35	.54	178.20	180
75—40 ,,	1.16	.46	153.12	160
40—20 ,,	.96	.38	126.72	130
20—6 ,,	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 = $24.30 \times 1.30 = 31.5$ M.T. say 30 M.T.

Aggregate Processing

Coarse aggregate required per hour = $\frac{509.52}{3} = 170$ M.T.

Fine aggregate required per hour = $\frac{182.16}{3} = 61$ M.T.

Total = 170 + 61 = 231 M.T.

Allowing Transit loss @5%

Finished output required = $231 \times 1.05 = 242$ M.T.

Assuming 10% product reject from the plant then capacity of processing plant = 242×1.1
= 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 stockpiles 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 mm $\frac{126.72}{3} \times 10 \times 10 = 4224$ 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 cu.m., 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 lits. at 25°C

Assuming that it is required to place concrete at 20°C

Thermal heat Balance for mix without cooling

S.No.	Ingradient	Wt. Kg.	Sp. Heat	KcalPer °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	40	2760
	Total			£1594.3		62733

$\therefore$ Temp. of concrete = $\frac{62733}{1594.3} = 39.34°$

Temperature of concrete desired at the time of placement = 20°C

$\therefore$ Heat required to be removed = 1594.3 (39.34—20°)
= 30833 Kcal per batch

If only ice is used for cooling the mix then quantity of heat removed by 1 kg of ice flakes.
= 80 + (20 × 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

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

$= \frac{13.567 \times 10}{24} = 5.67$ MT

Allowing 20% standby capacity = 5.67 + 1.12 = 6.9
say 7 MT per hour

EXAMPLE NO. 6

Example of selecting pump for dewatering 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

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

$$\frac{VAP}{10800} = \frac{3.3\ cd^2s}{p} \quad \frac{Ap}{10800} = \frac{cd^2As}{3270}$$

value of k can be selected from the following table :

Porosity ratio	Fine 0.10	0.20	Med 0.30	0.40	Coarse 0.50	0.8	Fine gravel 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

EXAMPLE

A steel sheet piling coffer dam enclosed an area 50 ft wide 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 this porosity to be 400

$$d=0.5 \quad p=0.3 \quad s=\frac{50}{50} \quad k=\frac{3.3\times400\times0.5^2}{0.3}$$

$$= 1100$$

and from table we have a value of 1070

$$s=\frac{50}{50}=1 \quad \text{hydraulic graduate}$$

then 50

$$v=1100\times1=1100 \text{ ft.}$$

$$Q.=\frac{1100\times50\times200\times0.3}{10{,}800}=305 \text{ gpm}$$

H.P. of pump regd.

static head = 50 ft.

Assuming a 2½" dia hose pipe is used

frictional loss	
1 footvalve & strainer	55 ft.
suction pipe	10 ft.
outlet pipe	150 ft.
	215 ft.

So we take the nearest equivalent length from standard tables.

Friction loss equivalent 250 ft. pipe 2½" dia = 37 ft.

Total head regd. 37 + 50 = 87 ft.

$$\text{H.P.}=\frac{WQH}{33000\times n} \quad \frac{8.34\times305\times87}{33000\times0.60}=11.17$$

So we select 2 pumps of 6.5 HP each suction & delivery 2½" size and 1 pump kept as stand by.

EXAMPLE NO. 7

Tunnel Excavation

—Diversion tunnels = 4 nos. (T-1, T-2, T-3, T-4)

—Diameter Excavated 15 m
Finished 12 m

—Length 1000 meter each tunnel

—Tunnels are proposed to be excavated in four sections/phases.

—Thickness of lining 900 mm

—Rib depth 250 mm

—Three shifts work/day, working 10 months/year 25 days/month, 16 hours/day.

Total working hrs/years—10 × 25 × 16 = 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 = 57 m²

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 Tunnelling 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 tunnelling employihg 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 crores 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 countries on the tunnelling and subway 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 i.e. 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 method is specially beneficial for squeezing ground conditions.

The actual application of N.A.T.M. consists in applying in intial 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 100 mm thickness is applied. Anchoring is carried out behind the cutting machine if the convergency 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/Austria is a light U shaped section of 10-15 kg/M weight compared to the useof 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 specificatioh 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 overbreak is 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 upto 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/cm² and with less efficiency upto 1000 kg/cm². Beyond 1000 kg/cm² 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 alingment of the tunnels to ascertain the type of rock, rock strata and their thicknesses along with compression 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-m³*

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 sand 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 damfill 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 Dumper* 25T

These rear dumpers will be deveployed 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 *H.P.*)

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. crawler 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 opertions 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 machines would also be used for shotcreting of open cut hill slopes along the spillway and power house benches wherever the rocks are very week.

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 accomodating drills at the bench. Drilling with these drills is very fast and accurate as compared to hand held machines and drills 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 tunnelling 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 excavation 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, 2 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 and 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, anchor rods, drill machines and other miscellaneous civil, electrical and mechanical stores for the tunnel works. 8 to 10 tonne capacity trucks will be required as follows:

1. no. for Electrical Division
1. no. for Mechanical Division
2. 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 accidently despice all precautions. 2 nos Pneumatic placers on upstream and 2 nos placers on down stream will meet the requirement of any emergency concreting 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 mm 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 m3/hr cap. (Annexure-E).

19. *Transit Mixers*

To provide matching supply of concrete to the truck mounted concrete pumps, high capacity transit mixers of 10 m3 capacity will be deployed for transportation of concrete from Batching and Mixing plant to the site of placement. Total requirement of 10m³ 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 extendsometer, 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 instruments enable the variations parameters of support system to be varied so asto 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 up stream and down stream works outside tunnel portal.

(iii) *Rock drills and pusher legs*

Drilling with hand held machines will have to be carried ou for fixing of anchors for pipe line, 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) *Axial flow fans and ducts*

(vi) *Gunteries and vibrators*

(vii) *Welding sets, transformers, cable and switch gecr.*

ANNEXURE—A

Excavation of Section-I of tunnels T-1 & T-2 with point excavators.

Progress of machine	= 20 m³/hr (Average)
Quantity to be excavated per meter length	= 35 m³
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. machines will work on 2 faces of each tunnel.

Length to be excavated by each machine $= \frac{1000}{2} = 500$ meter

Time required for excavation $= 500 \times 7 = 3500$ hrs.

Taking 4000 working hrs/year

Time required $= \frac{12 \times 3500}{4000} = 10.5$ 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 m³/hr (Average)

Quantity of muck = $57 \times 2 = 114$ 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

3 m progress will be achieved in one cycle at one face Quantity of muck $= 57 \times 3 = 171$ m³

Time required for mucking $= \frac{171}{20} = 8.55$ hrs

Time required for excavation of portion-III

$$\frac{8.55}{3} \times 500 = 1425 \text{ hrs}$$

$$= \frac{1425 \times 12}{4000} = 4.27 \text{ months}$$

say = 4.30 months

Excavation of Section-IV

Quantity of muck to be removed by one machine

$$500 \times 27.70 = 13850 \text{ m}^3$$

Mucking time

$$= \frac{13580}{20} = 692.5 \text{ hrs}$$

$$= \frac{692.5 \times 12}{4000} = 2.07 \text{ months}$$

say = 2 months

Total = 11 + 7 + 4.30 + 2 = 24.30

Say = 24 months

ANNEXURE—C

Hydraulic Excavator, Crawler mounted 3m³ capacity Excavation of Section-II

2 m progress will be achieved in one cycle at one face.

Quantity of muck = $57 \times 2 = 114$ m³/cycle (loose)

$$= \frac{114}{0.67} = 170.1 \text{m}^3 \text{ (loose)}$$

Ideal progress with hydraulic excavator = 390m³ (with 0.9 fill factor)

Considering (i) Job management factor = 0.75

(ii) Time factor

Actual production/hr = $390 \times 0.75 \times 0.83$

242.7 m³ (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 = $57 \times 2 = 114$ m³

Taking swell factor as 0.67 for well blasted rock

Quantity of muck = $\frac{114}{0.67} = 170$ m³

Average lead inside the tunnel = 250 m

Average lead outside the tunnel = 500 m

TOTAL = 750 m

Cycle time (Dumper)

(i) Loading time = $\frac{11.47 \times 60}{242.7} = 2.83$ 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 oneway traffic inside the tunnel = 4.00 mts

*17.83 mts

No. of trips/dumper/hr = 3

Progress for 3 dumpers/hr = $34.41 \times 3 = 103.23$

Time required to haul the muck = $\frac{170}{34.41 \times 3} = 1.64$ 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

$$= \frac{8 \times 500}{2} = 2000 \text{ hrs}$$

$$\text{i.e.} = \frac{2000 \times 12}{4000} = 6 \text{ months}$$

Time required for Excavation of Secteon-III

Quantity of muck/cycle = 57 × 3 = 171 m³
= 255 m³ (loose)

Progress of dumper/hr = 11.47 × 3 = 34.41 m³

Progress of 3 dumper = 34.41 × 3 = 103.23 m³

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 hrs.

