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AGENCY FOR INTERNATIONAL DEVELOPMENT
Washington, D.C. 20523

PROJECT PAPER

I N D I A

MAHARASHTRA IRRIGATION TECHNOLOGY AND MANAGEMENT

VOL I:
MAIN TEXT AND ANNEXES

USAID/NEW DELHI, APRIL 1982

UNCLASSIFIED

MAHARASHTRA IRRIGATION TECHNOLOGY AND MANAGEMENT

PROJECT PAPER

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VOL. II

PROJECT ANALYSES

CHAPTER

1. Economic Analysis
2. Social Soundness Analysis
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AGENCY FOR INTERNATIONAL DEVELOPMENT

PROJECT DATA SHEET

1. TRANSACTION CODE: A (A = Add, C = Change, D = Delete) — Amendment Number: _____

DOCUMENT CODE: 3

2. COUNTRY/ENTITY: INDIA

3. PROJECT NUMBER: 386-0481

4. BUREAU/OFFICE: ASIA BUREAU [04]

5. PROJECT TITLE (maximum 40 characters): Maharashtra Irrig.Technology & Mgt.

6. PROJECT ASSISTANCE COMPLETION DATE (PACD): MM 03 DD 31 YY 87

7. ESTIMATED DATE OF OBLIGATION (Under 'B.' below, enter 1, 2, 3, or 4)

A. Initial FY 82 B. Quarter 3 C. Final FY 82

8. COSTS ($000 OR EQUIVALENT $1 = Rs.9.00)

A. FUNDING SOURCE	FIRST FY 82 B. FX	C. L/C	D. Total	LIFE OF PROJECT E. FX	F. L/C	G. Total
AID Appropriated Total	2,200	44,800	47,000	2,200	44,800	47,000
(Grant)	(2,200)	(800)	(3,000)	(2,200)	(800)	(3,000)
(Loan)	(-)	(44,000)	(44,000)	(-)	(44,000)	(44,000)
Other U.S. 1.				-	-	-
Other U.S. 2.				-	-	-
Host Country	-	2,000	2,000		150,600	150,600
Other Donor(s)						
TOTALS	2,200	46,800	49,000	2,200	194,800	197,000

9. SCHEDULE OF AID FUNDING ($000)

A. APPROPRIATION	B. PRIMARY PURPOSE CODE	C. PRIMARY TECH. CODE 1. Grant	2. Loan	D. OBLIGATIONS TO DATE 1. Grant	2. Loan	E. AMOUNT APPROVED THIS ACTION 1. Grant	2. Loan	F. LIFE OF PROJECT 1. Grant	2. Loan
(1)	2T2	064	064	-	-	3,000	44,000	3,000	44,000
(2)									
(3)									
(4)									
TOTALS				-	-	3,000	44,000	3,000	44,000

10. SECONDARY TECHNICAL CODES (maximum 6 codes of 3 positions each): 011 | 022 | 032 | 091

11. SECONDARY PURPOSE CODE: 242

12. SPECIAL CONCERNS CODES (maximum 7 codes of 4 positions each)

A. Code: BR | DEL | INTR | TNG | XII

B. Amount

13. PROJECT PURPOSE (maximum 480 characters)

To improve the efficiency of surface irrigation in Maharashtra.

14. SCHEDULED EVALUATIONS

Interim MM 10 YY 83 | MM 10 YY 84 Final MM 07 YY 86

15. SOURCE/ORIGIN OF GOODS AND SERVICES: [X] 000 [ ] 941 [X] Local [ ] Other (Specify) _____

16. AMENDMENTS/NATURE OF CHANGE PROPOSED (This is page 1 of a _____ page PP Amendment.)

17. APPROVED BY

Signature: Priscilla M. Boughton

Title: Priscilla M. Boughton, Director, USAID/India

Date Signed: MM 03 DD 12 YY 82

18. DATE DOCUMENT RECEIVED IN AID/W, OR FOR AID/W DOCUMENTS, DATE OF DISTRIBUTION: MM 03 DD 15 YY 82

AID 1330-4 (8-79)

UNITED STATES INTERNATIONAL DEVELOPMENT COOPERATION AGENCY
AGENCY FOR INTERNATIONAL DEVELOPMENT
WASHINGTON D C 20523

PROJECT AUTHORIZATION

INDIA

Maharashtra Irrigation
Technology & Management
Project No. 386-0481
A.I.D. Loan No. 386-T-232

1. Pursuant to Section 103 of the Foreign Assistance Act of 1961, as amended, I hereby authorize the Maharashtra Irrigation Technology and Management Project for India (the "Cooperating Country") involving planned obligations of not to exceed Forty Four Million United States Dollars ($44,000,000) in Loan funds and Three Million United States Dollars ($3,000,000) in Grant funds over a one year period from date of authorization, subject to the availability of funds in accordance with the A.I.D. OYB/allotment process, to help in financing foreign exchange and local currency costs for the project commencing April 1, 1982.

2. The project is intended to improve the efficiency of surface irrigation in the State of Mararashtra by the design and construction of approximately 13 new prototype medium irrigation systems (MIPs) that will be used to test and demonstrate innovations in design, construction and operation of irrigation systems involving farmer/irrigators more actively in the process. Grant funds will finance training and technical assistance in appropriate technical areas as well as studies related to the project and a resident project coordinator. Loan funds will finance portions of the construction costs of the MIPs, and the Cooperating Country will finance the remainder of such costs.

3. The Project Agreement which may be negotiated and executed by the officer to whom such authority is delegated in accordance with A.I.D. regulations and Delegations of Authority shall be subject to the following essential terms, covenants and major conditions, together with such other terms and conditions as A.I.D. may deem appropriate.

4. a. Interest Rate and Terms of Repayment

The Cooperating Country shall repay the Loan to A.I.D. in U.S. dollars within forty (40) years from the date of first disbursement of the Loan, including a grace period of not to exceed ten (10) years. The Cooperating Country shall pay to A.I.D. in U.S. dollars interest from the date of first disbursement of the Loan at the rate of (a) two percent (2%) per annum during the first ten (10) years, and (b) three percent (3%) per annum thereafter, on the outstanding disbursed balance of the Loan and on any due and unpaid interest accrued thereon.

b. Source and Origin of Goods and Services

Goods and services, except for ocean shipping, financed by A.I.D. under the project shall have their source and origin in the Cooperating Country or (in the case of Grant funds) the United States or (in the case of Loan funds) in countries included in A.I.D. Geographic Code 941, except as A.I.D. may otherwise agree in writing. Except as A.I.D. may otherwise agree in writing, ocean shipping financed by A.I.D. under the project shall be financed only on flag vessels of the United States or the Cooperating Country.

c. Covenants

1. The Cooperating Country agrees to make available sufficient funds, through the Irrigation and Agriculture Departments or such other departments of the Government of Maharashtra as may be appropriate, when needed, to complete all aspects of the project in accordance with the budget and schedule as agreed by the Parties.

2. The Cooperating Country agrees to establish a special unit within the Irrigation Department of the Government of Maharashtra and to staff such unit to coordinate and assist in managing and monitoring all project activities.

3. The Cooperating Country agrees to establish an adequate number of positions and to post experienced, qualified staff to those positions at the field level, to implement all project activities satisfactorily and in accordance with the project schedules and budgets established for approved subproject MIPs.

4. The Cooperating Country agrees to support the prototype concept being advanced under this project through the use of demonstration chaks, technical collaboration and special studies, and agrees to utilize the technological innovations and findings arising out of the project to improve new and existing irrigation facilities throughout the state wherever feasible.

Signature _____
M. Peter McPherson
Administrator

4/27/82
Date

Clearances:	Date	Initial
Robert Halligan, A/AA/ASIA	4/21	RH
John R. Bolton, AA/PPC	4/24	
for Kelly C. Kammerer, GC	4/22/82	

SMT
GC/Asia:SRTisa:hp:4/20/82
Ext 28092

AGENCY FOR INTERNATIONAL DEVELOPMENT

ADVICE OF PROGRAM CHANGE

COUNTRY:	India
PROJECT TITLE:	Maharashtra Irrigation Technology and Management
PROJECT NUMBER:	386-0481
FY 82 CP REFERENCE:	Main Volume (amended version), p. 278
APPROPRIATION CATEGORY:	Agriculture, Rural Development and Nutrition
LIFE-OF-PROJECT FUNDING:	$47,000,000 Terms of Loan: 40 years; 10 years grace period; 2% per annum first 10 years; 3% per annum thereafter
INTENDED FY 1982 OBLIGATION:	$47,000,000 ($44,000,000 Loan and $ 3,000,000 Grant)

This is to advise that A.I.D. intends to obligate $47,000,000 ($44,000,000 loan and $3,000,000 grant) for the Maharashtra Irrigation Technology and Management Project. This represents an increase of $4,000,000 loan and $2,500,000 grant from the authorized FY 82 life-of-project funding levels shown in the FY 82 CP.

During preparation of the project, refined cost estimates were developed for the thirteen prototype irrigation projects which are to be constructed in the major districts and agro-climatic zones of the State of Maharashtra. These will incorporate the innovations in irrigation design which are the essential elements of this project. Under the revised estimates, $44 million in loan funds will be required to provide such support for the initial five years of project activities.

Grant financing has been increased from $500,000 to $3,000,000 in order to expand the training component of the project to include field level technicians in irrigation system planning, design and construction, and in water management and system operation. The grant will also finance special studies of key problems constraining the efficient use of irrigation systems. Finally, grant funds will support resident project coordination to maximize technical collaboration and the transfer of technology on a day-to-day basis.

ANNEX: Activity Data Sheet

PROGRAM: INDIA

AGENCY FOR INTERNATIONAL DEVELOPMENT
ACTIVITY DATA SHEET

CP 81-05 (8 79)

TITLE Maharashtra Irrigation Technology and Management	FUNDING SOURCE Agriculture, Rural Development and Nutrition	PROPOSED OBLIGATION (In thousands of dollars) FY 82 $44,000 Loan $ 3,000 Grant	LIFE OF PROJECT (Auth.) $47,000
NUMBER 386-0481 GRANT [X] LOAN [X] NEW [X] CONTINUING [ ]	PRIOR REFERENCE Main Volume, p. 278 (amended version)	INITIAL OBLIGATION FY 82 / ESTIMATED FINAL OBLIGATION FY 82	ESTIMATED COMPLETION DATE OF PROJECT FY 87

Purpose: To improve efficiency of surface irrigation in Maharashtra.

Background: Most of Maharashtra is arid and drought prone. Even in wet regions rainfall occurs only during three or four months of the year. Increased irrigation efficiency to expand water availability is one of Maharashtra's highest priorities.

Project Description: The project will support planning, construction, operation and management of thirteen new prototype irrigation systems. Short-term training of technicians involved in design, construction and operation of medium irrigation systems in Maharashtra and studies of key problems constraining optimal use of irrigation will also be funded.

The loan will help finance construction costs incurred for the 13 prototype systems during the five-year life-of-project. The most appropriate U.S. and Indian irrigation technology will be drawn on in the design and operation of these prototypes. The successful aspects of the prototypes will guide the design of new systems, both physical structures and managerial systems.

The grant will cover engineering, training, studies and research.

Relation of Project to A.I.D. Country Strategy: The project contributes to reducing the proportion of the poor among the rural population and sustaining growth of agricultural production. Improved efficiency of irrigation will increase foodgrain production, expand rural employment, improve utilization of natural resources and improve small farmer incomes. It is fully consistent with the Country Development Strategy Statement.

Beneficiaries: Immediate beneficiaries will be landless and marginal laborers employed as a result of the project. Employment will increase 104,000 work-years during construction, and 32,000 additional work-years annually because of increases in agricultural production. Primary beneficiaries will be 20,000 families, roughly 120,000 people, in the prototype medium irrigation project (MIP) command areas, roughly half of whom are poor. Ultimate beneficiaries will be 250,000 families--1,500,000 people--living in surface irrigation system command areas in Maharashtra, and 750,000 additional families--4,500,000 people--in areas where surface irrigation is feasible.

Host Country and Other Donors: The host country will provide $48.2 million equivalent in local currency over the life-of-project. Total project cost during this period is $95.2 million. Projected irrigation sector expenditures in Maharashtra for 1980-85 are $1,500 million. The only other donor in the State's irrigation sector is the World Bank. Two loans totaling $280 million support construction and improvement of ten major (exceeding 10,000 hectares) projects.

Major Outputs	All Years
Prototype MIPs constructed, testing innovations	13
Government of Maharashtra (GOM) officers trained in India in land development, conjunctive water use	75
GOM officers trained in the U.S. in groundwater development, drainage engineering, agricultural water management, systems analysis	60
Studies completed; results used to refine subproject criteria	10

A.I.D.-Financed Inputs	Life of Project ($ thousands)
MIP construction	$44,000
Studies	1,412
Training	1,115
Liaison/Coordination	369
Other	104
	$47,000

U.S. FINANCING (In thousands of dollars)	Obligations	Expenditures	Unliquidated
Through September 30, 19XX 1980	0	0	0
Estimated Fiscal Year 19XX 1981	0	0	
Estimated through September 30, 19XX 1981	0	0	0
		Future Year Obligations	Estimated Total Cost
Proposed Fiscal Year 19XX 1982	47,000	0	47,000

PRINCIPAL CONTRACTORS OR AGENCIES

To be selected

III. Project Rationale and Description

A. Summary Project Description

The project will improve the efficiency of surface irrigation in Maharashtra. Irrigation systems will be designed to accommodate more closely the needs of farmers and their crops; the potential of individual systems will be more fully exploited; greater emphasis will be placed on the equitable distribution of water among all participating farmers within an irrigation system; the available water will be more efficiently used, resulting in greater quantities of crops being produced. Thus overall agricultural production and rural incomes will be improved.

This will be done through specialized training of technicans, engineers, economists and agronomists involved in the design, construction and operation of medium irrigation systems in Maharashtra and by applying what has been learned in the planning, construction, operation and management of thirteen new prototype irrigation systems. Some highly specialized training will be done in the United States, but most will be done in India with a focus on system diagnosis improvement and monitoring. Also, special studies will be undertaken to examine certain key problems constraining the optimal use of irrigation facilities, and these findings, too, will be applied and tested on the thirteen prototypes.

The Water Management Synthesis II Project will be used to provide intensive training for key individuals in the United States and for structured field tours of similar projects underway elsewhere in Asia. For example, visits will be arranged to the Philippines and to Sri Lanka to observe how farmer involvement is being encouraged and expanded; trips to Egypt will permit observation of how research findings can systematically be applied; trips elsewhere will demonstrate various methods of undertaking on farm development and water management. All such trips will provide exposure to functioning mechanisms for the transfer of irrigation technology and thus to examples of how such transfer might be introduced and broadened in India.

The best of U.S. and Indian irrigation technology will be drawn on the design and operation of these prototype projects. The most successful prototypes will be used to refine technology and to serve as demonstration models to guide in the design of new systems, both with respect to physical structures as well as managerial systems.

The objective is to make irrigation water available to all potential users within a command area, when and where it is needed, in sufficient quantities; to tie its control more closely to crop needs, and to coordinate irrigation more closely with the other inputs required by farmers for optimal crop production and marketing.

The absence of a reliable source of water at the field is the principal constraint to higher crop yields as well as to multiple cropping in Maharashtra.

Maharashtra has developed medium and major surface irrigation projects which have an irrigated potential of over 1,000,000 hectares. However, these projects have performed well below their potential in terms of water conveyance efficiencies, irrigation intensities and crop yields. An important reason for this is that the three major components of a functioning irrigation system -- the headworks, the distributaries, and the on-farm development -- have often been treated as separate entities, to be designed and managed with little or no relationship to each other. The prototype approach being followed through this project, with its focus on the productive end of the system, will for the first time link all three components into an integrated whole the purpose of which is to serve all farmers, down to the last one at tail end of the system.

A grant of $3 million will fully finance training, both in India and in the United States, in planning, design, construction and operation of irrigation networks, water management in irrigated agriculture, and water resources systems analysis and management. In addition, special studies of key problems relating to irrigation efficiencies will be grant financed. The studies will be of actual problems on real irrigation systems. Their findings wll be documented in technical reports prepared for and distributed to irrigation and agricultural specialists throughout India and in shorter, less technical summaries prepared for and distributed to policy makers. This will be done through Government of Maharashtra channels and through the Central Water Commission to other states throughout India. A resident project coordinator will help to arrange the training and studies, and will plan and arrange short term technical assistance.

An AID loan of $44 million will finance two-thirds of eligible construction costs incurred during the five year life of the project, roughly half of total costs incurred during that period.

B. Objectives of the Project

1. Goal, Purpose, Outputs

This project contributes towards the Mission's and the Government's goal of increasing food production and increasing the employment and incomes of the rural poor.

The purpose of the project is to improve the efficiency of surface irrigation in Maharashtra, both on existing irrigation systems as well as on those yet to be designed and constructed. Such improvement will make possible increased irrigated crop yields and intensification of cropping of land within irrigation system command areas. To achieve this will require building up the human and institutional capacities of Maharashtra's irrigation and agricultural establishments, and a reorientation away from simply engineering concerns and toward the productivity of water and the primacy of the farmer and his needs.

The outputs of the project that will lead to improved efficiency of surface irrigation are as follows:

a. Training of personnel in a variety of specialized disciplines to improve their contributions to the design, construction and operation of these systems;

b. special studies of key problems and application of their findings to the project's prototype systems;

c. support for collaboration between U.S. and Indian irrigation specialists; and

d. support for construction of thirteen medium irrigation projects in each of the various agro-climatic zones of Maharashtra, to serve as prototypes to test and demonstrate innovations in the design, construction, operation and maintenance of surface irrigation systems.

The subproject MIPs constitute field sites for refinement, application and demonstration of the technological innovations to be introduced and developed under this project. Understanding and acceptance of improved technology by a large cadre of technical personnel who have been directly involved in its development is essential to successful, sustained technology transfer in surface irrigation projects. With one or more subprojects in each of the four geographical regions of the Maharashtra Irrigation Department, most field personnel in that department and in the Agriculture Depart-

ment and their supervisors will become familiar with the improved technology and techniques for its introduction through design and operation criteria.

Workshops in the design of chaks and water management studies to be financed under the project will begin shortly after obligation of the project. Existing MIPs in Maharashtra will be used for demonstration purposes. The activities will be targeted to personnel of the GOM who will be assigned to field establishment offices at each of the prototype MIPs, including both irrigation department personnel as well as Agriculture Extension Officers who are responsible for direct farmer contacts. The field workshops will focus not only on optimum layout of watercourses, but also, and more importantly, on how to engage the participation of the prospective beneficiaries in this process. It is essential that farmers be satisfied with the location of water outlets, and that they have a sense of proprietorship over the system. This requires their active participation from the outset in the design, construction and operation of the system. The core activity of the workshops will involve on-the-ground examinations of existing systems. This will help to highlight mistakes made in the past, and how they affect efficiencies in the operation of irrigation systems.

These workshops and studies will be initiated in the first project year. After the first batch of three prototype MIPs has been approved and construction initiated, participants in the workshops will be assigned to the field establishment to apply what they have learned to the new MIPs. This new cadre will include an interdisciplinary mix of skills including farmer extension and irrigated technology. At least one demonstration chak will be designed, constructed and operated in each prototype, as soon as possible after construction has begun. The field establishment personnel, in consultation with their parent Agriculture and Irrigation Departments, CWC and USAID, will identify potential demonstration chaks in areas where water can be delivered as soon as the reservoir and main channel is operational. They will involve the prospective beneficiaries in the initial design of the chak, in the establishment of farmers' organizations for the operation and maintenance of the chaks and will work out the beneficiaries' contribution to construction and operation of the chak. Contributions can be in the form of construction labor and/or water charges.

When the demonstration chak has been set up, organizations established and contributions identified, and when water delivery begins, the field establishment personnel will remain at site to assure continued efficient operation, to work out any unforeseen difficulties, and to encourage the demonstration of the chak to all other prospective beneficiaries within the MIP command area.

Additional chaks will be designed similarly, applying what has been learned not only in the initial workshops but also with the experience gained in setting up the demonstration chaks.

This process will be repeated in each of the thirteen prototype MIPs.

2. End of Project Status

At the completion of this five year project, substantial portion of the professional staff of the Irrigation and Agriculture Departments f the Government of Maharashtra will have participated in the development and application of new concepts of planning, design, construction and operation of surface irrigation systems. The central element of the new approach will be the end-user, the farmer, and his needs, and the importance of involving him actively at every stage of the building process, from initial planning through construction to operation and maintenance. Studies of major constraints to efficient use of irrigation infrastructure, from technical design aspects to organization and management of water users, will have been completed, and their findings incorporated into the GOM's criteria and procedures for building and operating surface irrigation systems.

In order to consolidate and strengthen these new concepts, thirteen prototype medium irrigation systems will have been planned and designed under the project, and construction initiated, applying what has been learned. Farmers will be actively involved in the planning, design, and construction of each of the thirteen systems, and in the operation and maintenance of demonstration chaks (individual irrigation service areas)completed during the LOP. These demonstration chaks will show policy makers, technicians and farmers how real MIPs can work -- efficiently, equitably, with farmers assuming major portions of responsibility for the entire process. The demonstration chaks, the first of which will be operational after the third year, will help to test, perfect and spread and concept, not only throughout the rest of the thirteen prototypes as additional chaks become operational, but also throughout other planned and existing irrigation systems in Maharashtra and elsewhere in India as well.

Construction of the thirteen prototypes, using improved designs and oriented towards the needs of the users, will be well along. Each of the thirteen systems will require a minimum of seven years from the beginning of construction to completion, so given a five year life of project, none will be fully operational by

the Project Assistance Completion Date (PACD)[1/]. However, as mentioned above, all demonstration chaks will be fully functioning. On the basis of an in-depth evaluation to be undertaken after the third year of project implementation, AID, the Government of India and the Government of Maharashtra will determine whether to prepare a follow-on project to complete construction and begin full operation of the thirteen prototype systems[2/]. However, close collaboration between U.S. and Indian irrigation and water management specialists will have led to the development of new technological innovations in irrigation system design and operation during the first five years, and these will have been applied to the thirteen subproject MIPs; it is expected that many of these new developments will have been incorporated as part of the GOM's statewide policies and procedures for surface irrigation projects as well.

"Cross fertilization" between the states benefitting from USAID's irrigation portfolio will be actively encouraged. For example, personnel from Governments of Gujarat and Rajasthan may be called upon to help undertake training courses in Maharashtra. Field trips between these states will be financed under the project to permit the respective states to learn from each other and to facilitate sharing ideas.

3. Beneficiaries

Most farmers who will benefit from irrigation in Maharashtra are included in AID's small farmer target group. Average farm size statewide is 3.7 hectares, but 43 percent of all farms are below 2 hectares and 72 percent are below 5 hectares. Farm sizes vary by agro-ecological region, ranging from 2.6 hectares in the higher rainfall zones to from 4.4 hectares to 5.7 hectares in the scarcity to moderate zones. For three existing MIPs examined, average farm size ranged from 1.42 hectares to 2.80 hectares with 82.5 percent below 4 hectares. Particularly important to this target group is the reliability of the irrigation system and associated water management and irrigation agriculture technology. It is the small farmer who suffers most from un-

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1/When the thirteen prototypes have been completed, an additional 87,000 hectares of cropland will be under irrigation, increasing annual net farm income by Rs.300 million ($33 million) and annual food grain production by 260,000 tons or more plus vegetables and other cash crops not grown under rainfed conditions. Additional employment opportunities will be created. Agricultural employment will be increased by 32,000 work years annually. Construction will provide an additional 104,000 work years of employment during the life of the project. These estimates are based on averages developed by the National Commission on Agriculture, New Delhi. Irrigated agriculture generates, on the average, 51 work days of employment per hectare per year.

2/In any case, the GOI has agreed to provide sufficient resources to complete and maintain the irrigation systems.

reliable irrigation water supplies, because he has little or no financial margin of safety against crop failure.

For a four hectare farm in low to moderate rainfall areas irrigation and associated agricultural practices under the project will raise net annual farm income from the range of Rs.2400 - 3500 ($267 - $390), the approximate poverty level for a family of five[2/], to Rs.12,000 - 15,000 ($1330 - $1670). Conjunctive development of groundwater, emphasized by this project, can increase these incomes another Rs.4,000 - 6,000 ($440 - $670). A farmer with only two hectares can increase his income from Rs.1270 ($140) to Rs.8600 ($950). See Financial Analysis, Section IV.B.1.

C. Rationale

1. Irrigation Efficiency in India

Provision of adequate water for agriculture is complicated by India's climate and geography. Average rainfall of about 1200 millimeters (47 inches) is above the global average, but this average hides a highly seasonal, erratic and geographically concentrated rainfall pattern. Most rainfall occurs during the southwest monsoon in June to September, and only half of the country actually receives 1000 millimeters of rain or more on average[3/]. The consequences of erratic rainfall were dramatically demonstrated in 1979, when a severe drought resulted in a 17% fall in annual foodgrain production (from 132 million metric tons in 1978-79 to 109 million MT in 1979-80).

As a result of this rainfall pattern, irrigation has been practiced in India almost since the beginning of recorded history[4/].

[2/] The World Bank has drawn the poverty line at per capita income of Rs.600 ($67) per year. See IBRD staff appraisal report for Maharashtra Irrigation II project, September 13, 1979, Section 6.06. Under this criterion, well over 50 percent of the farm families in Maharashtra are below the pverty line.

[3/] Gary S. Posz, Bodh Raj and Dean F. Peterson, "Water Resource Development in India", U.S. Embassy, New Delhi, January 1980. This report is included as Annex A in Jack Keller et al, USAID/India, "Irrigation Development Options and Investment Strategies for the 1980s", Water Management Synthesis Special Report No. 4, August 1981.

[4/] Information in this paragraph is drawn from the 12th Lal Bahadur Shastri Memorial Lecture, given by Mr. G.V.K. Rao, Member Planning Commission, February 1, 1980, page 2-4.

The Moghals are believed to have constructed some irrigation channels during their reign. The British also undertook the construction of irrigation facilities in India during the 19th Century. In the year 1800, approximately 800,000 hectares are believed to have been under irrigation in India. This figure increased to over 13 million hectares by 1900. At the time of independence in 1947, 19.4 million hectares were under canal and well irrigation systems. By 1980 this figure had increased to 57 million hectares. The Sixth Five Year Plan for the period 1980-1985 calls for the bringing of an additional 14 million hectares of crop land under irrigation. Thus the total cropped area under irrigation systems will be almost 73 million hectares by the end of 1985. An additional 40 million hectares of crop land is sufficiently near sources of surface and groundwater for irrigation projects to be technically feasible. Thus, ultimately 113 million hectares of crop land is potentially irrigable as compared with India's present cultivable area of 140 million hectares.

The Government of India (GOI) classifies irrigation infrastructure by the size of the area covered or "commanded", and by source (surface water or groundwater). Surface irrigation projects commanding over 10,000 hectares (ha) are "major"; projects from 2-10,000 hectares are "medium", and projects below 2,000 hectares are "minor". Groundwater irrigation is also classified as "minor", since the area commanded by dugwells or tubewells is generally only a few hectares. The breakdown of "created irrigation potential"5/ by type of irrigation infrastructure is as follows:6/

Table 1 Irrigation Potential
(Gross Million Hectares)
All Figures Cumulative Except 6th Plan

Period	Major & Medium	Minor Irrigation Ground	Minor Irrigation Surface	Minor Irrigation Total	Total Irrigation
Pre-Plan (1950-51)	9.70	6.50	6.40	12.90	22.60
End of 2nd Plan (1960-61)	14.33	8.30	6.45	14.75	29.08
End of 4th Plan (1973-74)	20.70	16.50	7.00	23.50	44.20
1979-80	26.60	22.00	8.00	30.00	56.60
Target (6th Plan)	(5.74)	(7.00)	(1.00)	(8.00)	(13.74)
Ultimate Feasible	58.50	40.00	15.00	55.00	113.50

5/A term used in India to denote the area within the command areas of existing irrigation systems and thus having theoretical access to irrigation water.

6/Posz. Raj and Peterson, Op.cit.,p.11, and GOI Planning Commission Sixth Five Year Plan 1980-1985, Chapter 10.

The importance of irrigation to India's agricultural production is illustrated by the fact that while only 37 million hectares, or less than a third of the total of 127 million hectares, of crop land devoted to food grains are irrigated, the irrigated area produces 63 million tons or half of the total grain production in India each year. Average yield on irrigated land in India is 1.7 tons per hectare, as compared to 0.7 tons per hectare for rainfed crops. However, even this figure of 1.7 tons per hectare is far below what it could be. Experience with irrigated agriculture in other countries as well as on many individual farmers' fields in India suggests that yield levels can easily approach four to five tons per hectare, i.e., almost triple present irrigated yields.

This gap between actual yields and potential yields under irrigation highlights both the problems and the promise of irrigation in India. Efficiently utilized, irrigation water can make a much greater contribution to agricultural growth in India than it has in the past. The challenge is how to increase the efficiencies of the existing systems and how to design and develop new systems such that they take fuller advantage of the technical potential provided by controlled water supplies.

This problem of low irrigation efficiencies may be broken down into two broad sets of interrelated problems.

The first set of problems relates to the use of water as an input in combination with other inputs to achieve high yields. These problems became much more acute with the introduction of high-yielding foodgrain varieties (HYVs) in the mid-1960s, since these varieties generally require both higher levels and more precisely timed applications of water and fertilizer to reach their full potential. This puts a heavier burden on the input supply system in general and irrigation in particular and requires development of a new set of management skills by both the farmer and the irrigation system.

The second set of problems relates to the operation of the irrigation system itself, especially for surface irrigation systems. Like canal irrigation in most parts of the world, under-utilization is a common feature of Indian surface irrigation systems. At present India has irrigation systems covering about 57 million hectares of "created irrigation potential".

However, the area actually irrigated by existing irrigation systems is presently substantially less than their design potential. There are several reasons for the shortfall. According to the irrigation strategy paper prepared by USAID, the problems can be

attributed to lack of the following[7]:

1) efficient and effective facilities to distribute water from the project canals (or pumps) to the farm yields (i.e. adequate design of the main system);

2) efficient means to distribute water to the plants growing in the fields (i.e. adequate on-farm water conveyance facilities); and

3) effective management of the total irrigation system between the plants and the water supply.

These problems are manifested in excessive losses due to leakage from canals, insufficient control of water levels and flows in water channels, inadequate maintenance of channels and control structures, application of more water than is needed for crops on one field, resulting in shortages for others (especially "tailenders"), reduced demand for water due to unreliability of water delivery and absence of sufficient incentives for farmers to incur the added costs and risks of growing additional crops. Although there is relatively little hard data available on irrigation efficiencies, the AID irrigation strategy team (which visited 14 irrigation projects in India) concluded that

> ...utilization of the theoretical irrigation potential of the projects we visited ranged from a low of about 10% up to 100%. Private wells were effectively utilized, but too many of the major and medium projects seemed to fall in the 50% utilization range[8].

The Government of India and several of the state governments are becoming increasingly appreciative of the importance of improving the efficiency of existing irrigation systems. The Sixth Five Year Plan[9] for the years 1980-1985 allocates $13 billion or roughly 15% of Plan expenditures to irrigation and flood control.

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[7] Jack Keller et al, op.cit., p.vi. See also Robert Wade, "Performance of Irrigation Projects", Economic and Political Weekly (EPW), January 17, 1976 and Robert Wade and Robert Chambers, "Managing the Main System: Canal Irrigation's Blind Spot", EPW, Review of Agriculture, September 1980.

[8] Ibid.

[9] GOI Planning Commission, Op. Cit., Chapter 10.

The Plan places major emphasis on improving the use of irrigation systems through better operation of existing systems, integrated or "conjunctive" use of surface and groundwater to improve water utilization in surface irrigation and the adoption of rotational distribution of water. The Plan also stresses improved efficiency in water management through strengthening of Command Area Development (CAD) organizations and authorities, and integration of the functions of canal management authorities with those of CAD authorities. Restructuring management procedures should enable farmers and others in command, catchment and watershed areas to participate fully in the management of the water and soil resources in the area.

The Plan discusses in some detail the Government's disappointment in the lagging utilization of the irrigation potential already created. This is said to be due to delays in construction of field channels and water courses, land leveling and land shaping, and lack of reliable supplies of water to farmers due to improper design and use, leading to water logging and salinity. Because of such problems farmers have often been reluctant to adopt improved cropping practices such as the use of high yielding varieties, fertilizer, pesticide, etc.

The main point made in the Sixth Five Year Plan discussion of irrigation efficiency is that there must be beneficial interaction between the irrigation authorities and the farmers whom they were established to benefit. To be effective, the interaction must be continuous. The Plan proposes to cover approximately one million hectares for on-farm development works in land leveling and shaping. Field channels to move water from the existing public outlets to individual farmers' fields are to be constructed covering an area of approximately four million hectares. In addition, modernization of the irrigation system including improvement of drainage arrangements, development of conjunctive use wherever feasible, integration with other sectoral development programs such as rural roads is also to be undertaken.

2. AID Assistance Strategy

India accounts for roughly half of all the poor and malnourished people in A.I.D.-assisted developing countries. Improving the efficiency of India's irrigation facilities will have major and far-reaching impact upon the livelihood and welfare of this population, and it represents one of the most important opportunities the United States has to bring its established expertise to bear on a major constraint to development.

The central problem of Indian surface irrigation is that the benefits in terms of crop production have not been commensurate with the costs incurred for system construction. While these problems relate to some extent to inadequate farmer access to seed, fertilizer, extension advice etc., the high yields often achieved with privately-controlled groundwater irrigation suggest that the main problems associated with surface irrigation relate specifically to water supply. Farmers are unlikely to accept the risks involved in shifting to improved varieties, higher-value crops and higher cropping intensities permitted by irrigation if there are major uncertainities about the timeliness and adequacy of the required water supplies. Consequently the primary contribution to higher returns to surface irrigation must come from improved efficiency in delivering water from the water source to the farmer's field. This requires higher design standards for the main system, extension of more adequate water conveyance and drainage facilities down to the farmer's field, and improved management of the overall system. Given the very large numbers of farmers involved in surface irrigation systems in India, the water supply cannot be fine-tuned to the extent of providing water to each farmer on demand, but the rotational water supply systems used in parts of northern Indian provide a feasible and cost effective alternative.

The Government of India's Central Water Commission (CWC) has correctly diagnosed the problems of low irrigation efficiencies, and has established general guidelines for revised design standards, construction of field channels down the eight hectare level, and enhanced support for crop production through the establishment of Command Area Development Authorities (CADA). However, bringing about the reforms required on major, medium and minor surface irrigation projects covering 35 million hectares and perhaps 17 million farms[10/] in widely varying ecological, sociocultural and administrative conditions faces a number of constraints. In addition to shortages of financial resources, the most important constraints are inadequate information on problems in specific systems, lack of familiarity with all of the relevant technical alternatives (particularly for cost-effective water delivery at the lower end of the irrigation system), a weak tradition of collaboration among organizations and disciplines in dealing with irrigation system problems, and inadequate development of management skills at all levels.

AID's strategy for improving the efficiency of surface irrigation is to assist the GOI and selected governments in over-

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[10/] The all-India average farm size is 2.0 hectares, compared to 3.7 hectares for Maharashtra. See Table 7.3, Basic Statistics Relating to the Indian Economy, Volume 2, October, 1981; Centre for Monitoring Indian Economy, Bombay.

coming these constraints by providing an appropriate mix of support for technical collaboration, studies, training and construction. This effort will draw heavily on U.S. technical expertise to strengthen the capacity of national and state-level institutions to deal effectively with the complex problems of water management in surface irrigation systems. The U.S. has a strong comparative advantage in providing this type of support. Largely during the first third of this century, U.S. land grant universities and associated US Department of Agriculture laboratories initiated research linking the efforts of irrigation engineers and agronomists and placing the results into practice. Economists and other social scientists became involved, because the socio-economic environment strongly conditions the functioning of irrigation technology. Over the years these universities have trained hundreds of international students and have advised in most irrigated areas of the world. Although many other countries have developed capabilities in this area, the land-grant universities in the United States and USDA together represent the largest and most advanced multidisciplinary resource in this field. USAID/India's efforts in Maharashtra, as well as in the other states covered in the Mission's irrigation portfolio, will be substantially augmented through the use of the Water Management Synthesis II project.

India has likewise pioneered research and developed and practiced innovative technology in the field of irrigation. For example, the rotational distribution of irrigation water by turns among the various farmers served by an outlet, development of crop water requirements, and large channel and lining design and construction techniques are all Indian contributions to the art of irrigation. However, India has yet to develop a cadre of specialists to manage the integration of the engineering and agronomic aspects of irrigated agriculture. The GOI's preliminary estimates are that as many as 50,000 professionals may require some type of in-country or overseas retraining to meet the requirements of improved water management. The design and implementation of appropriate training programs on this scale will clearly demand a high level of technical and financial inputs.

Technology transfer and institutional development can only be effective in this sub-sector if innovations are devised, demonstrated and applied in the context of total surface irrigation systems in varying ecological and sociocultural settings. Consequently AID will finance the modernization and construction of model systems in a limited number of states. Although training and studies will apply to all types of surface irrigation, limited AID resources dictate that

financing for construction be limited to medium and minor projects. These projects also provide the advantage of a shorter construction period (3-5 years for minor and medium projects versus 8-10 years for major projects).

This strategy represents an evolution from the original irrigation strategy adopted by USAID when the India program resumed in 1978. AID's portfolio initially included financial support only for the Gujarat Medium Irrigation Project and substantial funding for groundwater development through a $58 million loan to the Rural Electrification Corporation (REC) and a $100 million loan for the Agricultural Refinance and Development Corporation (ARDC). Experience with the appraisal of the Gujarat project led USAID in the FY 1980 Rajasthan Medium Irrigation project to emphasize support for GOI and Government of Rajasthan interest in improving economic and technical design standards, extending the system closer to the individual farm and carrying out studies on various system problems. This emphasis was reinforced by the findings of the team of U.S. irrigation specialists which visited India in November 1980 to assess various assistance possibilities. Their report, "Irrigation Development Options and Investment Strategies for the 1980's[11/]", confirmed the importance of improved system design and management at all levels of surface irrigation projects. Their review also provided the framework for extensive discussions with GOI and state government officials on the areas in which AID could contribute most effectively. These discussions were the basis for the design of the Maharashtra Irrigation Technology and Management project, and the proposals for the FY 1983 Water Management and Training, Rajasthan Command Area Development (CAD), and Madhya Pradesh Minor Irrigation Projects.

For the period FY 1984 and beyond, continued support for water management studies, demonstrations and training at the central and State levels will be complemented by long-term assistance to a limited number of states to establish "model systems" and build up the overall capabilities of their Irrigation Departments and related agencies. With more efficient model systems in place and operating under diverse conditions, and irrigation institutions with enhanced technical and management capabilities, USAID would expect that India could be reaping the gains of greater irrigation efficiencies on a broad scale by the end of the 1980's.

3. Agriculture and Irrigation in Maharashtra

Agriculture in Maharashtra is subjected to wide variation

[11/] Op. Cit.

in annual rainfall throughout the state and, more importantly, uneven distribution during the year. Annual rainfall varies from about 1750 mm (70 in.) on the eastern plateau to 500 mm (20 in.) in the central drought prone region and to more than 4,000 mm (160 in.) west of the Sahyadri range along the western coast. The monsoon rains, which supply 90-95 percent of the annual precipitation, nearly all fall between June and October (kharif season). Because of the uneven annual distribution of rainfall, all of the unirrigated agricultural land suffers from severe water scarcity during the rabi (November to February) and summer (March to May) seasons.

Maharashtra has about 18.3 million hectares of land available for cropping (net cropped area)12/. Of this, the foodgrains sorghum, rice, wheat and pulses occupy 6.4, 1.5, 1.1 and 2.8 million hectares respectively, a total of 11.8 million hectares which produces about 9.3 million tons. Cotton, groundnut and sugarcane together cover nearly 3.5 million hectares. A wide variety of minor crops, including oilseeds, jute, condiments, spices, vegetables and potatoes supplement traditional farming preferences. Maharashtra accounts for the following proportion of the country's total production of various crops: sorghum 43.1%; cotton 16.3%; sugarcane 14.9%; millet 11.6%; groundnut 9.9%; rice 4.4%; wheat 3.9%; and gram 2.6%.

Nearly 84 percent of the geographical area of the state is covered by vertisols, more commonly referred to as black cotton soils (see Volume II Chapter 6, Agriculture). These soils range from very deep to shallow and contain high amounts of expanding clay. Vertisols exhibit shrink and swell characteristics, low permeabilities and high water holding capacities which often cause poor stability and drainage problems. Special management considerations are important in designing tillage, engineering, drainage and crop water requirements.

In many areas, the land is left fallow during the rainy season due to tillage difficulties or flooding. In some cases it is left fallow in an attempt to conserve soil moisture reserves accumulated during the rainy season for use during the rabi season. Soil management limitations, inherent rainfall patterns and lagging development of irrigation account for the low cropping intensity in Maharashtra (107 percent)

Even including irrigated crops, average yields of foodgrains in Maharashtra are less than 0.8 tons per hectare.

12/ "Net Cropped Area" means actual land area cropped at least once per year. Gross cropped area refers to the area cropped each year. One hectare planted twice in a year would represent a net cropped area of one hectare and a gross cropped area of two hectares.

Improved varieties, particularly of sorghum, wheat and rice, can produce better yields under proper management, but often are limited by inadequate water. Fertilizers and other inputs are normally used only on cash crops (cotton, sugarcane and groundnut) and HYVs of foodgrains. Nearly half of the approximately 380,000 tons of fertilizer consumed in Maharashtra annually is used for irrigated crops.

In 1981 Maharashtra began improving and reorganizing its extension service with the assistance of a World Bank project totaling $33.3 million. It is being restructured to follow the Training and Visit system already adopted in several other Indian states, emphasizing increased specialized staffing, systematic farmer contacts and linkage with research institutions for training and technological transfer. Farmers will be given help and advice on proven farming practices and techniques best suited to their specific conditions. The restructuring is planned for completion in three years and will cover all districts in Maharashtra[13/]. USAID/India's Water Management and Training Project, scheduled for obligation in late FY 82 or early FY 83, will provide specialized training in water use extension. Personnel of the T&V system will be trained in water use practices and in the organization of farmers under this companion project, and will begin to apply what they have learned initially on the thirteen prototypes.