$= \frac{12 \times 1000}{4000}$ = 3 months

Excavation of Section-IV (T-1 and T-2)

3 m progress will be achieved in one cycle at one face

Quantity of muck = 27.70 × 3
= 83 m³

$= \frac{83}{0.67}$ = 123.88 m3 (loose)

Progress of 3 dumpers/hr = 34.41 × 3 = 103.23 m³

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 = $\frac{3 \times 500}{3}$ = 500 hrs.

or = $\frac{500 \times 12}{4000}$ = 1.5 months

Total time excavate = 11 + 6 + 3 + 1.5
= 21.5 months
say = 22 months

ANNEXURE—D

Low Profile Shuttle Dumpers (Capacity 7.0 m³—struck)

Production of point excavator = 20m³/hr.

$= \frac{20}{0.67}$ = 29.85 m³ (loose)

Cycle time

Lead = 750 m (Assumed) outside tunnel 500 m & inside tunnel 250 mm.

(i) Loading time	= 14.10 mts.
(ii) Travel time @ 10 km/hr	= 4.50 mts.
(iii) Return time @ 10 km/hr.	= 4.50 mts.
(iv) Fixed time	= 2.00 mts
Total	= 25.1 mts.
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 concrete/m length	= 176.70 = 1/4 × (12)²
	= 176.70 = 113.09
	= 63.61 m³
Quantity of concrete for invert	= 1/5 (63.61)
	= 12.72 m³

Quantity of concrete for overt portion = 4/5 (63.61) = 50.89 m³

(Invert extends 72° angle to the centre of tunnel × section)

Time required for overt portion

Length = 10 m

Quantity to be placed in 10 m length = 50.89 × 10 = 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	61 hrs.

Concrete placement rate = $\frac{508.9}{10}$ = 50.89 m³ hr.

So we provide concrete pump of capacity 60m³/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 hrs.

or = $\frac{12 \times 3050}{4000}$ = 9.15 months

say 9 = months

Time required for invert portion

1. Length of pour	= 30 m
2. Quantity to be poured/pour	= 12.72 × 30 = 381.60 m³

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

or $\frac{1000 \times 12}{4000} = 3.0$ months

Total time required for the overt and invert concreting
=9+3=12 months

ANNEXURE—F

Assuming a lead of 1 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 @ 10 km/hr	=6.0 mts
6. Spot at B/M plant	=1.0 mts
Total	=30.00 mts

No. of trips per hour at 83 percent efficiency $= \frac{50}{30} = 1.66$

Concrete hauled/hr $= 10 \times 1.66 = 16.6$ m³

The average quantity to be poured/hr. is 50 m³. The peak pump capacity may be about 60m³/hr.

No. of mixers required $= \frac{60}{16.6} = 3.75$ say 4 mixers

Total of 8 nos. transit mixers of 10m³ capacity 4 each on U/S & D/S of the tunnels will be required.

ANNEXURE—7

CALCULATION OF B.C. RATIO OF A TYPICAL IRRIGATION PROJECT

(Refer Chapter 3.18)

	Rs. (lakhs)	Rs. (lakhs)
I. (a) Estimated cost of the project	2 8365	
(b) Cost of Land Development @ Rs. 2000/- per ha. (assumed) for CCA 4.25 lakhs ha.	8500	
	36865	36865
II. ANNUAL BENEFITS :		
(a) Gross value of the produce post project.		10104.23
(b) Gross value of the produce pre project	2010.69	
(i) Cultivable Command Area		
(ii) Loss in agriculture production in area coming under submergence and land going out of cultivation in project area canal distribution system etc.	148.90	
Total	2159.59	2159.59
Net value of benefits		7944.64

	Rs. (lakhs)	Rs. (lakhs)
III. ANNUAL COST		
(a) Interest @10% of the estimated of the total cost of project (Rs. 36865 lakhs)	3686.50	
(b) Depreciation of the project @1% of the cost of project (Rs. 28365 lakhs) assuming life of the project 100 years	283.65	
(c) Depreciation of the pumping system @8.33% of the estimated cost of the pumping system (Rs. 108.9 lakhs) assuming life of the system as 12 years	9.08	
(d) Depreciation of the raising mains @3.33% of the estimate cost (Rs. 7.88 lakhs) assumed life 30 years	0.26	
(e) Charges of the power for lift irrigaton at Rs. 90/- per ha. for 16000 ha.	14.40	
(f) Annual operation & maintenance charges @Rs. 50/-per ha. for 4.58 lakh ha. gross irrigated area	229.25	
(g) Maintenance of the head works @1% of its cost (Rs. 8168 lakhs)	81.68	
	4304.82	4304.82
IV. BENEFIT—Cost Ratio	7944.64 / 4304.82	= 1.85

ANNEXURE—8

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 1/2 col. 2+5, of previous year
	Direct charges	Indirect charges	Total cost	Direct charges	Interest charges betterment levy	Total	
1	2	3	4	5	6	7	8

Simple interest@ % col. 8	Accumulated interest	Net Revenue after deducting working expenses	Accumulated Revenue	Accumulted simple interest(—) accumulated Revenue Col. (10—12)	Sum at charge @ 7+13	%age Return on sum at charges Col. $\frac{11 \times 100}{14}$	Remarks
9	10	11	12	13	14	15	16

1. %age return on capital cost of projeet $\frac{\text{Col. } 11 \times 100}{\text{Col. } 4\text{(Total)}}$

2. %age return on capital cost of the project less betterment levy $= \frac{\text{Col. } 11 \times 100}{\text{Col. } 4 \text{ (Total)} - \text{Betterment levy}}$

3. %age return on sum at charges = (Maximum of Col. 15)

ANNEXURE—9

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	Rs.
	(ii) 16% of allocated cost of embankment (10% interest+2% Depreciation+4% maintenance)	Rs.
	(iii) Total annual cost (i+ii)	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 $= \frac{\text{Item 7}}{\text{Item 4(iii)}}$	

COMMAND AREA DEVELOPMENT

COMMAND AREA DEVELOPMENT

SECTION—1

CHECK LIST

General and Hydrological

1. Has the following meteorological and other data been furnished in the Report? Are the weekly, fortnightly, monthly and annual data for last 10 years in respect of rainfall, temperature (max. and minimum), relative humidity, cloud cover, wind velocity, pan-evaporation in respect of all the stations falling in the command area furnished?
2. Have the socio-economic bench mark surveys been carried out and the results discussed in the report?
3. Is ground water potential, its present stage of utilisation and future prospects discussed?
4. Is the suitability of the ground water for drinking and irrigation purposes discussed ?

Soil Surveys

5. Has semi-detailed soil survey of the entire Gross Command area been conducted and report prepared ?

Engineering Surveys for OFD Works

6. Has slope groupwise classification of the command area been done and slope groups indicated?
7. Has detailed survey of the representative area in each slope group been done and contour maps on the scale of 1 : 2500 with contour interval 15/20 cm been prepared and attached with the report?
8. Has cost estimates for the OFD works in representative areas in different slope groups condition been prepared and given in the report? Has quantum of land development works and its cost been estimated and projected?

Water logging, salinity and drainage

9. Have the following been investigated and necessary data collected :
   (a) Extent of existing water logged areas and reasons of water logging and future possibility
   (b) Extent and frequency of flooding
   (c) Extent of salt effected areas
   (d) Adequacy of the existing drainage
   (e) Proposals for drainage and reclamation of water logged and salt affected areas.

Cropping Pattern

10. Has survey and collection of data in respect of the following been done and appended with the project report :
    (a) Present cropping pattern in the area both under rainfed and irrigation.
    (b) Yields of various crops under rainfed and irrigated conditions.
    (c) Proposed cropping pattern and optimum crop calendars with justification.
    (d) Cost of cultivation of various crops
    (e) Irrigation practices in vogue
    (f) Extent of mechanisation and availability of human and animal power.

(g) Existing agricultural research, training and demonstration centres/farms located within and around the command area and future plans.

(h) Existing facilities in respect of supply of Agricultural inputs, seeds, fertilisers, pesticides etc. including Short-term credit.

(j) Proposed improvement in the supply of Agricultural inputs including cerdits.

Water management, water requirements and demands

11. Whether experimental data on crop water requirement available or actual field data for similar conditions available, if so, has it been used for calculation of water required?

12. Is the fortnightly/monthly water requirement for the proposed cropping pattern based on field plot data or agro-climatic data (Christiansen's or modified penman method)?

13. Have water requirements been estimated on the basis of climateological data, and whether detailed calculation been furnished in the report?

14. Has the maximum weekly fortnightly demand of water been calculated from crop water requirements and canal system designed accordingly?

SECTION—2

SALIENT FEATURES

2.1 Name of the Project

2.2 Type of the Project :

2.2.1 Irrigation/multipurpose

2.2.2 Storage/diversion

2.3 Location (Name) of Dam/Headworks/Diversion view.

(a) State

(b) District

(c) Taluk

(d) Village

2.4 Command

(a) State(s)

(b) District(s)

2.5 Talukwise/Districtwise Command Area

S. No.	Name of		Area (ha)	
	Taluka	District	GCA	CCA
1.				
2.				
3.				
4.				
5.				
6.				
7.				
Total				

2.6 Canal System

2.6.1 Length (km)

2.6.2 Discharge at head (cumec)

2.6.3 Lined/Unlined

2.6.4 Length of the distribution system (km)

2.6.5 Minimum discharge of the lined channel (cumec/Lusec)

2.6.6 Outlets:

(a) Number

(b) Area commanded (ha) :

(i) Maximum

(ii) Minimum

(c) Discharge (Lusec) :

(i) Maximum

(ii) Minimum

NOTE : Information shall be furnished for all main canals off taking from the head-work.

2.6.7 Efficiencies (Percent)

(a) Canal and distribution system

(i) Kharif

(ii) Rabi

(iii) Summer

(b) Field application efficiencies

(i) Paddy

(ii) Other crops

2.7 Cropping pattern and area under each crop (Cropwise)

Name of crop	Existing				Proposed				
	Unirrigated		Irrigated		Unirrigated		Irrigated		
	Area (ha)	Percentage of CCA	Area (ha)	Percentage of CCA	Area (ha)	Percentage of CCA	Area (ha)	Percentage of CCA	Delta/ GER at canal head.
1	2	3	4	5	6	7	8	9	10
Kharif									
1.									
2.									
3.									
4.									
Total									

	1	2	3	4	5	6	7	8	9	10
Rabi										
1.										
2.										
3.										
4.										
Total										
Summer										
1.										
2.										
3.										
4.										
Total										
Two Seasonal										
1.										
2.										
3.										
4.										
Total										
Perennials										
1.										
2.										
3.										
4.										
Total										
Grand Total										

2.8 Intensities of Irrigation (as Percentage of CCA)

2.8.1 Kharif

2.8.2 Two Seasonal

2.8.3 Rabi

2.8.4 Hot weather

2.8.5 Perennials

2.8.6 Total

2.9 Crop yields

Name of crop Seasonwise	Unirrigated kg/ha		Irrigated kg/ha	
	Existing	Proposed	Existing	Proposed
Kharif				
1.				
2.				
3.				
4.				
Two Seasonal				
1.				
2.				
Perennials				
1.				
2.				
Rabi				
1.				
2.				
Hot Weather				
1.				
2.				

2.10 Total production—(tonnes) Existing / After full development of irrigation

(a) cereals

(b) Pulses

(c) Oilseeds

(d) Fibre-cotton/jute

(e) Perennials—Sugarcane
other

(f) Vegetable and fruits

(g) Any other

2.11 Ultimate irrigation potential : (ha)

2.11.1 Likely Date of completion of project

2.11.2 Proposed Yearwise creation of potential

Year	Commulative potential (ha)	Percentage of CCA
1.		
2.		
3.		
4.		

2.12 Cost (Rs. lakhs)

2.12.1 Irrigation Project cost of
- (a) Headwork
- (b) Canal & Distribution system
- (c) Total
- (d) Cost per ha of
  1. Gross irrigated Area
  2. Culturable Command Area.

2.12.2 Cost of OFD Works (Rs.—Lakhs)
- (a) Total—through
  - (i) Govt. finances
  - (ii) Institutional finances
- (b) Cost per ha (CCA)

2.13 B.C. Ratio

COMMAND AREA DEVELOPMENT

SECTION—3

REPORT

3.1 INTRODUCTION

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

3.1.1 Brief description of irrigation project and aim of the project.

3.1.2 Location of the head works [village, taluk(s) & district(s), command area indicating name of the district(s), taluk(s)] and number of villages benefited.

3.1.3 Details of the command area (existing)

(a) Classification of land (Forest, Gross land, Cultivated land Fallow, Culturable Waste Barren Land etc.)

(b) Gross command area

(c) Culturable command area

(d) Net irrigated area

(e) Gross irrigated area

(f) Irrigation intensity

(g) Cropping intensity (for both irrigated and unirrigated crops)

3.1.4 Physiography of the command area

(a) General topography

(b) Vegetative cover

(c) General slope

(d) Colour and texture of the soil

(e) Extent of erosion

(f) Surface drainage

(g) Salt efforvesence

(h) Water logging

3.1.5 Climate of Command Area

(a) Name of IMD Station(s) for which data is adopted

(b) Period for which data is available/utilised.

(c) Average Annual (weighted) rainfall

(d) Monthwise distribution of rainfall (weighted average)

(e) Temperature (maximum, minimum & average—monthwise)

(f) Humidity (maximum, minimum & average—monthwise)

(g) ETO—(Fortnightly)

3.1.6 Socio-economic condition (Existing)

(a) Population, density major occupation(s), education, income etc.

(b) Size of land holdings—extent of small, marginal, medium and big farmers—average land holding

(c) Land tenure

(d) Income—average (i) from farm (ii) subsidiary sources

(e) Availability of agriculture Labour and wages

(f) Present sample (Bench mark) surveys for a representative area in the command.

3.1.7 Status of present agriculture

(a) Crops grown

(b) Average yields per ha cropwise/seasonwise

(c) Crops raised under irrigated conditions

(d) Use of fertilisers, pesticides

(e) Use of machinery and improved implements

(f) Attitude of the farmer towards adoptation of improved practices.

3.1.8 Status of surface Irrigation

(a) Present source 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 channel

(iii) Status of field channels/drains

(d) Assumed field application efficiency (percentage) with justification

3.1.9 Ground Water

(a) Availability of ground water

(b) Quality

(c) Depth from the ground and seasonal variations

(d) Present extent of exploitation

(e) Future prospects

3.1.10 Drainage

(a) Names of the important rivers, nallahs and tributaries

(b) Length of natural drains and drainage density per sq km of the area (GCA)

(c) General condition of the surface drainage

(d) Maximum rainfall recorded in/near the command in 24, 48 and 72 hours.

3.1.11 Status of infra-structural facilities in the command.

(a) Roads, type and length

(b) Markets

(c) Storage

(d) Processing centres.

(e) Seeds, fertiliser, pesticides, short-term credits.

(f) Credit institutions

(g) Cooperatives

3.1.12 Present status of extension, demonstration, seed, farms and adoptive trials training centres, etc.

3.1.13 Constraints in the Command Area Development.

(a) Soil depth

(b) Soil erosion

(c) Soil salinity/alkalinity

(d) Water logging

(e) Quality of ground water

(f) Land slopes

(g) Drainage

(h) Any other

3.1.14 Command area development

(a) Proposal

(b) Executing agency

(c) Financial agency

(d) Period over which development is proposed.

3.1.15 Benefits expected (with project)

(a) Increase in irrigated area

(b) Increase in yields per ha of various crops

(c) Total agricultural production

(d) Impact of development on agro and alied industries

3.1.16 Employment

(a) Availability of labour

(b) Employment potential likely after execution of CAD schemes

3.1.17 Any other item

3.2 SURVEYS AND COLLECTION OF DATA

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

3.2.1 Soil survey

NOTE : Semi-detailed soil survey required shall be carried out as per Soil Survey Mannual published by IARI, New Delhi 1971 or ISI Standares. The following items shall be discussed briefly.