Only about 2.3 million hectares or 11 percent of Maharashtra's gross cropped area of 20 million hectares has access to irrigation facilities compared to about 31 percent for India overall. Approximately half of the present irrigated area is served by wells, nearly all of them small dug wells overlying hard rock, serving one to two hectares each. Ultimate irrigation potential for Maharashtra has been estimated at 7.06 million hectares, including 1.8 million hectares from groundwater. Increased irrigation efficiencies, the principal objective of this project, could raise this to as high as 8.9 million hectares.

Irrigation is needed throughout the entire state, even in areas that are not drought prone because virtually all of the rain occurs during the June - September monsoon period. Major projects are confined primarily to the larger river basins. Medium and minor irrigation is directed toward smaller and generally higher watersheds.

[13/] Maharashtra Agricultural Extension Project, World Bank Staff Appraisal Report 3299-IN. See discussion in Vol. 2, Chapter 6, Agriculture.

With three growing seasons, the cropping intensity could theoretically be 300 percent if water were available. Much of the culturable land is left fallow during the monsoon because of difficulties of cultivation or risk of crop failure. Irrigation provides almost the sole opportunity to provide for multiple cropping. Yields under irrigation now range from 2 to 2.5 times those for rainfed. With greater use of improved agricultural technology, this could easily be doubled again, to five times the yields for rainfed crops. Four proposed subprojects analyzed show that average net farm incomes per hectare in command areas will be increased by irrigation from 2.5 to 5.5 fold. Full conjunctive development of groundwater could further increase net incomes by 25 to 60 percent.

During the past three decades about 1.06 million hectares of new irrigated potential have been added in Maharashtra at a cost of Rs.8.3 billion ($922 million at Rs.9/$1) through public development of major and minor irrigation with 20 major and 111 medium projects fully completed or under partial service up to June 30, 1980. Maharashtra currently has 49 major, 125 medium and 439 minor projects under construction, which will add approximately another 1.2 million hectares. Estimated cost to complete is Rs. 18.5 billion ($2.0 billion) with Rs. 2.8 billion ($310 million) for medium projects. The Sixth Plan targets Rs. 13 billion ($1.3 billion) to these activities of which Rs. 2 billion ($220 million) is planned for medium projects. This investment would add a further 600,000 hectares to the irrigation potential.

In 1974-75 Maharashtra adopted regional planning at the district level, placing a substantial share of the state's resources, including financing of medium irrigation schemes, under the purview of District Planning and Development Councils. Final decision regarding the allocation of funds is reserved to the state. The tendency has been to start too many new schemes, resulting in inadequate funding to complete projects on time. Under this project, Maharashtra will reserve the required funding to complete all qualifying subprojects. An important benefit of the project will be to insulate the annual funding of subprojects from budgetary competition, thus insuring financing for their timely completion. This will enable project benefits to begin accruing on time, and thus realization of acceptable economic rates of return.

4. Other Donor Activities in Maharashtra

The only other donor presently involved in large-scale irrigated agriculture in Maharashtra is the World Bank, which has two active loans totalling $280 million. These finance primarily the construction of major irrigation projects, and the modernization of existing major projects.

The International Fund for Agricultural Development is collaborating with the World Bank by supporting one major project, i.e., Bhim Irrigation Project, within the framework of the Bank's project. IFAD is providing a loan of $50 million for this activity. Implementation is handled through the Bank. Bank and IFAD-financed schemes will result in bringing 620,000 hectares under irrigation through MCIP-II (including BHIMA).

The Bank's projects focus primarily on the construction of major irrigation structures and facilities, construction or modernization of roads in the command areas of the major irrigation projects being financed, provision of buildings, vehicles and equipment. Financing is also provided for strengthening of command area development authorities in project areas. The training and special studies planned under the AID project, although directed primarily toward the thirteen medium irrigation projects to be undertaken as prototypes, will very likely have beneficial impact upon the Bank's projects as well, thereby further enhancing the dissemination and use of project technology in Maharashtra.

The Bank is also providing financial support under its Maharashtra Irrigation Projects for the Water and Land Management Institute located near Aurangabad. USAID regards this Institute as an important first step in developing a training program concerned with water management. However, its current focus is on training of Irrigation Department officials who are more concerned with the planning, design and construction of the irrigation system above the public outlet rather than with water management in its strict sense. The Institute has requested AID assistance to improve its capacity to train technicians and extension personnel in on-farm water management. Substantial strengthening of its water management capabilities is being considered under the proposed Water Management and Training Project. USAID plans, under the proposed project, to send staff members from the Irrigation and Agriculture Departments to the Institute. See Section III.D.1.b. below.

USAID/India has worked closely with the Bank throughout the preparation of this project, and both donors intend to continue close relationships throughout the lives of our respective irrigation efforts to assure maximum possible impact, spread and use of newly developed or introduced technology. For example, USAID has requested the services of Dr. Gilbert Corey of the World Bank's New Delhi office to help prepare the Water Management and Training Project.

5. Implications for Project Design

Given the AID strategy discussed in Section III.C.2, the status of agriculture and irrigation in Maharashtra and the World Bank involvement there, it is clear that medium irrigation in Maharashtra provides a major opportunity for improvements in surface irrigation efficiency. Crop yields under irrigation are low by Indian standards. Maharashtra is particularly dependent on surface irrigation and has developed less than 40% of its irrigation potential, as compared with the all-India average of slightly over 50%. AID's thirteen prototypes will serve as laboratories to help the Government of Maharashtra develop the institutional capacity, design and construction standards, monitoring procedures, and the necessary orientation emphasizing the end-users required to increase the efficiency of its irrigation facilities. This will serve to influence the design of approx. 150 medium irrigation projects currently under development in Maharashtra, as well as the numerous major and minor irrigation schemes planned or under construction. This project also provides an opportunity to work with the Water and Land Management Institute which is the first such state-level institute in India (and a possible prototype for other institutes to be supported under the proposed Water Management and Training project).

As noted above, the AID strategy supports Indian efforts to improve irrigation efficiencies through better design of the main system, fuller development of the lower end of the system, improved system management, and more comprehensive support for high-yield crop production. With respect to the main system, this project emphasizes the use of improved economic criteria, timely completion, the application of higher technical design standards, and canal lining on various soils based on economic criteria (see criteria 1-9 in Section III.D.2 below). In addition to in-country and U.S. training, approximately ten special studies will be supported. For example, hydrological climatological studies, investigations of seepage loss rates at various levels of the system and studies of the economics of various construction and design alternatives will be undertaken.

With respect to the lower end of the system, the Irrigation Department will take responsibility for extension of the system of field channels down to the individual farm as well as construction of a complete drainage system (see criteria 8-10). The project will place particular emphasis on conjunctive use of groundwater (criterion 11). As mentioned earlier, the availability of water in surface irrigation systems can be substantilly augmented with groundwater. Conjunctive use can increase the cropping intensity on a medium irrigation project's command area by up to 30% annually, while at the same

time balancing the average annual recharge and preventing significant waterlogging problems. The use of groundwater can permit the growing of perennials and hot weather cash crops. Therefore, there is a direct benefit especially in terms of farmers' household cash incomes. The use of groundwater increases the reliability of the irrigation system because groundwater is usually available even when surface water is in short supply. The conjunctive use of these two sources of water depends on the nature of the aquifer in much of Maharashtra. Each well producing groundwater for irrigation can yield on the average enough for only one or two hectares, in contrast to wells in the deep alluvium in the gangetic plains, the Punjab and elsewhere, which can provide up to 100 times as much. Thus each well can only be a relatively small unit, supplementing only one or two farmers' requirements. Because of this, groundwater pumps and wells usually are best obtained, owned and operated privately, by individual farmers, in contrast to surface systems which have historically been publicly financed and administered. Expanding the exploitation of groundwater thus requires extensive education as to its benefits and limitations, improved marketing and availability of appropriately designed and sized equipment, ready access to credit, spare parts, maintenance facilities and a suitable source of energy for pumps. The Irrigation Department will support the expansion of conjunctive use through groundwater utilization and balance studies.

Regarding overall system management, the system technical standards are designed to provide the physical capability for full establishment of rotational water supply. The Irrigation Department will establish a rotational water distribution system on all projects, and will carefully monitor progress (criterion 12). Special water management studies will assist the Irrigation Department in identifying problems and assessing alternatives. Training in management issues related to rotational water supply will be heavily stressed. Diagnostic analyses techniques will be applied initially on existing MIPs, and subsequently on each of the thirteen prototypes using the resources of the Water Management Synthesis II Project. This approach, using Colorado State University and Cornell University to conduct specialized studies of actual systems and real constraints to effective operation and management, will help define the most appropriate ways to organize farmers.

Regarding the problem of low utilization of irrigation, the preferred approach of the Government of India for major irrigation projects, as discussed above, has been the establishment of Command Area Development Authorities (CADA). To date, however, CADAs have not been considered for medium irrigation projects. We understand that a proposal is currently under review to establish CADAs on the thirteen medium prototypes being financed under this project. Even if this is

not approved, however, most of the essential elements addressed by CADAs in major irrigation projects are already being provided in other ways in the proposed subproject prototype MIPs. For example, CAD generally focuses on bringing irrigation from the public outlet serving 40 to eight hectare blocks down to individual farmgates, and on coordinating all other inputs and services necessary for optimal crop production. Training support will be substantially broadened and will be extended to include additional agencies, particularly the Agricultural Department. The commitment by the Government of Maharashtra to construct channels all the way to farmers' fields with public financing will insure that channels are actually in place when needed[14/]. A parallel decision to initiate land development of individual farm fields within three months of beginning of construction of final elements of the distribution system will accelerate an important part of the system package which has previously lagged for years. In-service training in the layout and design of the lower portions of the distribution system using improved standards will be initiated and these features will be subjected to formalized quality control procedures. Detailed soil surveys will be required for subprojects, and programs for improving their use in irrigation designs and agricultural production will be developed and extended. Waterlogging will be monitored and corrective and preventive measures taken where needed. Improved technology for constructing, maintaining and operating watercourses and field channels including utilization of farmer organizations will be developed using field level studies on existing and new subprojects. These initiatives, together with improved coordination with the Agricultural Department and full implementation of the Training and Visit Extension System, provide adequately for the functions normally assigned to CADAs.

D. Project Elements

1. Nature and Scope of Elements to be Financed

a. Construction

The Project will finance costs incurred over the next five years in the construction of thirteen prototype MIPs in Maharashtra. Completion of these MIPs will not be attained until after the scheduled termination of the project. See Implementation Plan, Section VI.D. Two-thirds of construction costs incurred during the life of the project will be financed under the $44 million Project Loan. Participating subprojects will be nominated by GOM. Costs

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14/ G.O.M. Planning Department Resolution No. ADP 1080/222/51, Bombay, May 26, 1980.

eligible for financing will include construction of headworks and control works, canals, distributaries, watercourses and field channels to carry water to individual farmgates. Also eligible are drainage works, roads and communication systems necessary for subproject construction and operation, civil works for resettlement of reservoir oustees and such other public physical works as may be required to make the subproject system of water storage and conveyance to farm fields operate efficiently and effectively.

The level and form of farmer participation in and contribution to irrigation system construction and operation will be determined through the application of diagnostic analysis at the chak level. The GOM will arrange to provide financing for on-farm development costs, mainly in order to facilitate timely construction. However, it is expected that the farmers themselves will ultimately pay for much or all of this work, either through contribution of labor or repayment of credit extended by the state.

Another cost which will be eligible for AID-financing will be field establishment costs. These were not eligible in the original Gujarat and Rajasthan projects, but the Mission has subsequently made them eligible on the Rajasthan project. In order to manage, supervise and monitor the planning, design and construction of a medium irrigation project, the Irrigation and Agriculture Departments set up field offices at each MIP project site containing engineers, draftsmen and other pertinent technical staff. These field offices exist throughout the construction phase of the MIP and are then disbanded upon completion. The Government of Maharashtra has procedures under which it sanctions and posts staff for these field sites. Historically budget and staffing constraints result in a pace of construction requiring fifteen to twenty years for completion of a medium irrigation project. In order to minimize cost escalations due to inflation and to enable accrual of project benefits as early as possible, AID believes, and the Irrigation Department agrees, that the construction schedule can and should be shortened to five years. The principal constraint to achieving this accelerated schedule is the lack of field staff. The benefits from an adequate strength of staff will be significant. The impact of this added expense will be to raise overall costs which are eligible for AID-financing by about fifteen percent. However, the benefits will be significant. Construction will be accelerated fourfold, and on-site supervision will greatly improve construction quality. The inability to get sufficient field staff has been the principal constraint to progress in both the Gujarat and Rajasthan MIP projects.

Once a subproject has been approved, payments for such subprojects made after the beginning of Indian Fiscal Year 1982 (April 1, 1982) will be eligible for reimbursement. Subprojects that are AID-financed in any part will be completed according to agreed criteria.

The thirteen prototypes and their demonstration chaks will serve as field sites for the refinement, application and demonstration of technological innovations to be introduced and developed on three existing MIPs. They will be undertaken in all six administrative regions of the State of Maharashtra, and in all five circles (administrative zones) of the Irrigation Department. At least one will be in each of the important agroclimatic zones in the state, except for high rainfall areas. Among the thirteen, all major topographical, soil and rainfall patterns, especially droughtprone areas, will be covered; as well as all major tribal and ethnic groups. Technical personnel from each of the administrative zones will be directly involved, through training, and, more importantly, through direct participation in collaborating with Indian and U.S. specialists provided through the project. Thus, the potential benefits of the project will spread far beyond the thirteen prototype systems to all irrigation activities in the state.

b. Training

The project will grant-finance 100 percent of the costs of in-country and U.S. training including international travel and offshore training costs such as consulting assistance and imported equipment. Training planned can be categorized roughly as follows:

i. In-country, in-service training:

Short courses, workshops and seminars will be provided for project design officers and for field technicians in land development including watercourse and field channel design and such fields as in conjunctive water use. (a) With respect to land development, approximately 45 officers from the Soil Conservation Unit of the Agricultural Department will be trained at the Water and Land Management Institute and the two soil conservation centers in Maharashtra with consulting assistance as needed. (b) Training in conjunctive water use will be provided for approximately 30 mid-level Irrigation Department officers at the Irrigation Department's Staff Training Institute at Nasik. The training will be undertaken by officers who will have participated in short-term U.S. training in the same disciplines (described below). In addition, workshops will be set up in conjunction with the field studies in order to disseminate their findings on improved technology. These workshops will be for the benefit of

both Agriculture Department and Irrigation Department officers. Substantially more training will be provided not only for personnel of Maharashtra but also for other states and the center under the Water Management and Training Project and through Water Management Synthesis II.

ii. Short-term U.S. training:

Short-term training of technicians, engineers, economists and agronomists responsible for investigation, design, construction, evaluation and operation of irrigation systems will be provided. Approximately 30 Agricultural and Irrigation Department personnel may be sent to the United States for short courses in such fields as conjunctive groundwater development, drainage engineering and agricultural water management. These are fields in which U.S. technology is advanced, and training courses readily available.

iii. Long-term U.S. training:

This component includes $1.04 million for twelve months of highly specialized training in the United States for 30 specialists in water resource systems analysis and management, simulation modeling, information systems and water resource economics for the Narmada River Basin Development Program. The Narmada is India's largest westward-flowing river and because of long-standing disputes between the riparian states, it remains relatively undeveloped. These disputes have now been resolved, thereby opening the way for development. The individuals to be trained are assigned to the Narmada Control Authority, a newly established entity responsible for coordinating development. Thirty major projects in irrigation, flood control and power generation are planned. These undertakings will irrigate five million hectares in Gujarat and Madhya Pradesh, generate 3,000 MW of power for these two states as well as for Rajasthan and Maharashtra, and moderate the widely fluctuating water flow at the river's lower end, thereby controlling flooding in Gujarat. The World Bank is planning to support this major effort, the total cost of which is estimated at over two billion dollars.

During the past eighteen months, GOI officials have discussed assistance in developing systems capability for Narmada with USAID. The concept of U.S. assistance was endorsed by the Indo-US Joint Subcommission on Agriculture in September, 1980, and was included in the PID for the Maharashtra Medium Irrigation Project in January, 1981.

This training is proposed to be supported under the Maharashtra Irrigation Technology and Management project instead of

under the Water Management and Training project or the Madhya Pradesh Minor Irrigation project for the following reasons. The more practical one is that timing is urgent. Planning of individual projects by the four participating states is underway, and the Narmada Control Authority needs to bring all together as integral components of one major system. Fiscal year 1982 funding is therefore important to bring systems analysis capability into full operation in the Authority.

The activity is fully consistent with USAID's irrigation strategy, and could therefore be funded under almost any part of the mission's irrigation portfolio. It is in AID's interests to contribute to this important effort at the very beginning, and thus to become involved at the outset. At a relatively modest cost, AID can support and participate in technology development and transfer that will have a profound impact on an immense irrigation infrastructure program.

As discussed in Section III.C.2., AID does not intend to provide direct support for major irrigation projects per se because our leverage is greater with the smaller medium and minor projects, and the potential for improvement is great. However, this training represents a unique opportunity to exert a very beneficial and influential impact on the design of the largest project in India and one of the largest currently planned in the world. The systems analysis and design capabilities which will be applied to Narmada will contribute to its being soundly designed in the first instance. These skills will then be transferable to all other projects undertaken in India from henceforth, regardless of size. We have an unprecedented opportunity to influence the technology of this project, and therefore believe we should respond positively to the GOI's request for assistance.

c. Special Studies

A number of specific problem areas have become apparent during the implementation of existing irrigation projects in AID's portfolio, and in discussions with irrigation officials of the Government and of various states. Consequently, the project will finance special studies directed to these problem areas. Examples of the types of concerns which may be addressed include:

1. Determination of seepage loss rates for design.
2. Agricultural water management.
3. Groundwater utilization and balance studies.
4. Utilization of ICAR/ICRISAT kharif cropping techniques on MIPs.

5. Reason for apparent low utilization of kharif potential and its improvement.
6. Hydrological/climatological studies on selected subprojects.
7. Labor utilization and economic prices and costs for MIP construction.
8. Economic analysis of technological alternatives in MIP design, construction and operation.
9. Improved use of soil surveys in MIP planning and agricultural production under irrigation.
10. Socio-economic baseline surveys.

In addition, the demonstration chak in each MIP will be the subject of a special study beginning with baseline surveys, continuing through monitoring of the design and construction process, and culminating with an evaluation of the impact of the functioning irrigation system upon farmer income and productivity. The extent and nature of farmer involvement throughout the building and operation of the chak will be of special interest throughout implementation of the project.

The various recommendations resulting from these studies will be tested on a pilot basis on three existing MIPs. It is anticipated that the initial recommendations could begin to be tested during the second year of the project and continue to be evaluated and refined throughout the remaining project period. Based on results of the pilot studies, the most promising approaches will be implemented on qualifying projects during the remaining period of the project agreement.

d. Resident Project Coordinator

A substantial joint effort in development and transfer of irrigation and water management technology will be undertaken with this project. On the U.S. side, a large number of individual actions in implementing training and collaboration will be required. It is important that these efforts draw on the best available resources and that they be carried out in timely, businesslike fashion. To insure this will require the investment of a considerable amount of staff work identifying resources, making arrangements for acquiring them and organizing logistics. Responsible staff must be fully aware of available resources, must have a solid technological understanding of the program and must have time dedicated to the tasks, i.e. not be divertable to other responsibilities. Neither Maharashtra/ID, CWC, nor USAID's staffing constraints will permit meeting these staff requirements with current regular staff.

These coordinative services will therefore be procured with A.I.D. grant financing, utilizing the services of a fully-qualified U.S. institution, possibly through a Title XII arrangement. The U.S. institution will provide two years residence in India for one or two representatives who will be fully qualified in water management and irrigation technology. Similar coordinative resident services will also be required under the Water Management and Training and Madhya Pradesh Minor Irrigation Projects. It is anticipated that the same institutional arrangement will be developed to cover all three projects; thus, during the five year life of this project, the resident coordinators will serve an average of 40 percent of his or their time on this project. The share would be larger during the first part of the project because of the concentration of training needs, and planning needs for implementing special field studies during that portion of the project life.

The coordinators will be fully responsible for the quality of the services provided. Details in each case will be worked out directly with GOM/ID and the concerned U.S. and international personnel and institutions in liaison with USAID and CWC. The coordinators will be expected to remain fully cognizant of progress, activities and problems with the training and technical assistance components of the project. They will maintain liaison with USAID and with the Water and Land Management Institute at Aurangabad and other institutes strengthened under the Water Management and Training Project whenever appropriate for technical assistance and for assistance in monitoring and evaluation. Supervision of the coordinators will not be by USAID or USAID staff but directly by CWC and GOM/ID as set forth in its agreement with GOI/AID.

2. Summary of Criteria and Conditions for Subprojects

Individual subprojects (MIPs) will be designed by the Irrigation and Agricultural Departments of the Government of Maharashtra. The Central Water Commission (CWC) will appraise subprojects nominated by the State Government for compliance with project criteria.

The criteria and conditions which are planned to be applied to each subproject are:

(1) an economic rate of return of 12 percent or more, or 10 percent or more in tribal or drought prone areas: (2) all standard engineering design and cost estimating criteria of CWC and GOM/ID must be met; (3) construction of major works and conveyance systems must be completed within five years after initiation; field channels must be completed within the sixth year; land development on individual field must be completed not later than the seventh year; (4) water

supply design must be based on at least a twenty-year reservoir operations study, with water requirements calculated by fortnightly estimates of evapotranspiration and a water delivery budget based on best estimates of seepage and other conveyance losses; (5) conveyance channels must be adequately designed and regulated to permit full delivery to all outlets when the main system is operating with flows at 50 percent of full capacity; all canals must be adequately protected by cross drainage structures and escapes with gated controls at divisions and branch points and must be provided with gates and measuring devices so that flow can be fully controlled and measured in all reaches at all times; (6) main and branch canals are to be selectively lined based on economic criteria; (7) delivery systems must be capable of delivering streams of approximately 28 liters per second (one cusec) to gated outlets serving areas of approximately eight hectares on a rotational basis; (8) fully integrated surveys and designs must be undertaken for watercourses and field channels, minors and distributaries with at least o.15 m service head available at outlets to watercourses, field service channels and commanded fields; watercourses and field channels with division boxes must be included where streams are divided and with check structure and gated outlets to fields and branches; (9) there must be monitored quality control of watercourse and field channel design and construction; (10) complete surface drainage system must be planned and constructed; (11) plans for promoting conjunctive use of groundwater must be developed, including preparation of credit packages; (12) rotational water distribution (Shejpali) system must be established on all projects; (13) completion of detailed soil survey and land capability classification must be not later than two years after initiation of construction; (14) qualified personnel must be made available by Government of Maharashtra to undertake all planning design, and supervisory activities; (15) provisions must be made for an administrative entity and adequate staff to coordinate and assist in carrying out the special studies and training activities; (16) a demonstration chak must be planned shortly after approval of each prototype MIP for operation as soon as water is available; and (17) farmer involvement must be engaged to the maximum extent feasible.

IV. Summary Project Analyses

A. Economic Analysis

Under this project an Appraisal Committee will be formed within the Central Water Commission of the Ministry of Irrigation, New Delhi. Among other things, the Appraisal Committee will review each proposed subproject prototype MIP for economic viability, using analytical procedures set forth in the Economic Analysis (Volume II, Chapter 1). In order to be approved for financing under this project, each proposed MIP must yield an economic internal rate of return of 12 percent or more, except in the case of MIPs in tribal or drought prone areas, where the standard has been reduced to 10 percent. Accordingly, AID is assured that only economically viable MIP proposals will be approved for financing. AID will participate in the CWC appraisal process, and thus will be able to monitor the application of these economic criteria.

Construction costs average between Rs.18,000 and Rs.20,000 per hectare, i.e., between $2000 and $2200 per hectare. Operation and maintenance costs will average Rs.100 to Rs.200 ($11 to $22) per hectare per year thereafter. With an average farm size of 3.7 hectares, and average family size of 5.7, initial costs work out to about $1400 per capita. This figure includes not only those costs financed by AID, but also those covered by the Irrigation and Agriculture Departments of the Government of Maharashtra. These costs are higher, and the EIRR lower, than they might otherwise be because of the extensive rather than intensive nature of the MIPs. They are designed to maximize the number of beneficiaries rather than to exploit fully the productive potential of a smaller command area. Even so, each newly irrigated hectare will yield between two and three additional tons of foodgrains each year; depending upon the types of crops grown, this will range in value from $500 to $1,000 per hectare, every year. With proper maintenance, this incremental production should continue indefinitely; many irrigation systems in India are well over 100 years old and still functioning. Therefore it is clear that surface irrigation projects, including those designed to be extensive rather than intensive, are highly economic.

Furthermore, the technological and managerial innovations which will be developed and introduced under this project will be applied not only to the thirteen prototypes, but also to all other irrigation systems throughout the state. Therefore the gains in production attributable to this project will extend far beyond the thirteen subproject MIPs to all surface irrigation systems in Maharashtra.

B. Financial Analysis

1. Financial Effect on Project Participants

The principal participants with which this analysis is concerned are the small farm operators within an MIP command area. Operated properly, an MIP will increase the reliability of the water supplied for crop irrigation, and thus reduce the risks inherent in farming. In addition, full utilization of increased availability of water will raise both the expenditures and incomes accruing to the farmer. The comparative statements presented below compare the incomes and expenditures of a typical two hectare farmer with and without irrigation; the crops hypothetically shown are typical of the types and mixes grown by small farmers in Maharashtra, and the prices and other variables are based on 1981 data. Income and expenditure figures for a farm family without irrigation assume a cropping intensity of 100 percent. This is overstated somewhat. Figures for a farm family with irrigation assume a cropping intensity of 160 percent; this is below the current national average for irrigated agriculture (170 percent). Taken together, the use of these "with" and "without" cropping intensities causes the calculation of net additional farm income to be conservative.

Table 2 Comparisons of Income & Expenditures for a Two Hectare Farm Family with and without Irrigation (area in hectares; output in quintals; income/expenditure in rupees)

I. Income

Crop		Without Irrigation Area	Output	G.Income[15] Rs.	Without Irrigation Area	Output	G.Income[15] Rs.
Kharif:	Sorghum	0.5	3	435			
	Millet	0.5	2	255			
	Fodder	0.5	100	1000	0.2	60	600
	Paddy				1.0	35	6374
Rabi:	Wheat	0.5	3	350	1.0	25	3850
	Fodder				0.5	175	1750
Perennial:	Sugarcane				0.5	320	5120
				2040			17694

[15] Includes value of byproducts.

II. Expenditure

	Without Irrigation Area Output G.Income	Without Irrigation Area Output G.Income
Seed	120	2097
Fertilizer		1200
Water Charges		1600
Others[16]	650	4200
	770	9097

III. Net Income

Without Irrigation	1270	
With Irrigation		8597

The analysis suggests that a two hectare farmer, by increasing his cropping intensity only 60 percent and adding some cash crops to his annual mix of plantings, can increase his net income almost seven fold, from Rs.1270 ($141) to Rs.8600 ($960). Considering that this increase is conservative, and that it is accompanied by improvement in the reliability of water supplies and thus a reduction in his risks, it is clear that the introduction of surface irrigation is highly beneficial to small farmers. In addition, a significant portion of the currently unemployed rural labor force can be employed due to increased agricultural production.

2. Financial Effect on Implementing Agency

The Irrigation Department of the Government of Maharashtra receives an allocation of funds annually under the Five Year Plan of the Government of India for the construction of irrigation facilities. As a matter of policy capital costs are not recovered from users; however, Maharashtra does seek to recover annual recurring costs for operation and maintenance through water charges. At present these charges are sufficient to cover O&M costs. Water charges are reviewed regularly and adjusted when necessary. The most recent rise in charges was in 1980. Maharashtra's water charges are considered to be some of the highest in India. AID supports the policy of covering recurrent costs through user charges. The charges are set for each crop on the basis of its value and its relative demand for water. The set of water charges in effect as of January, 1982 is as follows:

[16] Includes costs of labor, land revenue and interest.

Table 3

Water Rates Charged on Flow Irrigation Schemes (Major, Medium and Minor Irrigation) Works

Name of Crop of Season	Water Rates per Hectare Rs.	Per Acre $
1. Sugar Cane and Plantains	750.00	33
2. Other Perennials	500.00	22
3. Kharif Seasonal Crops	50.00	2
4. Rabi Seasonal Crops	75.00	3
5. Hot Weather Seasonals	150.00	7
6. Hybrid Commercial Crops:	50.00	2
a) Kharif Crops	50.00	2
b) Rabi Crops	75.00	3
7. Hybrid Seed and Foundation Crops:		
a) Kharif Season	100.00	4
b) Rabi Season	150.00	7
8. Hot Weather Cotton (Water supply from March 1st)	400.00	18
9. Hot Weather Groundnut	300.00	13
10. Hot Weather Paddy	150.00	7
11. Pre-seasonal watering	75.00	3
12. Post Seasonal Watering to Kharif Crops in Rabi Season	20.00	1
13. Post Seasonal Watering to Rabi Crops on Hot Weather Season	25.00	1

Using the cropping pattern for Karwappa Nalla, a typical MIP in Maharashtra, USAID calculated that on the average an irrigated hectare will yield water charges of Rs.217.50 ($24) per year at current cropping intensities. This figure will of course rise as cropping intensities rise.

Table 4

Calculation of Average Water Charge
Per Hectare for Karwappa Nalla MIP

Cropping Pattern Crops	% Area	Water Charges ha Rs.	Composite Revenue Per ha Rs.
Sugarcane	9	750	67.5
Other Perennials	1	500	5.0
Chillies	10	500	50.0
Turmeric	5	500	25.0
Paddy (Kharif)	45	50	22.5
Sorghum	5	50	2.5
Gram (Rabi)	25	75	8.75
Sorghum (Rabi)	15	75	11.25
Wheat	20	75	15.00
Total Cropping Intensity:	135	Average Charge per hectare:	217.50

The costs of operation and maintenance have been running between Rs.50 ($5.50) and Rs.100 ($11) per hectare per year; therefore water charges currently are adequate to cover these expenses. USAID and GOM/ID will monitor O&M costs and will review periodically whether water charges should be adjusted.

C. Social Soundness Analyses

The Governments of both India and Maharashtra are increasingly concerned about low rates of utilization of irrigation systems, and they are looking more and more closely at the social factors involved. This is a significant departure from traditional practices, which have been to focus almost exclusively on engineering and design, primarily of the upper end of irrigation systems where the technical aspects -- e.g. design of reservoir and dam and main canals -- are more interesting.

Some of the social factors to be addressed during implementation of this project are discussed briefly below. We believe that

growing appreciation of the importance of these factors will lead to their being examined not only for the prototypes undertaken under this project, but also for all other irrigation efforts.

1. Beneficiary Participation

Farmers have generally not been consulted before or during construction of surface irrigation projects in India. Nor have they had to commit personal resources to their systems. Rather, they have participated only as users, and only after irrigation water has begun to flow. This pattern is hard to change, but there is growing recognition in India that farmer participation is crucial to the efficient use of irrigation systems. Therefore, farmer participation is an important element of the project, both in terms of special studies and in terms of testing and demonstrating various methods to encourage participation, and organizational patterns to structure it.

Workshops in the design of chaks and water management studies to be financed under the project will begin shortly after obligation of the project. Existing, functioning MIPs in Maharashtra will be used for study purposes. The activities will be targeted to personnel of the GOM who will be assigned to field establishment offices at each of the prototype MIPs, including both Irrigation Department personnel as well as Agriculture Extension Officers who are responsible for direct farmer contacts. The field workshops will focus not only on optimum layout of watercourses, but also, and more importantly, on how to engage the participation of the prospective beneficiaries in this process. It is essential that farmers be satisfied with the location of water outlets, and that they have a sense of proprietorship over the system. This requires their active participation from the outset in the design, construction and operation of the system. The core activity of the workshops will involve on-the-ground examinations of existing systems. This will help to highlight mistakes made in the past, and how they affect efficiencies in the operation of irrigation systems.

These workshops and studies will be initiated in the first project year. After the first batch of three prototype MIPs has been approved and construction initiated, participants in the workshops will be assigned to the field establishment to apply what they have learned to the new MIPs. This new cadre will include an interdisciplinary mix of skills including farmer extension and irrigated technology. At least one demonstration chak will be designed, constructed and operated in each prototype, as soon as possible after construction has begun. The field establishment personnel, in consultation with their parent Agriculture and Irrigation Departments, CWC and USAID, will identify potential demonstration chaks in areas

where water can be delivered as soon as the reservoir and main canal is operational. They will involve the prospective beneficiaries in the initial design of the chak, in the establishment of farmers' organizations for the operation and maintenance of the chaks and will work out the beneficiaries' contribution to construction and operation of the chak. Contributions can be in the form of labor and/or water charges.

When the demonstration chak has been set up, organizations established and contributions identified, and when water delivery begins, the field establishment personnel will remain at site to assure continued efficient operation, to work out any unforeseen difficulties, and to encourage the demonstration of the chak to all other prospective beneficiaries within the MIP command area.

Additional chaks will be designed similarly, applying what has been learned not only in the initial workshops but also with the experience gained in setting up the demonstration chaks.

This process will be repeated in each of the thirteen prototype MIPs.

The longer term aspect of participation - operation and maintenance - will be the topic of a special study of pilot farmer water use organization. This study will result in recommendations to the Government of Maharashtra on which models of farmer organizations have the greatest potential for effectively harnessing the talents and energies of beneficiary farmers for optimizing the use of irrigation systems. The study's findings will likewise be applied to the demonstration chaks, refined as experience is gained, and spread as additional chaks become operational.

2. Benefit Distribution

There are many factors which influence the distribution of irrigation benefits to farmers within the command area of a MIP. For example, the size and location of individual farms, the conveyance losses sustained by the system enroute to each farm, the behavior and influence of other users, especially those "upstream", or closer to the water source, and water allocation practices are all important variables, affecting the availability of water to individual farms. These factors will be addressed in several ways. First, each system will be constructed to bring water directly to each farm rather than leaving distribution at the "tailend" to whatever ad hoc arrangements can be worked out, as has been past practice. This is expected particularly to help the interests of small farmers for whom the burden of unreliable water supply is the greatest. Extension services in all

districts in Maharashtra are being reorganized under the Training and Visit system with World Bank assistance. This will be accomplished throughout the state, including the 13 prototypes, well before they become operational. The T&V system is an effective vehicle for motivating farmers and for transferring technological messages for crop production. An appraisal team for the World Bank-financed Maharashtra Irrigation II project assessed the availability and distribution mechanisms for agricultural inputs. They were found to be satisfactory. Therefore, inputs are not expected to be a constraint for this project.

3. Water Allocation Practices

The reliability of irrigation systems and water allocation practices directly influence whether a farmer obtains water at the time and in the quantity required to achieve the greater yields for which he has invested. A farmer will understandably be reluctant to purchase expensive HYV seeds, fertilizer, pesticides, etc., if he is not confident that irrigation water will be available when needed. A study of the Shejpali system of water allocation used in Maharashtra will be financed as part of the project to understand how water allocation factors interact to affect the response of farmers to the availability of water. The study will help shape decisions on whether improvements in the distribution system could more equitably distribute benefits among irrigators. For example, eligibility requirements for water applications, which are part of a complex system used to sanction crops for irrigation, would be one aspect of the study. The block system which guarantees water supplies to perennial crops for a fixed period (generally 6-12 years) to an area would also be studied. Since the block and area basis system permits a small group of farmers to pre-empt a large share of water and benefits, the study will address alternative methods of allocating water.

4. Employment Effects

Agricultural employment will increase by 32,000 work years annually through the need for increased farm labor for irrigated agriculture. Landless laborers, who constitute 30 percent of the male rural labor force and 56 percent of the female labor force in Maharashtra, will directly benefit from construction of the irrigation system. A total of approximately 104,000 person years of construction employment will be created during the life of the project. The GOM is committed to labor-intensive construction techniques of which one essential element since 1974 has been the Employment Guarantee Scheme. This program creates productive employment for the rural poor who cannot otherwise find work.

5. MIP Effects on Tribals and Scheduled Castes

Scheduled Castes and Scheduled Tribes constitute about one-eighth of the Maharashtra population. Special provisions have been made to (1) identity Scheduled Castes and Tribes within the command area of the subprojects during initial baseline surveys and assess the impact of irrigation on these groups and (2) reduce the economic rate of return criterion from 12 to 10 percent on subprojects that include at least 50 percent Scheduled Castes or Tribes. This will assure that benefits of irrigation are provided as well to these minorities even though they are generally located on less productive and less accessible land.

6. Effects on Women

In India, women do most of the tasks in agriculture (e.g., sowing, transplanting, weeding and harvesting) and in related occupations such as animal husbandry, poultry, fisheries, processing of food products, post-harvest operations and storage of foods. Almost half of all agricultural laborers in Maharashtra are women. Thus, one immediate effect of MIPs on women will be the increased opportunity for employment. Approximately half of the additional women employed are expected to be from landless households. For resettlement, arrangements will be explored for implementing the Sixth Five-Year Plan recommendation to give joint titles to the husband and wife in the transfer of lands and housesites. This will contribute to improving the economic status of women by reducing their dependence upon their husbands.

7. Reservoir Displacement and Land Acquisiton

The resettlement of displaced people for the AID-financed subprojects will take place under the provision of the comprehensive legislation enacted in 1976, the "Maharashtra Resettlement of Projects Displaced Persons Act". No data is available to assess how effectively this act has been implemented; however, a USAID appraisal team for Maharashtra found during informal discussions with resettled farmers that they were generally satisfied with the provisions of the act. USAID will monitor on a selective basis the adequacy of resettlement arrangements. Selected villages designated for resettlement will be included as part of the baseline studies. This will provide the means to assess how different categories of people are affected by resettlement.

The GOM realizes that "pockets of prosperity exist where irrigation facilities are provided"[17]. The objective of a socially-

[17] Maharashtra State Irrigation Commission report, Resolution No. MRC.1063-1 (5), 30 June 1961.

sound irrigation system is to see that prosperity is as uniformly distributed as possible among all beneficiary farmers. This project will improve the efficiency of irrigation systems, including the spread of benefits and their optimal and equitable use by all beneficiaries.

D. Technical Analysis

1. Design Innovations for Prototype MIPs

MIPs proposed as prototype subprojects under this project will be designed following norms and criteria mutually developed by the Irrigation Department of the Government of Maharashtra, the Central Water Commission and AID. Briefly, these new requirements will include the following:

a. Water Supply: Reservoirs will be designed on the basis of 75 percent reliability in heavy and normal rainfall areas, and 50 percent in water scarcity areas[18]. The accuracy of water supply estimates will be enhanced through the installation of more stream gauging stations.

b. Water Budgets: Except in high rainfall zones, water supplies in MIPs are not usually allocated to hot weather seasonal crops nor to perennials. Reservoir storage will be designed for rabi and hot weather allocations with a provision to meet about 20 percent Kharif demand. Irrigation requirements at the main canal will be computed using the modified Penman formula for water requirements accounting for losses in canal system, watercourses and field channels based on soil characteristics and time of operation. Realistic estimates of conveyance and operation losses including field application efficiencies will be assumed.

c. Dams and Reservoirs: Design standards developed by the CWC and formalized as Indian standards, will be used for the design of dams, spillways and sizing of reservoir capacities taking into account the silt deposition. The watershed treatment program being undertaken by the Department of Agriculture will be extended to all the subproject to insure control and regulate flow of silt into the reservoirs. Monthly reservoir operation studies will be prepared for each subprojects using not less than 20 years of historical information in order to ascertain availability of water for the proposed cropping pattern.

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[18] This means that the system would be able to meet full or nearly full water requirements (60% or greater) for the design cropping pattern three out of four years and two out of four years respectively.

d. Canals, Distributaries, Minors: Irrigation distribution network will be designed and operated so that water can be delivered equitably at any point within the distribution system with minimal waste. Embankments will be properly compacted. The distribution system will be designed to deliver a stream of not less than one cusec (28.3 litres/sec) on a rotational basis to gated outlets each serving approximately 8 hectares. Canal lining and structures, especially in expansive soils, will be protected using technology developed at the Indian Institute of Technology, Bombay.

e. Watercourses, Field Channel, Land Development: GOM/ID at present uses topographic maps prepared by the Survey of India which are not sufficiently accurate for locating/planning outlet locations and layouts for watercourses, field channels and for computing earthwork requirements for land leveling. The subprojects will use maps to the scale of 1/1,250 with CI of 15 cm vertical tolerance of 15 cm between FSL and land to be controlled and for the layout purpose. For land development, including layout of field channels - 15 meter grid interval will be used. The same basic surveys and vertical control will be used for location of minors and outlets.

f. Water Allocation and Rotation: In Maharashtra, water allocation and rotation is governed by the Irrigation Act of 1976. The act is quite detailed and spells out the responsibilities of functionaries associated with water allocation, maintenance of field channels, water rates, provisions and penalties, use of irrigation water by individuals and organizations. The system of water allocation in Maharashtra through formal rotations is called "Shejpali". Based on the demand for water and sanctioned applications, a rotation is fixed for the running of distributaries, minors and outlets assuming average loss rate between distributary head to farm gate. This provides the basis for individual timings on field channels. Under the "Shejpali" system, if the irrigation supply is interrupted, the individual irrigators do not miss their turn; it is only delayed. The existing system of water allocation and rotation will be practiced in the subprojects. Meanwhile, studies will be conducted on the existing system of water allocation and rotation and improvements tried on pilot basis to facilitate recommendations.

Monitoring of compliance with these criteria will be a special concern of the GOM monitoring team established for the project, and will also be reviewed carefully by USAID. It is expected that a procedural manual for monitoring both the technical and organizational aspects of the project will be developed with assistance provided through the Water Management Synthesis II Project.

2. Studies and Technical Collaboration

The results of the studies to be undertaken on water losses, water management, hydro-climatology, farm organizations, improved utilization of soil surveys, alternative water allocation techniques, groundwater utilization, etc., as set forth in Volume II Chapter 4, will be used to improve and refine project design and management criteria. These will lead to improved irrigation network design including precise requirements for lining, more reliable planning and design data, development of improved cropping patterns, establishment of water users organizations, development of groundwater, improved water allocation procedures, etc. These improvements will result in efficient utilization and management of water during the project construction and operation period. The outcome of the studies will not only benefit irrigation throughout the state but also will be applicable to similar agro-climatic zones in other states.