3.2.1.1 Description of area surveyd

(a) Location

(b) Physical feature

(c) Geology

(d) Agro-climatic description

(e) Slope groups

(f) Vegetation

(g) Present land use

3.2.1.2 Methodology of soil survey adopted for semi-detailed soil surveys

3.2.1.3 Physical properties of soil

(a) Colour

(b) Texture

(c) Structure

(d) Depth

(e) Moisture holding capacity

(f) Permeability

(g) Infilteration Capacity

3.2.1.4 Chemical properties

(a) P_H

(b) Soluble salts

(c) Sodium Alkali Ratio (SAR)

(d) Exchangeable sodium percentage

(e) Alkalinity and salinity

(f) Organic matter

(g) Soil fertility (N P K and micro neutrauts)

3.2.1.5 Ground water

(a) Quality for

(i) Drinking

(ii) Irrigation

(b) Depth

(i) Premonsoon

(ii) Post monsoon

3.2.1.6 Soil Erosion

(a) Types

(b) Extent

3.2.1.7 Soil Classification and correlations

(a) Family and extent

(b) Series and extent

(c) Type and extent

3.2.1.8 Land capability classification and extent

3.2.1.9 Land irrigability classification and extent

3.2.1.10 Special problem of the area and remedial measures

3.2.1.11 Conclusion

3.3 ENGINEERING SURVEY (OFD WORKS)

A brief description of the area surveyed and contour interval etc. shall be given under this chapter

NOTE : 1. Engineering surveys shall be carried out for 1 percent of culturable command limited to a maximum area of 1000 ha for each broad soil type (3.2.1.7-C)

2. The map shall be prepared to a scale of 1 : 2500 and contour interval of 15 cm for slopes upto 1 percent and 25 cm for slopes above 1 percent.

3.4 GROUND WATER SURVERYS

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

NOTE :—Information under this chapter shall be based on the soil survey report, data collected from Central and State Ground Water Boards and other agencies engaged in this works.

3.4.1 Status of study

3.4.2 Hydrological setting

3.4.3 Occurrence and behavior of ground water including Stratigraphy Lithology and Aquifer characteristics.

3.4.4 Status of Ground Water Potential (M cum)

(a) Total potential

(b) Present status of utilization

(c) Future prospects including studies of water balance with scope of further development through dug-wells, dug-cum-bore wells, shallow and deep tubewells etc.

3.4.5 Ground Water Table observations (Annexure-1)

(a) Premonsoon

(b) Post monsoon

(c) Behaviour during monsoon

Minimum observed data for three year shall be supplied based on the information collected round the year. The data shall be recorded as per Annexure-1.

3.4.6 Quality

(a) Total soluble salts

(b) Injurious salts chlorides, florides, etc.

(c) Injurious elements, Boron, Iron, etc.

3.4.7 Identification of Area

(a) Where Ground water is available

(b) Where ground water can be exploited economically.

(c) Where conjuctive use is possible

(d) Where area outside irrigable command can be irrigated.

3.4.8 Assessment of possible impact on ground water recharge due to canal lining and ground water utilisation and proposals, if any, for its replenishment.

3.4.9 Conclusions & Recommendations

3.5 WATER LOGGING, DRAINAGE AND RECLAMATION

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

3.5.1 Existing surface drainage (Natural/artificial)

(a) Aggregate length

(b) Average distance between two consecutive drains

(c) Average density (in km) per sq km of GCA

3.5.2 Identification of the water logged areas (Ground water)

3.5.3 Identification of area affected by

(a) Salinity

(b) Alkalinity

3.5.4 Identification of area needing drainage

(a) Surface

(b) Sub-surface

(c) Vertical (by pumping)

3.5.5 Land requiring treatment and extent

(a) Saline/alkaline

(b) Water logged

(c) Sand dunes

(d) Ravines and heavily eroded areas

(e) Forest

(f) Any other

3.6 SURVEYS OF EXISTING WATER MANAGEMENT PRACTICES

The following items and additional items, if any, shall be discussed under this chapter.

3.6.1 Review of the existing system of operation and distribution of irrigation water including its measurement.

3.6.2 Review of existing on farm development and on farm management of irrigation water.

3.7 CROPPING PATTERN

The following items and additional items, if any, shall be discussed under this chapter. Data shall be furnished as per Annexure-2.

3.7.1 Existing cropping pattern in the command area in irrigated and unirrigated areas of the CCA. (Annexure-2)

3.7.2 Designed cropping pattern with justification based on soil surveys, agro-climatic condition etc. to suit water availability. (Annexure-27)

3.7.3 Existing/proposed legislative and administrative provisions for enforcing the proposed cropping pattern.

3.7.4 Existing yields of crops (seasonwise) and projected yeilds with project.

3.7.5 Additional benefits expected (Projected minus existing)

3.8 WATER REQUIREMENTS, WATER AVAILABILITY AND DEMAND TABLE

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

3.8.1 Experimental/actual observed data on crop water requirements of various crops grown in the area, alternatively computed data based on climateological data by modified penman/Christanen's method (Proforma attached for computation—Annexure-3).

3.8.2 Estimation of weekly/fortnightly irrigation requirements.

3.8.3 Water availability and demand table (Annexure-4).

3.9 ON-FARM DEVELOPMENT (OFD)

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

3.9.1 Type of layout proposed for integrated on-farm development.

3.9.2 Field layout on contour map (s) for sample area(s) showing the location of the field channels, field drains, farm roads and structures including field boundary realignment.

3.9.3 Design of water courses, field channels and lining if required including the justification for the same.

3.9.4 Design of land levelling and calculatios for earth work (Annexure-5) computations including the cost of levelling for sample area with projections for the whole project.

3.9.5 Land consolidation and realignment proposals with details of sample area and how they will be implemented.

3.9.6 Design of field drains including their alignment, spacing, depth etc. of both surface and subsurface drains.

3.9.7 Detailed proposals for field drainage of sample area to be given with projections for the whole area, cost etc.

3.9.8 Proposal for reclamation of lands affected by salinity/alkalinity indicating the procedure adopted for the reclamation (simple leaching or use of amendments to be specified).

3.9.9 Proposals for reclamation of ravine eroded areas, forest lands, sand dunes, low-lying areas, etc. If required, may be given.

3.9.10 Farm roads-proposals for provision of farm roads to be integrated with on-farm-development works indicating the length/ha and standards to be adopted for roads.

3.9.11 Assessment of equipment required for the project.

3.9.12 Total cost of on-farm development based on estimates for representative areas for the whole project.

3.9.13 De'ails of financing through.

(a) Government.

(b) Institutions.

3.10 WATER DISTRIBUTION AND CONTROL

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

3.10.1 Water distribution and control above the outlet

3.10.2 Water distribution below the outlet—proposals for Warabandi/Osrabandi, etc. and farmers' associations, water distribution committee etc. to be set up.

3.10.3 Arrangements to intrdouce night irrigation if not being practised in the neighbouring areas.

3.11 RESEARCH EXTENSION AN TRAINING

The following items and additiona ems, if any as relevant to the project shall be chapter.

3.11.1 Extension services—existing position and proposals for strengthening.

3.11.2 Trial cum demonstration farms—present position and proposals for establishing additional farms.

3.11.3 Training programmes for field staff and farmers—existing position and proposals for strengthening.

3.12 SUPPLIES OF INPUTS AND SERVICES INCLUDING CREDIT

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

3.12.1 Present quantum of use of fertilizers, insecticides, pesticides, weedicides etc. in the CCA and future requirement assessed based on the cropping pattern.

3.12.2 Arrangement for supply of inputs like seeds fertilizers, insecticides, pesticides etc. and other sources indicating the facilities at present available and proposed to be created.

3.12.3 Present quantum of use of credit and forecast for future requirements.

3.12.4 Credit institutions existing in the area and proposals for their strengthening (assessment of short-term and long-term credit also to be made).

3.12.5 Organisation and staff—existing and proposed for motivation, processing credit including verification of farmer's eligibility for credit.

3.12.6 Problem of overdues, ineligibility of farmers and proposal to solve these.

3.13 IMPLEMENTATION SCHEDULE

Time phasing of each item to be included under implementation schedule including items of survey, planning. design, calling of tenders and procurement of equipment etc. shall be discussed under this chapter.

This shall be supported by sutiable bar-chart giving phasing of each important activity.

3.14 FINANCING

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

3.14.1 Funds required for the CAD Project on yearly basis for the whole project period.

3.14.2 Institutional finance required-involvement of ARDC, LDBC, etc.

3.14.3 Measures proposed to make land titles uptodate to reduce ineligibiles and for making recovery of past loans.

3.14.4 Avaliabllity of funds from other departments foı infrastructure items like roads, markets, main drains and for modernisation of the system etc.

3.15 ORGANISATION AND MANAGEMENT

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

3.15.1 Organisation proposed for command area development.

3.15.2 Arrangement for monitoring of the programme at the State level.

3.15.3 Arrangement proposed for coordination with different agencies and departments like irrigation, Agriculture Cooperation, Revenue and Ground Water Development.

3.16 LEGISLATION

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

3.16.1 Existence of legislation to make on farm-development compulsory and if not measures proposed to enact them, give details.

3.17 OPERATION AND MAINTENANCE

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

3.17.1 Agency responsible and arrangement proposed for maintenance of community items of OFD works such as irrigation and drainage channels, related structures etc.

3.17.2 Enforcement of Warabandi for distribution of water and introduction of night irrigation.

3.18 AYACUT ROADS

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

3.18.1 Existing Ayacut roads in the Command Area (type of roads, length etc.) and proposals for providing new or improvement of existing roads.

3.18.2 Technical Specification and standards of Ayacut roads proposed to be adopted (MDR, ODR, village roads etc) and the lengths under each class of roads (New or to be upgraded)

NOTE—For accessibility criteria and technical specifications & standards, refer Annexure-6.

3.18.3 Agency(s) to execute the different types of Ayacut roads

3.19 TYPICAL FARM BUDGET

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

3.19.1 Typical farm budget(s) for marginal (0 to 1 ha), small (1 to 2 ha), medium (2 to 4 ha) and big farms (above 4 ha) discussing—

(a) Production
(b) Market
(c) Prospects
(d) Price and
(e) Farm income

3.19.2 Production-details of production expected from the various crops.

3.19.3 Market propsects-careful analysis of the market prospects for the various agricultural commodities to be made.

3.19.4 Price levels adopted for computation of benefits in the projects to be indicated with basis.

3.19.5 Farm income-net farm income expected after deducting the production cost.

3.20 EMPLOYMENT

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

3.20.1 Employment to be created.
(a) for construction period
(b) for farm operations

3.21 BENEFITS

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

3.21.1 Benefits and justification.

3.22 PHYSICAL AND FINANCIAL TARGETS

3.22.1 The physical and financial targets shall be furnished on yearwise basis for the project period.

COMMAND AREA DEVELOPMENT

SECTION-4

LIST OF DRAWINGS

1. Map of the area showing location of the head-works 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. Index map of the project command showing location of the existing and proposed irrigation (major medium and minor) schemes utilising surface and ground water.

3. Map showing the location of raingauge stations, IMD stations in/around the command area or nearby locality representing the climate of the command.

4. Plan of the command area scale 1 : 10,000 contour interval 0.5 m showing the alignment of the canal(s), location of the structures, off-taking channels, area commanded (CCA) by each off-taking channel, alignment of the off-taking channel, bed level, full supply level and discharge of the main canal and off-taking channel at the point of take-off.

5. Index Map showing the location of the soil profiles taken and studied.

6. Soil map of the command scale 1 : 10,000 (covering GCA).

7. Land capability map of the command scale 1 : 10,000 (covering GCA).

8. Land irrigability classification map of the command (covering GCA demarcating areas of different constraints under each class).

9. Map showing the soil depth in the entire GCA.

10. Map of the command area showing pre and post monsoon ground water contours, scale 1:10,000.

11. Map of the command showing the existing (natural and man-made) and proposed drains.

12. Layout map of the sample area(s) surveyed for OFD works including layout of conveyance and field channels, location of outlets, drainage channel etc. natural and man-made etc.

13. Typical map of the OFD block(s) showing the details of the OFD works scale 1 : 2500.

14. Typical L-Section(s) and Cross-section(s) of the water courses, field channels, field drains, structures, farm roads etc.

15. Map showing the ground water potential areas and areas of conjunctive use existing and proposed scale 1 : 10,000.

16. Map showing the sub-surface water quality in the command.

17. Map showing the water logged and other problematic areas needing reclamation.

18. Map showing depth to ground water in the Command Area (These maps are available with state/ Central Ground Water Boards.)

APPENDIX

Appendix-1—Soil Survey Report

This report shall be prepared as per procedure suggested in the Soil Survey Manual published by Indian Agriculture Research Institute, New Delhi or as per IS Standard No. 5510-1969. It shall cover the following aspects and additional, if any, of the semi detailed/detailed soil survey :—

1. General description of area surveyed—location, physiographic features, geology, agro-climatological description, broad slope groups.
2. Vegetation and present land use—crop grown, yields, crop rotations and cultural practices.
3. Methodology of soil survey used.
4. Physical properties of soils—colour, texture, structure, depth, moisture holding capacity, infiltration rates, permeability etc.
5. Chemical properties—PH, soluble salt content, exchangeable sodium, soil fertility, salinity and alkalinity, organic content.
6. Ground water—quality, depth, fluctuations in different seasons, present stage of development and potential available.
7. Soil erosion—type and extent.
8. Soil classification and correlation—soil family, series, type phase.
9. Land capability classification.
10. Irrigability classification & its interpretation for crop planning.
11. General problems of the area and broad suggestions.
12. Summary and conclusions.

ANNEXURE—1

Measurement and recording of data pertaining to ground water

Periodic measurements should be made to show the depth from the measuring point to the ground water level in each well. These measurements must be tabulated and reduced to show the actual elevation of the water level and to show the depth from the ground surface to the water level in each well. The measurement may be recorded in the following form :

WELL RECORDS

for

Drainage Investigation

Name of owner of the well..... Village.....

Field No. ..... Distt. .....

Technician ..... B.M. Elevation .....

Well No. Ref.	Elev.	Dates (Readings taken)			Remarks
		Read (Elev. W.S.)	Read (Elev. W.S.)	Read (Elev. W.S.)	

NOTE :—Readings to be taken once a month preferably on the same date.

ANNEXURE—2

Existing Cropping Pattern and Production/Proposed Cropping Pattern and Production

Kharif/Rabi/Summer (Zaid)

	CROPS				PRODUCTION					COST OF PRODUCTION					
Sl. No.	Name of Crop	Variety	Duration of crop		Area in ha	Yield in Q per ha	Total field in Q	Rate per Q	Total cost of the produce	Cost of seed	Cost of fertilizers	Cost of other inputs Labour, Irrigation charges, power bullock machinery etc.	Total cost of production	Net income	Remarks
			from Month & Date	To Month & Date											
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Kharif															
1															
2															
3															
4															
Rabi															
1															
2															
3															
4															
Two Seasonal															
1															
2															
3															
4															
Perennial															
1															
2															
3															
4															
Summer															
1															
2															
3															
4															

ANNEXTURE—3

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		July		Aug.		Sept.		Oct.		Nov.		Dec.		Jan.		Feb.		March		April		May		Total
		I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	
1.	Average Rainfall (mm)																									
2.	Evapotranspiration ET_o (mm)																									
3.	Crop factor K_c																									
4.	Consumptive use of crop ET_o (mm) (=ET_c × K_c)																									
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) x 10^{-2} = '000 Cum 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—4

Sample calculation for Irrigation Demand for each branch Canal system with different proposed cropping pattern

Area (ha).....Irrigation Demand at Canal Head.....

Crops (All crops proposed to be included)	Jan.		Feb.		Mar.		Apr.		May		June		July		Aug.		Sept.		Oct.		Nov.		Dec.	
	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II
Kharif																								
Coarse paddy																								
Fine paddy																								
Bajra (hybrid)																								
Jowar (fodder)																								
Maize (hybrid)																								
Groundnuts																								
Pulses																								
Mixed																								
Rabi																								
Wheat																								
Potatos																								
Vegetables																								
Eight-Monthly crops																								
Tobacco																								
Cotton																								
Perennial																								
Sugarcane																								
Hot-weather																								
Bajra (hybrid)																								
Jowar (fodder)																								
Monthly Totals																								
Post Monsoon season																								
Monsoon season																								

Total seasonal irrigation demands (rounded) : Monsoon :—.....Annual.....

N.B. : Cropping pattern should be so selected as to keep the ratio between the peak monthly demand and the minimum monthly demand not to exceed 4 : 1 to facilitate proper operation of the canal system.

ANNEXURE—5

Table for Earth Work Computation

Name of the Project
Command Area of

Distributaries/Minors/Outlets of sample area
Area in ha
Name of village

Sl. No.	Slope group in Percentage	Percentage of total area	Area in ha	Earth work in cum/ha on the basis of sample surveys	Total earth work in cum. (Col. 5 x CCA)
1.	0—1.0				
2.	1.0—2.0				
3.	2.0—3.0				
4.	Above 3.0				
	TOTAL				

ANNEXURE—6

Extracts from the Draft Report of the Technical Group to go into the norms and specification of Ayacut Road in the Command Area constituted by the Ministry of Irrigation

1. Definition of Ayacut Roads

1.1 Ayacut roads shall include the main roads to market centres, which shall be of Other District Roads (O.D.R.) category and the roads linking the villages to O.D.R.