E. Administrative Analysis

Civil engineering, especially construction and hydraulic engineering, is well developed in India. The Central Water Commission (CWC) at the National level is equipped with over 1,000 highly knowledgeable and experienced engineers. It sets design and construction standards and reviews design of all irrigation projects exceeding 2,000 hectares in area. The GOM/ID has about 9,000 engineers (2,760 graduate and post graduate) who are highly competent in the design and construction of irrigation infrastructure. The state also has a Central Design Organization (CDO) established in 1957 to guide in the design of dams, canals and other complex works requiring special design. Maharashtra Engineering Research Institute (MERI) located at Nasik possesses capabilities in hydrodynamics, soil mechanics, material testing, computer programming and environmental engineering research. In addition GOM/ID has developed a manual for quality control on major engineering works, canal structures and canal lining.

Six Soil Conservation Divisions (30 subdivisions) under the control of the Department of Agriculture assigned for land development works in medium and minor irrigation works have a capacity of developing 48,000 hectares of land area per year. Soil Conservation technicians are diploma graduates and some of them have six month in-house general soil conservation training.

The Maharashtra Ground Water Survey and Development Agency (MGWSDA) headquartered at Pune is responsible for development and utilization of the groundwater potential in the state and is adequately staffed with professionals. Quality control of construction is a major concern and will receive careful attention under this

project. Subproject proposals will be reviewed and approved by CWC for soundness and completeness of design. After such approval, a special monitoring cell will be established by CWC. This cell will, with the GOM Irrigation Department, undertake in-depth on-site quarterly reviews of progress and on quality of work. USAID will participate in these reviews. Similar monitoring systems have been set up for both the Gujarat and Rajasthan projects, and because of the experience gained on those projects, construction quality is carefully examined. Where inadequate work is found, the CWC issues directives for corrective action. This process has significantly improved construction both in Gujarat and Rajasthan, and we are confident that it will serve to maintain satisfactory construction quality in Maharashtra as well.

F. Environmental Analysis

Environmental issues were identified by a USAID Scoping Committee and documented in a Scoping Statement that was approved by AID/Washington. The Scoping Statement, which identifies issues needing further analysis as well as those that do not, is consistent with the new environmental regulations which require environmental assessments of all surface irrigation projects. The conclusions reached on each of the issues identified for study are summarized below:

i. Land Capability and Use of Vertisols. The project design team noted that there could be a significant impact on land use and cropping patterns on vertisols because of their special physical characteristics (expansion when wet and shrinkage when dry). Farmers avoid cultivating a kharif crop during the monsoon because tillage is difficult, temporary flooding reduces crop yields, and because farmers believe that sufficient moisture reserves would not be available for the rabi season. However, the team also noted that assured irrigation under controlled conditions such as those contemplated for the project will encourage farmers to plant high value rabi crops such as wheat maximizing irrigation potential with minimal adverse impact on soil conditions. The design proposed for the prototype medium irrigation systems in Maharashtra will also include provisions for kharif crops. Irrigation during the kharif season will be of importance particularly during periods of low or no rainfall. Accordingly measures will be introduced to encourage farmers to plant kharif crops. While the constraints of temporary flooding due to excessive monsoon rains may still occur, this project is not expected to exacerbate this situation. Instead, flood control is expected as a result of the construction of dams to mitigate monsoon flooding.

ii. Water Logging Salinity Alkalinity. As an integral component of the design of individual subprojects, there will be surface drainage facilities to remove excess irrigation water from farmers' fields. A number of measures such as design criteria, waterlogging surveys of medium irrigation projects, and AID-financed training in the U.S. of drainage engineers will be incorporated to mitigate the incidence and impact of waterlogging, salinity, and alkalinity of medium irrigation projects in the Maharashtra program.

iii. Conjunctive Use of Groundwater. The project proposes the introduction of groundwater irrigation in subproject command areas for several reasons. Chief among them is the added potential that can be realized from irrigation sources within command areas of surface irrigation systems. Groundwater levels in such areas are augmented by the deep percolation process traceable to reservoirs, canals, and irrigated fields. The use of conjunctive water will also aid in mitigating any unanticipated waterlogging problems. In introducing this method of complementary irrigation, care will be taken to maintain optimum water table balances through studies that are required as a part of the planning process of conjunctive irrigation.

iv. Water Losses and Canal Operations. Of special concern in the irrigation systems proposed is the problem of canal seepage losses and alternative measures to control them in the interest of attaining economic and environmental objectives. Canal lining is generally acknowledged as an acceptable technical solution in reducing seepage loss rates which in turn can mitigate the problem of waterlogging. However, lining canals in vertisol soils poses a separate problem in maintaining canal shape over time. In light of these problems, rather than line all canals, field tests will be made to determine seepage loss rates at strategic points along the canal distribution system. Data collected will serve as the basis for deciding where in the system lining is technically, economically, and environmentally feasible.

Based on the analyses of these issues and the recommended measures for minimizing their impact on the environment, the project is concluded not to have a significant adverse impact on the environment.

G. Agriculture Analysis

The State of Maharashtra comprises a geographical area of 30,770,000 ha. The state lies within the semi-arid tropics and is subjected to monsoonal rains. Annual rainfall varies from 500-4,000 mm across the state, and it largely occurs within a 60 - 90 day

period (July - September). The uneven distribution of rainfall results in water scarcity during the dry season and water run-off and erosion during the rainy season. The major river systems draining the state are the Krishna, Godavari and Tapti.

Vertisols or black cotton soils cover approximately 84 percent of Maharashtra and have a significant impact in irrigated crop production. Because of the high content of expansive clay, vertisols often crack when dry and swell when wet. High water holding capacities and low infiltration rates are typical of these soils. Soil erosion and water logging can be problems under certain conditions but can also be avoided by incorporating appropriate technology into irrigation and crop production practices. More importantly, vertisols are potentially highly productive and provide a means to increase cropping intensities especially under irrigation.

The cultivable area of Maharashtra is about 20 million ha of which about 18.3 m ha is actually cropped. The principal foodgrains are sorghum, rice, wheat and pulses. The important cash crops are cotton, groundnut and sugarcane. To meet the increasing demand for foodgrains, efforts are being directed to increasing the cropping intensity and the production output per unit of land. The distinct wet and dry seasons and the undependable monsoon rains impose major limitations, the availability of irrigation is an important key to improving agriculture in Maharashtra.

Of significance for the AID-financed subprojects is the Training and Visit system (T&V), introduced in Maharashtra in 1981 with World Bank assistance. T&V provides systematic farmer contacts and a vehicle for transferring technological messages developed by research institutions. State-wide implementation of the T&V system is planned over a 3-year period and will cover all districts in Maharashtra. This plan has been discussed with the World Bank and with the GOM to assure that T&V will be in place in the AID subproject areas. The T&V system has the capability to introduce subject matter specialists trained in water management into irrigated farming areas. USAID/India's Water Management and Training Project, scheduled for obligation in late FY 82 or early FY 83, will provide specialized training in water use extension. Personnel of the T&V system will be trained in water use practices and in the organization of farmers under this companion project, and will begin to apply what they have learned initially on the thirteen prototypes.

The GOM Agriculture Department (AD) is responsible for agricultural services covering technical extension (including the T&V system); planning, monitoring and distribution of input requirements; and soil conservation/land development works. At the local level,

these services operate through the local district and block level governments. Farmer contacts are carried out by Village Extension Workers (Gram Sevak) who are responsible to the Agricultural Extension Worker through the block and district councils. Fertilizers, pesticides and seed requirements are planned in advance of each growing season by a special district committee in cooperation with AD officials. Distribution of these inputs is done through a combination of private and public channels.

Short, medium and long-term loans are made available to farmers through cooperative credit societies and commercial banks. The amount of lending on a per unit land basis is roughly 2-3 times higher for irrigated crops (canal irrigation) than for non-irrigated. Marketing is progressive and well organized throughout the state. The marketing system is regulated by the Maharashtra Agricultural Produce Marketing Act of 1963 which provides a mechanism to establish market committees. Market committees serve village or block units and are represented by growers, traders, local and state government authorities. The Marketing Act provides funds for new market outlets in areas where crop production increases arise.

V. Cost Estimate and Financial Plan; Disbursement Procedures

A. Summary Cost Estimate and Financial Plan

The total cost to complete all thirteen prototype subproject MIPs is estimated at $191.6 million, incurred over a ten year period. AID's project is planned to cover only the initial five years of construction, when the provision of training and special studies and the technical collaboration between Indian and U.S. irrigation and water management specialists will have the greatest impact. $44 million in loan funds and $3 million in grant funds will be provided. See Table 5. After the third year of project implementation, AID and the Government of India will consider whether a follow-on project to help finance the prototypes to completion would be the best use of AID's resources. It is projected that approximately $41 million in further construction costs would be eligible for AID financing; if AID or another donor does not pick up these costs, they will have to be borne by the Irrigation Department of the Government of Maharashtra.

During the five year life of this project, AID's loan funds will be matched roughly one for one by the Irrigation Department. ID funds will be used for a one-third share of the eligible costs as well as for all ineligible costs such as purchase of land and construction equipments. In addition to the ID contributions, the Agriculture Department of the Government of Maharashtra will budget for all on-farm development works. These begin to accrue during the third project year and continue until the tenth, totaling a projected $18.4 million. See Table 6.

In addition to these initial capital costs, operation and maintenance costs will be incurred averaging about Rs.100 ($11) per irrigated hectare. These will be budgeted for by the Irrigation Department; however, the Government of Maharashtra intends to recover operation and maintenance costs from the beneficiary farmers in the form of water use charges. At present these average an estimated Rs.217.50 ($24) per hectare per crop. See details in Financial Analysis, Section IV.B. Water charges are reviewed regularly and were most recently raised in 1980. The procedure for setting rates, and the pattern of rate adjustments over the past decade have been discussed with the Government of Maharashtra and the Central Water Commission, along with the policy of fully recovering operation and maintenance costs from the users. AID concurs with this policy and foresees no difficulty in its continued achievement.

Table 5

SUMMARY COST ESTIMATE AND FINANCIAL PLAN
1982-1987
($'000)

Project Element		A. I. D.			Govt. of Maharashtra			Grand Total
		Loan	Grant	Total	GOM/ID	GOM/AD	Total	
(1)		(2)	(3)	(4)	(5)	(6)	(7)	(8)
MIP Construction								
	FX		-					
	LC	44,000.00	-	44,000.00	44,000.00	2,192.00	46,192.00	90,192.00
	T	44,000.00	-	44,000.00	44,000.00	2,192.00	46,192.00	90,192.00
Studies								
	FX	-	806.00	806.00	-	-	-	806.00
	LC	-	606.56	606.56	-	-	-	606.56
	T	-	1,412.56	1,412.56	-	-	-	1,412.56
Training								
	FX	-	19.46	19.46	-	-	-	19.46
	LC	-	55.51	55.51	-	-	-	55.51
	T	-	74.97	74.97	-	-	-	74.97
Narmada Systems Analysis								
	FX	-	1,040.10	1,040.10	-	-	-	1,040.10
	LC	-	-	-	-	-	-	-
	T	-	1,040.10	1,040.10	-	-	-	1,040.10
Liaison/ Coordination								
	FX	-	286.00	286.00	-	-	-	286.00
	LC	-	82.78	82.78	-	-	-	82.78
	T	-	368.78	368.78	-	-	-	368.78
Contingency								
	FX	-	-	-	-	-	-	-
	LC	-	103.59	103.59	-	-	-	103.59
	T	-	103.59	103.59	-	-	-	103.59
Total								
	FX	-	2,151.60	2,151.60	-	-	-	2,151.60
	LC	44,000.00	848.40	44,848.40	44,000.00	2,192.00	46,192.00	91,040.40
	T	44,000.00	3,000.00	47,000.00	44,000.00	2,192.00	46,192.00	93,192.00
Required to complete MIPs								
	FX	-	-	-	-	-	-	-
	LC	-	-	-	82,220.00	16,228.00	98,448.00	98,448.00
	T	-	-	-	82,220.00	16,228.00	98,448.00	98,448.00
TOTAL								
	FX	-	2,151.60	2,151.60	-	-	-	2,151.60
	LC	44,000.00	848.40	44,848.40	126,220.00	18,420.00	144,640.00	189,488.40
	T	44,000.00	3,000.00	47,000.00	126,220.00	18,420.00	144,640.00	191,640.00

B. Projection of Expenditures by Fiscal Year

Three subproject MIPs are scheduled to begin construction during the first year of project implementation. Five more will be started during the second year, and the final five will begin the third year. Costs during the first several years of MIP construction are the heaviest because of the large costs involved with the headworks and main canals; costs are incurred more slowly as the construction reaches the distributaries, minors, watercourses and land development works, all of which are widely scattered and relatively minor undertakings. Table 6 below projects expenditures for the construction of all thirteen subproject MIPs through the five year life of the AID project and beyond to full completion in the tenth year. The figures shown in parentheses in Column (2) for years 1987, 1988 and 1989 are costs that would be eligible for AID financing in the event a follow-on loan is approved. If a follow-on project is not obligated, these sums will have to be added to those in the corresponding rows in Column (5) to arrive at the total GOM/ID budget requirement to complete the MIPs.

C. Details of Grant Budget

Because of the importance of the development and application of new technology for irrigation, special attention has been directed to the needs for training, special studies and technical collaboration. Table 7 below outlines the costs projected for these critical components.

D. Disbursement Procedures

1. Loan Funds

All of the AID loan funds will be used to finance local currency costs of construction on the thirteen prototype MIPs. Financing will be on a fixed amount reimbursement basis for discrete construction components. In each subproject MIP, agreement will be reached during the appraisal of revised designs by CWC on the amount to be reimbursed for the headworks, main canals, distributaries, minors, watercourses and field channels, drainage works and roads necessary for project operations. As progress toward completion is made on the headworks, partial reimbursement can be made on the basis of percentage of completion. For canals, distributaries, etc., reimbursement will be made on the basis of completed kilometers.

Certain construction costs, e.g., resettlement of persons living in the reservoir area, establishment costs of Irri-

Table 6

PRELIMINARY
PROJECT EXPENDITURES BY FISCAL YEAR
(In '000 of $)

Fiscal Year	A. I. D.			Govt. of Maharashtra			Grand Total (4 + 7)
	Loan	Grant	Total	GOM/ID	GOM/AD	Total	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1982	1,987	1,195	3,182	1,987	-	1,987	5,169
1983	4,240	767	5,007	4,240	-	4,240	9,247
1984	9,166	743	9,909	9,166	96	9,262	19,171
1985	13,849	295	14.144	13,849	576	14.425	28.569
1986	14,758		14,758	14,758	1,520	16,278	31,036
SUBTOTAL LIFE-OF-PROJECT	44,000	3,000	47,000	44,000	2,192	46,192	93,192
1987	(15,050)[a]	-	15,050	15,050	2,782	17.832	32,882
1988	(14,982)	-	14,982	14,982	3,394	18,376	33,358
1989	(14,078)	-	14,078	14,078	3,639	17,717	31,795
1990	-	-	-	-	3,753	3,753	3,753
1991	-	-	-	-	2,660	2,660	2,660
TOTAL	88,110[b]	3,000	91,110[b]	88,110	18,420	106,530	191,640

a/ Sums in parentheses represent expenditures which will be eligible for AID-financing but which will be in excess of the $44 million proposed. Such expenditures may be covered with a follow-on project. If not financed by AID or another donor, they would have to be added to the parallel figures in column 5, and thus picked up by the GOM/ID. Totals in column 8 would remain the same.

b/ Includes $44,110 in expenditures that could be financed by AID if a follow-on project is approved. If not approved, this sum will have to be added to column 5.

Table 7

Details of Grant Budget

MAHARASHTRA IRRIGATION TECHNOLOGY AND MANAGEMENT PROJECT
COLLABORATIVE SPECIAL STUDIES AND LOCAL AND U.S. TRAINING-ESTIMATED COSTS

	Local Costs		International Costs ($)			
	Rupees	$ Equiv.	Indian Participants 1/	U.S. Participants 2/	Equipment	Total($)
I. DIRECT MAHARASHTRA ACTIVITIES						
A. Special Studies & Programs & Training						
1. Seepage Loss Studies	530,000	58,900	24,300	17,700	---	100,900
2. Agricultural Water Management Studies	1,812,000	201,335	210,600	85,155	60,000	557,090
3. Groundwater Utilization & Water Balance Studies	371,000	41,225	72,000	13,725	---	126,950
4. Utilization of Improved Kharif Water Management Technology	582,300	64,700	---	---	---	64,700
5. Utilization of Kharif Potential	300,000	33,335	---	---	---	33,335
6. Hydrological, Climatological and Reservoir Operation Studies	183,000	20,335	28,800	14,115	---	63,250
7. Improved Utilization of Soil Surveys	631,000	70,110	149,100	21,420	---	240,630
8. Socio-Economic Baseline Studies	250,000	27,800	---	---	---	27,800
9. Economic Analysis of Labor Use in Construction & Optimization of Subprojects	643,000	71,445	86,400	22,720	---	180,565
10. Alternative Water Allocation Studies	156,000	17,335	---	---	---	17,335
Sub-Total	5,458,300	606,520	571,200	174,835	60,000	1,412,555
B. In-Country Training Programs						
1. Training of Land Development Technicians	392,000	43,555	---	6,820	---	50,375
2. Training in Conjunctive Use of Groundwater	107,600	11,955	---	12,640	---	24,595
Total of Maharashtra MIP	5,957,900	662,030	571,200	194,295	60,000	1,487,525
II. NARMADA SYSTEMS ANALYSIS	---	--	1,010,100	30,000	---	1,040,100
III. LIAISON & COORDINATION	745,000	82,780	---	271,000	15,000	368,780
IV. CONTINGENCIES	932,400	103,595	---	---	---	103,595
GRAND TOTAL	7,635,300	848,405	1,581,300	495,295	75,000	3,000,000

1/ Indian Nationals sent to U.S. for Training.
2/ Short-term consultants.

gation Department personnel assigned at site, etc., will be reimbursed on an actual cost basis.

Upon satisfaction that a certain construction component has been completed or a certain percentage of completion achieved according to agreed plans, USAID will initiate reimbursement procedures. This involves transferring the dollar equivalent of 67 percent of the agreed unit cost figures for completed items into the New York account of the Reserve Bank of India.

2. Grant Funds

AID grand funds will be used for direct financing of foreign exchange costs associated with training in the United States; expatriate technical assistance and coordination; special equipment required for studies, and for financing, through the Government of India, for certain local currency costs for training, coordination and the conducting of special studies. These latter activities are all expected to be expenditures incurred by the GOM beyond and in addition to approved items in the state's irrigation or agriculture budgets. To provide for local currency expenses, USAID will transfer the dollar equivalent of planned costs for each activity into the New York account of the Reserve Bank of India, and will advise the Department of Economic Affairs of the Ministry of Finance, New Delhi, when this has been done. DEA will then arrange to have the rupee amount credited to Maharashtra's current general budget, for the account of the Irrigation Department.

To facilitate implementation of the training, coordination and special studies to be done in India, upon completion of conditions precedent, an advance of grant funds will be provided in the equivalent of the initial three months projected expenditures. This is estimated to be approximately Rs.600,000. Each three months thereafter, the Government of Maharashtra will report to USAID on actual expenditures for the previous quarter and estimated requirements for the ensuing quarter. On this basis USAID will liquidate the previous advance and will advance sufficient funds for the next quarter.

VI. Implementation Plan

A. GOI/GOM Administrative Arrangements

1. Planning and Budgeting

The Irrigation Department of the State of Maharashtra develops and proposes an overall plan for surface irrigation development in the state,long-range in Five Year Plans and annually for each budget year. The state's Medium Irrigation Program is a part of this overall plan. Irrigation Department proposals are reviewed by the State Planning Department, and a final program is submitted to the GOI Planning Commission for approval. After approval of the overall program, including the identification of specific projects, by the Planning Commission, the State Irrigation Department proceeds with detailed project development.

Under the GOM's decentralized planning program a Planning and Development Council of official members headed by a Minister decides the development priorities for each of the 26 districts taking into account local considerations. The state government allocates funds to provide employment of unemployed persons through public works under the State's Employment Guarantee Scheme (EGS). EGS funds may be utilized to pay for labor on MIPs.

2. Subproject Design and Implementation

MIP designs are developed under the supervision of regional Chief Engineers with certain exceptions. For example, special features such as dams over 27.5 m high must be referred to a central design section. Feasibility reports for subprojects will be prepared based on these designs by a special Project Preparation Cell (ID/PPC) set up under the Chief Engineer, Projects, at the state level for the AID financed projects. Cropping patterns, expected yields and cost of production and inputs for use in benefit cost analysis are specified by the Director of the Agriculture Department. These cropping patterns will be used in economic evaluation of prospective subprojects; however, benefits will be calculated as described in Volume II Chapter 1 para.c, "Procedures and Criteria for Subproject Analyses and Approval". After subproject sanction, the required engineering divisions and subdivisions are established by the ID at the subproject site to finalize designs and supervise construction. For some qualifying subprojects, construction may have already been started under the normal procedure of approval and sanction. The Soil Conservation Division of GOM/AD is responsible for designing and constructing field channels below 8 ha. outlets to farmers fields. The AD is

also responsible for providing land development services on individual farms and coordinated agricultural services.

3. Subproject Appraisal and Approval

The Central Water Commission (CWC) under the GOI Ministry of Irrigation is responsible for technical appraisal and approval of all surface irrigation schemes serving 2,000 ha. or more prior to submission for Ministry of Finance and Planning Commission sanction for funding. Accordingly, the CWC Appraisal Committee will be responsible for appraising subprojects under this project and for certifying their compliance with project criteria as set forth in the Project Paper and Loan Agreement. See Section III.D.2. above. Appraisals will be done collaboratively with the GOM and summaries of subproject appraisals will be forwarded to USAID. USAID will participate in the appraisal of selected subprojects. Upon approval by the Appraisal Committee, costs incurred on the subprojects will be eligible for financing.

4. Water Allocation and Management

General principles for allocating water among farmers are set forth in the Maharashtra Irrigation Act of 1976. These provide that irrigators desiring water service must make applications in advance. Applications are received and approved by the Executive or Deputy Engineer in charge and schedules for delivery are established and posted. On qualifying subprojects rotational water service (shejpali) will be established (see Vol. II, Chapter 4, Sec.B.2.e.), and a program to accelerate groundwater development will be implemented.

B. AID Implementation Arrangements

1. AID Administrative Arrangements

USAID/New Delhi has designated a Project Officer who will be responsible for coordinating project analyses and formulation and will handle all facets of project implementation. In addition, an FSN engineer will be assigned to the project on a fulltime basis. A USAID Project Committee will support these officers. USAID's Controller will make all project disbursements in accordance with standard AID procedures regarding fixed reimbursement for loan-funded construction and regarding direct financing for grant-funded studies and training.

2. Progress Reporting

CWC/AC will prepare and submit the following progress reports: (a) Project Implementation Reports will be prepared annually after a review with GOM officials. They will include status of subprojects under planning, implementation and operation and projections for the ensuing year and the remaining life of the project, giving particular attention to management and financial considerations. (b) Reports will be submitted following visists to Divisional Offices and/or field sites for each subproject on the following schedule: (1) Preparation Report every six months; (2) Implementation Report two times during the construction season; (3) Operation Report annually after completion of implementation. Reports will comment on scheduled activities, assess performance and flag present and potential problem areas.

C. Preliminary Calendar of Project Events

April 1982: GOI and USAID sign Project Agreement. USAID issues Project Implementation Letter No. 1. Initiation of contracting procedures for resident project coordinator.

May 1982: Conditions Precedent met.

June 1982: Study chak designated on an existing MIP. GOM Irrigation and Agriculture Departments finalize revised design of first subproject MIP as a model. Contract signed for resident project coordinator.

July 1982: CWC and USAID review model subproject and prepare appraisal report. Long term U.S. training in water resources systems analysis and management commences.

August 1982: GOM finalizes revisions of addtional two subproject MIP designs.

September 1982: Resident coordinator arrives. CWC approves first subproject MIP.

October 1982: Resident coordinator, with assistance of CWC, GOM/ID, GOM/AD and USAID, prepares workplan for all project training and finalizes scopes of work for special studies. Construction of first subproject commences in accordance with revised plans. CWC and USAID review two additional subproject MIPs and prepare appraisal reports.

November 1982: Resident coordinator initiates contracting actions for all special studies. CWC approves two additional subproject MIPs. Short-term, in-country training courses commence. First batch of short term U.S. training commences.

December 1982: Construction of additional two subprojects commences in accordance with revised plans.

January 1983: Special studies commence.

Spring 1983: GOM finalizes revised designs for five additional subproject MIPs.

Summer 1983: CWC approves revised designs; construction commences in accordance with revised designs.

Fall 1983: First annual evaluation.

Spring 1984: GOM finalizes revised plans for final five subproject MIPs. Demonstration chaks started on initial three prototype MIPs.

Summer 1984: CWC approves revised designs; construction commences in accordance with revised designs.

Fall 1984: Second annual evaluation.

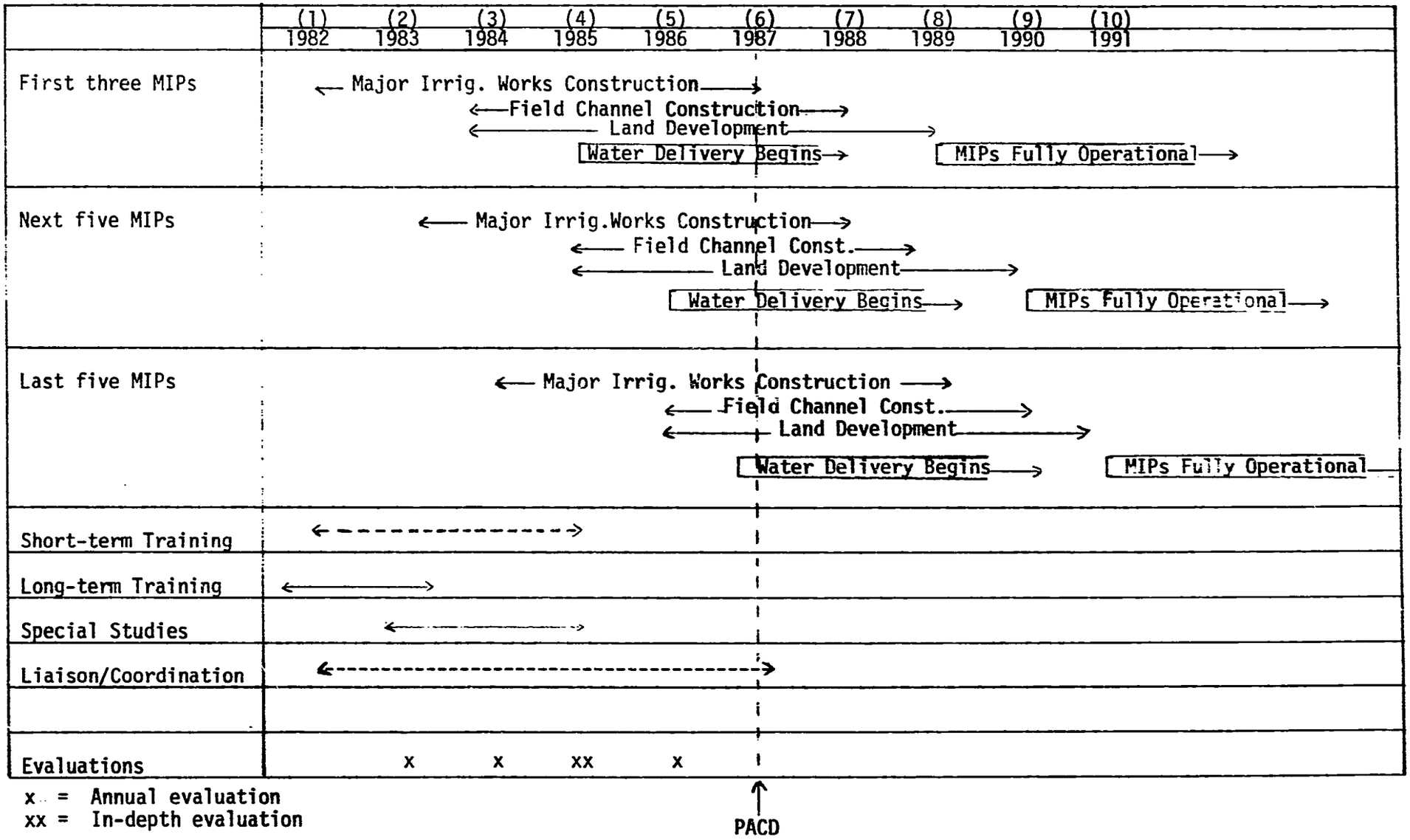
Spring 1985: In-depth evaluation to determine necessity for follow-on project. Demonstration chaks started on second batch of five prototype MIPs; initial three operational.

Fall 1986: Annual evaluation. Demonstration chaks started on final batch of five prototype MIPs; second five operational

April 1987: Project assistance completion.

Summer 1987: Final five demonstration chaks operational; EOPS evaluation.

D. PROJECT IMPLEMENTATION SCHEDULE



x = Annual evaluation
xx = In-depth evaluation

VII. Monitoring and Evaluation

A. Monitoring

1. Things that could go Wrong

a. Delay in obtaining qualified long-term resident coordinator for the project.

USAID staff will be in frequent contact with AID/W until qualified institution and personnel have been identified and procured for this important function. Approximately one work week is expected to be required until arrival of the coordinator's resident staff.

b. Delays in preparation of subproject MIP plans or revised plans; delays in appraisal and approval of these plans by CWC. Three subproject MIPs are planned for approval during the first project year. USAID irrigation staff plan to work closely with GOM/ID and CWC throughout this period to assure that the design-appraisal-approval process is working satisfactorily. The appraisal model developed for Rajasthan will be provided to the GOM for use as a sample and guide in preparing the first project report. Relatively intensive monitoring is planned for the first year for this item; it is expected that monitoring requirements will diminish once two or three subprojects have made it through the approval process. Approximately two work months of USAID/ARD time will be devoted to this activity during the first year.

c. Delays in sanctioning and acquiring adequate staff to implement the project.

This has proved to be a serious problem on both the Gujarat and Rajasthan MIP projects, and it will be addressed in the project agreement as a covenant. USAID/ARD staff will continually follow-up on this matter in conjunction with visits to Maharashtra on subproject MIP preparations and approval.

d. Delays in finalizing training plans, identifying appropriate institutions to conduct the training, designation of suitable candidates to be trained; delays in finalizing scopes of work for special studies, delays in completing arrangements to have the studies done, e.g., contracting.

Finalization of plans and preparations for training and special studies will be the principal responsibility of the resident coordinators. Assuming his or her/their timely arrival,

this should not be a problem, although USAID will continually monitor this item with CWC and GOM/ID. Anticipating arrival of the resident coordinator no later than September, 1982, USAID will have to spend approximately one work month on these items; if the coordinator's arrival is delayed until January, 1983, an additional two work months will be required during the last quarter of CY 1982, for a total of three work months during the first project year.

e. Inadequate Irrigation Department budgets to continue or complete MIP construction on time. USAID staff will review on a continuous basis the adequacy of GOM budgets to complete the project. This will be done in conjunction with the CWC in New Delhi, during field visits to Maharashtra, and in the review of reimbursement vouchers. Approximately one work month will be devoted to this item during the first project year.

f. Poor quality construction; inadequate supervision and adherence to specifications, lack of construction materials.

USAID/ARD irrigation staff will visit each of the first three MIP sites at least once during the first project year, and more often if necessary. In consultation with the GOI and GOM, it will be determined whether quality control workshops are needed. If so, they will be established to train the field technicians involved and will be funded under the grant. Each field visit is expected to take a minimum of one week, including travel time. Assuming return visits will be required to two of the three, a total of five work weeks of the project officer's time will be required, plus one additional work week for the project officer's supervisor. An additional five subproject MIPs are scheduled for approval the second project year. Thus eight sites will require at least one visit each during the second project year, with perhaps four requiring repeat visits. Therefore, a total of twelve to fifteen work weeks of ARD time will likely be devoted to field visits during the second project year.

The final five subproject MIPs will be approved and started the third year, thereby adding five more sites to be visited then.

g. Inadequate training; transfer of participants who have completed project-financed training from project activities to other, unrelated assignments.

USAID staff will monitor in-country training through selective visits; the USAID project officer may sit in one some of

the sessions and workshops, and USAID staff will probably participate in some as technical resources. This has been the pattern in training courses held in Gujarat and elsewhere. A total of four work weeks of USAID/ARD time is expected to be required for this item during the first project year.

USAID staff will also closely monitor the assignment and transfer patterns of project counterparts, to assure that maximum feasible benefit is accrued from the training for the project. This item will be discussed as appropriate with CWC and the GOM if it becomes a problem. No significant additional time is anticipated to be required for this item now.

h. Unsatisfactory studies; inadequate application of knowledge gained from the studies to the planning, construction or operation of MIPs.

USAID will review each study during its implementation and upon completion; USAID will also follow through on any recommendations arising from the studies. Approximately one and one half work week will be devoted to each study. About ten such studies will be undertaken during the project, with all begun the first year and completed the third; therefore roughly five work weeks will be required for review and follow-up during each of the first three project years.

i. Inadequate budget coordination between the Irrigation and Agriculture Departments, resulting in delays in undertaking land preparation works below the MIP public outlets and on farmers' fields.

This problem has been anticipated by the Government of Maharashtra, and it will be addressed in the Project Agreement as a covenant. It will not arise until most of the major works are completed, three to four years hence. USAID will monitor the GOM and GOI budget process to assure that adequate provisions are made beforehand.

2. Schedule of Monitoring Actions by USAID Staff

April - June, 1982

Follow up on resident coordinator	One work week
Review conditions precedent	One work day
Monitor subproject plans	Four work weeks
Monitor preparations for training and studies	Two work weeks

July - September 1982

Monitor operation of resident coordinator	Two work days
Monitor and participate in first subproject appraisal	Four work weeks
Monitor preparations for training and studies	Three work weeks
Visit first subproject MIP	One work week

October - December 1982

Monitor operation of resident coordinator	Two work days
Monitor and participate in second and third subproject appraisals	Three work weeks
Monitor implementation of training and studies	Four work weeks
Visit two subproject MIPs	Two work weeks

January - March 1983

Monitor operation of resident coordinator	Two work days
Monitor appraisal of five MIPs	Four work weeks
Monitor training and studies	Three work weeks
Visit GOM/ID and AD	One work week

April - June 1983

Monitor operation of resident coordinator	Two work days
Monitor training and studies	One work week
Visit three MIPs	Three work weeks

July - September 1983

Monitor operation of resident coordinator	Two work days
Monitor training and studies	One work week
Visit one MIP	One work week
Conduct first annual evaluation	One work week

October - December 1983

Monitor operation of resident coordinator	Two work days
Monitor training and studies: review completed programs	Two work weeks
Visit four MIPs	Four work weeks

January - June 1984

Monitor operation of resident coordinator	One work week
Monitor appraisal of five MIPs	Three work weeks
Monitor training and studies	Two work weeks
Visit ten MIPs	Ten work weeks

July - December 1984

Monitor operation of resident coordinator	One work week
Monitor training and studies	One work week
Visit ten MIPs	Ten work weeks
Conduct second annual evaluation	One work week

January - December 1985

Monitor resident coordinator	Two work weeks
Visit twenty MIPs	Twenty work weeks
Conduct in-depth evaluation	Six work weeks

January - December 1986

Monitor resident coordinator	Two work weeks
Visit twenty MIPs	Twenty work weeks
Conduct evaluation	One work week

January - June 1987

Monitor resident coordinator	One work week
Visit ten MIPs	Ten work weeks
Conduct final evaluation	Two work weeks

3. USAID Staffing Implications

The minimum USAID staff time required during the life of this project, assuming no unforeseen difficulties such as the delayed arrival of the resident coordinator, as outlined in the preceding section, is as follows:

Fiscal Year (U.S.)	Work weeks of staff required
82	16
83	26
84	25
85	32
86	30
87	13

USAID has obtained approval for, and is recruiting, an FSN irrigation engineer who will be assigned fulltime to this project to assist the project officer.

Day-to-day implementation of the grant funded components of the project, i.e., special studies, training and technical assistance, will be the fulltime responsibility of the resident coordinator. In addition, monitoring assistance will be requested under the Water Management Synthesis II Project. Therefore, USAID's involvement in these functions is expected to be minimal, and limited to periodic monitoring. Accordingly the project can be adequately monitored within approved staffing levels.

B. Evaluation

1. Regular Evaluations

The GOM, CWC and USAID will conduct regular evaluations at annual or more frequent intervals following commencement of the Project. These evaluations will cover progress and quality of physical construction, extent of farmer involvement, progress of training and special studies, including their use upon completion and their dissemination elsewhere, expenditure accruals, etc. The resources of the Water Management and Training and the Water Management Synthesis II Projects will be drawn on as appropriate.

2. Baseline Surveys

Detailed socio-economic baseline surveys for selected subprojects will be conducted by the GOM, either directly or with

contract assistance. AID will provide grant financing of these studies as part of the project. Particular attention will be paid to assessing the situation in the market town or towns serving the command areas of subprojects. This will include an assessment of the off-site employment generating effects of irrigation development as well as the adequacy of input systems. Baseline data will be used in the mid-project evaluation and for post-project evaluations.

3. In-Depth Evaluation

An in-depth evaluation is scheduled for the end of the third project year to assess the need for a follow-on project. It will examine the results of the special studies; effectiveness of training, and progress thus far in planning, designing and construction of physical works. An assessment will be made of the impact of the project upon the irrigation sector in Maharashtra, both actual and potential; special attention will be directed to whether further AID assistance would be needed to consolidate and institutionalize these technological gains, and to assure their spread throughout Maharashtra.

VIII. Conditions and Covenants

A. Conditions

No special conditions precedent to disbursement are proposed.

B. Covenants

1. The Cooperating Country agrees to provide sufficient funds, through the Irrigation and Agriculture Departments or such other departments of the Government of Maharashtra as may be appropriate, when needed, to implement all aspects of the Project in accordance with the project budget and schedule as agreed by the parties.

2. The Cooperating Country agrees to provide for sufficient resources in the Seventh Five Year Plan for the period 1985 to 1990 to complete all subproject MIPs in timely fashion. Such resources will be made available as needed to both the Irrigation and Agriculture Departments of the Government of Maharashtra in accordance with the illustrative budgets and as agreed by the parties.

3. The Cooperating Country agrees to establish a special unit within the Irrigation Department of the Government of Maharashtra and to staff such unit to coordinate and assist in managing and monitoring all project activities.

4. The Cooperating Country agrees to establish an adequate number of positions and to post experienced, qualified staff to those positions at the field level, to implement all project activities satisfactorily and in accordance with the project schedules and budgets established for approved subproject MIPs.

5. The Cooperating Country agrees to support the prototype concept being advanced under this project through the use of demonstration chaks, technical collaboration and special studies, and agrees to utilize the technological innovations and findings arising out of the project to improve new and existing irrigation facilities throughout the state wherever feasible.

ANNEX A.1

NOTES ON PID ISSUES

(STATE 057860, March 7, 1981; STATE 163457, June 21, 1980)

From STATE 057860

1. The project paper should provide detailed information and analysis indicating and justifying unit costs and economic benefits expected from irrigation schemes. The physical aspects of expected project accomplishments should be closely examined so that we have confidence that the targets set out in the PP are feasible and obtainable. A firm commitment by the Government of Maharashtra (GOM) to meet design targets through capital investments of its own will be necessary. For example, if it is estimated that the project will finance 100,000 hectares in irrigated command area at certain standards -- with the associated production, income and employment gains -- the PP should provide the analytical assurance that planned finance and management will achieve the desired results. If costs escalate or the prescribed quality on portions of intended schemes is harder to obtain than estimated, will the GOI or GOM guarantee in the loan agreement to meet the shortfall or have alternative schemes with adequate economic return?

Unit Costs, Economic Benefits:

Construction costs are calculated to average between Rs.15,000 to Rs.18,000/ha ($1700-$2000/ha). Operation and maintenance costs will average Rs.100-Rs.200/ha ($11-$22/ha) per year thereafter. Using an average farm size of 3.7 hectares, and an average family size of 5.7, initial costs work out to about $1400 per capita. In terms of economic benefits, each newly irrigated hectare will yield between two and three additional tons of foodgrains each year, ranging in value from $500 to $1000. Added agricultural employment will rise by 32,000 person years annually and construction will increase employment by 104,000 person years during project construction. The annual net farm income in the command area of subprojects will increase by Rs.300 m ($32 m). See economic analysis in Volume II, Chapter 1 for detailed information, analysis and justification of the costs and benefits.

Physical Aspects:

When completed, the thirteen MIPs will command an area of 87,000 ha. Irrigation requirements at the main canal will be computed using the modified Penman formula for crop requirements. GOM/ID has had many years of successful experience in design and constructing dams and spillways, and the GOI/CWC has developed excellent design standards. GOM/ID has a program for measuring silt accumulations in existing reservoirs, and silt samples are routinely taken at stream gauging stations. Computer facilities are available to calculate fortnightly

irrigation requirements. Improvement of the effectiveness of delivery systems within the limits of economic feasibility is a major objective of this project. The distribution system on the AID-financed subprojects will be designed to deliver a stream of not less than 28 liters/sec (one cusec) on a rotational basis to gated outlets serving about 25 ha. Where constructed in expansive soils, canal structures including lining will be protected and channels stabilized by replacement of surrounding soil with cohesive non-swelling soils. None of these design aspects is beyond the technical capabilities of the GOI or GOM. Rather, they represent refinements and modifications to an already effective and functional design and construction capability. These and other features of the design standards for the AID-financed subprojects are described and analyzed in Volume II, Chapter 4, Technical Analysis, Section B.2.a-e.

Maharashtra's Commitment to Project:

See project budget and projected expenditure tables, Section V of main text. The figures shown for the GOM were discussed with and agreed by the GOM. The GOM's commitment to planned targets through capital investments of its own has also been established by Covenants 1 and 2 of Section VIII of main text. These covenants establish that (1) the Cooperating Country will provide sufficient funds to implement all aspects of the project within the PACD and in accordance with the agreed project budget and schedule, and (2) the Cooperating Country will provide sufficient resources in the Seventh Five-Year Plan to complete all subproject MIPs in timely fashion.

Agreement to Meet Shortfalls:

The project agreement will contain such a guarantee ("Cooperating Country Resources for the Project").

2. The PP should contain a comprehensive institutional analysis with emphasis on the implementation, monitoring and general operation capabilities of the GOM. One objective of AID in this sector is to promote and encourage better downstream irrigation management and operation, including better treatment of data at the scale of each scheme (e.g., yield measurement, relationship of canal and groundwater use, and provision through the normal state apparatus of CAD-type services). To achieve this, USAID/GOM should consider the possibility of establishing an annual audit of crop yields, water deliveries and input deliveries for each scheme. The PP should show how yield, water and input data for each scheme will move through the agricultural and engineering administrative hierarchies and affect decision making.

Institutional Analysis:

The GOM is well staffed and equipped to plan, design and construct the major dams and canal works required under the proposed project; however, based on experience in other states, programs for improving

design and quality control of construction of minor works and on some canal structures may be needed, and are planned under the project. See Administrative Analysis, Volume II, Chapter 3, and Implementation Plan, Section VI of main text.

How Yield, Water and Input Data Affect Decision-making:

One of the special studies to be undertaken under this project will be done on three existing MIPs. This study, the Agricultural Water Management Study, will establish relationships between inputs, water deliveries and crop yields. The resulting information will be used in improving the management procedures to be used on the thirteen prototype MIPs to be initiated under this project.

3. Please direct attention to the groundwater problem and to assumptions concerning farmers investments and management capacity for water pumping. Specifically, it would be helpful to indicate how design specifications will treat combined ground and canal water use and avoid problems of well abandonment, salinization and uncontrolled water table.

Groundwater:

Conjunctive use of groundwater is an important factor in expanding the availability of water, especially in extensive systems where insufficient surface water is available for maximum cropping intensities. Groundwater provides a valuable supplemental source of water, especially for perennial or hot weather cash crops. Full well development within subproject command areas will help to eliminate potential waterlogging hazards. Many wells already exist in the thirteen proposed subproject areas. Surface water quality (salinity) in Maharashtra is generally very good. Special studies to develop and facilitate conjunctive groundwater use will be part of the project. See Volume II, Chapter 4, Technical Analysis, Section B.h. for discussion of groundwater.

4. The matter of quality control in the construction of works should also be addressed. The APAC was concerned that the system for ensuring quality of civil works constructed under the Rajasthan loan, and likely here, is not yet proved. We are aware that MIPs in India assume a very low level of AID inspection before disbursement. In this context, the conclusion of the APAC was that the need for detailed USAID monitoring here may be considerably less than in other countries. What the Mission should be striving for is the design of a QTE process UNQTE to accomplish mutual objectives. USAID would then only monitor the process and spot check actual implementation results to assure adequate progress and to support fine-tuning as appropriate. The PP should set forth in detail the monitoring plan.

Construction Quality Control:

Quality control of MIP construction is a major concern and will receive careful attention under this project. The quality control cell already established by the GOM Irrigation Department will be expanded to review technical standards and to monitor construction quality on site on a continuous basis. USAID will participate in this appraisal process to assure that adequate quality control is applied at all levels of construction and to recommend remedial action where necessary. See summary Administrative Analysis, Volume I, Section IV.E., and Volume II, Chapter 3, Part A, Section 1 and 2 as well as the Technical Analysis, Volume II. Chapter 4, Section B.1.

Monitoring Plan:

Relatively intensive USAID monitoring is planned for the initial year of the CWC appraisal, approval and on-site process for subprojects. USAID will visit each of the first three MIP sites at least once during the first project year and more often if problems arise. As the CWC and GOM monitoring becomes routinized, USAID's involvement will diminish. In-country training will be monitored through selective visits. Section VII.A. of the main text (Volume I) describes the monitoring plan.

5. The APAC was concerned with the possible overburdening of the GOM with this project on top of large-scale, World Bank supported irrigation projects, as well as with the possible inclination of the GOM to conceive and manage MIPs more in the Bank's than AID's style (e.g., perhaps with less concern for downstream operations, monitoring by scheme, and technology transfer).

Possibility of Overburdening GOM: Potential to Concentrate on Upper rather than Lower End of System:

The GOM is increasingly aware of the importance of operations at the bottom end of MIPs; so is the World Bank. USAID has established very close and cooperative relationships with the Bank's irrigation staff. The project's large training component is designed to strengthen the GOM's capacity to implement irrigation projects; the GOM, the Bank and AID are aware of and sensitive to the possibility of overload.

6. A concern related to that of para 4 above is how the Mission will deploy its limited human resources to handle effectively day to day implementation of AID-style irrigation projects in three states simultaneously, and whether this can be done without the addition of direct-hire personnel during the lives of these projects.

A resident coordination capacity is introduced as an integral part of this project. It has been discussed with the GOM and the CWC,

both of which support the concept. See main text Section III.D. 2.d. We will explore expanding this capacity to cover all AID-financed irrigation activities.

7. The Mission might consider more technical assistance than is proposed in the PID if greater operational improvements, as suggested above, or other management development seem desirable and would be acceptable to the GOM. We are not repeat not advocating a large-scale TA program which would be unacceptable to ourselves or the GOI. Concur with the Mission that TA should be grant funded, although level/availability of Grant funds are expected to remain constrained.

Level of Technical Assistance:

Mission has agreed, and project is proposed with substantial increase in the TA component.

From STATE 163457

8. To the maximum extent possible at the time the PP is prepared, lessons learned in terms of engineering, administration, water management, and benefits in the Gujarat and Rajasthan project should be analyzed and included in PP for the present proposal. PP should also discuss how experience resulting from actual implementation of MIPs in one state will be taken into account, and conclusions considered and applied in MIPs initiated in other states. Are there other organizations besides CWC that will ensure that this happens?

The project has been designed with the experiences of Rajasthan and Gujarat in mind. The Technical Assistance Component has been structured precisely to address the problems of design, farmer participation, water allocation, construction quality, rates of utilization, etc. that have been confronted in the earlier projects. CWC and the GOM have been actively involved in this process, and are keenly aware of the shortcomings and difficulties this project is designed to tackle. Moreover, the experimental nature of this project is meant to provide the basis for applying what is learned in the design and operation of the prototypes and in the special studies to all other surface irrigation activities, both existing and planned. "Cross fertilization" between the states benefitting from USAID's irrigation portfolio will be actively encouraged. For example, personnel from the Governments of Gujarat and Rajasthan may be called upon to help undertake training courses in Maharashtra. Field trips between these states will be financed under the project to permit the respective states to learn from each other and to facilitate sharing ideas.

9. PP should make special effort to clarify managerial and administrative arrangements for project. In particular, need to know what organizations will be involved in the project, precise responsibilities of each, capability of each to assume assigned functions, and relationships and coordination among them.

CWC sets design and construction standards and reviews design of all irrigation projects exceeding 2,000 ha in area. The GOM/ID central design organization provides guidelines and technical advice in the design of dams, canals and other complex works requiring special design. The Maharashtra Engineering Research Institute possessess capabilities in hydrodynamics, soil mechanics, material testing, computer programming and environmental engineering research. The GOM Agricultural Department has responsibility for land development works for medium and minor irrigation works. The Maharashtra Groundwater Survey Agency is responsible for development and utilization of the groundwater potential in the state. CWC will review and approve the AID-financed subprojects for their design compatibility and the GOM/ID with the help of the other agencies described earlier, will design, construct and/or supervise construction. See Volume II, Chapter 3, Administrative Analysis, for a full description of these arrangements.

10. In general, APAC stressed importance of determining that target beneficiaries will, in fact, be in a position to benefit from the MIPs. This requires careful look at all ancillary inputs and aspects of MIPs, including access to agricultural inputs, credit, extension, etc., to confirm their accessibility. More particularly, however, PP should elaborate on potentially critical problems of on-farm water management as they might affect water distribution and use, and proposed means of addressing these problems during project implementation.

<u>On-Farm Water Management; Ancillary Inputs; On-Farm Development</u>

These activities will be undertaken by the GOM as part of the country contribution to the project. The T&V extension system is planned for introduction in all subprojects within the LOP. Recently universities in Maharashtra have begun to focus more attention on problems of irrigated agriculture such as crop water requirements, methods of irrigation, drainage, etc. The T&V system provides a vehicle for disseminating such research results. Although ancillary inputs

are not a part of the project, their availability will be closely monitored, and remedial action considered if necessary. The T&V extension system and ancillary inputs are described in detail in the Agriculture Section of Volume II, Chapter 6. The Social Soundness Analysis in Volume II, Chapter 2, Section D.3 addresses the problems of water distribution and use. The principal means of addressing these problems will be a special study of the Shejpali system for water distribution system in Maharashtra. Effective and equitable on-farm water management is a central concern of this project, and will be addressed through design and operation of demonstration "chaks" or irrigation service areas of about 40 hectares each. At least one demonstration chak will be established in each of the thirteen prototype MIPs as soon as water delivery can begin, and they will be used as laboratories to test and demonstrate various water user organizations and various forms and methods of water management.

Excerpts From NEW DELHI 19182: AID's Assistance Strategy for India
October 16, 1981

1. SUMMARY.

This message reviews the changes in AID's portfolio from the resumption of AID in 1978 to the proposed program for FY 83. Major projects which were resource transfers only will have been replaced by ones where technology transfer and institution building is an integral part of our investment. Significant efforts to develop lasting relationships between U.S. and Indian institutions in applied research and development should be underway. Programs to integrate Development Assistance and PL 480 Title II to improve development impact are planned.

2. BACKGROUND

AID's Development Assistance program in India was resumed in FY 1978 along the lines recommended by a high-level U.S strategy team (Lindblom report, June 1978). The team's recommendations assumed increases in U.S. Development Assistance levels for India on the order of $100-150 million annually along with severe restrictions on USDH staff levels in New Delhi and a limited role for U.S. technical assistance. Their recommendations consequently stressed the opportunities for major resource transfers in agriculture and in health and family planning, in subsectors characterized by sound policies, established institutions and ample absorptive capacity. This resulted in an FY 1978-81 program which featured major resource transfers for fertilizer promotion, agricultural credit, rural electrification and malaria control. In addition the program included (1) investments in forestry, irrigation and health, where technology transfer and institution building form an integral part; and (2) collaborative research in agriculture and alternative energy. USAID has been progressively eliminating the projects which are resource transfers only. After discussions with the Administrator in March 1981 USAID/I negotiated a reduction of $50 million in the Fertilizer Promotion program. FY 1982 will be the last year for the Agricultural Credit program. This credit project provides financial resources for the development of groundwater irrigation, and appears to have a highly favorable and relatively immediate impact on production, employment and small farmer incomes. Obligation of the balance of the amount authorized would meet AID's commitment to a highly worthwhile project and would close out the stage of large-scale resource transfers.

Thereafter, all projects will have technology transfer and/or institution building as a major focus. This has been possible because of the close working relationships which USAID/I has established over the last few years with the GOI and would not have been possible when the program first resumed. The following paragraphs summarize the present USAID strategy.

3. OBJECTIVES

India accounts for well over half of the poor people in AID-assisted countries, and 80 percent of India's poor live in rural areas. Given the pressure of population on resources in a country which accommodates one-sixth of the world's population on one-fortieth of its land area the most urgent requirement is to support the expansion of India's capacity to improve the balance between food and energy on the one hand and population on the other. Consequently AID's sector goals are expanded food supplies and rural employment, expanded energy supplies and reduced fertility and mortality. Given AID's comparative advantage in certain technical fields and current staffing and funding constraints, we believe that AID can have the greatest long-term impact on these sectors by concentrating on expanding India's agricultural research capacities, improving the management of irrigation systems, developing institutions for local management of forest resources, supporting development of alternative energy resources, and expanding and improving the quality of rural family planning, nutrition and health services. The achievement of these objectives requires major institution-building efforts over an extended period, and can draw upon U.S. expertise in predominantly private American institutions. Each of these areas is discussed more fully below.

(.....)

4. IMPROVING THE MANAGEMENT OF IRRIGATION SYSTEMS

A. The Lindblom report concluded that irrigation development along with agricultural research and education provided the greatest potential pay-off for AID. Subsequent USAID reviews for the FY 1981, 1982 and 1983 CDSS have confirmed this judgment. Given India's monsoonal rainfall, irrigation is essential to increasing multiple cropping. Food grain yields under irrigation are 2.5 times greater than under rainfed conditions and can be greatly increased per hectare. Net incomes are from three to ten times those for rainfed agriculture where reasonably good irrigation management exists. India plans to double its irrigated area from about 55 million hectares at present to 107 million hectares by the year 2000. Irrigation absorbs half of India's investment for agricultural and rural development, and will continue to do so for at least two decades. Annual investments in irrigation involve $4-6 billion annually.

The key role of controlled water supplies for high-productivity agriculture, the size of the investment involved and the potential for major improvements in the efficiency of the systems make irrigation a highly desirable area for assistance. Moreover, the availability of U.S. expertise, the GOI's receptivity to technical collaboration with the U.S. in this area, and its interest in developing extensive new institutions for irrigation management or training confirm USAID's belief that irrigation should be the major sector of emphasis for the U.S. Development Assistance program in India.

B. Irrigation in India is divided about equally between areas served by wells or groundwater and areas served by rivers, canals and reservoirs, or surface water. AID has invested in groundwater development through providing agricultural credit for wells and pumpsets, and through financing rural electrification for energizing pumpsets. While such projects offer a high pay-off through bringing land under irrigation quickly, they do not provide a major avenue for institution building or technology transfer. The credit and rural electrification institutions are well developed (partially due to past USAID involvement), and technology transfer to farmers newly irrigating their land is provided mainly through the extension service. India is revamping its extension service in collaboration with the World Bank, and we do not see this as a good opportunity for AID involvement.

On the other hand, surface irrigation provides a unique opportunity for technology transfer and institution building. India has experienced major problems in building reliable systems to deliver water efficiently to the end-user and in managing the on-farm water use. Moreover responsibility for providing the knowledge and other agricultural services necessary to obtain optimum efficiency at the farm has been diffuse.

While these deficiencies have been discussed for decades the Irrigation Department has recently acknowledged the need to change its policies. The need for improvements in the management of water systems is an idea whose time has now come.

Moreover, USAID has developed excellent relations with the Irrigation Department over the last few years. U.S. engineering and water management experts are highly respected in India. The GOI has turned to USAID for assistance in expanding and improving their irrigation system.

C. USAID plans programs in a limited number of states which should serve as different models for efficient delivery of water to the farmer. For instance, in Rajasthan, where we are financing medium irrigation projects (MIPs) publicly-constructed channels will be extended for the first time beyond the 40 hectare block to 8 hectare blocks, greatly reducing problems in organizing farmers to use the system. Better physical design and improved water control structures should assure more efficient and reliable operation. Pilot studies and training in the U.S. should improve the capacity of the Rajasthan Irrigation Department to manage the improved system. A complementary "Command Area Development" project will address the problems of coordinating farmer organization and providing related agricultural services. Most of irrigation's problems stem from the design and management of the system itself. Thus for technology transfer and development to take place, AID must be involved in development of at least some actual systems. Investments in the state programs need to be large enough to demonstrate improvements and impact on a significant scale. They also need to be large enough to demonstrate USAID's concern and to gain an entree for our experts to discuss qualitative improvements. Without an active partnership advisors would not be acceptable and studies would likely remain on the shelf.

D. Improvements in systems at the state level will be enhanced by a water management and training project. Under this project USAID would assist the GOI in establishing three water management institutes in states where USAID is involved in systems improvement. Pilot studies will also be financed. This project should institutionalize the capacity to manage improved systems and disseminate findings throughout the state. Under the project USAID would also assist in establishing a national water management training institute and cadre of water management specialists which should further enhance the spread of improved practices throughout the country. In this regard, it should be remembered that each state in India is larger than many AID-assisted countries. Therefore, institutions are necessary at both state and national level.

E. Respective roles of AID and World Bank: The World Bank has been committing an average of about $400 million per year recently to surface irrigation development in India, and will probably continue to do so. With its limited financial resources AID must concentrate on building model systems. AID is also avoiding the large and complex major irrigation schemes financed by the Bank and concentrating on programs which will include attention to farmer organization and downstream development. In this regard, AID has relative advantages over the World Bank per dollar invested in terms of flexibility, depth of technical resources, field staffing and access to U.S. technical expertise on a long-term basis.

F. International Water Management Center: The concept of an International Water Management Center was endorsed by the GOI at the September 1980 meeting of the Indo-U.S. Agricultural Sub-commission. An international center would complement a national institute and state institutes by concentrating on more basic research and development, leaving training and most applied research to the national and state institutes. Further progress on the development of an international center will depend primarily on the Consultative Group for International Agricultural Research (CGIAR). In any case AID should strongly support the establishment of an International Water Management Center in India.

(.....)

MAHARASHTRA IRRIGATION TECHNOLOGY AND MANAGEMENT LOGICAL FRAMEWORK

NARRATIVE SUMMARY	OBJECTIVELY VERIFIABLE INDICATORS	MEANS OF VERIFICATION	IMPORTANT ASSUMPTIONS
Program Sector Goal:	Measures of Goal Achievement:	Date:	Assumptions for Achieving Goal Targets:
1. Increased food grain production.	1. Annual food grain production in CCA of 87,000 ha from 35,000 to about 220,000 tons.	1. Baseline studies made under project.	1. Labor intensive agriculture methods and construction practices continue.
2. Increased additional year-round employment.	2. Added agricultural employment by 32,000 person years annually and construction by 104,000 person years.	2. Production statistics from Revenue and Agricultural Departments.	2. Market, storage, and credit network remains adequate for increased production.
3. Increased farm income.	3. Annual net farm income in CCA increased by Rs 300m ($33m).	3. Impact evaluation studies.	3. Farm-to-market roads and support services adequately in place to support irrigated farming.

Project Purpose:	End-of-Project Status:	Data:	Assumptions for Achieving Purpose:
1. Improved irrigation technology in place and replicable.	1. Systems designed to deliver full flows at individual outlets when operating at 50% capacity; field channels to be constructed to farmgates.	1. GOM construction records for subprojects.	1. GOM remains committed to completing all subprojects according to agreed project criteria.
	2. Complete surface drainage included in plans, to be constructed by State.	2. DA/SC records	2. Credit needs in subproject areas adequate to support increased conjunctive use of groundwater and irrigated cropping practices.
	3. 12% economic rate of return (ERR) applied for subprojects; 10% ERR for tribals and drought prone subproject areas.	3. Implementation plan.	3. GOM promptly applies results and findings of special studies.
	4. Water delivery budgets developed and used.	4. Final evaluation results.	4. Ag. extension system strengthened in subproject areas.
	5. Detailed soil surveys and land capability of CCA included as part of design and operational criteria.	5. GOM/ID project reports.	5. Reservoir releases are timely and reliable.
	6. Monitoring systems for quality control of watercourses included.		6. Ag. and Irrigation Departments coordinate activities well.
	7. Farmers actively involved in system planning, design, construction, operation and maintenance.	7. Evaluation of farmer organization models; special studies.	7. Ag. and irrigation departments to work with farmers.
	8. Area irrigated from conjunctive use of groundwater increases from 4 to 21% of the CCA of subprojects.		
	9. GOM adopts results of testing improved irrigated cropping systems.		
	10 GOM adopts results of improved criteria for watercourses and field channel design, O&M and decreasing seepage losses.		

Outputs: (results)	Magnitude of outputs:	Data:	Assumptions for achieving outputs:
1. Trained personnel undertake design, implementation activities and special studies.	1. Training: a. U.S. Training: 60 officers trained in groundwater development, drainage engineering, Ag. Water Management and systems analysis b. In-country training: 75 officers trained in land development and conjunctive water use.	1. GOM/ID & AD records and GOM & CWC project reports	1. Special studies completed on time and generate reliable data.
2. Irrigation systems construction ongoing.	2. 100% planning & design of civil works, 60% construction & 10% on-farm development complete by PACD.	2. Evaluation studies	2. Training program produces necessary personnel to staff planning and construction units on timely basis.
3. Problems identified and solutions tested for improved irrigation systems design criteria.	3. 13 special studies conducted and results utilized in clarifying and meeting subproject criteria by PACD.	3. Reports of baseline and water management studies.	3. GOM staff available for training.
4. Construction ongoing and design and construction specifications checked for quality control.	4. Planning and design of approx.13 subprojects subjected to formalized quality control procedures.	4. USAID monitoring and surveillance reports and records.	4. GOI/GOM budget sufficient resources and release funds on timely basis.
5. Socio-economic baseline studies.	5. Socio-economic baseline studies completed on approx.4 subprojects by end of year two of project.		5. Adequate number of new projects identified and selected as suitable to meet implementation criteria.
6. Demonstration chaks established and functioning.	6. At least one on each of 13 MIPs, plus pilot chak established on an existing MIP.	6. Monitoring reports and evaluation.	

Inputs: (Activities)	Implementation Target: (Type & Quantity)	Data:	Assumptions for achieving inputs:
1. 67% of eligible construction costs of MIPs (half of total costs) 2. Technical assistance (direct hire & contract). 3. Participants 4. Special studies 5. Training	Project Expenditures by Fiscal Year	1. GOM/CWC/AID monitoring. 2. CWC/AC reports. 3. Subprojects accounts. 4. GOI/GOM audit reports 5. GOM/GOI vouchers.	(Beginning of project status)

$in '000	82	83	84	85	86	TOTAL
AID loan	1,987	4,240	9,166	13,849	14,758	44,000
AID grant	1,195	767	743	295	-	3,000
GOM	1,987	4,240	9,262	14,425	16,278	46,192

COUNTRY CHECKLIST

Listed below are, first, statutory criteria applicable generally to FAA funds, and then criteria applicable to individual fund sources: Development Assistance and Economic Support Fund.

A. General Criteria for Country Eligibility

1. FAA Sec. 113. Has particular attention been given those programs, projects, and activities which tend to integrate women into the national economies of developing countries, thus improving their status and assisting the total development effort?	This project is designed to improve the productivity and incomes of the rural poor in Maharashtra; both men and women will benefit equitably.
2. FAA Sec. 116. Can it be demonstrated that contemplated assistance will directly benefit the needy? If not, has the Department of State determined that this government has engaged in a consistent pattern of gross violations of internationally recognized human rights?	The assistance will directly benefit the needy.
3. FAA Sec. 481. Has it been determined that the government of recipient country has failed to take adequate steps to prevent narcotics drugs and other controlled substances (as defined by the Comprehensive Drug Abuse Prevention and Control Act of 1970) produced or processed, in whole or in part, in such country, or transported through such country, from being sold illegally within the jurisdiction of such country to U.S. Government personnel or their dependents, or from entering the United States unlawfully?	No.
4. FAA Sec. 620(b). If assistance is to a government, has the Secretary of State determined that it is not controlled by the international Communist movement?	Yes.
5. FAA Sec. 620(c). If assistance is to government, is the government liable as debtor or unconditional guarantor on any debt to a U.S. citizen for goods or services furnished or ordered where (a) such citizen has exhausted available legal remedies and (b) debt is not denied or contested by such government?	No.

6. FAA Sec. 620(e)(1). If assistance is to a government, has it (including government agencies or subdivisions) taken any action which has the effect of nationalizing, expropriating, or otherwise seizing ownership or control of property of U.S. citizens or entities beneficially owned by them without taking steps to discharge its obligations toward such citizen or entities?	No.
7. FAA Sec. 620(a), 620(f), 620D; Continuing Resolution Sec. 511, 512 and 513; ISDCA of 1980 Secs. 717 and 721. Is recipient country a Communist country? Will assistance be provided to Angola, Cambodia, Cuba, Laos or Vietnam? (Food and humanitarian assistance distributed directly to the people of Cambodia are excepted). Will assistance be provided to Afghanistan or Mozambique without a waiver? Are funds for El Salvador to be used for planning for compensation, or for the purpose of compensation, for the confiscation nationalization, acquisition or expropriation of any agricultural or banking enterprise, or property or stock thereof?	No. No assistance will be provided to these countries.
8. FAA Sec. 620(i). Is recipient country in any way involved in (a) subversion of, or military aggression against, the United States or any country receiving U.S. assistance, or (b) the planning of such subversion or aggression?	AID is not aware of any such involvement.
9. FAA Sec. 620(j). Has the country permitted, or failed to take adequate measures to prevent, the damage or destruction, by mob action, of U.S. property?	No.
10. FAA Sec. 620(k). Does the program furnish assistance in excess of $100,000,000 for the construction of a productive enterprise, except for productive enterprises in Egypt that were described in the Congressional Presentation materials for FY 1977, FY 1980 or FY 1981?	No.

11. FAA Sec. 620(l). If the country has failed to institute the investment guaranty program for the specific risks of expropriation, inconvertibility or confiscation, has the AID Administrator within the past year considered denying assistance to such government for this reason?	Not applicable.
12. FAA Sec. 620(m). Is the country an economically developed nation capable of sustaining its own defense burden and economic growth and, if so, does it meet any of the exceptions to FAA Section 620(m)?	Not applicable.
13. FAA Sec. 620(o); Fishermen's Protective Act of 1967, as amended, Sec. 5. If country has seized, or imposed any penalty or sanction against, any U.S. fishing activities in international waters:	No such actions have been taken against U.S. fishing activities in international waters.
a. has any deduction required by the Fishermen's Protective Act been made?	Not applicable.
b. has complete denial of assistance been considered by AID Administrator?	Not applicable.
14. FAA Sec. 620(a); Continuing Resolution Sec. 518. (a) Is the government of the recipient country in default for more than 6 months on interest or principal of any AID loan to the country?	No.
(b) Is country in default exceeding one year on interest or principal on U.S. loan under program for which App. Act appropriates funds?	No.
15. FAA Sec. 620(s). If contemplated assistance is development loan or from Economic Support Fund, has the Administrator taken into account the percentage of the country's budget which is for military expenditures, the amount of foreign exchange spent on military equipment and the amount spent for the purchase of sophisticated weapons systems? (An affirmative answer may refer to the record of the annual "Taking Into Consideration" memo: "Yes, as reported in annual report on implementation of Sec. 620(s)". This report is prepared at time of approval by the Administrator of the Operational Year Budget and can be the basis for an affirmative answer during the fiscal year unless significant changes in circumstances occur.)	Yes. India spends a relatively small amount of its foeign exchange on military equipment. Latest available figures are an estimated $300 million military imports or 4% of $7.5 billion in total foreign exchange in FY 80. India proposes to spend only 16% of its budget on defense in U.S. FY 80-81.

16. FAA Sec. 620(t). Has the country severed diplomatic relations with the United States? If so, have they been resumed and have new bilateral assistance agreements been negotiated and entered into since such resumption?	Diplomatic relations have not been severed.
17. FAA Sec. 620(u). What is the payment status of the country's U.N. obligations? If the country is in arrears, were such arrearages taken into account by the AID Administrator in determining the current AID Operational Year Budget?	India is not in arrears regarding its U.N. obligations.
18. FAA Sec. 620A; Continuing Resolution Sec. 521. Has the country granted sanctuary from prosecution to any individual or group which has committed an Act of international terrorism?	No.
19. FAA Sec. 666. Does the country object, on basis of race, religion, national origin or sex, to the presence of any officer or employee of the U.S. there to carry out economic development program under FAA?	No.
20. FAA Sec. 669, 670. Has the country, after August 3, 1977, delivered or received nuclear enrichment or reprocessing equipment, materials, or technology, without specified arrangements or safeguards? Has it detonated a nuclear device after August 3, 1977, although not a "nuclear weapon State" under the nonproliferation treaty?	Based on information received from the State Department/ Embassy the answer to both of these questions is no.

B. Funding Criteria for Country Eligibility

1. Development Assistance Country Criteria

a. FAA Sec. 102(b)(4). Have criteria been established and taken into account to assess commitment progress of country in effectively involving the poor in development, on such indexes as: (1) increase in agricultural productivity through small-farm labor intensive agriculture, (2) reduced infant mortality, (3) control of population growth, (4) equality of income distribution, (5) reduction of unemployment, and (6) increased literacy?	Yes. These criteria are based on India's Five Year Development Plan as Revised (1980-85) and are incorporated in the Country Development Strategy Statement (CDSS).

b. FAA Sec. 104(d)(1). If appropirate, is this development (including Sahel) activity designed to build motivation for smaller families through modification of economic and social conditions supportive of the desire for large families in programs such as education in and out of school, nutrition, disease control, maternal and child health services, agricultural production, rural development, and assistance to urban poor? Yes.

2. Economic Support Fund Country Criteria

This section not applicable. Assistance is provided under the Development Assistance category.

PROJECT CHECKLIST

Listed below are statutory criteria applicable generally to projects with FAA funds and project criteria applicable to individual fund sources: Development Assistance (with a sub-category for criteria applicable only to loans); and Economic Support Fund.

CROSS REFERENCES: IS COUNTRY CHECKLIST UP-TO-DATE? Yes

HAS STANDARD ITEM CHECKLIST BEEN REVIEWED FOR THIS PROJECT? Yes

A. General Criteria for Project

1. Continuing Resolution Unnumbered; FAA Sec. 653(b); Sec. 634A. (a) Describe how Committees on Appropriations of Senate and House have been or will be notified concerning the project; (b) is assistance within (Operational Year Budget) country or international organization allocation reported to Congress (or not more than $1 million over that figure)?	(a) Formal notification to Congressional Committees was given in AID's FY 1982 Congressional Presentation. To the extent additional funds are required or funding categories shift, proper Congressional notifications will be made. (b) Yes.
2. FAA Sec. 611(a)(1). Prior to obligation in excess of $100,000, will there be (a) engineering, financial, and other plans necessary to carry out the assistance and (b) a reasonably firm estimate of the cost to the U.S. of the assistance?	(a) Yes, see Section VII Project Paper. (b) Yes, see Section IV Project Paper.
3. FAA Sec. 611 (a)(2). If further legislative action is required within recipient country, what is basis for reasonable expectation that such action will be completed in time to permit orderly accomplishment of purpose of the assistance?	Not Applicable.
4. FAA Sec. 611(b); Continuing Resolution Sec. 501. If for water or water-related land resource construction, has project met the standards and criteria as per the Principles and Standards for Planning Water and Related Land Resources dated October 25, 1973?	Yes

5. FAA Sec. 611(e). If project is capital assistance (e.g., construction), and all U.S. assistance for it will exceed $1 million, has Mission Director certified and Regional Assistant Administrator taken into consideration the country's capability effectively to maintain and utilize the project?	Yes, see Annex E of Project Paper.
6. FAA Sec. 209. Is project susceptible to execution as part of regional or multilateral project? If so, why is project not so executed? Information and conclusion whether assistance will encourage regional development programs.	No, because multilateral and other donors have similar projects and the GOI requested AID assistance in this case. However, the project will benefit other, similar projects in Maharashtra and elsewhere in fields of irrigation and and agricultural development. Regional development programs are not pertinent to medium irrigation projects.
7. FAA Sec. 601(a). Information and conclusions whether project will encourage efforts of the country to: (a) increase the flow of international trade; (b) foster private initiative and competition; (c) encourage development and use of cooperatives, credit unions, and savings and loans associations; (d) discourage monopolistic practices; (e) improve technical efficiency of industry, agriculture and commerce; and (f) strengthen free labor unions.	(a) Not applicable. (b) Yes, in letting of certain construction and technical assistance contracts. (c) Yes, especially rural credit institutions and water-user cooperative committees. (d) Not applicable. (e) Yes, especially irrigation as managed by the Government of Maharashtra (f) Not applicable.
8. FAA Sec. 601(b). Information and conclusion on how project will encourage U.S.private trade and investment abroad and encourage private U.S. participation in foreign assistance programs (including use of private trade channels and the services of U.S. private enterprise).	U.S. technical assistance will be provided under this project; technical collaboration between U.S. and Indian private institutions will be encouraged.

9. FAA Sec. 612(b); Sec. 636(h). Describe steps taken to assure that, to the maximum extent possible, the country is contributing local currencies to meet the cost of contractual and other services, and foreign currencies owned by the U.S. are utilized to meet the cost of contractual and other services.	The GOI will finance 33 percent of construction costs and is contributing sufficient amounts of local currencies for contractual and other services. (See item 10 for U.S. owned currencies.0
10. FAA Sec. 612(d). Does the U.S. own excess foreign currency of the country and, if so, what arrangements have been made for its release?	The U.S. owned Rupees are being used for various U.S. government agencies' program and administrative support and these currencies are expected to be liquidated over the next 10 years.
11. FAA Sec. 601(e). Will the project utilize competitive selection procedures for the awarding of contracts, except where applicable procurement rules allow otherwise?	Yes.
12. Continuing Resolution Sec. 522. If assistance is for the production of any commodity for export, is the commodity likely to be in surplus on world markets at the time the resulting productive capacity becomes operative, and is such assistance likely to cause substantial injury to U.S. producers of the same, similar or competing commodity.	Not applicable. Agricultural products produced will be consumed in India.
B. Funding Criteria For Project	
1. Development Assistance Project Criteria	
a. FAA Sec. 102(b); 113: 281a. Extent to which activity will (a) effectively involve the poor in development, by extending access to economy at local level, increasing labor-intensive production and the use of appropriate technology, spreading investment out from cities to small towns and rural areas, and insuring wide participation of the poor in the benefits of development on a sustained basis, using the appropriate U.S. institutions; (b) help develop cooperatives, especially by technical assistance,	(a) These represent the entire intent of the project. See Sections III and VII of the Project Paper (b) Water user organizations will be created on a prototype basis. Cooperative modes may be tried.

to assist rural and urban poor to help themselves toward better life, and otherwise encourage democratic private and local governmental institutions; (c) support the self-help efforts of developing countries; (d) promote the participation of women in the national economies of developing countries and the improvement of women's status; and (e) utilize and encourage regional cooperation by developing countries?	(c) This project entirely supports Indian self-help in agricultural development. (d) See Social Soundness Analysis in the Project Paper. (e) Not applicable.
b. FAA Sec. 103, 103A, 104, 105, 106, & 107. Is assistance being made available: (include only applicable paragraph which corresponds to source of funds used. If more than one fund source is used for project, include relevant paragraph for each fund source.)	
(1) [103] for agriculture, rural development or nutrition; if so, extent to which activity is designed to increase productivity and income of rural poor.	The project is specifically designed to increase productivity of the rural poor, especially small farmers.
c. [107] is appropriate effort placed on use of appropriate technology?	c. Yes, especially regarding agricultural inputs and improved water management.
d. FAA Sec. 110(a). Will the recipient country provide at least 25% of the costs of the program, project, or activity with respect to which the assistance is to be furnished (or has the latter cost-sharing requirement been waived for a "relatively least-developed" country)?	Yes.
e. FAA Sec. 110(b). Will grant capital assistance be disbursed for project over more than 3 years? If so, has justification satisfactory to the Congress been made, and efforts for other financing, or is the recipient country "relatively least developed"?	Not applicable.

f. FAA Sec. 281(b). Describe extent to which program recognizes the particular needs, desires, and capacities of the people of the country; utilize the country's intellectual resources to encourage institutional development; and supports civil education and training in skills required for effective participation in governmental and political processes essential to self-government.	The project addresses the need for increased food production and will also minimize the risks of drought through the development of irrigation systems. Institutional development will be fostered insofar as the host country's implementing agencies will acquire a strengthened capacity to design, execute and maintain an effective irrigation system. Cooperative water management activities will be strengthened, encouraging local, self-government efforts.
g. FAA Sec. 122(b). Does the activity give reasonable promise of contributing to the development of economic resources, or to the increase or productive capacities and self-sustaining economic growth?	Yes, especially land made more productive by irrigation.
2. Development Assistance Project Criteria (Loans Only)	
a. FAA Sec. 122(b). Information and conclusion on capacity of the country to repay the loan, including reasonableness of repayment prospects.	India's foreign exchange reserves are currently $7.0 billion. This $40 million loan represents .005% of India's average yearly value of exports in an expanding economy.
b. FAA Sec. 620(d). If assistance is for any productive enterprise which will compete in the U.S. with U.S. enterprise, is there an agreement by the recipient country to prevent export to the U.S. of more than 20% of the enterprise's annual production during the life of the loan?	Not applicable.
3. Project Criteria Solely for Economic Support Fund	
This Section not applicable.	

ANNEX D

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Department of State

INCOMING TELEGRAM

PAGE 01 NEW DE 16749 300755Z 6428 027722 AID9696
ACTION AID-00

ACTION OFFICE ASTR-01
INFO STEN-01 SAST-01 RELO-01 TELE-01 MAST-01 ASBI-03
/009 A6

INFO OCT-00 INR-10 ED-08 NEA-07 AMAD-01 INRE-00 /061 W
204744 300817Z /38

O 300754Z AUG 82
FM AMEMBASSY NEW DELHI
TO SECSTATE WASHDC IMMEDIATE 2359

UNCLAS NEW DELHI 16749

AIDAC

E.O. 12356: N/A
SUBJECT: MAHARASHTRA SOCIAL FORESTRY PROJECT

FOLLOWING IS EXACT TEXT OF LETTER REQUEST DATED AUGUST 28, 1982 AND RECEIVED THE SAME DAY:
QUOTE DEAR MRS. BOUGHTON,

- THE GOVERNMENT OF INDIA HEREBY REQUEST A LOAN OF DOLLARS 25 MILLION AND A GRANT OF DOLLARS 5 MILLION TO ASSIST IN FINANCING THE MAHARASHTRA SOCIAL FORESTRY PROJECT. THESE FUNDS, ALONG WITH THE COOPERATING COUNTRY CONTRIBUTION OF APPROXIMATELY DOLLARS 30 MILLION, WILL FINANCE THE COST OF IMPLEMENTING THIS PROJECT OVER A PERIOD OF APPROXIMATELY EIGHT YEARS.
2. WE WOULD APPRECIATE YOUR EARLIEST CONSIDERATION OF THIS REQUEST FOR ASSISTANCE.

- WITH REGARDS,

- YOURS SINCERELY,
- SIGNED (PURSHOTTAM LAL) END QUOTE.
CREEKMORE

UNCLASSIFIED

ANNEX E

Section 611 (e) Certification

MAHARASHTRA IRRIGATION TECHNOLOGY & MANAGEMENT PROJECT

(386-0481)

This project will loan-finance 67 percent of eligible construction costs and Grant-finance 100 percent of associated long and short-term technical assistance and coordination, training and research costs of thirteen prototype medium irrigation subprojects planned by the Government of Maharashtra to test and demonstrate ways to improve the efficiency of irrigation in Maharashtra.

I, Priscilla M. Boughton, Principal Officer of the Agency for International Development in India, do hereby certify that in my judgment the Government of India and the Government of Maharashtra have both the financial capacity and the human resources to carry out, maintain and utilize this project effectively. This judgment is based upon the analyses contained in the Project Paper, as well as upon the successful maintenance and utilization of projects in India previously financed or assisted by the United States.

Priscilla M Boughton

Priscilla M. Boughton, Mission Director
USAID/India

ANNEX F. DEFINITIONS

General Terms:

Aquifer	Water-bearing stratum of premeable rock below ground surface
Conjunctive Use	Combined use of surface and groundwater in order to meet crop water requirements. Not only does the use of groundwater supplement surface water supplies, but also it reduces the likelihood of waterlogging.
Created Irrigation Potential	The area within the command areas of existing irrigation systems and thus having theoretical access to irrigation water.
Cropping Intensity	Number of crops grown per year on a given area of land, times 100.
Diagnostic Analysis	On-site, multidisciplinary examination of all aspects of an irrigation system, concentrating on the productive end and including agricultural, engineering economic, educational, social and other factors, to identify and address the constraints to optimally efficient operation. This is a concept refined and articulated by Wayne Clyma, Max Lowdermilk and others, Colorado State University, and implemented under the AID-financed Water Management Synthesis I and II Projects.
Shejpali	Rotational water supply based on applications from individual farmers. Water is shared on a rotational basis by all farmers served by an outlet. The amount of water each farmer receives is based on the requirements of the crops he indicated in his application that he would be growing each season.
Waterlogging	Saturation of soil pores by excessive water, causing oxygen depletion and anerobic conditions which can adversely affect soil fertility and plant growth. The condition is usually associated with poor drainage, heavy soils and high water tables. It can often be mitigated by increasing use of groundwater through tubewells or dugwells.

Water Management	The coordination of various public and private sector entities such as farmers and farmer organizations, irrigation and agriculture departments, markets and credit facilities to provide, when and in the quantity and form required, all information, inputs and facilities necessary to maximize the efficiency of water in the production of crops.

Seasons

Kharif	Monsoon (rainy season), June to October.
Hot Weather	Summer, March to May.
Rabi	Winter, November to February.