2. Accessibility Criteria for Ayacut Roads

2.1 The Working Group on Rural Roads set up by the National Transport Policy Committee (NTPC) of the Planning Commission recommended that on an average, no village should be more than 1.5 km from a road at the end of 15–20 years from now. This would give a road density of 60–65 km per 100 sq km of area, as against the present density of 32–35 km/100 sq km of area. The Working Group also envisaged that within this overall objective, the distance of any village in developed and irrigated agricultural areas would be 1 km from the nearest road and in under-developed and uncultivated areas, this distance could be upto 2.2 km. However, in order to implement the recommendations mentioned above, the Working Group estimated enormous investment of over Rs. 11,000 crores.

2.2 The Technical Group recommends that the Ayacut roads should be so planned that within the command area, the distance of any village from the nearest road shall not be more than 1 km. This would mean a road density of approximately 100 km/100 sq km of area. The existing road net work should be improved and expanded to this level in all the command area. The Technical Group further recommends that the implementation of the rural roads programme should be coordinated with the CAD and other road programmes so as to derive full benefit from the project.

3. Broad Technical Specifications and Standards for Rural Roads

3.1 The specifications for rural roads have been gone into in depth by the Rural Roads Committee of the Indian Roads Congress. Rural roads are essentially low cost roads and specifications for pavements have to be chosen to be as economic as possible, consistent with traffic, climate and the availability of local materials etc. The following are the general types :

(a) Roads with ordinary earth surface

(b) Roads with improved surface but not black-topped

(c) Roads with black-topped surface

3.2 The most rudimentary form of road construction is to have an earth road which would act as the running surface. However, the presence of a large number of iron tyred vehicles in rural areas limits the utility of this specifications as the roads may become dusty in dry weather and slushy in wet weather. Adequate drainage is an important requirement for such type of road.

3.3 The Technical Group would recommend that the specifications for roads in the command area should be in conformity with the "Manual or route location, design, construction and maintenance of rural roads" published by Indian Road Congress, subject to the following modifications :

(a) Main roads to market centres would be the O.D.R. category and would be all weather black-topped, and the stream crossings should normally be submersible vented cause-ways with single lane. This may, however, vary in special cases where high level bridges may be constructed depending upon the need of the area.

(b) Village roads linking the villages to O.D.R. or a group of villages would be of Water-bound macadam type or even of gravel, if good gravel is available, with the proviso that some of the roads may be black-topped on a vary selective basis depending on the local needs. The drainage crossings may be of low level paved dips or of submersible/vented cause-ways.

MODERNISATION OF IRRIGATION SCHEMES

MODERNISATION OF IRRIGATION SCHEMES

Section I

CHECK LIST

Reference Page No. etc.

1. Have the salient features of the project as envisaged at the time of execution of project and as at present, been indicated ?
2. Has the culturable command area been actually assessed and compared with that at the time of planning of the project and shortfalls, if any, discussed ?
3. Have the deficiencies in the existing irrigation system been identified ?
4. Has the need for modernisation been justified ?
5. Have the hydrological studies been reviewed and compared with those made at the time of preparation of the original project in respect of :
   (i) rainfall
   (ii) runoff
   (iii) flood
   (iv) sediment
   (v) ground water
6. Have the semi-detailed soil surveys been carried out for the entire command and soil and land irrigability classification brought out in the report ?
7. Is the method used for determining the crop water requirement discussed ?
8. Has justification for the proposed cropping pattern been furnished ?
9. Has the proper cropping calendar been devised with a view to maximise the production and canal enclosures for maintenance etc. ensured ?
10. Are the areas and percentage of CCA that will be irrigated during Kharif, Rabi, two seasonal, Hot weather and perennial been indicated and compared with the existing cropping pattern ?
11. Is the justification furnished for irrigating perennial and hot weather crops from the reservoir ?
12. Are the most suitable depths and frequencies of irrigation to be adopted, based on the characteristics of the soil and crops, worked out ?
13. Have the values of conveyance efficiency and field application efficiency been indicated with basis thereof ?
14. Has the pattern of releases (weekly/fortnightly etc.) from the storage/diversion headworks been worked out ?
15. (a) Has the need for remodelling and extension of canal and provision of additional canal and distribution system upto 5/8 ha block been discussed ? Has the quantum of additional land to be acquired for extension of the system been estimated and indicated ?

15. (b) Has the canal been redesigned to cater for peak requirements +10 per cent for rush irrigation. If not, have the alternative proposals for carrying the required discharge been discussed ?
16. 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 ?

17. 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 including the aspect of quality, been carried out ?
18. Have the economics of ground water development been studied ?
19. 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 ?
20. Is the possibility of the ground water irrigating areas not commanded by the canal system considered ?
21. Has the quality of surface water as also ground water, drainage water, if intended for irrigation use, been tested ?
22. Have the requirements of drainage in the command area, been studied and a suitable integrated drainage plan drawn up ?
23. Have the arrangements for the following been discussed :
    (a) execution of OFD works
    (b) Training programmes for field staff and farmers—existing position and proposals for strengthening
    (c) Provision of extension services
    (d) providing important inputs like seeds, fertilizers etc.
24. Are available road communication facilities adequate and if not, are the improvements necessary, discussed ?
25. Is the improvement in reliability/dependability of the annual irrigation of the existing/ proposed command area discussed in the light of modernisation ?
26. Is the net additional agricultural produce expected due to modernisation, worked out ?
27. Are the cropping pattern and the estimates of benefits concurred by the Agricultural Deptt. ?
28. Are the detailed cost estimates included in the Report ?
29. Has the concurrence of the State Finance Department been obtained for taking up the project ?
30. Whether the scheme has already been started ? If so, is the present stage of construction indicated ?
31. Is the scheme included in the plan ? If not, what is the present position regarding its inclusion in the plan ?
32. Have the yearwise requirement of funds been indicated ?
33. Is the scheme covered under state sector or Central sector ?
34. Is the scheme covered under any foreign assistance/aid agreement ?
35. Has the benefit-cost ratio been worked out ? Has the agricultural department been consulted ?
36. Are any special reasons to undertake the project discussed where the project is unproductive ?
37. Are the financial returns attached ?
38. Are the rates of betterment levy proposed, the period of recovery and the estimated total recovery indicated ?
39. Are there any charges levied for irrigation facilities as distinct from water charges ?
40. Is the scale of water rate indicated ?
41. Have the rates of betterment levy, water charges, etc. been compared with those obtained in other regions of the State ?
42. Has the concurrence of the State Revenue Department been obtained for these rates ?
43. Is the programme of construction and the expenditure involved furnished ?
44. Has the requirement of staff been estimated and furnished with justification ?
45. Is the adequacy of the existing irrigation laws and revision, if any, considered necessary, discussed ?
46. Has the impact of the scheme on the overall development of water resources in the basins been discussed ?

MODERNISATION OF IRRIGATION SCHEMES

SECTION—2

SALIENT FEATURES

2.0 Name of the project

2.1 General Data

2.1.1 District

2.1.2 Tehsil

2.1.3 River

2.1.4 Location of dam

2.1.5 Name of river/basin

2.1.6 Longitude & Latitude (at dam site)

2.2 Hydrological data

2.2.1 Catchment area at dam site (ha)

2.2.2 Rainfall (mm) Original Revised

(a) Maximum annual rainfall

(b) Minimum annual rainfall

(c) Mean annual rainfall

(d) 75% dependable annual rainfall

2.2.3 Annual runoff (M cum) Original Revised

(a) Average

(b) Maximum

(c) Minimum

(d) 75% dependability Present Proposed

2.2.4 Water utilisation (M cum)

(a) Reservation for upstream use

(b) Reservation for downstream use

(c) Water saved due to modernisation

2.2.5 Ground water potential (M cum)

(a) Total potential

(b) Present use

(c) Balance for future utilisation after modernisation

2.2.6 Reservoir data Existing Proposed

(a) Storage (M cum)

(i) Gross storage capacity

(ii) Dead storage capacity

(iii) Live Storage

(iv) Annual carry over.