Irrigation Channels

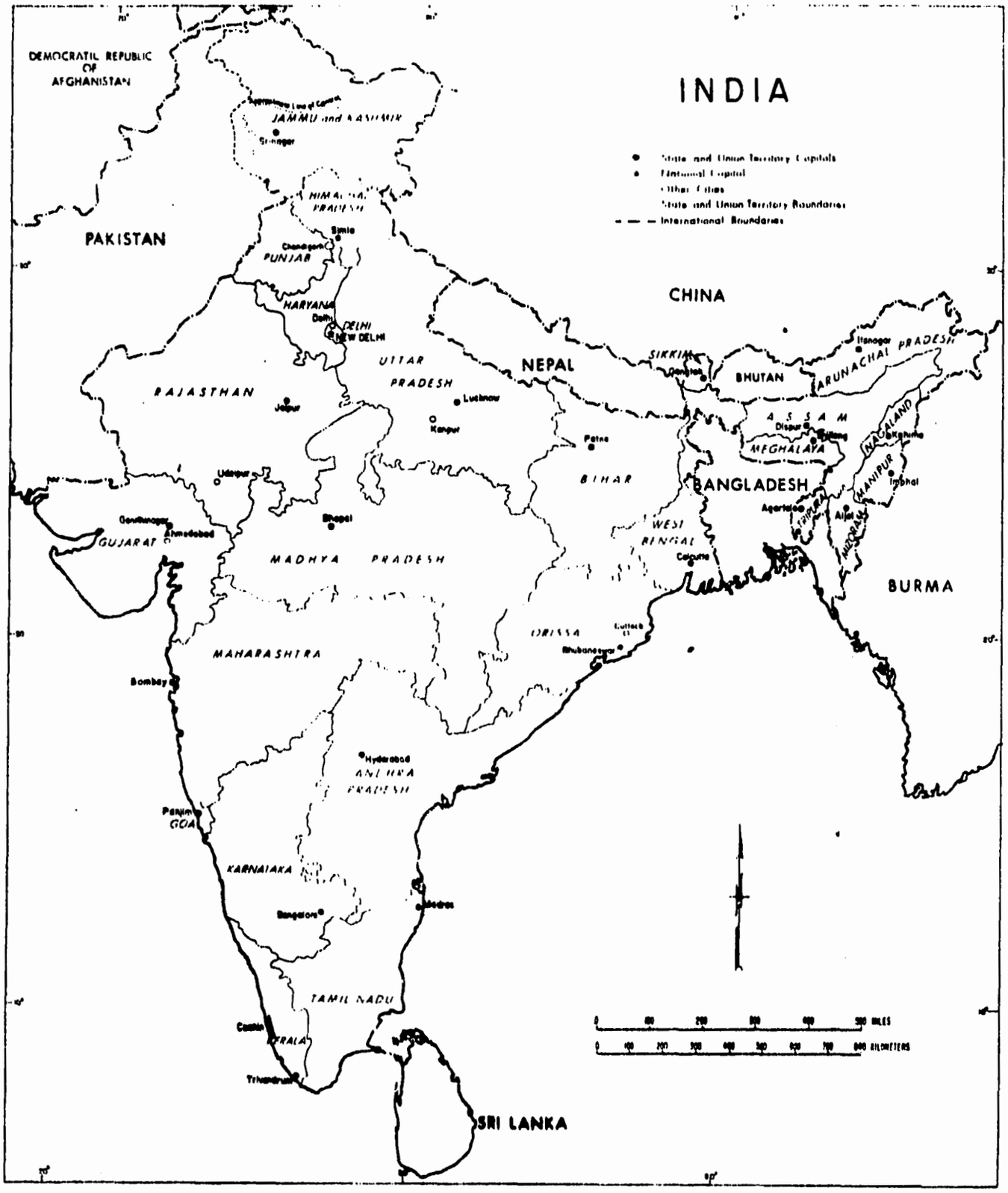
Main Canal	Canal feeding directly from a reservoir or river.
Branch Canal	Canal feeding directly from the main canal for distributing water throughout the command area.
Distributary Canal	Tertiary level channel, taking water from either the main canal or from a branch canal, and supplying water to a minor canal.
Minor Canal	Smaller canal receiving water from distributaries and supplying outlets.
Watercourse	Irrigation channel constructed to convey water from a canal outlet serving approximately 40 hectares to an eight hectare block outlet.
Field Channel	An irrigation channel built by cultivators below the watercourse to serve individual farm holdings.

Irrigation Areas

Block Irrigation Unit	Irrigation service area of about eight hectares served by a single watercourse outlet.

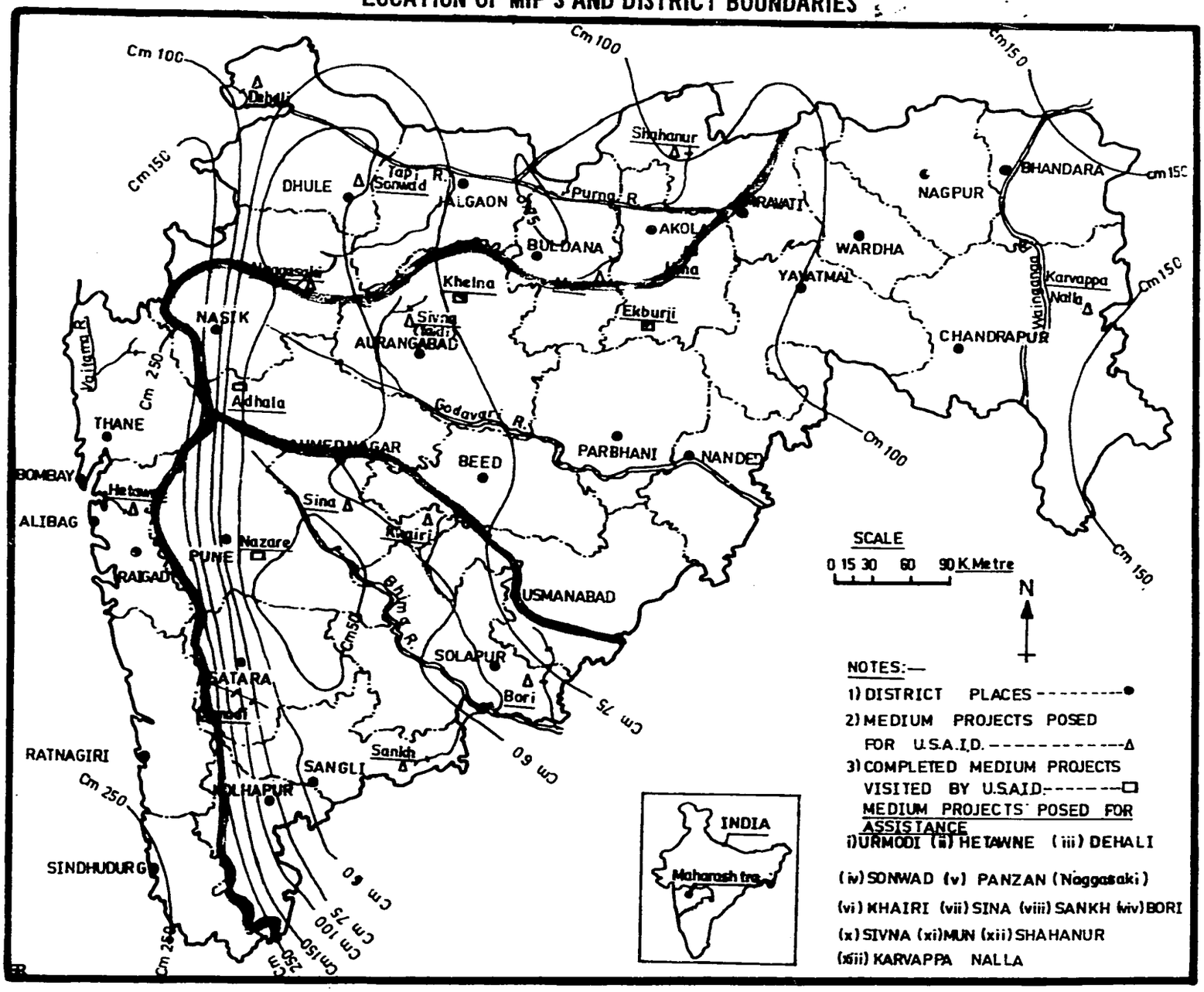
Chak	Irrigation service area of about 40 hectares served by a single canal outlet.
Culturable Command Area	That portion of the gross command area which is cultivable.
Gross Command Area	The total area within the boundaries of an irrigation project, including the areas covered by roads, villages, and both cultivable and uncultivable lands.
Gross Cropped Area	An unofficial term, used loosely in India, generally meaning the total area cropped during the three cropping seasons in a year. Three hectares, each cropped twice during the year, would be counted as six hectares for purposes of this term.
Net Cropped Area	As with Gross Cropped Area, a loosely used term in India. Generally means land cropped at least once during a year. A given parcel of land cropped more than once would only be counted once.
Irrigated Command Area (ICA)	The area within the culturable command area that can receive surface irrigation water.

Map G 1


INDIA
State and Union Territory Capitals
National Capital
Other Cities
State and Union Territory Boundaries
International Boundaries
DEMOCRATIC REPUBLIC OF AFGHANISTAN
PAKISTAN
CHINA
NEPAL
BHUTAN
BANGLADESH
BURMA
SRI LANKA
JAMMU and KASHMIR
Srinagar
HIMACHAL PRADESH
Simla
Chandigarh
PUNJAB
HARYANA
Delhi
DELHI
NEW DELHI
UTTAR PRADESH
Lucknow
Kanpur
RAJASTHAN
Jaipur
Udaipur
Gandhinagar
Ahmedabad
GUJARAT
Bhopal
MADHYA PRADESH
BIHAR
Patna
SIKKIM
Gangtok
ARUNACHAL PRADESH
Itanagar
ASSAM
Dispur
Shillong
MEGHALAYA
NAGALAND
Kohima
MANIPUR
Imphal
TRIPURA
Agartala
MIZORAM
Aizal
WEST BENGAL
Calcutta
ORISSA
Cuttack
Bhubaneswar
MAHARASHTRA
Bombay
Hyderabad
ANDHRA PRADESH
Panjim
GOA
KARNATAKA
Bangalore
Madras
TAMIL NADU
Cochin
KERALA
Trivandrum
MILES
KILOMETERS

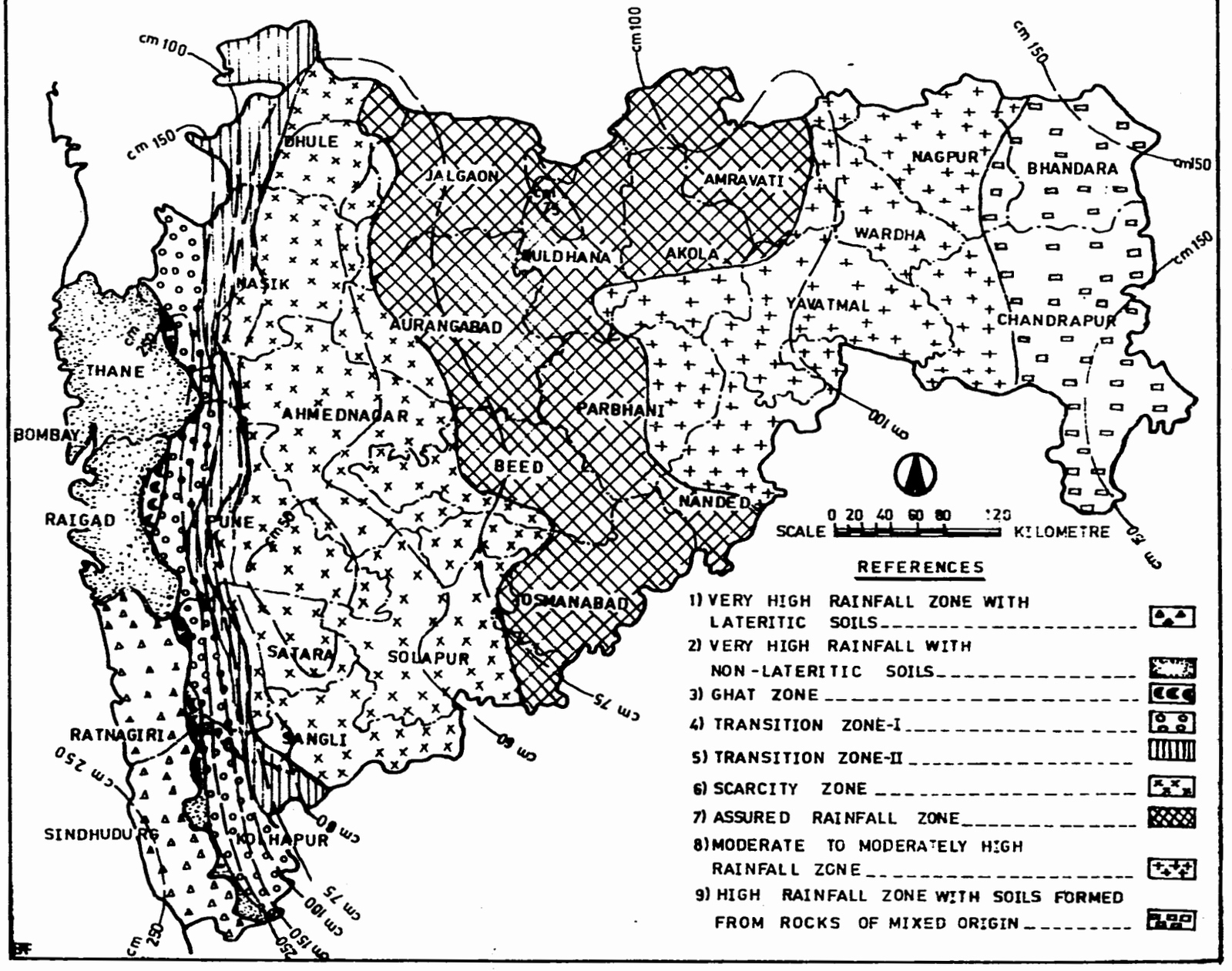
Map G 2

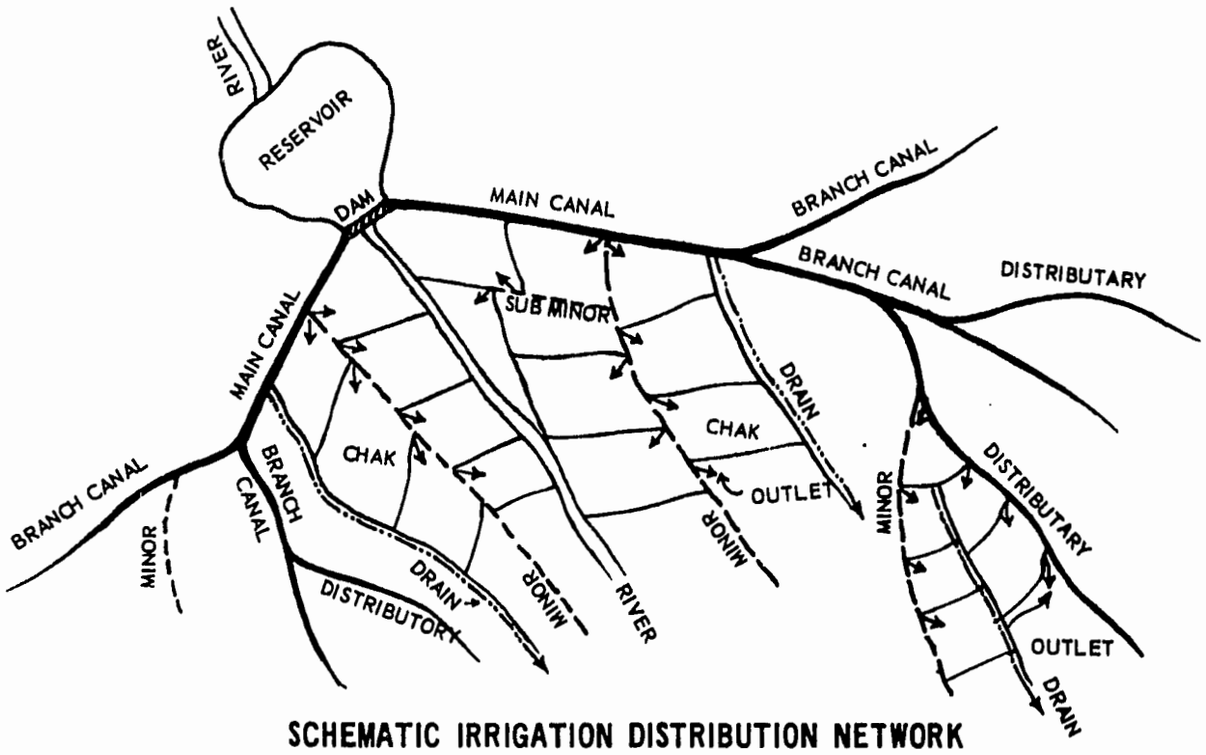
LOCATION OF MIP'S AND DISTRICT BOUNDARIES



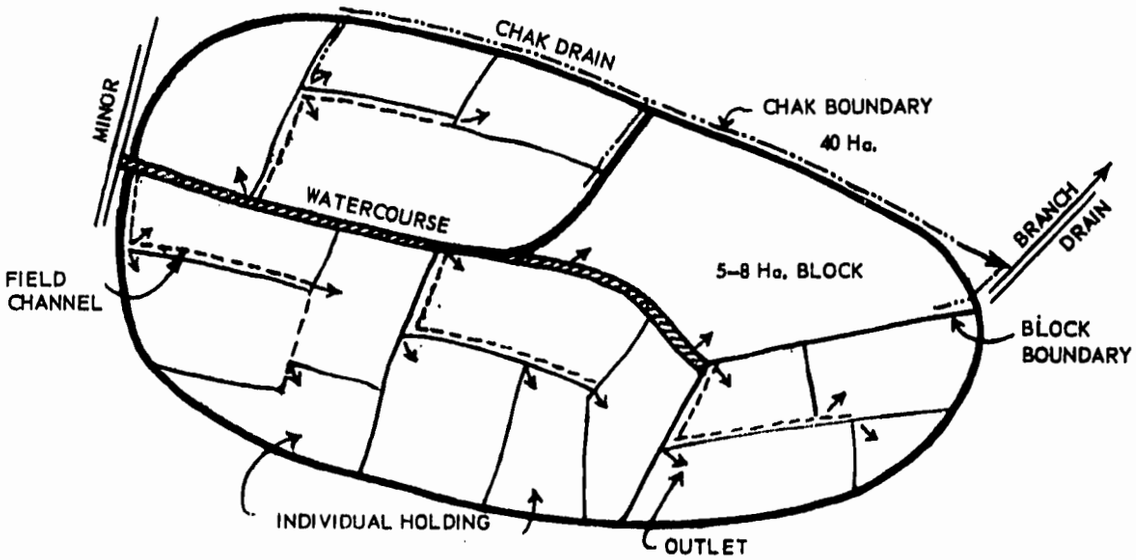
Map G 3

AGRO - CLIMATIC ZONES OF MAHARASHTRA STATE





SCHEMATIC IRRIGATION DISTRIBUTION NETWORK



WATER DISTRIBUTION WITHIN A CHAK

UNCLASSIFIED

DEPARTMENT OF STATE
AGENCY FOR INTERNATIONAL DEVELOPMENT
Washington, D.C. 20523

PROJECT PAPER

I N D I A

MAHARASHTRA IRRIGATION TECHNOLOGY AND MANAGEMENT

VOL.II
PROJECT ANALYSES

USAID/NEW DELHI, APRIL 1982

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VOL. II

PROJECT ANALYSES

CHAPTER

1. Economic Analysis

2. Social Soundness Analysis

3. Administrative Analysis

4. Technical Analysis

5. Environmental Assessment

6. Agriculture

CHAPTER I

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A. Introduction

1. General: Economic viability of the Project was examined using time discounted cash flow analysis of a sample of four proposed subprojects and of one existing project based on historical information. The four subprojects, Hetavne, Sankh, Shivna and Karwappa Nalla, were selected as being representative of principal agro-climatic zones (See Map, G 3, Vol.II). Khelna was selected as the existing project. Sensitivity due to variations in design or production estimates was examined and an illustrative examination of conveyance losses, lining and groundwater development was made. Economic methodology and criteria to be used for analysis of new subprojects are summarized.

2. Present GOM Procedure: This analysis differs from present benefit cost procedures used by GOM/CWC which do not use discounted cash flows. For these, the net direct annual benefits after full development taken as total increase in net farm income attributable to irrigation is divided by the sum of the annual interest on capital construction investment, depreciation, and project operation and maintenance (O & M) costs. These costs were calculated for the subprojects examined using annual interest at 10 percent, straight-line depreciation of works over the subproject lifetime (either 75 or 100 years) and O & M at 25 Rs/ha of CCA. Recently GOI/Ministry of Irrigation (GOI/MI) revised its procedures to provide that an allowance for land development costs (1000 - 3000 Rs/ha) be added to the capital costs and O & M costs be increased to 50 Rs/ha plus one percent of the cost of the headworks.1/

   Projected with project (W/P) yields are estimated by Director GOM/AD who also approves projected crop patterns and determines yields and existing crop patterns to be used for the without project (WO/P) case.

   Farm budgets are calculated using local market prices for farm products, estimated financial costs of fertilizer and pesticides. Allowances for value of financial costs of harvesting, tillage and labor are taken as fixed percentages of gross income after deducting harvesting costs.

   Benefit/cost ratios (B/C) calculated by GOM/ID for the sample MIPs using the old guidelines are: Hetavne, 1.71; Shivna, 1.61; Sankh, 1.40; Karwappa Nalla, 1.86.

1/ Govt. of India, Ministry of Irrigation, "Working Group Report: Guidelines for Preparation of Detailed Project Reports of Irrigation and Multi-Purpose Projects", 1980.

3. Methodology used for AID Analysis

a. General: Using economic rather than financial prices, Economic Internal Rate of Return (EIRR) was calculated for each of the study subprojects. Only direct benefits, the economic value of the increased ("With Project" [W/P] minus "Without Project" [WO/P] net farm income (excluding transfer payments such as increased taxes and water charges) after deduction of operation and maintenance costs are included in the benefit stream. Costs include the cost of capital investments necessary to achieve the increased income such as irrigation works and distribution system, drainage and land development costs regardless of whether publicly or privately financed. Total investment cost included capital costs of land acquisition for reservoirs and canal rights-of-way. Thus, no deductions were made for loss of income on these lands.

The AID analysis utilized World Bank (WB) projected 1990 world economic prices for farm crops indexed to 1979 purchasing power and "backed" to the farm gate.[2/] These were used by WB to develop crop budgets for Maharashtra conditions for analysis of the IDA/IFAD composite Maharashtra II Major Irrigation Project. WB crop budgets priced opportunity cost of labor at Rs.2.6/day and financial costs at Rs.4.6/day. For AID's analysis labor costs were adjusted to Rs.3/day and Rs.5/day. All labor, whether farm operator or hired, is included as an expense. Similar adjustments were made to financial costs for construction and O & M expenses. For this latter purpose, World Bank's Construction Cost Factor (CCF) for Maharashtra was utilized. CCF works out at 75 percent of financial costs assuming that traded items at international prices constitute 15 percent of total costs; international prices of non-traded items, utilizing skilled labor inputs, constituting 30 percent of construction costs are 80 percent of in-country financial costs and that opportunity costs of unskilled labor, constituting 55 percent of construction costs, are 65 percent of actual financial costs. EIRR computed using this procedure properly measures the economic costs and returns to a capital project by pricing out the social welfare costs. It also favors use of under-employed labor in subproject selection.

Yields and prices assumed by World Bank appear reasonable. Table 1 shows World Bank estimated yields for principal crops in comparison to yields reported for existing study subprojects. Table 2 shows a historical

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2/ The World Bank, India, Staff Appraisal Report. Maharashtra II Project No. 2529a-IN, Vol. 1, September 13, 1979.

record of wheat yields in an existing MIP. If the investments in land leveling and other criteria for subproject qualification are met, no difficulty should be encountered in reaching the W/P projected yield levels within the assumed transition period. Table 3 compares W/P projected farm crop prices with those used for GOM/ID for their analysis of the new study subprojects. Table 4 shows some recent wholesale prices. Capital costs for construction of major works, canals, distributaries and minors were taken from the subproject reports.

Land development capital costs, including development of communal field channels, distributaries and drainage below 40 hectares (Part I) and land leveling and drainage on individual farms (Part II) were based on estimates by GOM/AD/SC for an average slope distribution assuming that lands under 0.6 percent and over 3 percent slopes would not be graded. Part I (field channels and drains below the outlet) were applied to 100 percent of CCA, Part II costs (land development on individual farms) to 50 percent of CCA. GOM/AD and ID will develop cost information and methodology for estimating Part I and II land development costs on individual subprojects. Until such time as these are available and agreed to by the Appraisal Committee, Part I costs may be estimated at Rs 1725/ha and Part II at Rs 2135/ha or at 50 percent of CCA, 1068 Rs/ha or a total of 2803 Rs/ha of CCA for Part I and Part II costs applied to total CCA. Annual operating and maintenance (O & M) costs of irrigation works were estimated at 50 Rs/ha plus one percent of headworks cost as provided by the GOI/MI guidelines. O & M costs for land development were estimated at five percent of capital costs.

For the analyses, all costs and prices were expressed in terms of 1979 purchasing power since most data were available on that basis. Where sunk costs or earlier or later estimates were involved, these were corrected using all India wholesale commodity and labor cost indices or an appropriate combination. Values of these indices are shown in Table 5.

For comparative purposes, analyses without shadow pricing for non-traded items (CCF = 1.0) were made for some of the sample subprojects.[3/]

3/ Ibid, p. 85.

b. Transitions and Development Period: Time is required to place the additional area under irrigation and to implement new agricultural technology. Thus, transition estimates are needed from the "Present" case to the W/P and WO/P cases. A review of development history was made of transition to new irrigation on existing projects. While there were always shortfalls in achieving design areas; area ultimately irrigated tended to be reached in three or four years. Generally the seasonal demands were shifted heavily toward higher-water-using rabi over kharif in comparison to design projections (Table 7)4/.

For the "With Project" (W/P) case, a five-year linear areal transition was assumed. Study of the productivity of present irrigation in comparison to projected productivity as measured by effect on net W/P returns suggested an agricultural technology transition beginning at 0.5 level, i.e. present productivity is only one-half of full development productivity. An eight-year linear transition period was assumed. This transition is applied successively to each incremental area brought under irrigation. To reduce calculations a combined transition obtained by multiplying area and technology transitions for each successive incremental area and summing for each year was applied to W/P net return (Table 6). Even if the subproject is not built, some improvement in productivity and possible shifts in cropping pattern can be expected. An eight-year linear transition is assumed for transition of net revenue from the "Present" case to the WO/P case.5/

No transitions were assumed for shift in cropping patterns for each incremental area. Given subproject and project criteria, the transitions are expected to be relatively short and were assumed to be subsumed in the areal transition.

4/ For a detailed analysis of shortfall in development, see Technical Analysis, Chapter 4, Section A3.

5/ WB "Present" net returns were developed in about 1979; their WO/P net returns presumably reflect 1990 conditions. Therefore, these transitions presumably will have essentially taken place by the time the first subprojects enter the development period in 1987, thus there is an argument for omitting this transition if WB cropping patterns and estimates are used; however, this was not done in the present analysis.

Given present GOI requirements for environmental reviews, time for mobilizing resources, labor and materials, GOI/GOM officials felt that five years would normally be required for construction of major works. Construction of Part I land development is expected to take three years, beginning two years before the end of construction. Part II land development is scheduled to follow rapidly and assumed to be completed by the end of the second year following completion of construction. The combination is thus assumed to be completed in four years at 15, 35, 25 and 25 percent each successive year.

B. Analysis of Proposed Subprojects

1. Summary of Procedures: The following information is needed for economic analysis for each subproject.

(1) Cropping patterns: present, WO/P and W/P for each season, both irrigated and rainfed crops.

(2) Irrigated and rainfed areas: present, with and without project for each season. Areas to be irrigated should be based on average water supply, rather than design supply.

(3) Farm budgets showing net economic returns per hectare for each crop: present, WO/P and W/P. In order to estimate increased farm employment, labor was included as a separate cost in the analysis of some subprojects. World Bank values of net returns as stated earlier were used except that opportunity cost of labor was adjusted from 2.6 Rs/Day to 3 Rs/Day. Table 8 shows adjusted values of net returns for principal crops.

(4) Annual operating and maintenance costs for the irrigation works, land development, pumping, etc.

(5) Capital costs of major works, land development and any other required investments necessary to achieve the projected production.

(6) Transitions from present to projected areas and cropping patterns and from present to projected level of agricultural technology.

From this information future benefit and cost streams are computed. Table 9, using Karwappa Nalla as an example, illustrates calculation of returns per composite hectare of irrigated cropped area (ICA). Where separate farm labor costs are desired, separate columns are added to Tables 9 and 10.

Table 11 shows schedule of capital and operating costs. In time discounted analysis, present worth (PW) of each annual cash flow entry is discounted by multiplying by $PW=(1+R)^{-n}$ where R is the interest or discount rate which for economic analysis should be the opportunity cost of capital and n is the number of years after the base year,[6/] and summing over the lifetime of the subproject. Table 12 shows a format for this analysis. Actually this analysis was run for 25 years. This is made equivalent to project lifetime by introducing credit for salvage value (undepreciated capital) into the final year. In benefit cost (B/C) analysis B/C is the ratio of the PW of benefits (crop net returns less operating and maintenance costs) to PW of capital investment costs. Alternatively Internal Rate of Return, IRR, may be calculated graphically, or by iteration, preferably using a computer, until PW benefits equal PV of costs. For the present analysis, IRR was computed using a computer at Indian Institute of Agricultural Research Statistics.

2. Description of MIPs Examined

Hetavne: Hetavne MIP is located in the very high rainfall non-lateritic soil zone west of the Ghats. Annual rainfall is 3,050 mm (120 inches), 95 percent occurring during June - September. Irrigation will be provided to 6,753 ha irrigated command area (ICA) out of 7,456 ha of culturable command area (CCA). See engineering Section for an explanation of ICA and CCA. Present rainfed cropping pattern includes mostly rice (79 percent) and fodder (14 percent) with pulses, finger millet and other food grains making up 100 percent cropping intensity. Cropping intensity will be increased to 199.7 percent on the CCA by adding irrigated bananas and horticultural crops (perennials), late-season kharif paddy, rabi paddy, fodder, vegetables and pulses, and hot weather (March - June) groundnuts. The crop irrigation intensity will be 140 percent on the CCA[7/]. (See Table 1, p. 4 of the Technical Analysis).

Shivna: Shivna MIP is located in the western mid-plateau, somewhat east of the main rain shadow,with an average annual rainfall of 816 mm (32.14 in), 90 percent occurring during the June - September southwest monsoon. While in the "assured rainfall" zone, Shivna serves areas officially

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6/ In these tabulations the base year (the year in which construction begins is taken as year zero (0). Expenditure made during the base year are not discounted, i.e. PW for Year 0 = $(1+R)^0$ + 1.0000 = 1,0000.

7/ Cropping and irrigation intensity as used in this section counts perennials thrice and two-seasonal crops twice in contrast to usual practice in India which counts seasonal, two seasonal and perennial crops only once. The intensity as used herein is a correct index of multiple cropping. See A2, Engineering, Water Supply and Use Analysis.

designated as "drought prone". Right and left bank canals provide irrigation for 7,490 ha (18,500 A). An additional 405 ha (1,000 A) of lands adjacent to the reservoir and occupied by reservoir oustees will be served by pumps making an irrigated area of 7,895 ha in a culturable command area of 8,992 ha. Present rainfed crops include kharif crops of sorghum, millet, pulses and groundnuts with rabi, wheat and two seasonal chillies. Cropping intensity will be increased from 100 to 167 percent on the CCA with 92.2 percent (22.0 percent kharif, 70.2 percent rabi) crop irrigation intensity using improved varieties of cereals and groundnuts and introducing vegetables into the cropping pattern.

Sankh: Sankh MIP is located near the southern extremity of the plateau area in the rainfall "scarcity" zone. Annual average rainfall is about 550 mm (21.7 in), but unlike the other three MIPs examined, only 35 percent falls in the normal June - August southwest monsoon period, 45 percent during September and October and appreciable rainfall, 13 percent, during hot weather (March - May) period. Left and right bank canals command 3,543 ha culturable with an irrigated command area of 2,834 ha. Existing rainfed cropping pattern includes principally rabi (75 percent), sorghum and millet with small areas of wheat and kharif (25 percent), mostly pulses with some oilseeds, chillies and turmeric. Irrigation would support two-seasonal crops of chillies, turmeric and cotton (10 percent) and kharif hybrid sorghum, millet and groundnuts (25 percent) with follow-on and rabi seasonals of hybrid and ordinary sorghum, HYV wheat, vegetables and fodder (65 percent) with an irrigation intensity of 88 percent on the CCA, over the two seasons. No rainfed was included by GOM for the with project case.

Karwappa Nalla: Karwappa Nalla MIP is located in the far eastern part of the state in the high rainfall plateau zone; average annual rainfall is 1,750 mm (68.9 in) with 1,651 mm (65.6 in) or 94.3 percent occurring during the June - October southwest monsoon period. Irrigation will be provided to 3,890 ha within a culturable command area of 8,048 ha. Present cropping intensity is about 85 percent rainfed kharif consisting of paddy, sorghum and pulses. Irrigation intensity will be 81.2 percent of the CCA, including kharif and rabi seasonal crops, two seasonals and perennials. Rainfed crops will bring the cropping intensity to 139 percent on the CCA.

Under GOM policy, MIPs do not provide water for perennial or hot weather season crops except in the high rainfall zones west of the Ghats or in the eastern portion of the state.

3. Economic Returns for New MIPs

A base case study was made for each of the four projects using the

irrigated areas and cropping patterns given by GOM/ID subproject feasibility reports. Economic rates of return (EIRR) were as follows:

	EIRR Percent	Investment Costs w/CCF Rs 000 Major Works	Land Dev.	Other	Total	Ultimate Net Returns Rs 000/Ann.
Hetavne	12.78	115,200	22,902	--	138,102	34,267
Shivna	12.72	57,471	17,852	140	78,235	18,577
Sankh	12.67	22,559	7,032	--	29,591	7,601
Karwappa	12.67	41,896	15,997	--	57,873	14,913

Sensitivity analyses were made on questions raised by the appraisal study. (1) Reduced estimate of water deliverable to crops due to estimated higher delivery losses, (2) Applying the available water supply to a smaller command, thus increasing the intensity of the irrigation, (3) Decreasing irrigation development time, (4) Omitting kharif seasonal crop irrigation benefits. Results were as follows:

	EIRR	Points change from base	Unit Rate of Change
(1) Karwappa Nalla. Assume delivery loss increased from 45 percent as estimated to 50 percent	11.71	- 0.96	0.19
(2) Shivna. Irrigation potential based on seepage losses of 8 cfs/Msf	10.03	-2.64	-2.64
(3) Sankh. Reduce CCA by 20 percent, thus reducing losses by 5 percent and increasing irrigation intensity on CCA by 31.25 percent	15.45	2.78	0.14
(4) Sankh. Reduce irrig. development time from five to three years	13.90	1.23	1.23
(5) Shivna. Omit benefits from kharif irrigation of seasonal crops	11.41	-1.31	-1.31
(6) Sankh. Omit benefits from kharif irrigation of seasonal crops	11.94	-0.73	-0.73

(7) Sankh. Include rainfed area in with-project cropping pattern	13.53	0.86	0.86

Omitting shadow pricing and using 1990 projected World Bank farm commodity prices reduced IRR by about 3.0 percentage points, i.e. a DRR of about 9.0 percent is equivalent to an economic IRR of 12 percent.

C. Analysis of Existing MIPs

1. General Description - Khelna MIP

Khelna MIP, located in Sillod Taluka, Aurangabad District was chosen for an intensive review. This project is in the "assured rainfall zone" with average rainfall of about 630 mm. It was constructed during the period 1960-61 to 1964-65 at a cost of Rs.7,065,000. It serves a Gross Command Area of 3,555 ha with a planned annual irrigated area of 2,429 ha plus an extension of 720 ha for kharif irrigation. Water was available for rabi during the last construction year. There are 949 farm units under the unextended command with an average area under the command of 2.55 ha. Total population of the villages in the command area is 13,521.

Planned irrigated cropping pattern was as follows:

Heavy perennial	20 ha
Light perennial	40 ha
Kharif	1276 + 721 ha extended command
Rabi	324 ha
Two seasonal	729 ha
Hot weather	40 ha
	2429 ha

Information on irrigated areas and water use by seasons over the 17 year development history is quite complete and provides the basis for hydrological and economic analysis. Based on total area, utilization appears to have been low (See Table 7) ranging from 43 to 66 percent in normal years[8] and averaging only about 59 percent. Actually this inference of low utilization may be more apparent than real for reservoir water. Rabi utilization has exceeded design ranging from 84 to 175 percent and averaging 110 percent. Storage-water releases for rabi - except for four years, including the initial development year, have ranged from 115 to 174 percent of design averaging 133 percent (Table 4 Chapter 4 Technical Sec. A3 on Water Utilization)[9]. The project design visualized that 80 percent of the kharif

[8] Excluding 1964-65, 1972-73, 1979-80 and 1980-81.

[9] The ratio of relative area served and water delivered 110/133 = 0.827 indicates that design values for water requirement were about 20 percent too low.

water would come from excess flow-through and only 20 percent from storage. Apparently the kharif demand was greatly overestimated, but on the other hand, farmers have developed rabi potential to the limit of water supplies. Principal crops irrigated are wheat and gram during rabi, and sorghum and maize during kharif. Water was delivered during the hot weather season in only three of the seventeen years.

With the addition of canal irrigation, the amount of water stored in the free aquifer[10] under the command area was greatly increased. Groundwater development increased slowly until about 1975-76 when it increased rapidly, probably accelerated because of establishment of a branch cooperative bank in a project village and a sugar factory in the Taluka during that year.

2. Economic Evaluation of the Khelna Project

Table 13 gives crop/areas served by canal and well irrigation and estimated rainfed crop area during the project's history. For the four major crops, sorghum, maize, wheat and gram, net economic returns are calculated for each year. For rabi and kharif "other" crops, hot weather and well irrigated crops, composite cropping patterns were synthesized based on information about cropping patterns generally in the agro-ecological zone and on field observations (Table 14). "Without Project" returns were based on the reported existing cropping patterns prior to the project. "With project" rainfed areas were estimated as the non-irrigated kharif area with an allowance of 10.75 percent for fallow based on historical data for years 1975-76 to 1980-81. Net returns were calculated for each year using World Bank estimated net returns. Technological transitions described earlier in this section, Table 6, were imposed on net returns for canal and well irrigation.

Construction costs for major works incurred in 1960-61/1964-65 were converted to 1978-79 purchasing power by using a combination index of labor and wholesale price indices of 3.05. Land development costs, and system and land development O & M costs were estimated as for new projects as outlined earlier in this section. Groundwater development capital and operating costs were estimated using the rates developed for the conjunctive use analysis of the Shivna Project, Table 18. Estimated EIRR were (1) canal development only, 9.85; (2) combined canal and groundwater development, 11.29; (3) groundwater development only, 113. Average estimated net annual returns from canal irrigation during the period 1968-69 to 1980-81 was Rs.3,320,000. Using the previous GOI/MI guidelines, annual cost of interest and depreciation are calculated as 0.11 (21,548,000) = Rs.2,370,280 and of O & M, 25(3555) = 88875 Rs giving a benefit cost ratio of (3,320,000 - 88,875)/2,370,280 = 1.36.

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[10] The partially weathered and fractured rock zone several meters thick overlying the base rock and underlying the medium or shallow depth soils found in the project.

3. Utilization of Irrigation Potential in Existing MIPs

Actual utilization achieved on the sample of existing projects, Table 7, is not impressive, especially as shown by the "Overall" column. These data may be somewhat misleading, but nevertheless raise serious concern. Kharif irrigation is primarily drought insurance to supply irrigation if the monsoon is interrupted or for longer season crops which need irrigation after the monsoon ends. Ordinarily reservoir storage is provided for 20 percent of estimated kharif irrigation requirements, the remainder being provided by "flow through" runoff. For example, GOM/ID made the following design assumptions for Khelna:

	Area to be Irrigated	Water Requirement[a] Mm^3/Ann
Kharif	1,276	7.142
Rabi	1,053	4.874
Hot weather	100	2.543
	2,429	14,559

a/ After deducting reservoir evaporation.

After allowing for the full year's evaporation, reservoir water available totals 8.400 Mm^3. In typical year 1976-77, for example, irrigation was provided to 231 ha kharif, 1,127 ha rabi, a total of 1,358 ha or an overall utilization of only 56 percent. GOM/ID delivered 0.821 Mm^3 for kharif, 7.958 Mm^3 for rabi and none for hot weather.

Table 7 indicates that farmers are not utilizing kharif water but reserve reservoir allocations for rabi. Except for Pus, little or no design allowance was made for hot weather irrigation on the existing projects studied and it occurred on small scale, only sporadically.

Why kharif irrigation is not being used is unclear. Climatological differences between the sample MIPs do not provide a consistent explanation. Possibly kharif water shortages are increasingly met by well irrigation. Possibly water rate revisions would encourage more irrigation use during kharif. For economic evaluations to be accurate, kharif irrigation benefits apparently should be excluded.

Exclusion of kharif benefits is not without complication. Besides kharif single season crops like sorghum, two-seasonal crops like chillies extending through rabi and perennials like sugarcane and horticultural crops are allocated kharif water. The extent to which the existence of kharif irrigation potential induces farmers to take higher risks with more productive crops is unknown.

D. Study of Water Losses, Groundwater and Lining

1. General

The purpose of this study was to assess the economic effects of seepage losses on potential irrigated area, of lining and of potential for groundwater development and to illustrate an analytical methodology for such studies. Shivna subproject was selected for this examination and is described in Sec. B2. It will interact hydraulically with other existing or proposed MIPs. The first 9.0 km of the Left Bank Canal (LBC) will irrigate 2,632 ha and also will convey surplus waters from Shivna reservoir 13 km to a proposed new MIP reservoir (Devgaon) at tailend. The LBC is to be lined with concrete placed in situ. The unlined 62 km Right Bank Canal (RBS) serves 4,858 ha with Shivna water, picks up water provided by planned Sasegon MIP at km 9.20 providing main canal service for 1,498 ha from that source and transports reservoir water from existing Dheku MIP from km 17.82 to proposed Dehigoan MIP reservoir at tail. In addition, Shivna reservoir will provide water for 405 ha to be pumped to serve lands riparian to the reservoir giving a total ICA of 7,894 ha and a CCA of 8,992 ha. Subproject cost estimates include only the cost of an equivalent LBC service canal. The additional transport function of RBC does not substantially increase the cost.

2. Water Budgets

Water requirements at outlets given by the GOM report are calculated using crop water duties[11/]. These have an implicit crop evapotranspiration efficiency of about 60 percent. Rabi canal losses are estimated at 20 percent, kharif at 10 percent, giving implied irrigation efficiencies of (0.8) (0.6) = 48 percent for rabi and (0.9) (0.6) = 54 percent for kharif of deliveries from the reservoir outlet. For the analysis, 48 percent was assumed to have been the design efficiency.