(b) Elevations (E.-m) Original Revised

(i) Maximum water level

(ii) Full reservoir level

(iii) Lowest water level

(iv) Dead storage level

(v) River bed level

(vi) Irrigation outlet level

(c) Water spread area at (sq km) Original Revised

(i) Dead storage level

(ii) Full reservoir level

(iii) Maximum water level

2.2.7 Canal system (Irrigation) —Information to be furnished for each canal separately

Existing Proposed

(a) Length of main canal (km)

(b) Full supply levels at canals head (m)

(c) Full supply discharges at canal heads (cumec)

(d) Length of complete distribution system upto channels carrying 25 hu. sec (km)

(e) No. of villages served

(f) Areas (ha)

(i) Gross command area

(ii) Culturable command area

(iii) Gross area irrigated

(iv) Intensity of Irrigation

2.2.8 Cropping pattern (cropwise)—Seasonwise

Name of rop season-wise	Planned originally Area		Actual achieved Area		Proposed Area	
	ha	% of CCA	ha	% of CCA	ha	% of CCA
1.						
2.						
3.						
4.						
5.						
.						
.						
.						

2.3 Benefits

2.3.1 Additional Benefits

	Additional	
	Area (ha)	Yield (Tonnes)
(a) Foodgrains		
(b) Commercial crops		
(c) Others		

2.3.2 Value of additional produce (Rs. Lakhs)

2.4 Revenue (Rs)

2.4.1 Revenue from water rates

2.4.2 Revenue from Irrigation cess other than water rates

2.4.3 Recovery of betterment levy

2.4.4 Other source of revenue, if any.

2.5 Benefit Cost Ratio

2.5.1 Estimated cost (Rs lakhs)

2.5.2 Net Benefit (Rs lakhs)

2.5.3 B.C. Ratio

SECTION 3

REPORT

3.1 INTRODUCTION

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

3.1.1 Brief description of major components of the project as formulated/conceived originally.

3.1.2 Salient features/aspects

(a) Envisaged at the time of execution of the project

(b) Improvements and/or changes carried out subsequently during the operation of the project

(c) As at present

(d) Comparison between the existing and proposed features

3.1.3 Present performance of various components of the project

3.1.4 Irrigation potential envisaged originally

(a) Its development year to year (indicate what changes have taken place in the development of irrigation potential during the operation of the project).

3.1.5 Deficiencies in the existing Irrigation System

(a) Engineering
(b) Agronomical
(c) Administrative
(d) Legislative

3.1.6 Justification/need for modernisation

3.1.7 Dove-tailing of the project in the basin plan/ master plan

3.2 HYDROLOGY

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

3.2.1 Original studies made at the time of preparation of the project in respect of

(a) Rainfall
(b) Runoff
(c) Flood
(d) Sediments
(e) Ground water
(f) Any other

3.2.2 Additional data collected after the completion and during the operation of the project in respect of

(a) Rainfall
(b) Runoff
(c) Floods
(d) Sediment
(e) Ground water
(f) Any other

3.2.3 Review of all studies under 3.2.1 taking in the light of new information collected under 3.2.2

3.3 LAND POTENTIAL

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

3.3.1 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 and the basis thereof, (Refer item (b)(i), (ii) and (iii) above)

3.3.2 Soil Surveys

(a) Pre-irrigation (at the time of original project formulation stage), if any.

(b) Post-irrigation (after completion of the original project and/or during its operation)

(c) Latest surveys carried out for formulation of this scheme

3.3.3 Soil Capability classification based on the latest soil survey

3.3.4 Land Irrigability classification based on the latest soil surveys

3.4. 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

3.4.1 Details of original cropping pattern, crop calendar (Annexure 1) 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

3.4.2 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

(c) Net Irrigation and field irrigation requirements cropwise

(d) Assumed field application efficiency with basis

(i) Paddy

(ii) Upland crops

3.4.3 Cropping pattern (details of crop to be discussed Annexure 1 & 2) 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

3.4.4 Estimation of effective rainfall (fortnightly) in different periods of crop season with basis (refer Annexure-3)

3.4.5 Assessment of crop water requirements

(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 christiansen's or Modified Penman method (refer annexure 4 and 5)

3.4.6 Assumed conveyance efficiencies with basis

(i) Kharif

(ii) Rabi

3.4.7 Irrigation water requirement (at canal head)

(a) Cropwise, (refer Annexure 5)

(b) Seasonwise, (refer Annexure 10)

(i) Kharif

(ii) Rabi

(iii) Two Seasonal

(iv) Perennials

(v) Hot weather

3.5 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 a tabulated data.

3.5.1 Capacity as originally planned, (refer Annexure-7).

3.5.2 Hydraulic Survey of the Canal System.

(a) As existing today.

(b) Analysis of its performance viz-a-viz its original design.

3.5.3 Identification of the reaches needing improvements like (Annexure-6 & 7)

(a) Lining (keeping in view item 3.6.6)

(b) Resectioning

(c) Strengthening of banks

(d) Stabilisation of embankment reach by reach.

3.5.4 Review of the capacity of existing canals.

(a) Present peak requirement.

(b) Its sufficiency or otherwise.

3.5.5 Review of the existing canal structures and needs for additional structures and/or remodelling.

(a) Headworks

(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 or drains.

(g) Bridges

(h) Water measuring devices.

3.5.6 Need for remodelling and extension of existing canal system/new canals and distribution system upto 5 8 ha block additional land acquisition etc.

3.5.7 Estimation of Conveyance (Canal and distribution system) efficiency

3.5.8 Gross Irrigation requirements at the canal head cropwise, seasonwise (3.4.7 a & b) (Annexure-8 & 10)

3.5.9 Availability of river supplies and storage.

(a) Their efficiency to meet diversion requirements based on monthly reservoir operation tables, for sufficient number of years (Annexure-9).

(b) 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.

NOTE :—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.

(iv) Stability analysis of the major component, of head works.

(v) If the available supplies are adequate and the headworks not capable to divert the peak requirements into the canal system, the headworks may be redesigned suitably based on proper investigations.

3.5.10 Details of land-water budgetting showing whether land available is more than corresponding quantity of water or vice-versa.

3.5.11 Intensity of irrigation cropwise (seasonwise).

(a) As originally proposed.

(b) As actually attained.

(c) As proposed in post-modernisation stage.

3.6 GROUND WATER

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

3.6.1 Assessment of the Ground Water potential in the Command Area :

(a) total potential

(b) present use

(c) balance for future utilisation.

3.6.2 Depth of Ground Water.

(a) Pre-monsoon

(b) Post monsoon

3.6.3 Quality of Ground Water (Salanity, P . SAR, B,Γ, etc.)—Suitability for Irrigation & drinking.

3.6.4 Assessment of possibile impact on Ground Water recharge due to canal lining and ground water utilisation and action taken for its replenishment.

3.6.5 Identification of areas where ground water

(a) Can be exploited economically.

(b) Cannot be exploited due to non-availability of groundwater aquifer or the quality being not suitable.

3.6.6 Conjuctive use of surface and ground waters Identification of areas where this is possible, such as areas of rising water table or declining water table.

3.6.7 Possible ground water utilisation for irrigation areas not commanded by a canal system.

3.7 DRAINAGE AND LAND RECLAMATION

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

3.7.1 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.

3.7.2 Type of drainage needed with proposals.

(a) Surface drainage.

(b) Sub-surface drainage.

(c) Vertical drainage (tubewells).

3.7.3 Type of reclamation needed with proposals.

(a) Soil salinity

(b) Alkalinity

(c) Acidity

3.8 WATER MANAGEMENT AND MAINTENANCE

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

3.8.1 Review of existing system of operation, maintenance and distribution.

3.8.2 Measurement of Irrigation Water (water distribution methods).

3.8.3 Improvements proposed

(a) Scope of introduction of modern technology like sprinkler, drip irrigation etc.

(b) Ground water recharging/conjunctive use

(c) Use of poor quality water.

(d) Recycling drainage water

(e) Instrumentation for assessing day to day canal requirement accurately.

(f) Any other improvements.

3.9 ON FARM DEVELOPMENT WORKS

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

3.9.1 Review of the present on-farm development works

(a) Water courses, field channels and field drains.

(b) Land levelling and land shaping.

(c) Improvements needed.

3.9.2 Status of individual holdings

(a) Land consolidation.

(b) Deficiencies and proposals for improvements.

3.9.3 Extension services—existing and proposed

(a) Trial-cum-demonstration farms, demonstration on farmers fields, package programmes etc.

(b) Dissemination of information to the farmers through audio-visual media, like radio, Television, films etc.

(c) Improvements needed and proposals for the same.