11/ Duty is the estimated area that can be served by a unit stream of water. For example, 150 A/cfs is a common assumption for rabi wheat. In terms of volume (or depth) needed per acre, volume = (seconds/day) x (number of days in the season)/(acres/cfs) = (86,400) (122)/150 = 70,272 cubic feet/acre or dividing by the number of square feet in an acre, 43,560, the depth of water would be 1.613 feet or 19.36 inches. Ordinarily duty is expressed as measured at the public outlet and thus includes an allowance for watercourse, field channel and on-farm losses in addition to the water transpired by the crop. Duty may also be expressed as the estimated area which a unit volume of water can irrigate. For example, a duty of 10 acres/million cubic feet would provide 1,000,000/(43.560) (10) = 2.296 acre feet per acre. This includes an allowance for all losses including canal and reservoir losses and those below the outlet.

Duty is based on experience. It is somewhat of a "rule of thumb" concept which is being replaced by more detailed analysis of crop requirements and all system losses.

The real efficiency depends on actual seepage and operational losses. Six studies in new main canals in Maharashtra[12] gave loss rates ranging from 9 to 25 cusecs/million square feet (cfs/Msf) of wetted canal perimeter with an average of about 16 cfs/Msf. Losses from lined canals are normally estimated at 2 cfs/Msf; this has been supported by some field tests, others show losses of up to 9 cfs/Msf, but with good design and quality control, 2 cfs/Msf is believed realistic.

An analysis using the average of the above measurements, 16 cfs/Msf for the unlined RBC was initiated. However, the estimated water losses for this long canal based on this assumption were so high that the canal would have been virtually inoperable so 8 cfs/Msf was used for the study with a lined value of 2 cfs/Msf. For sensitivity testing, an intermediate value of 5 cfs/Msf was assumed.

The efficiency applied to volume delivered (in contrast to flow at any given time) depends upon the number of days the canal or channel is operated. Values of 100 days out of the 123 day rabi season and 20 days for the 122 day kharif season were assumed. After reservoir evaporation losses, the subproject design provides 7.80 Mm^3 for kharif and 29.26 Mm^3 for rabi. Storage is provided for 1.56 Mm^3 for kharif with the remainder planned as flow through. Additional storage of 1.66 Mm^3 is provided for the lift pump area.

For the analysis, operational losses, Table 15, were assumed at 20 percent for unlined and 15 percent for lined canals with unlined distributary and field channels. Based on a loss rate of 8 cfs/Msf, the GOM/ID project report includes an estimate of seepage losses of 37.525 cfs for the RBC when flowing at peak capacity. Distributary, minor, canal and field channel losses were assumed at 20 percent with an overall field application efficiency for properly leveled fields of 80 percent. In line with Indian experience it was assumed that 50 percent of irrigation system losses could be recovered by pumping. Canals are sized to meet peak daily crop requirements. These occur only for a few days each season so average flow is less than design capacity. Operating the canal at average flow will not greatly reduce seepage loss over peak flow operation because the area through which water can seep is not substantially reduced. Considering the apparent tendency not to develop kharif irrigation in existing MIPs, the water budgets were based on the assumption that reservoir storage allocated to kharif would actually be used for rabi. The ratio of area that can be irrigated to that planned (water supply factor) for each case and the amount of water that can be recovered by pumping groundwater is also estimated in Table 15. This same methodology can be used for two or three season irrigation.

12/ World Bank, Staff Appraisal Report 2529a-IN, Maharashtra Irrigation II Project, Vol. 2, p. 102.

3. Costs and Benefits

a. Reservoir and Canal System Costs: The capital cost, Table 16, was adjusted by a factor of 0.954 to allocate an appropriate share of the cost of the headworks to the extra storage required to accommodate Devigaon. Land development costs, system and land development O & M costs and investment schedules were estimated as described in section A3. Cost for lining the RBC was estimated based on a direct cost of Rs 30/m^2 plus 14 percent indirect cost. All were converted to economic costs by a CCF of 0.75.

b. Groundwater Costs: Costs of well development and pumping were calculated based on information contained in World Bank Gujarat Medium Irrigation Project Assessment[13/] for dugwells in fractured rock, Table 17. These costs were developed in 1978. Since economic base year for this analysis was 1979 they were not adjusted for inflation. Table 18 shows the annual cost per 1000 m^3 capacity to develop and pump over a development period assumed at ten years at 10 percent each year, with 30-year life of well and five-year life of equipment. Well development is assumed to begin in the third year following completion of construction of major works.

c. Benefits: Economic benefits for canal irrigation were also calculated using cropping patterns provided in the GOM/ID report as described in Sec A3. Planned irrigated area was multiplied in each case by the water supply factor from Table 15. Under the assumptions made, for the 8 cfs/Msf seepage loss case, irrigated area would be 79.6 percent of that planned. With lining this would be 100.7 percent, or essentially as planned.

For groundwater, benefits were calculated per 1000 m^3 using an assumed cropping pattern inferred from information and observation on Khelna MIP (see Table 14) and estimates of irrigation requirements at the pump outlet. An estimated linear technology transition of from 70 percent to 100 percent in five years was assumed (Table 6). Costs and benefit streams for each case were obtained by multiplying the benefit and cost factors from Table 18 by the estimated volume of groundwater recoverable from Table 15.

13/ World Bank, Appraisal Report of the Gujarat Irrigation Project No. 1943a-IN. p. 109.

4. Internal Rate of Return

Internal rate of economic return for each of the three cases was calculated assuming (1) canal water only and (2) with conjunctive use of groundwater in combination with (i) full estimated irrigated kharif benefits and (ii) no benefits from canal irrigation of kharif seasonal crops. Results are shown below [14]

	Economic Internal Rate of Return, Percent				
	Full Kharif Irrigation Benefits		No Benefits from Irrigation of Kharif Seasonals		Groundwater Only
	Canal Only	Conjunctive Use	Canal Only	Conjunctive Use	
Unlined RBC 8 cfs/Msf	10.03	11.48	9.21	10.53	91.4
Unlined RBS 5 cfs/Msf	10.78	12.26	9.92	11.20	91.4
RBC lined 2 cfs/Msf	10.56	12.25	9.97	11.05	91.4

5. Area Commanded by Main Canals

It is not economical to extend canals beyond a point where the net returns from the added irrigated area does not at least return the added costs of extending the canal. The latter costs are the actual cost of constructing a unit length (km) of canal plus the reduction in irrigated area due to seepage lost in the kilometer length. These costs and benefits should be based on present worth of discounted cash flows. For 120 day operation (100 days rabi and 20 days kharif) volume losses in the 62 kilometer RBC at 8 cfs/Msf are 35.6 percent or about 0.57 percent per km. As a first approximation from the base B/C analysis at 12 percent discount, Table 19, the present worth of the design project benefits, less annual O & M, is Rs. 55.091 million or 6,979 Rs/ha for the 7,894 ha ICA. The reduction in present worth of net returns due to seepage losses per km is .0057 (55,091,000) or 314,000 Rs/km. PW cost of an additional kilometer of canal is 342,500 Rs/km. Thus 6,979 A = 314,000 + 342,500, A = 94.07 ha/km where A is the minimum economical irrigated area that can be served by one kilometer of canal. Lining the canal increases canal cost by 40 percent but reduces seepage losses by a factor of 0.25 thus 6,979 A = (1.4) (342,500) + (0.25) (314,000) = 79.95 ha/km.

As a general rule, qualifying projects canals should not be extended beyond a point where they command less than about 100 ha/km of ICA unless this can be justified by a special economic analysis made as outlined above.

14/ Land development costs and schedule were revised after this section was written. This would result in some rather small changes in the numerical results.

E. Summary of Analysis

The analysis shows that investments in MIPs proposed under the Project, if they meet their target service areas, can be expected to yield economic returns greater than 12 percent. Generally, the assumptions made are conservative. The construction period of four years is believed realistic and might be reduced on some subprojects. The transition period to irrigation is believed conservative. Existing projects, while they have not reached full planned kharif utilization, have generally reached full rabi/hot weather utilization in less than five years. The eight-year technology transition period combined with the area transition means 14 years (19 years after construction is started) before full returns are realized. Projected yields should be attainable given the early land development program included in the costs and being implemented by GOM. The crop net returns used are slightly lower than those forecast by World Bank because opportunity cost of labor was priced at 3 Rs/day instead of Rs 2.6/day. On the other hand, important factors which could cause shortfall are overestimation of water supply that can be delivered to fields because of high canal and channel losses and utilization of water during kharif. These generally appear too optimistic.

Analysis of the existing Khelna Project shows an EIRR of 9.85 percent, but with groundwater development enhanced by recharge from canal irrigation this rose to 11.29 percent. The reasons for shortfall of this project appear to be as stated above, although the overestimate of kharif irrigation was offset somewhat by increased rabi irrigation. Using the GOI/MI benefit/cost guidelines in force until 1981, the B/C ratio is 1.36. In any event, this post analysis demonstrates the economic benefits of MIPs in spite of shortcomings. GOI/GOM have taken some steps since Khelna was constructed which will improve economic returns. A number of additional steps will be taken under this project which will result in accelerated technological development.

The illustrative study of lining and conjunctive use of groundwater made of the proposed Shivna subproject applies a more rigorous methodology for estimating canal and other conveyance losses and calculating available crop water supply than is now commonly used. This procedure should reduce the uncertainty regarding irrigation potential. The results show that even with moderate seepage rates, losses from long unlined canals can significantly reduce areas that can be irrigated with available water supplies. Recovery of water losses by groundwater development can restore some of the benefits, raising the EIRR by from 1.0 to about 1.7 percentage points. This and the Khelna analysis emphasizes the economic importance of groundwater recharge and conjunctive use. Lining becomes economical if seepage losses exceed about 6-8 cfs/Msf for lining costing Rs.30 - 40/sq. meter regardless of whether or not losses are recovered by groundwater development. These conclusions are generally consistent with World Bank and other studies.

On any subproject actual losses will depend upon length of time canal is operated, its physical length and seepage loss rates. The Shivna analyses using the water budgeting procedure outlined in Table 15 showed EIRR of 10.03 percent for benefits from canal irrigation only, using an assumed seepage loss rate much lower than has been observed in Maharashtra canals. This illustrates the effect of canal loss assumptions on design and the importance of being able to predict canal losses in advance with reasonable accuracy.

This analysis does not mean that Shivna or other subprojects cannot meet economic targets. Steps can be taken to increase returns by lining canals if required and by increasing irrigation intensity and reducing culturable command areas. Karwappa Nalla, whose main canal is lined, shows a satisfactory EIRR even though lining costs are double those normally incurred (70 Rs/m^2 compared to about Rs 35/m^2) because rough sections through jointed rock will require additional masonry to bring the channel to desired shape prior to lining. EIRR also can be increased by reducing length of main canals and CCA thus decreasing seepage losses and increasing irrigation intensity. Sensitivity analysis (Sankh subproject) shows that reducing CCA by one percent increased EIRR by 0.14 percentages points. Technical and economic criteria for qualifying subprojects are designed to insure that water available for crops will be as required under design assumptions.

Seepage loss rates remains a big uncertainty in determining conveyance losses. Under this project, a program of seepage loss measurements correlated with soil or sub-soil characteristics will be initiated (See Chapter 4 Technical Sec. B2d). Where these losses are excessive, canals will be lined selectively based on economic considerations.

F. Subproject Criteria, Studies and Training

For subprojects qualifying under the loan, EIRR calculated along the lines outlined in Sections A3 and 'E' above shall be not less than 12 percent*. Before, WO/P and W/P cropping patterns for calculating benefits shall include the entire CCA, not just the ICA as now, and all rainfed crops shall be included for each case. No benefits will be taken for kharif irrigation of seasonal crops by canals; however, an equivalent area of kharif rainfed and credit for benefits from developing recoverable groundwater may be included following the procedure outlined in Section D3.

For continuing effectiveness in the allocation of scarce and abundant resources, facing a dynamic shift in price structure due to rising petroleum costs and other reasons, periodic assessments of the proportion of labor costs of construction and farming and of opportunity costs of farm and construction labor should be conducted and appropriate adjustments made in CCF and farm budgets. GOM/ID will initiate such a study utilizing internal or contract resources. The study will

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*Alternatively, a B/C ratio calculated at 12 percent discount rate shall be 1.0 or greater. Projects in tribal and drought prone areas may have an EIRR of 10 percent.

be completed by the end of the sixth month after signing the loan agreement and, if jointly agreed by GOI/GOM and USAID after review, used for estimating subproject economic returns. The study will be repeated and expanded to include review of economic prices and farm budget costs in time for the mid-term evaluation scheduled approximately 33 months after project implementation. Until the results of such a study or parts of it are reviewed and agreed upon, economic analysis of subprojects will use the CCF and economic farm budgets set forth in the WB Maharashtra II Report with adjustments to Rs.3/day labor cost as shown in Table 8.

The reasons for the apparent failure to realize kharif irrigation should be understood and steps taken to correct them, or if appropriate, adjust design procedures. Accordingly, GOM/ID will study five representative existing MIPs to ascertain why canal water is not being taken for kharif, the effect of kharif production under canal commands, even without taking irrigation, the potential for improving kharif utilization through water rate adjustments and other appropriate factors. In the meantime, benefits attributed to irrigation of kharif seasonal crops will not be credited in economic evaluation of participating subprojects but an equivalent area of rainfed kharif included. Two-seasonals and perennials, while high value crops, usually constitute a small fraction of the total cropping pattern and may be included, but special consideration should be given by GOM/ID as to how their kharif needs will be met. This possibly can be done by wells.

For qualifying subprojects, GOM/ID, within one year after completion of major construction, will prepare a development scheme for groundwater with credit packages, including establishment of a branch development bank in the area if necessary.

Additional capability in economic analysis with professionally trained economists will be established, possibly in the Project Preparation Cell or Central Design Section. This group will monitor economic analysis of subprojects; compile economic information resulting from baseline surveys, such as farm budgets; analyze economic implications of information collected by the water management studies as may be agreed, including irrigation water utilization or insurance on kharif crop benefits; make optimization studies of reservoir size vs. reliability; establish economics of canal lining; determine costs and benefits of groundwater development; analyze economics of conjunctive use of groundwater; and possibilities of increasing reservoir storage capacity to capture flow-through water now allocated to kharif so that it can be used for rabi. Based on its findings, the section may recommend changes in economic analysis standards and procedures for joint consideration by GOI/GOM and USAID. Using grant funds, AID will support costs of special studies, including consultants and three months U.S. training in economic analysis for four mid-level officers, responsible for subproject development and evaluation.

Table 1

WORLD BANK PROJECTED AND
REPORTED CROP YIELD ON EXISTING MIPs, QQ/ha.

WO/P (R.F.)	World Bank 2529a-IN	Ekburji	Adhala	Khelna	Pus
Sorghum	6.0	5.3	5.5	15-20 (kh)	
Millet	3.5		2.4	7.5	
Wheat	5.8	4.0	3.5	7.5 - 10	
Paddy	15.0		8.5		
Gram	5.0		3.2	2.5 - 5.0	
Oilseed	4.5		2.3		
Vegetables		25.0			
Chillies, etc.	5.8				
Other, Cereals		3.8	2.8		
Groundnuts	7.0		7.7		
Fodder	200.0				
Cotton	3.0	0.7		7.5	
Pulses	3.0		2.8		
W/P (IRR)					
Sorghum HYV	30	20.0	17.5 (R)	25-37.5	
Millet			17.5		
Wheat	25	25.0		20-25	24.8
Paddy	25-40				
Gram	12			15-20	
Oilseed	15				
Vegetables	200		92.5 (kh)(R)		
Chillies	11		16.25		
Other, Cereals		15.0			
Groundnuts(kh)	15		14.0		
Groundnuts(H.W.)	20				
Turmeric	30		27.5		
Onion (kh)	200		162		
Onion (rabi)	200		275		
Fodder	230				
Cotton		8.3			
Cotton L.S.	18		20.0	20-30	
Maize	40			30-45	

Kh - kharif
R - rabi
IRR - irrigated
RF - rainfed

Table 2 WHEAT YIELDS IN PUS PROJECT

Year	Number of Villages Reporting a/	Average Yield QQ/ha	Area in Wheat (ha) b/
72-73	8	25.66	2,035
73-74	9*	10.85	2,524
74-75	2	12.85	1,120
75-76	14	33.93	1,861
76-77	15	29.28	2,648
77-78	18	25.80	2,178
78-79	9	28.64	1,559
79-80	4	32.89	1,328
80-81	8	23.36	1,190
Unweighted Average			

a/ Out of 36 villages
b/ Not necessarily all reported in Col (2)
* Reservoir did not fill

Table 3 FINANCIAL FARM CROP PRICE COMPARISONS
Rs/Q

Crop	World Bank Financial 1979	Hetavne	Shivna	Sankh (1979)	Karwappa Nala (1979)	From Rajasthan MIP PP
Sorghum						
Local rabi	141			120		
All other	129		108	100	110/115	130
Paddy						160
Transplanted	95	85			141	
Drilled	107					
Millet	112		114	150		
Maize	112					117
Groundnuts	227	260	262	240		
Cotton						
Local	400					
Hybrid	500			320		400
Chillies	600		900	400	400	
Onions	66			27		
Pulses	187	280	235	190	190	180
Wheat	150		157	175	178	124
Gram/Peas	148		175		149	
Oilseeds	218					280
Fodder						10
Kharif RF	11			10		
HW Irrigated	13	10			12.5	
Sugarcane	12					13
Turmeric	400			400	400	

Table 4

WHOLESALE PRICES OF SELECTED COMMODITIES
IN MAHARASHTRA, 13 FEBRUARY 1981

Market	Commodity	Price
Kolhapur	Paddy (medium)	Rs. 145.00/Q
Gondi	Rice (coarse)	190.00/Q
Nagpur	Rice (coarse)	220.00/Q
Akola	Jowar (yellow)	137.00/Q
Nagpur	Jowar (white)	150.00/Q
Bombay	Wheat	141.00/Q*
Amravati	Wheat	193.00/Q
Aurangabad	Gram (yellow)	400.00/Q
Bombay	Arhar	427.50/Q
Bombay	Masur	537.50/Q
Bombay	Mung	462.50/Q
Bombay	Chillies	687.50/Q
Bombay	Groundnut seeds	590.00/Q

*Wholesale ex-godown price fixed by state

Table 5

WHOLESALE COMMODITY PRICE AND
AGRICULTURAL LABOR INDICES, INDIA
1970-71 Base

Year	Agricultural Labor*	Wholesale Commodity
1969-70	1.00	0.948
1970-71	1.00	1.000
1971-72	1.05	1.056
1972-73	1.22	1.162
1973-74	1.33	1.397
1974-75	1.87	1.749
1975-76	1.81	1.730
1976-77	1.62	1.766
1977-78	1.75	1.858
1978-79	1.75	1.858
1979-80	1.97	2.176
1980-81	2.08	2.565
June '81		2.79

* 1979-80 and 1980-81 estimated by linear regression with commodity price index.

Table 6

IRRIGATION DEVELOPMENT
AGRICULTURE TRANSITIONS

Year after construction of major works	Canal Irrigation			Well Irrigation		
	Area	Tech-nology	Composite	Area	Techn-ology	Composite
1	0.2	0.5626	0.11			
2	0.4	0.6250	0.24			
3	0.6	0.6875	0.38	0.1	0.76	0.076
4	0.8	0.7500	0.52	0.2	0.82	0.158
5	1.0	0.8125	0.69	0.3	0.88	0.246
6		0.8750	0.75	0.4	0.94	0.340
7		0.9375	0.81	0.5	1.00	0.440
8		1.0000	0.87	0.6		0.540
9			0.93	0.7		0.640
10			0.96	0.8		0.740
11			0.99	0.9		0.840
12			1.00	1.0		0.940
13						0.964
14						0.982
15						0.994
16						1.000

Table 7 DEVELOPMENT HISTORY OF EXISTING MEDIUM IRRIGATION PROJECTS

	KHELNA			PUS				EKBURJI			ADHALA				NAZARE
	Kharif	Rabi	Over-all[a]	Kharif[c]	Rabi[c]	Other[c]	Over-all	Kharif	Rabi	Over-all	Kharif	Rabi	Other[e]	Over-all	Over-all
Design Crop Irrigated Area, ha	1276	1053	2429	5011	7969	1150	14130	1822[f]	607[f]	2429	2544	2231	314	5089	2453
Year															
1964-65		23	10						24	6					
1965-66	29	84	52					30	74	43					
1966-67	34	85	55					60	242	100					
1967-68	38	90	61					39	129	62*					
1968-69	75	99	62						99	25					
1969-70	26	100	57						102	25					
1970-71		125	55						139	35					
1971-72	11	140	66*	9.0	6.9	9.2	7.8		27	7*					
1972-73		30	13*[b]	59.1	89.6	82.6	78.2		146	36*					
1973-74		175	75	27.4	94.5	79.2	67.2		149	37					
1974-75	34	103	62*	36.3*	54.6*	27.4*	4[illegible].0*		61	15*					
1975-76		133	65	5.0	61.2	58.6	38.5		129	32					
1976-77	18	107	56	20.9	95.3	65.0	64.9	0.3	184	46	71.5	91.7		75.9	
1977-78	15	101	54*	22.8	81.1[d]	65.1[d]	63.3		145	36	32.7	105.2	143.9	71.9	51
1978-79	13	90	43	20.7	60.8	98.2	54.1	4.3	140	38	15 1	77.4	256.4	57.3	32*
1979-80	2	54	23	61.9	71.1	135.8	80.2		140	35	4.4	33.3	178.4	27.8	41
1980-81	6	77	32	59.0	74.7	461.3	100.6				2.8	31.8	114.9	23.6	

Note: The crop irrigated area reflects the sum of seasonals, two-seasonals and perennials as shown in Table 2 - Water Supply and Engineering Section, only for Pus Project. In reporting actual areas, two seasonals were frequently included only once with kharif. This is the case for Ekburji; for rabi, it is unclear whether or not CWC seasonals were included so the columns on rabi and overall may be substantially overestimated for Ekburji which are included only to show trends.

a/ Includes 100 ha percent hot weather

b/ Scarcity year

c/ Perennials and two seasonals are added to seasonals

d/ HW g[illegible]eased from 8 ha in 1976-77 to 1741 ha in 1980-81, rabi wheat decreased from 2649 ha to 1191 ha in s

e/ Two

f/ Two [illegible]uded only in kharif

* Reservoir did not fill

Table 8 ECONOMIC CROP BUDGETS FOR PRINCIPAL CROPS IN MAHARASHTRA, 1990 PROJECTED ECONOMIC PRICES

	Yield QQ/ha	Price Rs/QQ	By-product Rs/ha	Inputs Labor Rs/ha	Inputs Other Rs/ha	Net Value Rs/ha
Before Project						
Kharif, RF						
Sorghum, Local	6.0	132	120	180	314	419
Sorghum, HYV	14.0	132	240	240	713	1135
Paddy	15.0	137	160	270	775	1170
Pearl Millet	3.5	115	115	120	178	220
Maize	10.0	115	96	216	424	606
Groundnuts	7.0	260	200	285	657	1078
Cotton	3.0	407	---	285	357	579
Chillies	5.0	522	---	525	1056	1029
Pulses	3.0	191	32	120	158	327
Fodder	200.0	10	---	270	457	1273
Rabi, RF						
Wheat	5.0	127	64	165	455	79
Sorghum, Local	4.0	144	144	135	134	451
Gram/Peas	4.0	151	48	135	190	327
Oilseeds	4.0	233	---	150	160	622
WO/P						
Kharif, RF						
Sorghum, Local	7.0	142	168	189	356	617
Sorghum HYV	16.1	142	307	249	853	1491
Paddy	17.0	161	176	281	978	1654
Pearl Millet	4.0	141	134	126	189	383
Maize	12.0	141	112	228	525	1051
Groundnuts	8.1	267	240	315	799	1289
Cotton	3.5	437		315	620	595
Chillies	5.8	770		540	1320	2606
Pulses	4.0	180	40	131	160	449
Fodder	230.0	10		288	540	1472
Rabi, RF						
Wheat	5.8	153	77	180	560	224
Sorghum, Local	5.0	154	180	144	226	580
Gram/Peas	5.0	214	60	147	365	639
Oilseeds	4.5	270		159	192	891
W/P						
Kharif, IRR						
Sorghum, Hyv	35	142	480	330	1522	3596
Paddy, Drilled	25	161	200	324	1236	2665
Paddy, Transp.	40	144	400	420	2101	3638
Pearl Millet	20	141	230	255	862	1933
Maize	40	141	400	342	1843	3855
Groundnuts	15	267	500	450	1371	2684
Cotton	18	544		630	2208	6954
Chillies	11	770		600	1674	6196
Turmeric	30	440		941	5751	6508
Vegetables (rabi & kharif)	200	60		996	2612	8392

Table 8 (con't)

	Yield QQ/ha	Price Rs/QQ	By-product Rs/ha	Inputs Labor Rs/ha	Inputs Other Rs/ha	Net Value Rs/ha
W/P						
Rabi, IRR						
Wheat	25	153	256	330	1558	2193
Sorghum, Local	16	154	600	219	843	2002
Sorghum, HYV	30	142	384	285	1214	3145
Sorghum, Rattoon	25	142	336	210	1008	2668
Maize	32.5	141	320	294	1222	3387
Gram/Peas	12	214	144	216	706	1780
Potatoes	200	86		540	6153	10507
Oilseeds	15	270		240	747	3063
Hot Weather, IRR						
Groundnuts	20	267	500	525	1421	3884
Fodder	350	12		354	1825	2021
Perennials, IRR						
Sugarcane						
Plant	1050	16		870	4691	11239
Rattoon	750	16		480	2036	8484
Lucerne						
Three Year	800	20		708	1759	13533

Adapted from World Bank Maharashtra Irrigation II. 2529a-IN.

Table 9

CROPPING PATTERNS AND NET ECONOMIC RETURNS, KARWAPPA NALLA

Crop	Net Return Rs/ha	Cropped Area Percent	Composite Net Returns - Rs/ha
Present - Rainfed			
1. Paddy	1170	65	760
2. Sorghum	419	6	25
3. Pulses, other	327	14	46
4. Fallow		15	
Total			831
WO/P - Rainfed			
1. Paddy	1653	65	1074
2. Sorghum	580	6	35
3. Pulses, other	448	14	63
4. Fallow		15	
			1172
W/P - Irrigated			
Perennials			
5. Sugarcane	11239	9	1012
6. Fruit, other per.	3015	1	30
Two Seasonals			
7. Chillies	6196	10	620
8. Turmeric	6508	5	325
Kharif Seasonals			
9. Late Paddy	3639	45	1638
10. Hybrid Sorghum	3596	5	180
Rabi Fallow On			
11. Gram	1790	25	448
12. Hybrid Sorghum	3145	15	472
13. Wheat	2189	20	438
		(135)	(5163)
Unirrigated			
14. Early Paddy	1653	10	165
15. Pulses	448	5	22
16. Green manure	1472	10	147
		(25)	(334)
TOTAL		160	5497

CCA = 8048 ha, ICA = 3890 ha, Average water supply = 0.97

Ultimate Net Returns W/P

Irrigated - (3890) (5163) (0.97)	=	19,482,000
Rainfed - (3890) (334)	=	1,299,000
W/P	Rs	20,781,000
WO/P (3890) (1172)	Rs	4,559,080
Before (3890) (831)	Rs	3,232,590

Table 10

ANNUAL CROP NET ECONOMIC RETURNS, KARWAPPA NALLA

	Transitions		Net Returns Rs.000 W/P				
Year	Composite	Old Area	New Irrigation	Present Area Transition[a]	Total	WO/P	Net Total
4				3233	3233	3233	0
5	.11	0.8	2286	2719	5005	3399	1606
6	.24	0.6	4987	2139	7125	3565	3560
7	.38	0.4	7897	1500	9397	3730	5667
8	.52	0.2	10806	774	11580	3869	7711
9	.69	0	14340	0	14340	4052	10288
10	.75		15586		15586	4228	11358
11	.81		16833		16833	4393	12440
12	.87		18079		18079	4559	13520
13	.93		19326		19326	4559	14767
14	.96		19950		19950	4559	15391
15	.99		20573		20573	4559	16014
16	1.00		20781		20781	4559	16222
--			"		"	"	"
--			"		"	"	"
24			20781		20781	4559	16222
25			20781		20781	4559	16222

[a]WO/P multiplied by transition factor for "old area".

Table 11

CONSTRUCTION AND O & M COSTS, KARWAPPA NALLA (Rs.000)

Year	Major Works	Land Development	System O & M	Land O & M	Total O & M
0	6284				
1	10477				
2	10477				
3	10477	2397			
4	4190	5592			
5		3994	102	160	262
6		3994	204	320	524
7			306	480	784
8			408	539	947
9			510	799	1309
-			"	"	"
-			"	"	"
24			510	799	1309
25	-27928*	-15977**	510	799	1309

*Salvage value at 75-yr life, straight line depreciation

**Assumed salvage value is 100 percent

Table 11 (con't)

Notes
Construction Cost

Construction Cost Estimates, 1980-81. 72,618,000 Rs.
Wholesale Price Index (CPI) 1978-79/1980-81 = 256.5/185.8 = 1.384
Agricultural Labor Index 288/172 = 1.188
Weighted Construction Index - (.4) (1.188) + (.6) (1.384) = 1.30
Base Year Cost 72,618/1.30 = 55,860
Apply CCF = 0.75 = 41,900

Land Development

Apply on slopes 0.6 - 3.0 percent. Part I on 100 percent of CCA
Part II on 50 percent. Weighted cost used in this example is 2647 Rs/ha.
(8048) (2647) = 21,303. Apply CCF = 0.75 (21,303) = 15,977.

System O & M (50 Rs/ha) (CCA) + (one percent of cost of headworks) CCF
(50) (8048) = 402; (.01) (27,800) = 278; (402 + 278) (.075) = 510

Land O & M Five percent of land development costs: (.05) (15,977) = 799

Table 12

CALCULATION OF B/C RATIO AT 12% DISCOUNT, KARWAPPA NALLA

Year	PW Factor	Capital Costs	Net Returns less O&M	Present Worth Capital Costs	Present Worth Benefits
0	1.00	6284		6284	
1	.893	10477		9356	
2	.797	10477		8326	
3	.712	12874		9166	
4	.635	9782	1344	6182	853
5	.567	3994	3036	2265	1721
6	.507	3994	4883	2025	2476
7	.452		6764		3057
8	.404		8979		3626
9	.361		10049		3628
10	.322		11139		3586
11	.287		12211		3504
12	.257		13458		3459
13	.229		14082		3223
14	.205		14705		3015
15	.183		14913		2729
16	.163		14913		2431
17	.146		14913		2177
18	.130		14913		1939
19	.116		14913		1730
20	.104		14913		1551
21	.093		14913		1386
22	.083		14913		1238
23	.074		14913		1104
24	.066		14913		984
25	.059	-43905	14913	-2590	880
				41034	50297

B/C Ratio = 50297/41034 = 1.23

Table 13

CROPPED AREAS IN KHELNA PROJECT
(Hectares)

Year	Canal Irrigation							Wells W/P - WO/P[a]				RAINFED [b]
	Kharif			Rabi			Hot					
	Sorghum	Maize	Other	Wheat	Gram	Other	Weather	Kharif	Rabi	H.W.	Total[c]	
1964-65	---	---	---	188	49	3					--	2317
1965-66	257	---	118	624	124	137					20	1942
1966-67	179	181	76	678	136	81					40	1781
1967-68	341	24	117	564	354	33	59				60	1755
1968-69	454	96	409	646	369	27					80	1278
1969-70	176	47	112	705	334	15					105	1902
1970-71	---	---	---	905	389	27					130	2237
1971-72	94	19	23	729	345	400					155	2001
1972-73	---	---	---	229	67	15					180	2137
1973-74	---	---	---	1135	528	163					205	2137
1974-75	145	205	79	372	572	122					231	1717
1975-76	---	---	---	793	505	103	167				257	2137
1976-77	25	130	76	791	302	34					283	1793
1977-78	71	73	44	732	288	48	45	334	383	384	394	1836
1978-79	118	32	47	659	217	77		452	345	382	500	1652
1979-80	17	---	15	436	86	50		378	405	425	610	1785
1980-81	11	19	51	473	160	72		446	576	---	720	1736

a/ 92 ha prior to 1964-65 has been deducted.
b/ Includes fallow. Calculated as CCA - (canal and well irrigated kharif)
c/ Actual areas reported for 1966, 1971, 1976, 1978, 1980. Intermediate values interpolated.

Table 14

COMPOSITE CROPPING PATTERNS AND NET RETURNS, KHELNA PROJECT
(Rs/ha)

WO/P	Net Return	Percent Area	Composite
Sorghum	617	21.9	135
Millet	384	17.0	65
Wheat	224	5.6	13
Maize	1052	0.2	2
Paddy	1653	1.2	20
Pulses	448	28.5	126
Oilseeds[a/]	1289	6.9	89
Sugarcane	9852	0.7	69
Cotton	594	16.5	98
Other Cash Crops	2607	1.5	39
Total			656
Less Fallow 10.75%			71
Total			585

a/ Mostly groundnuts
b/ Average fallow 1975-76 to 1980-81 - 10.74 percent of CCA

W/P			
Single crops			
Kharif sorghum (HY)			3596
Maize			3855
Wheat			2519
Gram			2006
Other Irrigated Kharif			
Groundnuts	2684	35	939
Vegetables	9302	15	1259
Millet	1933	25	483
Pulses	741	25	185
			2866
Rounded to 2850 Rs/ha			
Other Irrigated Rabi			
Vegetables	8392	15	1259
Sorghum	3260	65	2120
Cotton	6954	20	1391
			4770
Wells			
Sugarcane	11239	50	5620
Vegetables	8392	8	671
Fodder	3015	25	754
HW Groundnuts	3894	15	584
		98	7629
Less WO/P rainfed			585
			7044

Table 15

CANAL WATER BUDGETS
ALL WATER TO RABI

	RBC			L.B.C.
	Unlined		Lined	Lined
	8 cfs/Msf	5 cfs/Msf	2 cfs/Msf	2 cfs/Msf
1. Available to Canal	26.711	26.711	26.711	11.06
2. Operational Losses	5.34	5.34	4.00	1.66
3. Lining Losses	9.23	5.77	2.31	.30
4. Subtotal	12.14	15.60	20.40	9.10
5. Dist & FC Loss	2.43	3.12	4.08	1.82
6. Subtotal	9.71	12.48	16.32	7.28
7. Field Losses	1.94	2.50	3.26	1.46
8. Available for Crop	7.77	9.98	13.06	5.82
9. Overall Efficiency	29.1	37.4	48.9	52.6
10. Total Losses	18.94	16.73	13.65	5.24
11. Available for Crop Shivna (12/15.7)	5.94	7.63	9.98	5.82
12. Losses Shivna	14.48	12.79	10.43	5.24
13. Available for Pumping	7.12	6.40	5.21	2.61

Notes

Line 1

Area irrigated by LBC = 6500 A
Area irrigated by RBC = 12000 A
Total Shivna irrigated by canals 18500 A
Sasegon served by RBC 3700 A

Water available for canals if all reservoir storage is allocated to rabi

Available in reservoir 41.0906 Mm^3
Deduct:
Dead Storage (silt pocket) 2.9131 Mm^3
Reservoir evaporation during rabi 3.8894 Mm^3
Reservoir evaporation during hot weather 1.1593 Mm^3
Allocation to lift pumping scheme 1.6614 Mm^3
Available for canals 31.4754 Mm^3

Allocating Shivna according to area served

Shivna RBC = 31.4754 (12000/18500) = 20.416 Mm^3
Allowance for Sasegon at same rate per acre 6.295 Mm^3
Total RBC 26.711 Mm^3
Shivna LBC = 31.4754 (6500/18500) = 11.06 Mm^3

Line 2

20 percent of Line 1 for unlined canals, 15 percent for lined canals.

Line 3

Seepage Losses

Loss (Mm^3) = flow loss rate (ft^3/sec) (days operated) (seconds/day) $10^{-6}/(ft^3/m^3)$

Loss rate

8 cfs/Msf: (37.525) (100) (86400) (10^{-6})/35.31
5 cfs/Msf: Rabi = 5.77 Mm^3
2 cfs/Msf: Rabi = 2.308 Mm^3

Table 15 (con't)

LBC
Loss (Mm^3) = (sectional wetted perimeter, m) (Length m) (ft^2/m^2) x
(loss rate, ft^3/Mft^2) (days operated) (seconds/day) (10^{-6})/(ft^3/m^3)
8 cfs/Msf: Rabi = (100) (37.525) (.0864) / 35.31 = 9.231 Mm^3
5 cfs/Msf: Rabi = 5.77 Mm^3
2 cfs/Msf: Rabi = 2.308 Mm^3
LBC
Rabi = (6.29) (9000) (10.75) (2) (100) (.0864) / 35.41 = 0.299 Mm^3

Line 4
20 percent of Line 3

Line 7
20 percent of Line 6

Line 9
(Line 8)/(Line 1)

Line 11
Allocation between Shivna and Sasegon based on irrigated area served.

Irrigated Area Correction
Design Water Supply
Assume delivery efficiency of 0.48
Design rabi allocation = 30.8 Mm^3
Available for crop (30.8) (0.48) = 14.78 Mm^3
Area Correction (available water) / (design water supply)
Unlined 8 cfs/Msf seepage loss (5.94 + 5.82) / 14.98 = 0.797
Unlined 5 cfs/Msf seepage loss (7.63 + 5.82) / 14.98 = 0.911
Unlined 2 cfs/Msf seepage loss (9.98 + 5.82) / 14.98 = 1.069

Table 16
COST SCHEDULE FOR SHIVNA LINING AND GROUNDWATER STUDY
(Rs 000)

Headworks, Canals and Distributaries	RBC Unlined	RBC Lined
1. From project report	80,290	
2. Adjust for st age service to Deogaan	76,623	76,623
3. Lining RBC	--	13,954
TOTAL	76,623	90,576
4. Economic Total*	57,469	67,932
5. Land Development*	17,852	17,852
6. Irrigation System O & M*	504	504
7. Land Development O & M*	892	892
8. Lift Pumping	160	160

* CCF = 0.75 applied

Line 2 - Total cost - (storage for Deogaan/total storage)(cost of storage)
80,290 - (4.611/43.614) (34,600)
Line 3 - Wetted Perimeter = (cross section WP) (canal length) =
(6.59) (62000) @ Rs 30/m2 + 13.84 percent indirect cost
Line 4 - (Line 3) x (CCF)
Line 5 - [.Part I (Rs/ha) + 0.5 Part II (Rs/ha)] CCA x CCF =(2647)(8048)(0.75)
(2647)(8048)(0.75)
Line 6 - [50 Rs/ha + one percent of Shivna share of headworks cost] CCF
[(50)(7895) + (.01)(29,000,000)(.9453)] CCF
Line 7 - Five percent of Line 5
Line 8 - (400/ha for 400 ha) CCF

TABLE 17

ECONOMIC COST OF GROUNDWATER DEVELOPMENT

	Dugwell in Fractured Rock			Dugwell in Shallow Alluvium			Dug-cum-bore well in Deep Alluvium		
	Works	Equipment	Total	Works	Equipment	Total	Works	Equipment	Total
Well Yield per year (m^3)	---	---	20,000	---	---	32,000	---	---	99,000
Life (Years)	30	5		30	5		25	5	
Financial Investment (Rs)	17,800	3,800	21,600	8,100	4,400	12,500	14,100	11,900	26,000
Conversion Factor	0.75	1.00		0.75	1.00		0.75	1.00	
Economic Rate (Rs)	13,350	3,800	17,150	6,080	4,400	10,480	10,580	11,900	22,480
Annual Capital Cost at 12% (Rs)	1,660	1,050	2,710	750	1,220	1,970	1,310	3,300	4,610
O & M Cost									
Fuel/Power (Rs)		400 1/	400		700 2/	700		3,170 3/	3,170
Lubrication & Repairs (Rs)	130 4/	230 5/	360	60 4/	350 6/	410	110 4/	950 6/	1,060
Sub-Total	130	630	760	60	1,050	1,110	110	4,120	4,230
Total Annual Cost									
Cost per 1000 m^3 at Well (Rs)			3,570			3,080			8,340
Field Irrigation Efficiency			179			96			89
Cost per 1000 m^3 at field (Rs)			0.77 232			0.75 128			0.7 122

1/ Power requirement 0/067 kWh/m^3 @ Rs 0.3/kWh
2/ Pumping 775 hours @ 1.0 l/h @ Rs 0.9/l
3/ Pumping 1,760 hours @ 2.0 l/ha @ Rs 0.91
4/ 1% per annum
5/ 6% per annum
6/ 8% per annum

From World Bank Gujarat Medium Irrigation Sector Credit Report No. 1943a-IN Annex 2 Table 1.