3.9.4 Facilities for input suppli—esexisting and proposed

(a) Institutional finance
(b) Agricultural credit
(c) Seeds
(d) Fertilizers
(e) Pesticides
(f) Weedicides

3.9.5 Infra-structural facilities—existing and proposed

(a) Roads including ayacut and farm roads.
(b) Railways
(c) Navigable water ways
(d) Air fields
(e) Grain storage
(f) Agro-processing
(g) Agro-servicing
(h) Animal husbandary
(j) Poultry
(k) Dairying
(l) Markets (mandis)
(m) Any other

3.9.6 Communication facilities—existing and proposed

(a) Telephone
(b) Telegraph
(c) Wireless

3.10 CONSTRUCTION ORGANISATION

3.10.1 Organisation setup for execution of the modernisation works with justification.

3.10.2 Organisation setup for execution of OFD works with justification.

3.11 PROJECT ECONOMIC EVALUATION

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

3.11.1 Estimated cost.

3.11.2 Programme and phasing of construction and expenditure involved.

3.11.3 Operation and maintenance charges

(a) Present
(b) Propo.ed

3.11.4 Water rates

(a) Present
(b) Proposed

3.11.5 Betterment Levy

(a) Present
(b) Proposed

3.11.6 Assessment of crop yields

(a) Pre-modernisation
(b) Post-modernisation

3.11.7 Benefit cost Ratio

3.11.8 Assessment of socio-economic and environmental effects due to the project.

3.12 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.

3.12.1 Measures and procedures

(a) Deficiencies in existing measures and procedures.

(b) Proposed measures to overcome or remove the deficiencies.

3.12.2 Assessment and mode of collection of revenue

(a) Existing

(b) Modification proposed, if any

3.12.3 Assessment and mode of collection of betterment levy

(a) Existing

(b) Modification proposed, if any.

3.13 FACILITIES FOR TRAINING THE OPERATIONAL AND MAINTENANCE PERSONNEL

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

3.13.1 Existing.

3.13.2 Proposals for improvement and extension.

MODERNISATION REPORT

SECTION—4

LIST OF DRAWINGS

1. Existing layout plan of the headworks and appurtenances with super imposed proposed changes.

2. Existing cross-section of earth/rockfill dam, non-overflow concrete/masonry section, spillway, regulator etc. with super imposed changes in these sections.

3. Contour plan of the command scale (1 : 10,000 contour interval 0.5m) showing the existing 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-taking culturable command area under each channel etc.

4. Contour plan of the command scale (1 : 10,000 contour interval 0.5m) 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.

5. Condensed existing L-Section of the canal showing the location of the existing structures, off-taking channel, bed level, full supply level, bed slope etc.

6. Condensed L-Section of the canal showing the location of the proposed structures, off-taking channel, bed level, full supply level, bed slope etc.

7. Typical cross-section of the existing canal with the super imposed proposed section.

8. Contour and layout plan L-Section and Cross-Section of major new/proposed to be remodelled canal structures with location of the bore hole drilled, pits excavated shown on the plan and the log on the cross-sections.

9. Plan showing the classification of soils available in the command.

10. Land capability classification map of the command.

11. Map of the culturable command area showing the land irrigability classification with boundaries of the area having different constraints, pre and post monsoon ground water contours etc.

12. Map showing the ground water potential areas.

13. Map showing the water logged and other problematic areas indicating the problems.

14. Map showing the sub-surface water quality in the command.

15. Map showing depth to ground water in the Command Area (These maps are available with State/Central Ground Water Boards).

ANNEXURE—I

Cropping Pattern

(i) Cropping pattern as provided in the original project

(ii) Cropping pattern as developed at present

(iii) Proposed cropping pattern under Modernisation Scheme

Crop with variety	Growing period		Area in hectares			Remarks
	Optimum sowing date	Optimum maturity date	As provided in the original report	As developed at present	Under modernisation	
1	2	3	4	5	6	7
Kharif						
(i) **Early paddy**						
Local						
High Yielding						
Others						
(ii) **Late paddy**						
Local						
High Yielding						
Others						
(iii) **Jowar**						
Late						
Early						
(iv) **Bajra**						
Late						
Early						
(v) **Maize**						
Late						
Early						
(vi) **Cotton**						
Long staple						
Short staple						
(vii) **Groundnut**						
(viii) **Rabi**						
(i) **Wheat**						
Local						
High Yielding						
(ii) Groundnut						
(iii) Etc.						
(ix) **Summer**						
(i)						
(ii) Etc.						

ANNEXURE—2

Intensity of irrigation proposed under modernisation project

Crop Season	Name of Crop	Area in hectares	Percentage CCA
1	2	3	4
Kharif	1.		
	2.		
	3.		
Rabi	1.		
	2.		
	3.		
Summer	1.		
	2.		
	3.		
Perennial and other crops			

ANNEXURE—3

Fortnightly rainfall data (give 10 years' data)

(Command area)

Station.....Latitude.....Elevation.....metres
Longitude.....year

Year	Period	Jan.	Feb.	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.	Total
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1st	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 by Theissen Polygon method if more than two stations are considered in the command.

ANNEXURE—4

Fortnightly climate data

(Supply 10 years' data)

Station.....Latitudo.....Longitude.....Elevation(m).....Year.....

Year & Period		Temperature in degrees 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		
1		2			3	4	5	6	7	8	9
January	I										
	II										
February	I										
	II										
March	I										
	II										
April	I										
	II										
May	I										
	II										
June	I										
	II										
July	I										
	II										
August	I										
	II										
Sept.	I										
	II										
Oct.	I										
	II										
Nov.	I										
	II										
Dec.	I										
	II										

ANNEXURE—5

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	June II	July I	July II	Aug. I	Aug. II	Sept. I	Sept. II	Oct. I	Oct. II	Nov. I	Nov. II	Dec. I	Dec. II	Jan. I	Jan. II	Feb. I	Feb. II	Mar. I	Mar. II	April I	April II	May I	May II	Total
1.	Average Rainfall (mm)																									
2.	Evaporanspiration ET_o (mm)																									
3.	Crop factor K_c																									
4.	Consumptive use of crop ET_c (mm) ($=ET_o \times K_c$)																									
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) × Area under crop (ha) × 10^{-2} = '000 Cum 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 6

Statement showing water Saved due to lining

Sl. No.	Name of Channel	Reaches to be lined From	To	Total length to be lined	Discharge in the beginning of the reaches in cusec (cumec)	Channel dimensions before lining		
						Bed width 'B' in ft. (Meter)	Water depth (D) in ft. (Meter)	Wetted perimeter with side slop
1	2	3		4	5	6	7	8
	Main Canal							
	Branches							
	Distributaries							
	Water courses							

Sl. No.	Name of Channel	Losses actually observed in unlined state	Wetted perimeter with side slope in lined state	Losses in the lined state (based on other observed data	Total water saved due to lining (Col. 9-11) in cusec (cumec)
1	2	9	10	11	12
	Main Canal				
	Branches				
	Distributaries				
	Water courses				

ANNEXURE—7

Table showing Distribution System

Sl. No.	Canal system	Designed capacity as originally provided	Designed capacity as at present	Designed capacity as envisaged under modernisation scheme	Length in Km	Lined or Unlined	Remarks
1	2	3	4	5	6	7	8
I.	Main Canal(s)						
II.	Branches						
III.	Distributaries						
IV.	Minors						
	Total (where applicable)						

ANNEXURE— 8

Designed Delta and duty of Irrigation for different crops

(MONTHWISE)

Crop	Month	Delta at canal head	Duty at outlet	Duty at canal head	Remarks

ANNEXURE—9

Reservoir Operation Table
Year 19———

Sl. No.	Name of the Month	Storage at the beginning of the month		Inflow of water into reservoir Mcum	Water proposed to be released at canal head M cum	Evaporation losses	Spill	At the end of the month		Remarks
		Storage Mcum	El-m					Storage Mcum	El-m	
1	2	3	4	5	6	7	8	9	10	11
1.	January									
2.	February									
3.	March									
4.	April									
5.	May									
6.	June									
7.	July									
8.	August									
9.	September									
10.	October									
11.	November									
12.	December									

ANNEXURE—10

Demand Table at Canal Head (in '000 Cubic meters)

Fortnight		SEASONWISE									Total Irrigation Water demand
		Paddy	Wheat	Cotton	Sugar-cane	—	—	—	—	Crops	
1		2	3	4	5	6	7	8	9	10	11
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. Cropwise fortnightly demand shall be taken from Annexure-5.

2. Seasonwise : Kharif, Rabi, Two Seasonal, Perinnial, Hot weather.

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