Table 18

COSTS AND BENEFIT STREAM FOR 1000 m^3/Yr
GROUNDWATER DEVELOPED IN TEN YEARS, 10 PERCENT/YR

Year	Cost (Rs) Capital	Cost (Rs) Operation	Net Return (Rs) W/P	Net Return (Rs) WO/P	Net Return (Rs) W/P-WO/P	Area (ha)
8	85.75	3.15	47	6	41	.00812
9	85.75	6.30	98	13	85	.0162
10	85.75	9.45	153	19	134	.0244
11	85.75	12.60	211	26	185	.0325
12	85.75	15.75	272	32	240	.0406
13	104.75	18.80	335	39	296	.0487
14	104.75	22.05	387	45	342	.0569
15	104.75	25.20	459	52	407	.0650
16	104.75	28.35	521	59	462	.0731
17	104.75	31.50	583	65	518	.0812
18	38.00	31.50	598	65	533	.0812
19	38.00	31.50	609	65	544	.0812
20	38.00	31.50	616	65	551	.0812
21	38.00	31.50	620	65	555	.0812
--	38.00	31.50	620	65	555	.0812
26	-361.15	31.50	620	65	555	.0812

Notes: Initial and replacement economic costs: wells 667.5 Rs/1000 m^3 @ 30 yr life. Pumps 190 Rs/1000m^3 @ 5 yr life. Operating Costs: 31.50 Rs/1000m^3
Annual water requirements at pump: 12,310 m^3/ha
Annual net returns W/P: 7630 Rs/ha, WO/P 776 Rs/ha

Table 19

PRESENT WORTH OF BENEFITS AND COSTS AT 12 PERCENT 1/
SHIVNA PROJECT

YEAR	P.W.	M. WORKS	LAND DEV.	O & M	F LABOR	N.R.
0	1.000	9,034				
1	.893	13,444				
2	.797	11,999				
3	.712	10,714	2,859			
4	.636	3,850	2,554			
5	.567	80	3,795	170	69	1,221
6	.507		1,357	300	159	2,485
7	.452		1,210	395	235	3,473
8	.404		1,082	481	292	4,280
9	.361		967	539	362	5,150
10	.322		431	540	370	5,058
11	.287			534	386	5,075
12	.257			525	377	4,862
13	.229			470	364	4,615
14	.205			421	341	4,282
15	.183			377	317	3,959
16	.163			2,131 a/	1,816 a/	22,602 a/
17	.146					
18	.130					
19	.116					
20	.104					
21	.093					
22	.083			2063 b/ x 5.65 x .183	1758 b/ x 5.65 x .183	(21.881) b/ 5.65 x .183
23	.074					
24	.066					
25	.059	-2,665	-1,586			
		46,461	12,668	6,883	5,088	67,067
		12,668				
		59,129				-5,088
						-6,888
						55,091

B/C Ratio 55,091 / 59,129 = 0.932

SHIVNA PROJECT

ESTIMATED COST AND BENEFITS OF EXTENDING CANALS

1. Direct Cost of Canals (from subproject Report)

Total Canal Cost	Rs.	39,210,000
Less LBC		6,370,000
Less LBC distributaries (2,800,000) (6.3)/(18.5) =		984,000
		31,856,000

2. Ratio of Overall to Direct Cost

   45,197,000/39,210,000 = 1.153

3. Ratio of RBC Cost to Total Cost

   (1.153) (31,856,000)/80,290,000 = 0.457

4. Economic Present worth of RBC (See Table 19)

   0.457 (46,461,000) = 21,232,577 or 21,232,577 / 62 = 342,463 Rs/km

---

Footnotes:

1/ Land development cost estimates and schedule used in Sec. B were revised after this analysis was made.

a/ Present worth in Year 0 of deferred annuity from Year 16 to Year 25

$$\left[\frac{1 - (1 + R)^{-(25-15)}}{R} \right] (1+R)^{-15}$$

b/ Ultimate annual economic costs/benefits after full development for O&M, Farm labor and net W/P - WO/P returns, including attributed farm labor respectively.

C H A P T E R 2

SOCIAL SOUNDNESS ANALYSIS

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A. Summary Conclusion

Maharashtra covers an area of 30.8 million ha and is the most urbanised state in India; one-third of a population of 59.3 million live in urban areas. The average farm size is 4.3 ha, but varies according to six regional agro-climatic zones and rainfall patterns in the state. Maharashtra is also India's most advanced industrial state and more than two-thirds of the labor force is employed in agriculture. About 50 percent of the population has per capita incomes below the poverty level ($79) in an average year. Where agriculture is an important sector of the state's economy, land is an important productive asset. Tenancy and land ceiling legislation have reduced the problem of maldistributed land holdings but there is scope for further redistribution.

Expansion of irrigation facilities in Maharashtra has been less rapid than in the wheat-growing belt of Northern India. Much crop land remains rainfed. In the last three decades, the GOM has invested the equivalent of $1.3 billion in major and medium surface irrigation systems, adding over one million ha to the state's irrigation potential. The systems are designed for the practice of extensive irrigation where the benefits of irrigation are spread to as many farmers as possible. However, so far there has been a low utilization of the design potential created. In Maharashtra, the practice of water allocation is known as Shejpali which sanctions water rights to crops rather than to land. Although sanctions for seasonal crops are given, preference is given to block holders for perennial crops for a fixed area and time (generally 6-12 years). Irrigation is not compulsory and is supplied on demand.

Faced with soaring construction costs and low rates of system utilization, the GOM is beginning to assess the constraints to greater efficiency and equity in irrigation systems. The design, construction and operation of the AID-financed prototype systems raise this challenge. However, irrigation water is valuable, and there is no swift and easy path for answers to questions of who gets what, how, why and with what cost and benefits. Increasingly, attention has focused on unreliable water supplies at the farmgate. The problems are interlinked and can be found both up and down an irrigation system: management decisions about operation and maintenance (O&M) of the canal system, water allocation practices, farm unit size, chak size, and development of farm land for irrigation to cite a few. Some concern the design, operation and maintenance of the main system canal and others concern the socio-cultural setting below the public outlet: all have a cumulative effect on whether the farmer -- small, medium or large -- gets water on time and in the quantity needed.

The focus for the social soundness analysis is principally the farmer: the special role irrigation can play in reducing growing uncertainty in production, particularly for the small farmer. Greater control of water removes much of the random effect of weather from the farmer's calculus and paves the way for synergistic production effects between water and

other inputs such as HYVs and fertilizer. For the AID-financed subprojects, there are two keys to improving the impact of surface irrigation development. The first concerns decisions regarding the design and operation of the main canal system. Of these, perhaps the most important for the small farmer is the GOM decision to be responsible for construction of the distribution system down to the farmgate, operation down to the 8 ha block and on-farm development (OFD). This decision assures all farmers equal access to land development for irrigation and water supplies closer to the farmgate. The second concerns AID-financed special studies on existing MIPs in Maharashtra. Many answers to questions of improved equity and participation in irrigation systems are not known, a gap which research station findings cannot easily bridge. The main task of several studies will be to assess what reforms are needed, how to implement them and over what period of time for the AID-financed subprojects.

The GOM realizes that "pockets of prosperity exist where irrigation facilities are provided[1/]": production security results from reliable farmgate water supplies. The objective of a socially-sound irrigation system is to see that prosperity and security are distributed as uniformly as possible among all beneficiary farmers. Enhanced Government responsibility down to the farthest point in the system, as well as implementing the recommendations of the special studies on the AID-financed subprojects, would represent a large step in that direction and should help assure that the social objective of extensive irrigation, is in theory and in practice, equal in terms of farmer access to a specific quantity of water put unit of land.

B. Socio-Economic Setting

1. Population and Farm Size Distribution

The State of Maharashtra covers an area of 30.8 million hectares, has a population of 59.3 million and an annual population growth of 2.5 percent compared to a national average of 2.4 percent. Maharashtra is the most urbanized State in India, with about one-third of the population living in urban areas.

About one-eighth of the State's population consists of Schedule Castes and Scheduled Tribes. As is the pattern throughout India, Scheduled Castes are widely dispersed throughout the State while tribals are traditionally concentrated in the hill and forest areas. There are special GOM programs for developing tribal areas, which constitute the least developed areas of the State.

Population density and farm size distribution vary according to the six regional agro-climatic zones of the state. The average farm size in Maharashtra is 4.3 ha., but the variation is substantial:

1/GOM, Maharashtra State Irrigation Commission Report, Resolution No. MIC.1063-1 (5), 30 June 1961.

Agro-Climatic Zone	Annual Rainfall (in mm)	Average Farm Size (ha)
Coastal	2,000 - 2,500	2.6
Transition	600 - 2,500	3.9
Scarcity	500 - 750	4.4
Assured Rainfall	600 - 900	5.2
Moderate Rainfall	900 - 1,200	5.7
High Rainfall	1,200 - 1,700	2.9
Maharashtra (average)		4.3

The thirteen illustrative MIP districts fall in all agro-climatic zones except for the Moderate Rainfall Zone. Generally, greater population density occurs where agriculture is not limited by low rainfall or special soil fertility problems. Thus, in Maharashtra, the percentage of farms in the 0-1 ha size is significantly larger (49%) in high rather than low (18%) rainfall areas. Smaller farms and higher population are evident along the western side of the Sahyadri range (Western Ghats) and the eastern portion of the State which are both high rainfall zones. Drought prone areas are less able to support greater numbers of people and farm size tends to be larger.

2. Employment Conditions

In Maharashtra, the labor force constitutes 36.5 percent of the total population. Although Maharashtra is India's most advanced industrial state, two-thirds of the labor force is employed in agriculture. The labor force participation rates for cultivators and agricultural laborers are 41.8 percent and 46.9 percent respectively in the MIP districts[2/]; males account for 53.6 percent and females, 23.9 percent. Agriculture employs over half the labor force in the MIP districts.

3. Rural Incomes

About 50 percent of the rural population has per capita incomes below the poverty level ($US 79) in an average year. Since 1960 the level of poverty has remained constant, although the value of agricultural incomes has been falling at a rate of 0.9 percent per annum. This factor may be attributed to GOM investments in rural areas and employment generated by the Employment Guarantee Scheme[3/].

2/ Thana, Nasik, Dhule, Sangli, Sholapur, Ahmednagar, Aurangabad, Buldana, Amravati, Chandrapur and a new district not included in the statistics The thirteen MIPs in these districts are illustrative of typical MIPs in Maharashtra and may be chosen as qualifying subprojects if they meet the project criteria.

3/ See discussion in World Bank Staff Appraisal Report No. 2529a-IN, Maharashtra Irrigation II Project (VI), September 13, 1979.

4. Land Tenure

Before Independence, a variety of land tenure arrangements was in effect. Beginning with the Bombay Tenancy Act in 1939, the concept of "protected" tenancy was introduced for tenants who occupied the same land for more than six years. More comprehensive legislation was introduced in 1948 under the Bombay Tenancy in Agricultural Lands Act. Under the provisions of this Act, protected tenants were given the rights to purchase the land they occupied. The Act proved ineffective and little land was transferred to tenants. A 1955 amendment abolished the category of protected tenants and opened rights of land purchase to all tenants. So far, 1.2 million tenants have been declared owners of 1.4 million hectares of land.

According to the 1970 census for Maharashtra, 92 percent of holdings are farmer-owned, 5 percent are partly-owned and partly-rented, and 3 percent are wholly-rented. These figures may be misleading, precipitated by difficulties with enforcing provisions of the Land Reform Act. Evidence[4/] has shown, for example, that land owners do not allow share croppers to cultivate the same land from year to year for fear that they may lay claim over their land. Landlords also have rights of resumption to their land under certain conditions of the Act. If a tenant has been able to cultivate the same land, verification of his tenancy is often difficult: village land records may not record or recognize the tenancy relationship. However, the success or failure of abolishing tenancy cannot be attributed to tenancy legislation only; inheritance, purchases, and sales of land are also examples of conflicting factors affecting tenancy reform.

The land ceiling in Maharashtra depends on the nature of the water supply and family size:

Type of Land	Family Unit Land Ceiling
Perennially irrigated land	7.2 ha
Assured seasonally irrigated land	10.8 ha
Unassured seasonally irrigated land	14.4 ha
Assured rainfall land	14.4 ha
Other rainfed land	21.6 ha

4/M.L. Dantwala and C.H. Shah, "Evaluation of Land Reforms" (University of Bombay, 1971).

These ceilings apply to a family of husband, wife and minor children. For each member in excess of five, the land ceiling is increased by 20 percent, up to a maximum of 100 percent for families of ten or more members.

In Maharashtra where agriculture is an important sector of the state's economy, land is an important productive asset. More equitable redistribution of that asset has been slow, although Maharashtra is widely acclaimed as a pioneering state in land ceiling and land tenancy legislation. In Maharashtra, until 1977/1978, only about 175,000 ha had been distributed to landless households. The following GOM statistics indicate the current pattern of land distribution:

Size Hectares	Percentage Number of holdings	Percentage Area operated
0 - 1	26.1	3.3
1.0 - 2.0	19.8	7.9
2.0 - 10.0	46.7	57.7
10.0 +	7.4	31.1
	100.0	100.0

The problem of maldistributed landholdings has been reduced. However, since 46 percent of the farms are smaller than two ha. and include 11 percent of the total farm land, while 7 percent of the farms are larger than 10 ha and occupy 31 percent of the farm land, there is scope for further redistribution.

C. Spread Effects

Expansion of the area under irrigation and improved utilization of existing systems are major objectives of India's Sixth-Year Plan. Stemming from a rapid expansion of irrigation facilities in India in the past decade, the average yield of foodgrains per ha increased from 0.9 tons per ha in 1950-51 to about 1.71 per ha during 1978-79. However, experience in other countries shows that average yields of 4-5 tons per ha from irrigated areas are generally attainable. Although the reasons for this difference are complex, one constraint has been underutilization of the irrigation potential created. Many observers, noting the importance of this constraint, have concluded that:

> "The foremost task for the future in the field of irrigation development is therefore to give maximum emphasis on improving water management with a view to obtaining better yields and deriving full economic benefits from the huge investments made on irrigation during the Five Year Plans[5]".

5/Center for Monitoring Indian Economy, "Irrigation Development in India: Tasks for Future", G.V.K. Rao, October, 1980.

Because the benefits from large investments in irrigation have not been fully realized, the GOM and USAID have identified the need to plan, construct, and operate new prototype irrigation systems for achieving more complete utilization of the irrigation potential created and greater farmer security from reliable supplies of water.

The importance of prototype systems is that they will be in a position to serve as models and to provide a focal point for a major effort in irrigation technology, development and transfer. To achieve prototype systems, USAID and the GOM have collaborated closely to develop new guidelines for planning subprojects which will involve:

(a) Field channels constructed at project expense down to individual farmgates and operation of the distribution system down to the 8 ha block.

(b) Water supply design, based on atleast a 20-year reservoir operations study, with water requirements calculated by fortnightly estimates of evapotranspiration and a water delivery budget based on best estimatesof seepage and other conveyance losses.

(c) Conveyance channels adequately designed and regulated to permit full delivery to all outlets when the main system is operating at or above 50 percent capacity. Canals will be protected by cross drainage structures and control gates and measuring devices will be provided so the flow can be controlled and measured throughout the system.

(d) A complete surface drainage system planned and constructed.

(e) Fully integrated surveys with improved vertical control and detailed designs undertaken for watercourses and field channels, minors and distributaries. Water surface levels will be maintained sufficiently high to assure all fields are properly commanded. Quality control of watercourse and field channel design and construction will also be monitored.

(f) Rotational water supplies (Shejpali) established on all subprojects.

The impact of adopting these guidelines should extend beyond the prototype subprojects. The speed and effectiveness of spreading the knowledge, techniques and methods developed on the prototypes will depend heavily on the findings and results from the AID-financed special studies. The studies are described in detail in the Technical Analysis. The findings and results of the studies will be disseminated to the GOI and GOM. It is expected that the GOI through the Central Water Commission would use the knowledge gained through these studies in their future dealings with State Irrigation Departments and that the GOM would introduce new innovations in its existing design and construction standards as a result. For example, alternative models for farmer organization will study varying levels of farmer involvement and participation in irrigation systems. The results would indicate whether farmer organizations should be implemented on all the AID-financed subprojects. Disseminating the results of the special studies to the GOI

and GOM would also ensure that the new technologies developed are not only concentrated in the subprojects but are spread to other irrigation systems in Maharashtra specifically and in India in general. In addition, the results will be disseminated to all USAID irrigation projects, including the Water Management and Training Project, which will have an important influence on many states and educational institutions in India.

The prototype systems should also have a positive demonstration effect on farmers. Experience has shown that farmers who are assured timely and reliable farmgate supplies tend to adopt higher-yielding practices; to to grow crops with a higher value to water ratio; to plant higher-yielding varieties; and to use complementary inputs such as fertilizer and pesticides. The same demonstration effect will also apply to land development below the outlet: if farmers believe the water supply will be timely and reliable, evidence has also shown that the farmers will be less resistant to undertaking expensive OFD measures.

D. Social Consequences and Benefit Incidence

1. Beneficiary Participation

In a typical surface irrigation project in India, farmers are not consulted during the process of constructing an irrigation system, do not commit resources to the system, and participate as users only when irrigation water begins. A lack of beneficiary participation in irrigation systems has been one constraint which has contributed to an increasingly recognized pattern of disincentives for improving the efficiency of irrigated agriculture. As early as 1962, the GOM accepted in principle a recommendation by the Maharashtra State Irrigation Commission that water allocation should be entrusted to irrigator cooperative societies. Nearly two decades later, a GOM working paper[6/] reinforced the view that "for efficient water management, active participation, in fact full involvement of irrigators, is essential". About the same time, the Sixth Five-Year Plan (1980-85) emphasized the participation of farmers in the scientific management of water.

To instill a high level of commitment and cooperation among irrigators, participation will take several dimensions in the AID-financed subprojects. Within technical limitations, the design of the MIPs will provide for prior consultation and agreement with farmers on locating and constructing the minors, watercourses and field channels, to give a sense of local ownership as well as better designed and constructed physical works more likely to meet farmer needs.

The larger and more important dimension of participation will be the AID-financed pilot study on three existing MIPs of farmer organizations

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6/GOM, "Irrigation Management by Cooperative Societies of Irrigators", July 9, 1981.

for operation and maintenance (O&M) for various size command areas (e.g., 8 ha, 40 ha or 200 ha). If the results are favorable and show a workable model or models, recommendations will be made to the GOM during the mid-term evaluation for establishing farmer organizations on the subprojects by approximately the forth year of the project. The studies will be carried out within the legal framework of the 1976 Maharashtra Irrigation Act which provides a mechanism for purchasing and delivering irrigation water through an organizational arrangement called a Water Committee. According to the provisions of the Act, the Committee consists of four irrigators and the Sectional Officer, and is empowered to (i) allocate water; (ii) decide on the cropping pattern within the sanctioned provisions of the scheme; (iii) carry out maintenance; (iv) levy penalties for unauthorized use of water; and (v) maintain accounts for water charges.

The Act provides two means for the Committee to function. In the first, water is allocated on a time basis to an area not exceeding 200 ha, according to the crop requirements sanctioned by the water applications. The Water Committee representing this area ensures that the timings for water delivery are maintained. In the second, farmer participation is more direct. With the consent of over half the farmers in a given command area, water can be purchased on a volumetric basis, which would not require water applications. The volume would be determined according to the mixed cropping pattern sanctioned for that area. The Water Committee would be responsible for determining the allocation of water within the sanctioned cropping pattern.

The legal mandate of Water Committees and the two mechanisms (time and volume) for allocating water and maintaining the system provide a framework for studying farmer organizations. Within this framework, a study team, including a qualified social scientist with experience in irrigation water user organizations, will design the study and operational aspects of farmer organizations which could include:

(i) an appropriate role of the GOM/ID to the farmer organization;
(ii) procedures and levels of incentives required to induce sustained farmer participation in O&M;
(iii) alternative organizational forms of farmer participation;
(iv) the degree of formality required for effective farmer organization;
(v) a systematic plan or applied methodology of implementation to introduce farmer organizations, if successful, on qualifying MIPs; and
(vi) the functions, powers and leadership of the organization, particularly affecting more disadvantaged groups of farmers (e.g., Scheduled Castes and Tribes and small farmers).

Although the Act provides for Water Committees, Government policies on water management have been directed more towards O&M of the irrigation system above the public outlet, with little attention to the direct involvement or organization of farmers below the outlet. However, investigations[7] of farmers' attitudes towards cooperative water distribution have shown that farmers favor more rigorous Government responsibility for water distribution and not the participation of committees or other voluntary groups. A review[8] of the World Bank-financed Jayakwadi Pilot Water Management Project in Maharashtra concluded similar farmer attitudes. The success or failure of farmer organizations for O&M is a function of many factors; however, one frequently cited reason why farmers resist such efforts is the unreliability of surface irrigation supplies. Under such conditions, the associated crop risks for the farmer become far greater than the benefits of irrigation and cooperative water distribution. The ability of the AID-financed subprojects to deliver reliable water supplies would be an important measure of farmer trust in the system and willingness to participate.

The study team would therefore begin by reviewing the experience with and results of cooperative water distribution efforts in India, particularly the Jayakwadi Pilot Project in Maharashtra. This information would constitute a basis for forming a constitutional environment to study farmer organizations and for promoting trust and greater equity among farmers for O&M. In consultation with the extension wing of the Agriculture Department, the study team would also be responsible for designing different models of farmer organizations involving varying levels of farmer involvement for study on three selected MIPs. This could include farmer organzational models for maintenance only, for O&M covering one or two 8 ha blocks, in which few farmers have to cooperate together, and for O&M at the head of the minor in which many farmers would have to cooperate. The models would test which level of farmer involvement has the greatest potential for success and implementation on a wider basis on the AID-financed subprojects.

Although a GOM interim report[9] and a GOI policy letter[10] to the State Governments advocate a system of social water allocation (water allocation preference for small and marginal farmers), no surface irrigation project

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7/Two investigations have been carried out by the Indian Institute of Management in Ahmedabad: "Irrigation Systems, On-Farm Development and Extension Service in Chambal Project, Rajasthan" by V.N. Asopa et al and "Command Area Development in Mahi-Kadana" by V.N. Asopa and B.L. Tripathi.

8/GOM, Mimeo, "Report on January 27-February 3, 1979, Review of Jayakwadi Pilot Project", 1979

9/GOM, "Interim Report of the Committee to Study the Introduction of 8 Monthly Supply of Water on the Irrigation Projects in Maharashtra".

10/GOI, letter from J.K. Jain, Chairman, Central Groundwater Board to the State Governments, April 11, 1980.

in India has implemented social allocation. The GOM supports the concept, but since social allocation would establish new norms for irrigation systems, it will first be tested as part of the farmer organization studies on three existing MIPs. This would test the response of farmers to a new system of water allocation giving preference to small and marginal farmers, and how farmer organizations and irrigation officials cooperate to successfully manage such a system. This aspect of the study would also lead to mid-term recommendations on whether to establish the system on a wider scale for the subprojects.

2. Benefit Distribution

Farm Size and farm location within the command of a watercourse are major factors influencing water allocation in a surface irrigation system, generally benefiting small, medium, and large farmers in proportion to the size and location of holdings. There is little evidence to document the distribution of farm sizes in typical MIPs in Maharashtra. However, a study of 88 chaks (average size about 40 ha) in the Ukai Project in Gujarat gives an indication of the benefits that accrue to farmers located in the upper, middle and lower third of the chak[11]:

Location	Annual Intensity of Irrigation
Upper Third	117%
Middle Third	98%
Lower Third	78%

Farmers who are located at the tailends of the system have the least secure water supplies. Conveyance losses, maintenance problems and intervening irrigators who may disturb intended water distribution are all factors which contribute to the insecurity of the tailender. Farmers with larger holdings and other forms of economic power may also benefit from greater water security. For example, they may influence irrigation schedules so their field receive earlier, larger, and more assured deliveries of water.

Typically for irrigation systems already constructed, the turnout to the chak (generally 40 ha or larger) is the farthest point of ID responsibility and control. Mr. S.P. Malhotra, writing of northwest India, describes the following situation:

> "An outlet is the masonary structure through which water is admitted from the government distributary into a farmer's watercourse. It is the border where the State management ends and the farmer's management starts. It acts as a water-measuring device and hence is a subject of great interest to both the government and the farmer[12]."

11/ From "Gujarat State Irrigation CAD Composite Project -- Volume I, Ukai-Kakrapar Project" joint report by Project Preparation and Monitoring Cell, GOI and Area Development Commissioner, Udai-Kakrapar, Government of Gujarat.

12/ S.P. Malhotra, "The Warabandi System and its Infrastructure", forthcoming.

Between this turnout point and individual farmgates, inequities in water supplies may develop. As the chak size increases so do inequities. For example, as the number of farmers increases proportionate to the chak size, it becomes more difficult to coordinate irrigation schedules and jointly agree on maintenance of communal channels. Also, as the distance water is conveyed between the outlet and fields increases so do transport losses. For past surface irrigation project in Maharashtra the policy of the GOM has been to construct outlets serving irrigable command areas (ICA) of about 40 ha. However, the World Bank found as part of a sector review for its Maharashtra Irrigation II project that the gross geographic area of one chak was as large as 344 ha and only about 16 percent of fields were located in chaks 40 ha or less.

To reduce water distribution inequities inside chaks, the GOM will be responsible for construction of the distribution system down to the individual farmgate and operation down to an 8 ha outlet for the AID-financed subprojects. This means that typically only four or five farmers would have to cooperate sufficiently to assure water supplies to farm fields and jointly agree on maintenance of the communal channels inside an 8 ha block. This also means fewer intervening irrigators who could disrupt water supplies and less maintenance problems as the distance between the outlet and farm field decreases. When the outlet is closer to farmgates, irrigators can more easily check on breaches in field channels.

The least-advantaged irrigator who suffers under conditions of water inadequacy and uncertainty is the small farmer whose existence is limited by the land on which he subsists. For the subprojects, GOM responsibility for design and construction of the delivery system down to the individual farmgate will help protect the interests of small farmers who now bear the greatest burden of unreliable water supplies. This carries Government responsibility for water distribution down to the farthest point in the system which should benefit small farmers two ways. First, design of the distribution network within a block will be planned according to the physical contour of the land and readjusted according to the location of field boundries. This will avoid the influence of larger and thus more powerful irrigators to improve or relocate the distribution network to improve water supplies to their land. Second, Government responsibility for water supplies down to the watercourse outlet will help control intended water distribution so small farmers are less at risk from larger, intervening irrigators.

The institutional setting in which irrigation water is allocated also influences to what extent farmers benefit[13]: high yielding, high value crops on which optimal irrigated agriculture is based require credit for inputs, OFD, and extension services. Lack of clear land title and indebtedness are two problems associated with regular institutional credit

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13/ See discussion by D. Bromley, D. Taylor and D. Parket "Water Reform and Economic Development: Institutional Aspects of Water Management in the Developing Countries", in Economic Development and Cultural Change (January, 1980): 365-87, Vol. 28, No.2

in Maharashtra. Unrecorded rights of land transfer are common and over half the farmers in Maharashtra are reportedly classified as credit defaulters. When crops fail, small farmers with limited financial resources would be at greatest risk as credit defaulters.

The GOM has already recognized eligibility problems associated with institutional credit. For major irrigation projects in Maharashtra, a Special Loan Account has been created for financing long-term OFD credit to farmers who are ineligible for institutional credit. For the AID-financed subprojects, the GOM will now take credit facilities one step further: community works (Part I) and OFD works (Part II) will be entirely arranged by the GOM, thus no eligibility requirements will disqualify farmers. It also assures that all lands qualify for irrigation development and eliminates the past disqualifier in Maharashtra that required a farmer to own two or more ha of irrigated land to finance OFD credit. The cost of OFD works will be recovered from farmers. The GOM is developing a plan for the form of recovery and the types of subsidy policies for special categories of farmers.

The GOM requires farmer consent to begin part II works. A new GOM policy gives farmers three months to consent to part II works after construction of part I works begins. In the past, farmers have generally resited expensive OFD works. The GOM recognizes that extension assistance will be required for farmers to perceive the value of consenting to OFD works and a cost-recovery mechanism. What form of extension assistance would be appropriate will be studied during project implementation. One possibility is the Training and Visit System (T&V) which was introduced in Maharashtra in 1981 with World Bank Assistance and could provide a vehicle for transferring irrigated technology. However, most T&V technological messages in other states in India have concentrated on the problems of rainfed farming and adjustments would be necessary for the extension needs of irrigated agriculture. Whether World Bank Assistance could provide for the development of extension messages appropriate to irrigated crop practices wouldneed assessment.

3. Water Allocation Practices

Problems with O&M below the public outlet have often been diagnosed as among the greatest weaknesses in poorly performing surface irrigation systems. Less visible but equally important are management problems above the outlet[14]. To provide greater production security for the farmer, irrigation systems themselves have to be reliable and the use of water efficient. For a farmer to obtain water at the time and in the quantity required, an important and yet often fragile interaction exists between centralized irrigation management and on-farm water utilization. The actual practice of formal water allocation policies would be such a critical point of interaction.

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[14]/See discussion by R. Wade and R. Chambers, "Managing the Main System: Canal Irrigation's Blind Spot" in Economic and Political Weekly (September 27, 1980): A-107-A-112.

In Maharashtra, water is allocated to farmers on demand. Farmers file water applications for each irrigation season which sets a procedurally-complex system into process. The application uses an area basis system of sanctioning crops for irrigation. The water allocation system is known as Shejpali which is modified version of Warabundi used in northern India. Some basic differences in Shejpali from other systems used in Northern and Southern India include:

1. Irrigation is not mandatory, and water is supplied on a demand basis according to water applications and long-term block holders.

2. A block system guarantees water supplies to perennial crops for a fixed period (generally 6-12 years) and area. When determining allocation of available water supplies, preference is given to farmers with block guarantees.

3. The ID has the authority under the Maharashtra Irrigation Act to specify crops and areas that can be grown. Water rights are then allocated to crops based on government sanctions. This controls choices farmers can make about irrigated cropping practices.

4. The rotation period is not rigid. If a farmer misses his designated turn due to a delivery system malfunction, he will not have to wait two to four weeks for the next rotation period. He would receive his turn as soon as the system is back in operation.

The GOM recognises that "a block holder is a privileged irrigator and his claim is always considered on priority at the time of renewal[15/]". The block and area basis system for allocating water are factors which influence the response of farmers to the availability of water. For example, inequities in water allocation can develop when a farmer -- particularly a block holder for a high value crop like sugarcane -- gets a sanction for a high water requirement crop. He typically increases his income much more than the farmer who gets a sanction for a low water requirement crop. The problem lies not with the sugarcane block holder but with management decisions above the outlet which commit a small group of farmers to pre-empt a large share of the water and benefits. Because of such inequities, the GOM has tried to reduce the number of sugarcane blocks, and is also reviewing the question of whether to guarantee long-term water supplies to block holders on new projects.

Eligibility requirements for water applications are part of a complex system which is used to sanction crops for irrigation. Clear land title is one. Unrestricted and unrecorded rights of land transfer are common in Maharashtra and throughout India, and have been identified by the GOI as a problem[16/]. In practice, however, if a farmer's land is recorded in village records (which may not necessarily indicate clear land title),

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[15/] GOM working paper, "Management of Irrigation", undated.

[16/] GOI, "Report of the Working Group on CAD for Formulation of the Plan Proposals for the Sixth Five Year Plan", July, 1980.

he is generally eligible for water allocation. To what extent actual management practices relax such formal requirements as clear land title to determine water rights has not been comprehensively studied.

In assessing water allocation practices, it is also necessary to highlight the uncertainty for nearly half the farmers in Maharashtra where subsistence is provided by yields from 2 ha of land or less. If demand exceeds available water supplies and a small farmer cannot get his whole requirements, his production may fall below subsistence levels. Other factors may mitigate this situation. Frequently, small farmers seek off-farm employment opportunities to make up for limited crop production from their land. No data is available on the extent of the off-farm employment potential for farmers in Maharashtra, which would in any case vary widely from area to area.

The GOM reviewed water allocation practices in an interim report[17/]. In recognition of the uncertainties small farmers face, it advocated abandonment of the on-demand allocation system; freedom of choice for irrigators to decide areas and crops to be grown within the available water supply; and water allocation preference for small farmers (defined as less than 2.5 ha). Based on the conclusions of this interim report, the World Bank obtained an agreement from the GOM for their Maharashtra Irrigation II Project that the GOM would introduce new water allocation procedures in each distributary block not later than 2 years after the first water delivery. In addition to these recommended changes in water allocation, Girna and Jayakwadi Pilot Water Management Projects in Maharashtra have demonstrated the value of guaranteed, timely water deliveries using RWS.

Much field study is still required for understanding how water allocation factors interact to affect the response of farmers to the availability of water. Since water is a scarce resource in India, several factors seem to indicate that RWS may set into motion a more equitable system for rationing the amount of water a farmer can use. Volumetric supplies assumes a level of utilization based on land holdings rather than crops grown which allow farmers to vary crops and the irrigated area to maximize returns per cubic meter of water rather than per ha of irrigated land. Farmers have the option of deciding intensive or extensive irrigation on part or all of their land depending on the cropping patterns and inputs used. Questions regarding eligibility requirements and the complex management procedures for water applications would no longer apply. Because the same proportionate volume of water could be sanctioned for low as well as high water requirement crops, the benefits of irrigation could be more equitably distributed among a larger number of farmers.

However, to generalize about the merits and demerits of different water allocation systems as practiced in different parts of India is to overlook the complexly interacting factors up and down the system which

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17/GOM, "Interim Report of the Committee to Study the Introduction of 8 Monthly Supply of Water on the Irrigation Projects in Maharashtra".

contribute to whether water is allocated equitably, on time and in the quantity needed to farmers. Different systems also have both administrative and political implications, and equity factors associated with water allocation practices are complex. A study of the Shejpali system will take account of these factors[18]. The collection of information on how Shejpali actually works based on controlled field investigations should lead to a more informed knowledge about current water allocation practices in Maharashtra and decisions regarding whether improvements in the system could increase greater equity among farmers.

4. Employment Effects

Agricultural employment will increase by 32,200 workyears annually created by the need for increased farm labor for irrigated agriculture. This includes family and non-family labor. An irrigated and fertilized ha requires an average of 122 mandays of labor per year, or 48 days more than a dry ha. Landless laborers including women who constitute 30 percent of the male rural labor force and 56 percent of the female rural labor force in Maharashtra, will most directly benefit from construction of the irrigation system which will provide an additional 104,000 person years of employment during the life of the Project.

The State of Maharashtra is committed to labor-intensive construction techniques of which one essential element since 1974 has been the Employment Guarantee Scheme (EGS) which was introduced to create productive employment and increase employment for the rural poor who could not be absorbed in other economic activities. More than four-fifths of the EGS budget is now spent on irrigation, conservation and afforestation. Since EGS has its own source of finance and emphasis is given to projects that are directly aimed at increasing agricultural production, it will be instituted for construction of the Maharashtra MIPs. While EGS has been able to provide an equivalent of 0.4 million full-time jobs in the last couple of years, one disincentive is wage rates which have been kept at a slightly lower level than the minimum agricultural wage rate in Maharashtra.

The increased labor demand generated by irrigated agricultural practices may decrease over the longer term to avoid farm management difficulties associated with management or non-availability of farm labor. This may take the form of more mechanized agricultural practices such as the use of tractors or investments in fruit plantation which are low demanders of labor. However, this development may be partially off-set by the generation of opportunities in allied agricultural processing industries (i.e., sugarcane factories). Moreover, mechanization is associated more with the wheat-growing belt of northern India, where irrigation expansion has been rapid over the past decade and where mechanization has become a function of labor scarcity and rising labor wages.

18/ See Page 27 of the Technical Analysis for more information.

5. MIP Effects on Tribals and Scheduled Castes

About one-eighth of the population belongs to traditionally disadvantaged groups: Scheduled Castes (6%) and Scheduled Tribes (6%). In Maharashtra, the tribal population is heavily concentrated in hill areas in the northwest and east. These areas are the most backward parts of the state and are characterized by very deep water tables and severe soil erosion problems. A substantial share of the State's development resources are reserved for District Planning and Development Councils which, since 1977, have a committee for tribal development where tribal areas exist. Special provision will be made (1) to identify Scheduled Castes and Tribes within the command of the subprojects during initial baseline surveys in order to assess the impact of irrigation on this special category of farmers and (2) to reduce the required economic rate of return from 10 to 12 percent on subprojects that include at least 50 percent Scheduled Castes or Tribes.

6. Effects on Women

Women constitute nearly one-half of the population in India and about a quarter of the agricultural workforce, as well as the majority of the rural population in the 20-35 age group. Women do most of the tasks in agriculture (e.g., sowing, transplanting, weeding and harvesting) and allied occupations such as animal husbandry, poultry, fisheries, processing of food products, post-harvest operations and storage of foods. Women from Scheduled Castes and Tribal farms, where often shifting cultivation is practiced, do the majority of work associated with agricultural production. Mechanization of agricultural practices often occurs as the economic benefits of irrigated agriculture become evident and may replace some of the work women traditionally do. However, mechanization is more associated with the wheat-growing belt of northern India.

In rural areas, there is a clear negative correlation between family income and labor force participation rates which is most noticeable in the case of female workers. In medium and large size farm households, women barely take part in agricultural work, while as a group, all able-bodied women in landless households are working as casual agricultural laborers. Consequently almost half of all agricultural laborers are women. Thus, one obvious effect of MIPs on women will be the increased demand for agricultural labor of which half should constitute women from landless households.

As part of the AID-financed subprojects, steps will be taken to include women as participants in training programs aimed at farmers which take account of the tasks women traditionally do in agriculture. A review of the T&V system and other extension services in Maharashtra will be considered to assess ways and recommend means to benefit farm women in the subproject areas through extension services appropriate to the needs of irrigated agriculture.

Construction of the subprojects will also have a large employment-generating effect on women. The Maharashtra Employment Guarantee Scheme (EGS) will be instituted for this construction. Experience with EGS has shown that in low-income households the extra income earned by women is vital for these households to cross the proverty line. During January-March, 1979,women formed about 43 percent of the laborers employed by EGS. In all phases of subproject construction, steps will also be taken to ensure that the Equal Remuneration Act is in force which assures women equal wages for work.

Resettlement arrangements is another area where women can benefit: The Sixth Five-Year Plan (1980-85) recommends giving "joint titles to husband and wife in all development activities involving transfer of assets -- like distribution of land and housesites". Steps for evoking this measure for resettled families under the subprojects will be explored with the GOM.

However, the Sixth Five-Year Plan goes on to caution that "improvements in the socio-economic status of women would depend to a large extent on the social change in the value system, attitudes and social structure prevailing in the country". This is not to say that the special measures as part of the AID-financed subprojects will not help women become part of the development process that takes place in surface irrigation systems. Any new measures to help the low status of women in India will have a long-term effect, particularly in the traditionally male-dominated domain of irrigation.

7. Reservoir Displacement and Land Acquisiton

In the last three decades, the GOM has invested in constructing major and medium surface irrigation schemes. As a result, a large number of persons were displaced due to acquisition of land and/or houses for the project reservoir sites. Up to 1965, displaced persons were granted cash compensation and left on their own for resettlement. Since that time, the GOM issued various administrative orders to cover different aspects of resettlement for displaced people. More comprehensive legislation was enacted in 1976 under the "Maharashtra Resettlement of Project Displaced Persons Act". The resettlement of displaced people for the AID-financed subprojects will take place under the provisions of this 1976 legislation.

A GOM Directorate of Resettlement handles the resettlement plans and coordinates related activities. Actual field execution of the resettlement plans is the responsibility of the District Collector who is designated as the ex-officio Deputy Director of Resettlement (Land) and the Chief Executive Officer of the Zilla Parishad (District Counsel) who is designated as the ex-officio Deputy Director of Resettlement (Development). The major change in the 1976 legislation is Government responsibility for moving and resettling affected people. Provisions for affected people include: (i) agricultural land in the project area which the GOM has acquired, or appropriated as surplus under the land ceiling Act; (ii) house plots up to

8,000 Sq.ft. and a housing loan up to Rs.5,000 for homeowners and (iii) house plots up to 4,000 Sq.ft. and a housing loan up to Rs.1,500 for non-homeowners. The housing loans plus the cost of the house plots are recovered from the resettled beneficiaries at an interest rate of 6 1/4 percent per annum over a 20 year repayment plan. Agricultural land is distributed by drawing lots without consideration of a persons economic or socio-cultural background. Observers of this lot procedure have argued that it has direct social benefits since it marks the beginning of a social integration process of different caste groups.

Civic amenities are provided by the Zilla Parishad and include open water wells or bore wells, piped water supply, school buildings, internal and approach roads, electricity and public latrines to cite some. The Zilla Parishad is responsible for future repairs and maintenance. No data is available to assess the effectiveness of the resettlement arrangements, including civic amenities. However, a USAID appraisal team for Maharashtra found during informal discussions with resettled farmers that they were generally satisfied with the resettlement efforts of the GOM.

On a sample basis for the subprojects, USAID will monitor the adequacy of the resettlement arrangements as set forth in the 1976 legislation. The findings of the sample reviews will be summarized for the mid-term evaluation. Any recommendations resulting from a review of the resettlement arrangements will be disseminated to the GOM. Selected villages designated for resettlement under the AID-financed subprojects will be included as part of the baseline studies. The baseline survey information will be used to monitor the resettlement arrangements and would also provide a means to asses how different categories of people are affected by resettlement. For example,one category may be displaced artisans. Artisans are traditionally attached to and serve landowners classes on a hereditary basis. When artisans are resettled, they may loose this traditional source of work and income. Whether and to what extent this type of situation may exist could be assessed during the monitoring process or during special evaluations based on the baseline survey information.

CHAPTER 3

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CHAPTER - 3

ADMINISTRATIVE ANALYSIS

A. Capacities of Implementation Organizations to undertake the Project

1. Central Water Commission (CWC)

The Central Water Commission is the technical wing of the GOI Ministry of Irrigation vested with the responsibility of setting design and construction standards for all irrigation projects exceeding 2,000 hectares CCA (Major and Medium Irrigation Projects). The established standards are used by the States while preparing project proposals for each medium or major irrigation project. The CWC then carries out an indepth technical review of the proposals and certifies them as technically sound and qualifying for GOI financial support. CWC has over 1000 highly qualified and experienced graduate and post graduate engineers and specialist in the fields of Geology, Hydrology, Floods, Design and construction, Water Resources, Navigation, Construction, Machinery and Equipment etc. CWC is headed by a Chairman with equivalent rank of a Secretary and four members with equivalent rank of a Joint Secretary. Each specialised section is headed either by a Chief Engineer or a Director supplemented with adequate supporting staff.

For review of technical standards and monitoring implementation including quality control, for foreign assisted major and medium irrigation projects, CWC has set up three special cells. Each cell is headed by a Director. Prototype subprojects identified under the AID project will be appraised by one of these cells in order to insure compliance with the design criteria and guidelines established by CWC and USAID. The cell will carry out periodic progress reviews, conduct an annual implementation review, and keep USAID informed of progress of each prototype subproject.

2. Government of Maharashtra Irrigation Department

The Government of Maharashtra Irrigation Department (ID) is headed by a Minister, who is assisted in his work by a Minister of State and two Secretaries, one for Irrigation and one for Command Area Development on major projects. The Secretary for Irrigation is supported by three central technical sections each headed by a Chief Engineer (CE). The State is divided into five regions each also headed by a Chief Engineer. Regional

Chief Engineers have responsibility for much of the design and for construction and operation of projects in their region. Other Chief Engineers are assigned as needed to major projects. Headworks design, canal survey and planning and design of the irrigation distribution system down to the public outlets is undertaken by the Irrigation Department field units (circles) organized under five regional Chief Engineers. The circles also supervise construction and operation. Superintending Engineers (SE) are in charge of circle operations and normally supervise four divisions each. The Regional Chief Engineers have from three to seven circles under their direction.

Executive Engineers (EE) are in charge of divisional offices. They also hold all the powers of canal officers under the Irrigation Act, and are thus primarily responsible as Executive Officers for efficient management of and control over the irrigation works in their charge. The basic organizational unit is the subdivision. These are headed by a Deputy Engineer who reports to the Executive Engineer.

The GOM/ID staff includes about 9,000 engineers, 2,760 of whom are graduate or post-graduate engineers and the remaining 6,240 are diploma holders. The GOM/ID staff is highly competent in the fields of reinforced concrete and masonry design, hydraulics, hydrology, geology and soil mechanics.

Design of dams over 27.5 m high, major canals and more complex works and special problems designs, e.g., weak foundations and development of standards and procedures is done by the Central Design Organization (CDO) organized in 1957 under the Chief Engineer (Projects) and located in Nasik. CDO personnel are well trained and very knowledgeable in all the engineering fields concerned with the design of irrigation headworks and canals. CDO is well equipped, including in-house computer capability. Studies and investigations are supported by the GOM Engineering Research Institute (MERI) also located at Nasik. MERI has capability in hydrodynamics, soil mechanics, materials testing, computer programing with matrix and finite element methods, and environmental engineering research.

GOM/ID has a quality control system. Manuals have been prepared for controlling quality on major engineering works, particularly for earthwork and concrete masonry which constitute most of the major works.

Maintaining quality on minor and some major items, some canal structures, particularly lining and small structures has been a problem on other USAID and World Bank projects. This is more than a problem of quality control in the traditional sense but rather involves lack of experience on the part of small contractors and government supervising staff. Experience on MIPs in other states indicates that short-term training for supervisors and contractors has been helpful. Because of these problems, increased USAID monitoring capability will be needed. The CWC Appraisal Team with USAID and GOM representation will make a review of quality control and construction supervision for smaller structures on three or more on-going MIPs as soon as possible following project implementation to determine what GOM/ID action, including training, if any, needs to be taken to insure quality control at all levels of construction.

GOM/ID has established a division of Irrigation Research and Development (DIRD) under a Director. This has the assigned responsibility and sufficient staff for making detailed soil surveys on all irrigation projects and for designing sub-surface drainage schemes on major and medium irrigation command areas. Soil surveys are basically of good quality, however, some changes in procedures are suggested. See Chapter 4, B. 2. g. In addition, DIRD conducts research studies on soil and water management, although this latter activity is limited.

An engineering staff college was established in Nasik in 1964. While under the control of the Irrigation Department, orientation of new recruits, refresher training and continuing education is provided for the Irrigation, Public Works and Housing and Urban and Public Health Departments of the GOM. In response to increased concern about poor utilization of irrigation potential, a Water and Land Management Institute (WALMI) was established in 1980 by GOM/ID with assistance by the World Bank. This institute, located near Aurangabad, will conduct short and long-term training course for junior, mid-level and senior officers of the GOM/ID and AD responsible for improving land and water management. Curricula will include agronomic and social science courses applied to actual field problems. To handle schemes supported by international donors, GOM/ID has established a special Project Preparation Cell. This Cell will be responsible for seeing that projects are planned in accordance with AID criteria and will provide liaison with AID.

Engineering problems resulting from excessive swelling and contraction of cohesive soils containing high proportions on montmorillonite clays (vertisols or black cotton soils) have been studied in depth by the Civil Engineering Department at Indian Institute of Technology in Bombay. The work of this Department has received international recognition and satisfactory solutions have been found for major irrigation structures including canals and associated structures of capacity one cumec (35 cusec) and larger.

During the past 20 years, GOM/ID has engineered, constructed and implemented major and medium irrigation works serving 830,000 ha and costing Rs 8.3 billion ($1.03 billion)[1/]. Budgets in recent years have been about Rs 1.35 billion ($170 million). Sixth Plan budget (five years) project total Rs 11.4 billion ($1.3 billion) including Rs 1.8 billion ($200 million) for MIPs. In summary, GOM/ID is basically well staffed and equipped to plan, design and construct the major dams and canal works required under the proposed project; however, based on experience in other states, programs for improving design and quality control of construction of minor works and on some canal structures may be needed.

3. Soil Conservation Division, Agricultural Department

The responsibility for carrying out the land development works rests with the Department of Agriculture, Soil Conservation Division (AD/SC). The land development works under this project include all improvements from the eight ha outlet (ending point of the ID responsibility) down to and including improvement on the individual farmers' fields.

The AD/SC has six field divisions and subdivisions under the supervision of the Deputy Director of Agriculture (DDA) for carrying out land development works on medium and minor irrigation projects in Maharashtra.

The GOM recently reviewed the work norms of the subdivisions and has decided that each subdivision must complete land development works in an area of 1,600 hectares per year[2/] on an outlet basis rather than an item wise basis. These norms have been decided on the basis of experience gained and considering a field working season for construction activities of about four months. The revised norms appear to

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1/ At Rs 9/$. Total not corrected for inflation.
2/ Previous norms being 2,400 ha per year.

be reasonable. SC technicians are diploma graduates (High School plus two years). Some have had up to six months in-house general soil conservation training but majority of field formations lack essential engineering technical background. SC proposes that selected subdivision officers be required to take six weeks training at WALMI. These officers will then train the personnel in their respective subdivisions. In addition, the AD/SC has recently started a training program at Sholapur for training relating to communal and individual land development techniques and will open another center at Aurangabad in 1982. Training will be provided to Subdivisional Officers, Agricultural Officers, Supervisors, and Assistants. GOM and USAID will evaluate where additional training efforts may be required to insure satisfactory design and operation of watercourse and field channels. Training costs and needed consulting assistance will be fully reimbursable using AID grant funds.

4. Groundwater Survey and Development Agency

The Maharashtra Groundwater Survey and Development Agency (GSDA) is organized in the Department of Rural Development and has responsibility for development and utilization of groundwater potential in the State. It is well staffed with professionals. It assesses the potential and extent of development in the State's 1,481 watersheds. About one-third of these have been completed and completion of the remainder is scheduled within five years. Well development is financed individually, usually through institutional credit principally with the Land Development Bank (LDB). Control of over-exploitation is through credit control with GSDA certifying availability of groundwater in connection with loan applications. While this mechanism does not control private exploitation, over-exploitation in proposed subprojects does not appear to be a problem. GOI has developed a model groundwater bill and states have been asked to enact groundwater legislation. So far this has happened in Maharashtra.

The Central Groundwater Board (CGWB) is involved in assessing and monitoring groundwater on an extensive scale and maintains 250 test and observation wells in the State.

B. Procedures for Designing, Approving, Implementing and Monitoring Irrigation Projects

1. Schedule and Budgeting

Since Independence, 89 MIPs have been completed in Maharashtra. At present, 148 are under construction or design. Allocation of budgets for MIPs is normally done through District Councils. With such a large number started or under construction, completion of individual MIPs has been slow. Budgets for MIPs nominated for participation in the project will be allocated directly at State level rather than through District councils in order to assure completion of construction of the major works within four years and on-farm development within seven years.

2. Design

Subprojects will be jointly designed by the GOM Department of Irrigation and Agriculture according to the norms and criteria laid down by CWC and USAID. While the Department of Irrigation will be responsible for designing and furnishing details regarding Civil Works construction (dam, canal network, water courses and field channels), the Department of Agriculture will provide details on on-farm development (land grading/leveling), agricultural extension, cropping pattern and supply of inputs like seeds, fertilizers pesticides and credit etc. The project preparation Cell will coordinate design activities and submit a project summary to CWC Appraisal Committee for approval after the review by a GOM interdepartmental technical committee set up by the planning department.

3. Appraisal and Approval

The Central Water Commission (CWC) has designated a special cell (FA-III) headed by a Director to prepare an appraisal report on each AID-funded MIP in Maharashtra to appraise all proposed Medium Irrigation Projects (MIPs). The CWC appraisal report will be on the basis of CWC guidelines and AID's criteria as detailed in the project paper. CWC appraisal generally involves the following concerns.

a. design and engineering of the MIP, from the dam to field channels irrigating individual fields;

b. land development program including land grading, field access roads, field ditches, etc. ;

c. cropping patterns in the MIP command area,current actual patterns,plus those which would be feasible when the MIP is operational and water requirements of potential cropping patterns;

d. MIP construction cost - whether projected expenditures for the ensuing seven year period is within the approved seven year budget of the ID and AD (this is an AID requirement, to prevent the project's being delayed due to shortage of funds);

e. staffing of irrigation department at the construction and supervision level to assure that sufficient staff is available to supervise construction adequately (This is likewise an AID requirement, based on experiences in other states);

f. economic rate of return for the project: AID and CWC have been working together on improved procedures for calculating the rate of return and this improved formula will be used for all MIPs under this project ;

g. provision of agricultural support services such as seeds, fertilizers, pesticides, agricultural extension (T&V), short-term credit etc.

A CWC Appraisal Committee (AC) will then review each appraisal report and certify the subproject is eligible for AID financing. The AC will be chaired by the Member CWC with the Director of the special cell as Secretary and include representatives of AID and GOM/AD & ID.

After approval of the subproject by the CWC Appraisal Committee, the eligible expenditures accrued after the date of signing of the agreement will become eligible for reimbursement under the loan. Because most of the thirteen identified subprojects have already been approved and construction of headworks has commenced in a few cases, submission, review, appraisal and approval of subprojects in accordance with the new criteria is not expected to delay or alter works already in progress. The design of downstream works which are not likely to begin for at least another

construction season will be modified. However, this will not affect the pace of construction since necessary design changes will have been incorporated prior to the next construction season.

4. Implementation

The CWC Project Preparation Cell (PPC) for appraisal of the MIP will also be responsible for monitoring and evaluation of implementation progress throughout the project period and thereafter.

The GOM-Department of Irrigation has established a Project Planning Cell (PPC) which will have full time responsibility for subproject preparation in association with CWC and their approval by the CWC Appraisal Committee (AC). PPC will oversee implementation of this project, and maintain liaison with GOM Departments of Irrigation and Agriculture for coordinating project construction activities. This cell is headed by a Superintending Engineer and is headquartered at Pune.

GOM Department of Irrigation will assign one or more Executive Engineer (EE) to each approved subproject, to be in charge of construction activities on the site. Each EE is assisted by three to five Deputy Engineers on the site while each Deputy Engineer will manage five to six field supervisory personnel (Overseer, Surveyor, Technical Assitant etc.) Three to four subproject sites will be under the supervision of a divisional Superintending Engineer. A regional Chief Engineer (CE) will be in overall charge of MIP's in the region. The State of Maharashtra has been split into five regions each under the control of a Chief Engineer.

Administration and design costs until construction is started are paid from general ID funds. For completion of detailed designs and implementation and supervision of construction, the appropriate number of divisions and subdivisions are established. These costs are called "establishment costs" which are project costs.

Two different procurement procedures are used for construction: competitive bidding or force account by ID. Competitive bidding procedure follows usual practice. Legal notices stating the scope of the works, quantities, current unit rates established by the Irrigation Department, completion time and contractor qualifications are placed in newspapers.

Contractor's certification of qualification is established by the Public Works Department in one of four classes depending on experience and current financial resources and equipment inventory.

If the low bid for a project is close to the unit rates, the contract is awarded provided other legal requirements are met. Where bids are too high or no responsible bidder can be found through the competitive bidding procedure ID may do the work departmentally using their own machinery and a set labor rate. Piece work may also be let to small local contractors. Part of the labor for construction will be made available under Maharashtra's Employment Guarantee Scheme which provides local unemployed with unskilled manual labor at wage rates slightly lower than the minimum agricultural wage rate.

MIP's in Maharashtra are frequently located in isolated areas so that there is difficulty in obtainining qualified contractors. Fifty to seventy percent of MIP construction may be accomplished departmentally.

GOM Department of Agriculture (Soil Conservation Division) will move in the subproject area one year prior to the initial delivery of water and assume the responsibility of implementing land development (grading/shaping) works (individual works) in the outlets where field channels have been constructed up to individual farmer's fields. Simultaneously, other activities like agricultural extension (T&V System) will commence in the third year of the project implementation. PPC will coordinate the activities of Departments of Irrigation and Agriculture since no direct coordination mechanism exists over the two departments on the site. No undue difficulties are envisioned in this regard.

5. Monitoring and Evaluation

After the approval of each subproject by the Appraisal Committee, the CWC special cell will begin the process of in-depth on-site quarterly progress reviews and annual implementation reviews in association with Project Preparation Cell. During these reviews physical progress, adequacy of staff and budgets for timely completion of the project will be reviewed. Project Preparation Cell will be regularly advised on the inadequacies noted during the conduct of reviews for taking appropriate action. GOM Department of Irrigation and USAID will be kept advised on the project status through the review reports of the CWC. Based on our experience with

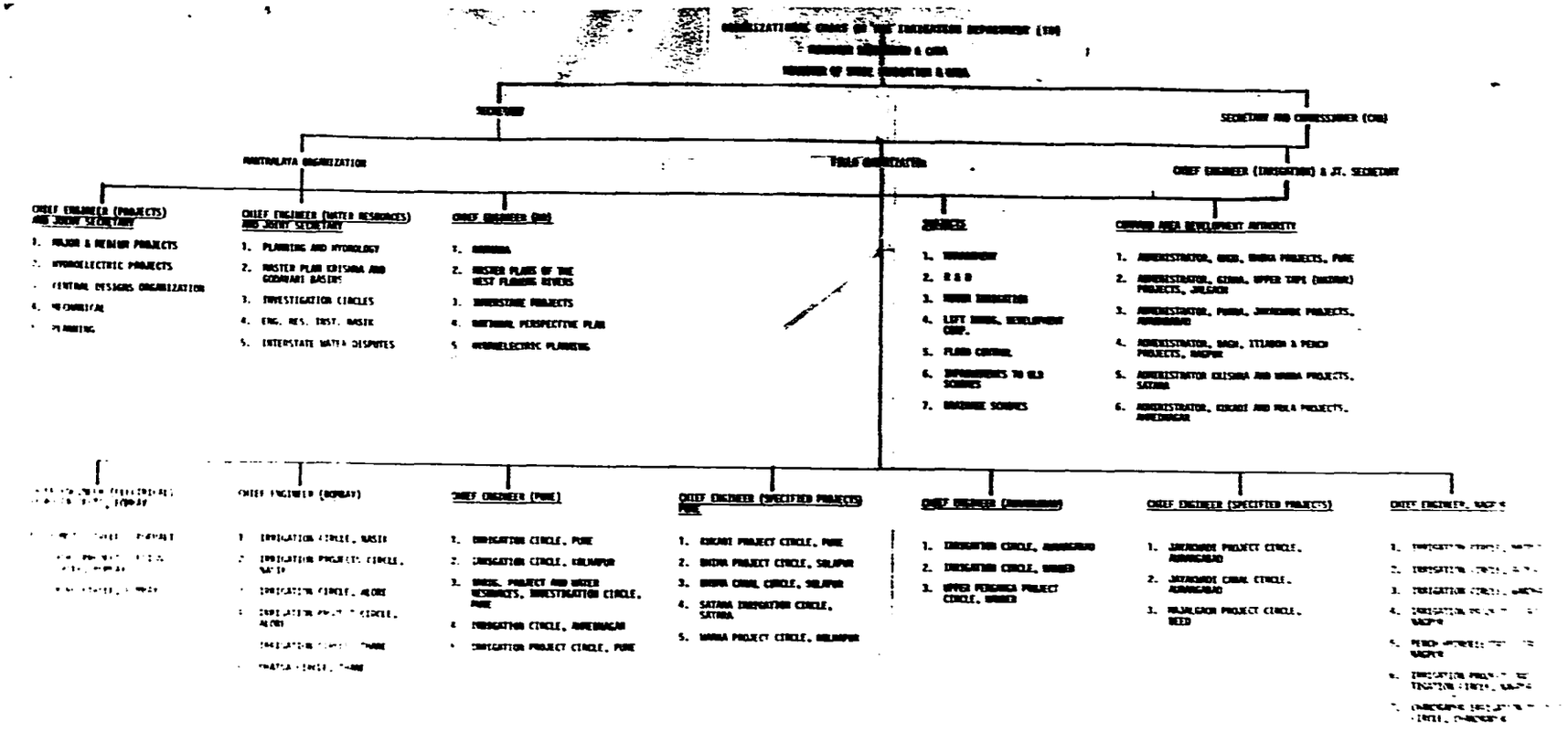
Gujarat and Rajasthan Medium Irrigation Projects, directives arising from the CWC from their review reports are promptly observed and appropriate actions initiated quickly. Regular quarterly and annual reviews will occur throughout the construction period of the MIP, and followed up thereafter until the project becomes fully operational. Review of the completed projects occur for an additional few years (about five) to evaluate operational effectiveness of the project and utilization of irrigation potential created.

AID will schedule its regular project evaluations to coincide with the CWC reviews to minimize duplication and to assure full participation by CWC. In addition further reviews will be conducted if desired necessary and as outlined in the project paper.

6. Operation and Maintenance

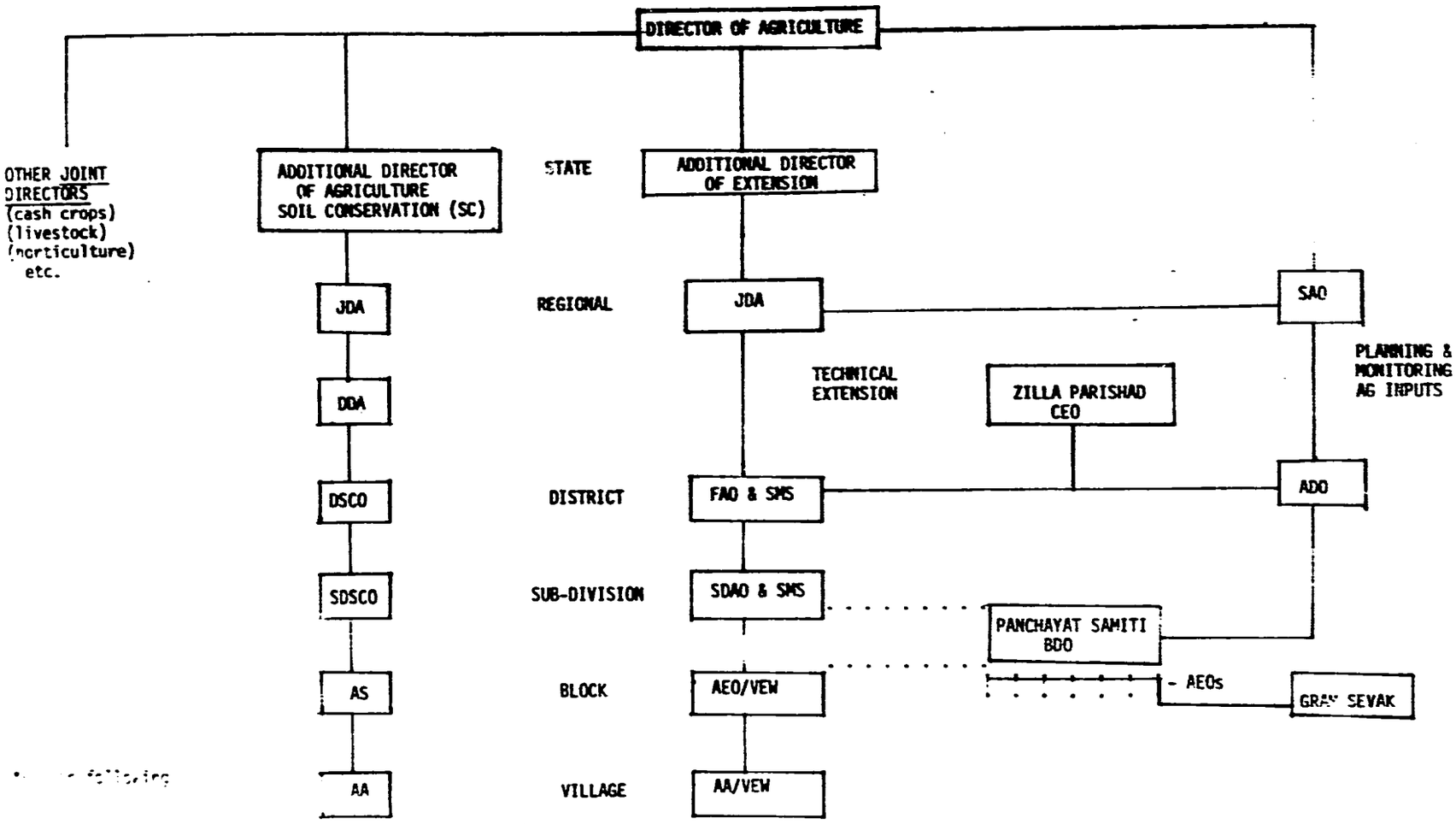
After the construction of the project, the construction personnel pull out and the project is handed over to operation and maintenance division. Depending on the size of the project, operation and maintenance division each headed by an Executive Engineer are assigned to the project. For comparatively smaller medium irrigation projects even one to two subdivisions each headed by a Deputy Engineer are assigned. These subdivisions work under the administrative and technical control of an Executive Engineer in charge of operation and maintenance of a nearby Major or Medium Irrigation Project.

Details regarding operation of a Medium Irrigation Project, maintenance of water conveyance system below an outlet and water allocation to farmers on rotation basis - called "Shejpali" in Maharashtra are explained in Chapter 4 - Technical Analysis.


SECRETARY
SECRETARY AND COMMISSIONER (CW)
MANTRALAYA ORGANIZATION
CHIEF ENGINEER (IRRIGATION) & JT. SECRETARY
CHIEF ENGINEER (PROJECTS) AND JOINT SECRETARY
1. MAJOR & MEDIUM PROJECTS
2. HYDROELECTRIC PROJECTS
3. CENTRAL DESIGNS ORGANIZATION
4. MECHANICAL
5. PLANNING
CHIEF ENGINEER (WATER RESOURCES) AND JOINT SECRETARY
1. PLANNING AND HYDROLOGY
2. MASTER PLAN KRISHNA AND GODAVARI BASINS
3. INVESTIGATION CIRCLES
4. ENG. RES. INST. NASIK
5. INTERSTATE WATER DISPUTES
CHIEF ENGINEER (WR)
1. KONKAN
2. MASTER PLANS OF THE WEST FLOWING RIVERS
3. INTERSTATE PROJECTS
4. NATIONAL PERSPECTIVE PLAN
5. HYDROELECTRIC PLANNING
SERVICES
1. WORKSHOP
2. R & D
3. MINOR IRRIGATION
4. LIFT IRRIG. DEVELOPMENT CORP.
5. FLOOD CONTROL
6. IMPROVEMENTS TO OLD SCHEMES
7. DRAINAGE SCHEMES
COMMAND AREA DEVELOPMENT AUTHORITY
1. ADMINISTRATOR, UKAI, BHIMA PROJECTS, PUNE
2. ADMINISTRATOR, GIRNA, UPPER TAPI (NIZAMAI) PROJECTS, JALGAON
3. ADMINISTRATOR, PURNA, JAYAKWADI PROJECTS, AURANGABAD
4. ADMINISTRATOR, WARDHA, ITIADOH & PENCH PROJECTS, NAGPUR
5. ADMINISTRATOR KRISHNA AND MANNA PROJECTS, SATARA
6. ADMINISTRATOR, KOYNA AND PALA PROJECTS, AHMEDNAGAR
CHIEF ENGINEER (BOMBAY)
1. IRRIGATION CIRCLE, NASIK
2. IRRIGATION PROJECT CIRCLE, NASIK
3. IRRIGATION CIRCLE, ALORE
4. IRRIGATION PROJECT CIRCLE, ALORE
5. IRRIGATION CIRCLE, THANE
6. IRRIGATION PROJECT CIRCLE, THANE
CHIEF ENGINEER (PUNE)
1. IRRIGATION CIRCLE, PUNE
2. IRRIGATION CIRCLE, KOLHAPUR
3. MECH. PROJECT AND WATER RESOURCES, INVESTIGATION CIRCLE, PUNE
4. IRRIGATION CIRCLE, AHMEDNAGAR
5. IRRIGATION PROJECT CIRCLE, PUNE
CHIEF ENGINEER (SPECIFIED PROJECTS) PUNE
1. KOYNA PROJECT CIRCLE, PUNE
2. BHIMA PROJECT CIRCLE, SOLAPUR
3. BHIMA CANAL CIRCLE, SOLAPUR
4. SATARA IRRIGATION CIRCLE, SATARA
5. MANNA PROJECT CIRCLE, KOLHAPUR
CHIEF ENGINEER (AURANGABAD)
1. IRRIGATION CIRCLE, AURANGABAD
2. IRRIGATION CIRCLE, BEED
3. UPPER PENGANGA PROJECT CIRCLE, BEED
CHIEF ENGINEER (SPECIFIED PROJECTS)
1. JAYAKWADI PROJECT CIRCLE, AURANGABAD
2. JAYAKWADI CANAL CIRCLE, AURANGABAD
3. MAJALGAON PROJECT CIRCLE, BEED
CHIEF ENGINEER, NAGPUR
1. IRRIGATION CIRCLE, NAGPUR
2. IRRIGATION CIRCLE, NAGPUR
3. IRRIGATION CIRCLE, NAGPUR
4. IRRIGATION PROJECT CIRCLE, NAGPUR
5. PENCH PROJECT CIRCLE, NAGPUR
6. IRRIGATION PROJECT CIRCLE, NAGPUR
7. IRRIGATION CIRCLE, CHANDRAPUR

ORGANIZATION CHART

Maharashtra Agriculture Department
(Soil Conservation, Extension, Ag. Inputs)



KEY

JDA - Joint Director of Agriculture
DDA - Deputy Director of Agriculture
SAO - Superintending Agriculture Officer
ADO - Agriculture Development Officer
CEO - Chief Executive Officer
BDO - Block Development Officer
PAO - Principal Agriculture Officer
SDAO - Subdivisional Agriculture Officer
AEO - Agriculture Extension Officer
AS - Agriculture Supervisor
AA - Agriculture Assistants
DSCO - Divisional Soil Conservation Officers
SDSCO - Subdivisional Soil Conservation Officer
SMS - Subject Matter Specialist
VEW - Village Extension Worker

Zilla Parishad - District Council

Panchayat Samiti - Block Council

CHAPTER 4

TECHNICAL ANALYSIS

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A. Irrigation and Water Use

1. General Description of an MIP

A medium irrigation project (MIP) provides canal irrigation to areas having culturable command areas (CCA) ranging from 2,000 to 10,000 ha. It consists of a dam which impounds monsoon runoff from streams and tributaries with a spillway for passing flood waters, and a branching distribution system consisting of main canals, branches, distributaries and minors serving public outlets. See map G4 Vol. 1. Water is conveyed to individual fields from outlets through watercourses and field channels. Surface drainage channels to remove excess rain and irrigation water is an essential element in MIPs. The net culturable area which is provided with irrigation facilities is termed the Irrigated Command Area (ICA).

MIPs may provide irrigation water to insure kharif crops from dry periods during or following the monsoon, provide irrigation for rabi and hot weather season crops or for pre-monsoon planting of Kharif crops. To be effective an MIP must not only be designed and constructed properly, but operated and maintained. There must be an orderly system for allocating proper quantities and delivering water when needed to fields which have been leveled and shaped for irrigation. To take full advantage of MIP infrastructure, irrigators must have access to production inputs like better seeds, fertilizer and pesticides, credit and market opportunities which provide economic incentives to adopt new practices and take new risks. Farmers also need to be fully informed about current irrigation agricultural technology, markets and pricing.

An MIP must be regarded as an integrated socio-technical agricultural production system in which irrigation and irrigation facilities are a dominating feature rather than as a reservoir and distribution system which simply stores and transports water. There are many opportunities for improving this system. These need to be approached on prototype scale; from the point of view of the entire system. This prototype systems approach is an essential condition and a key concept in a strategy for improving irrigated agriculture on millions of hectares of irrigated land in India and south and southeast Asia.

2. Seasons and Multiple Cropping

a. Cropping Seasons

The agricultural year in Maharashtra is divided into three cropping seasons, each from 120 - 123 days in length; kharif, rabi and hot weather. Kharif starts with the beginning of the southwest monsoon which lasts from about mid-June to about mid-October. Seasonal length is roughly the growing time for many annual (seasonal)

crops. Besides reflecting the cycles of planting and harvesting crops, irrigation water allocations and canal operations are tied to seasons.

Crops may be seasonal, i.e. sown and matured during a single season, like sorghum, wheat, pulses and oilseeds; two seasonals extending through all or part of kharif and rabi like chillies and some cottons; and perennials like sugarcane, horticultural crops and fodder, extending through three or more monsoons. Some seasonal crops, particularly kharif may extend into rabi or may not be harvested in time to plant the same land to a rabi crop thus limiting double cropping. In most of Maharashtra, rainfed rabi crops must rely primarily on residual soil moisture following kharif fallow. However, in some limited areas, such as for Sankh MIP in the southern part of the rainfall scarcity zone, a considerable portion of the rainfall comes during the early part of the rabi season. Without irrigation, rabi crops produce very low yeilds if they can be grown at all. Irrigation is necessary for hot weather season cropping.

b. Irrigation and Cropping Intensity

The combinations of natural seasons and varying lengths of crop growing season leads to some confusion about the meaning of cropping and irrigation intensity as used in India. Most commonly crops, whether seasonal, two-seasonal or perennial, are counted only once. For example, suppose 100 hectares culturable command area (CCA) has the following cropping pattern:

Irrigated sugarcane	10 ha (all three seasons)
Irrigated chillies and cotton	15 ha (two seasons)
Rainfed kharif sorghum	60 ha (seasonal)
Irrigated rabi wheat	30 ha (seasonal)
Irrigated hot weather groundnuts	15 ha (seasonal)
Total area of Crops	130 ha

The cropping intensity is said to be 130 percent with an irrigated command area (ICA) of 70 ha. Cropping intensity is appropriate to farm budgeting and assessing water charges, etc. which are calculated on an annual cropped area basis.

However, to describe seasonal land use on the entire CCA and for calculating water requirements, it must be clear how much of the land is covered by crops. For example, using the same cropping pattern as above on 100 ha CCA.

Irrigated Crop	Seasonal Area, ha/per 100 ha CCA Kharif	Rabi	Hot weather	Annual
1. Sugarcane	10	10	10	30
2. Chillies & Cotton	15	15		30
3. Wheat		30		30
4. Groundnuts			15	15
5. Irrigation Intensity, %	25	55	25	105
Rainfed Crops				
6. Sorghum	60			60
7. Cropping Intensity, %	85	55	25	165
Fallow	15	45	75	

The value of 165 represents a better index of multiple cropping than does conventional "cropping intensity". This convention is used in Tables 1 and 2 in descriptive information generally in this section and in the Economic Analysis Section except where one of the other conventions is needed for computational convenience.

The fraction of land to be placed under irrigation during any season varies depending upon agro-climatic zone but under actual practice in Maharashtra is always substantially less than 100 percent in any season. In these tables, rabi and kharif intensity includes two seasonals and perennial crops as well as seasonals. Hot weather crops include both seasonals and perennials.

Irrigated Area, Percent of CCA

New MIPs	ICA/CCA	Kharif	Rabi	Hot Weather	Total	Annual Rainfall mm
Sankh	0.80	36.0	52.0	0.0	88.0	536
Shivna	0.88	22.0	70.2	0.0	82.2	822
Karwappa	0.48	35.3	41.1	4.8	81.2	1,655
Hetavne	0.90	40.7	72.5	27.2	140.4	3,051
Existing MIPs						
Nazare	0.40	24	37	0	61	554
Khelna	N.A.					650
Pus	0.72	39	61	9	109	950
Ekburji	0.96	72	75	0	146	1,050
Adhala	0.61	44	40	0	84	1,016

TABLE 1 SEASONAL LAND USE ON PROPOSED PROJECTS IN HECTARES AND PERCENTAGES OF CCA AND ICA

			With Project							Without Project		
			ICA				Rainfed			Rainfed		
Project	GCA	CCA	Total	Kharif	Rabi	H.W.	Total	Kharif	Rabi	Total	Kharif	Rabi
Sankh	3,730	3,542	2,834									
Perennial												
Two-Season			566	283	283							
Seasonal			2,551	992	1,559							
Total			3,117	1,275	1,842					2,834	708	2,126
Irrig. Irt (CCA)			88	36	52					100		
Rainfed Int (CCA)[a]												
Overall Cropping Intensity[a]												
Irrigation Intensity (ICA)			110	45.0	65.0							
Hetavne	10,601	7,456	6,753									
Perennial			2,027	676	676	676	(676)	(676)				
Two-Season												
Seasonal			8,441	2,364	4,727	1,250	3,715	3,715		6,753	6,550	203
Total			10,468	3,039	5,403	2,026	3,715	3,715		6,753	6,550	203
Irrig. Irt (CCA)			140.4	40.7	72.5	27.2						
Rainfed Int (CCA)[a]			59.3	59.3			55(ICA)			100	97	3
Overall Cropping Intensity[a]			199.7	100	72.5	27.2	59(CCA)			100	97	3
Irrigation Intensity (ICA)			155	45	80	30						
Shivna	12,064	8,992	7,895				5,526			7,895		
Perennial												
Two-Season			790	395	395							
Seasonal			7,500	1,579	5,921		5,526	5,526				
Total			8,290	1,974	6,316		5,526	5,526		7,895	7,295	600
Irrig. Irt (CCA)			92.2	22.0	70.2							
Rainfed Int (CCA)[a]			74.5	73.7	.8		61.5	61.5(ICA)		100	92.4	76
Overall Cropping Intensity[a]			166.7	95.7	71		74.5	73.7	0.8(CCA)	100	92.4	76
Irrigation Intensity (ICA)			105.0	25	80							
Karwappa	13,962	8,048	3,890							3,306		
Perennial			1,167	389	389	389						
Two-Season			1,167	583	593							
Seasonal			4,201	1,867	2,334		1,128	1,128		3,306	3,306	
Total			6,534	2,839	3,306	389	1,128	1,128		3,306	3,306	
Irrig. Irt (CCA)			81.2	35.3	41.1	4.8	14	14 (ICA)		85.0	85.0	
Rainfed Int (CCA			57.9	57.9			57.9	57.9 (CCA)		85.0	85.0	
Overall Cropping Intensity[a]			139.1	93.2	41.1	4.8						
Irrig Intensity (ICA)			168	73	85	10						

TABLE 2 DESIGN IRRIGATION SERVICE FOR EXISTING MIPS

Project	CCA, ha	Total	Kharif	Rabi	Hot Weather
Khelna	N.A.	2,429			
Perennials		180	60	60	60
Two seasons		1,459	729	729	0
Seasonals		1,644	1,725	329	40
Totals		3,282	2,064	1,118	100
Irrig. Inten (ICA)		1.35	0.85	0.46	0.04
Pus	13,000	9,365			
Perennials		3,450	1,150	1,150	1,150
Two seasons		4,930	2,465	2,465	
Seasonals		5,750	1,396	4,354	
Totals		14,130	5,011	7,969	1,150
Irrig. Inten. (ICA)		1.51	0.54	0.85	0.12
Irrig. Inten. (CCA)		1.09	0.39	0.61	0.09
Ekburji	2,537	2,429			
Perennials					
Two seasons		2,574	1,287	1,287	
Seasonals		1,142	534	608	
Totals		3,716	1,821	1,895	
Irrig. Inten. (ICA)		1.53	0.75	0.78	
Irrig. Inten. (CCA)		1.46	0.72	0.75	
Adhala	6,427	3,913			
Perennials					
Two seasons		626	313	313	
Seasonals		4,775	2,544	2,231	
Total		5,401	2,857	2,544	
Irrig. Inten. (ICA)		1.38	0.73	0.65	
Irrig. Inten. (CCA)		0.84	0.44	0.40	
Nazare	6,075	2,453			
Perennials					
Two seasons		980	490	490	
Seasonals		2,649	957	1,742	
Totals		3,679	1,447	2,232	
Irrig. Inten. (ICA)		1.50	59.0	91.0	
Irrig. Inten. (CCA)		0.61	0.24	0.37	

Timing and amount of rainfall influences seasonal irrigation patterns and intensity to some extent. For Hetavne, west of the Ghats, 81 percent of the annual rain falls during July - August with most of the remainder coming in September. Only one to two percent comes during November - May. All but about 10 percent of the rainfall at Shivna and Karwappa Nalla falls during the regular June - September monsoon period.

For Sankh, in the scarcity zone, but in the extreme southern part, the pattern is different than for most of the state, only 35 percent of the rainfall comes during the regular June - August monsoon period with 45 percent during September - October and nearly all of the rest during March - May.

On all projects, irrigation intensity and economic return could be substantially increased during all three seasons by reducing the CCA. Available labor at actual periods of harvesting and planting has been shown to be a constraint to multiple cropping 1/ but probably the major reason for low design intensity is the social objective of providing benefits of the largest number of people within prescribed financial limits. In some cases, for certain soils avoidance of waterlogging hazard may be a consideration but this applies mostly to major projects which are located in the major river valleys where irrigation intensities are higher and soils generally are heavier than in MIPs.

1/ Dharm, Narain and Shavamal Roy, "Impact on Irrigation and Labor on Multiple Cropping: A Case Study of India. Research Report No. 2. International Food Policy Research Institute, Washington, D.C., November 1980.

3. Utilization of Irrigation Water

Table 7 Economic Analysis, Sec. C3 (Vol. II Chapter 1) gives historical information on percentage area of land placed under irrigation in relation to planned area for five existing projects. On an overall basis, results are discouraging, seldom exceeding 60 percent of targets with extremely low utilization during kharif for most projects; on the other hand, achievements for rabi, and hot weather crops where these have been included, are generally good, approaching or exceeding planned targets. Table 3 shows design water supply budgets from GOM/ID feasibility reports for these same projects.2/

Table 4 is analogous to Table 7 in the Economic Analysis Section. It shows utilization of water as the percentage ratio of water delivered over the main canal sills to the design value. For example, for Khelna in 1976-77, 29 Mcf were delivered for kharif, 280 Mcf for rabi and none for hot weather with a total of 309 Mcf compared to design estimates (Table 3) of 252.2, 172.1, 89.8 and 514.1 Mcf respectively, giving percentages of 11.5, 162.7, 0.0 and 60.1. This table shows that water deliveries measured as the canal gate during rabi and hot weather seasons, like land areas, generally achieved or exceeded design targets but that kharif deliveries did not. Except in the years marked with an asterik, the reservoirs were full at the beginning of rabi so that reservoir storage allocated to kharif was available for rabi and H.W. crops. Limitations on water supply did not inhibit achieving irrigated rabi area targets on khelna. Here the savings from kharif allocations approximately equaled the deficiency. On Pus, water supply clearly seems to have limited achievement of area targets.

Some idea of the actual delivery efficiency in comparison to that planned can be obtained by comparing water delivery percentages from Table 4 with the land utilization percentages in Table 4 Economic Analysis. For rabi on Khelna, actual water deliveries average 123.2 percent of design estimate for an average percentage

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2/ Available water supply, Line 1, is estimated from rainfall and hydrographic records. Deducting reservoir evaporation losses, Line 2, gives the amount of water available for delivery to the main canal gates, Line 3. Line 4b gives reservoir storage available assuming the reservoir is full at the end of kharif. For Khelna MIP, for example, total design water requirement Line 5d is 514.1 million cubic feet (Mcf). Backup storage is provided for 20 percent of estimated kharif requirements, or 50.44 Mcf, this added to rabi and kharif requirements of 261.9 (line 5e) totals 312.34 Mcf. The difference between this total and reservoir water available (312.24 Mcf less 296.6 Mcf, 15.64 Mcf) is made up by expected post monsoon flow into the reservoir.

TABLE 3 WATER SUPPLY BUDGETS FOR EXISTING STUDY SUBPROJECTS, Mcf/Ann

	Khelna	Ekburji	Pus	Adhala
1. Available water supply	713	588.6	4,074[a/]	
2. Evaporation from Reservoirs				
a. Kharif	43.8	30.8	76	
b. Rabi	78.6	51.8	151	
C. HW	70.1	52.2	303	
3. Available at main canal sill for three season service	520.5	426.8[b/]	3,544	
4. Live Storage	445.3	422.3	3,223	975
a. Evaporation chargeable	148.7	104.0	453	350[d/]
b. Available at sill	296.6	318.3	2,769	
5. Design Service				
a. Kharif	252.2	52.3[c/]	794	
b. Rabi	172.1	235.3	1,510	
c. HW	89.8	33.0	1,240	
d. Total	514.1	320.6	3,544	
e. Total Rabi & HW	261.9	268.3	2,750	625

a/ At 75 percent reliability - 3,575 Mcf; At 50 percent, 5,753; ave. 6,604
b/ 27 Mcf deducted for water supply to other uses
c/ Based on 16 days service
d/ Estimated at 36 percent for rabi and H.W. season

TABLE 4

UTILIZATION OF WATER IN EXISTING MIPs

(ACTUAL WATER DELIVERED/DESIGN WATER REQUIREMENTS IN PERCENT)

Year	KHELNA				PUS				EKBURJI		ADHALA
	Kharif	Rabi	Rabi & HW	Total	Kharif b/	Rabi	HW	Total	Rabi & HW a/	Total c/	Rabi & HW
1964-65		58.1	38.2	19.4					15.7	13.1	
1965-66	24.2	115.0	75.4	50.3					8.2	11.9	
1966-67	31.3	139.0	91.7	62.0					81.3	75.2	
1967-68	22.6	88.9	85.9	54.8					52.9	45.2*	
1968-69	25.7	141.4	94.7	60.9					101.0	84.5	
1969-70	7.9	139.4	91.5	50.6					150.9	126.3	
1970-71		162.6	106.9	54.5					164.4	137.5	
1971-72	5.5*	136.5*	89.7*	48.4*					17.9*	14.9*	
1972-73		32.0*	21.0*	10.6*					99.1*	83.0*	
1973-74		174.3	114.5	58.4	45.2	148.6	73.5	99.2	135.0	113.8	
1974-75	11.0*	61.0*	40.1*	25.7*	88.6*	96.4*	25.4*	69.8*	53.3*	44.6*	
1975-76		136.0	101.6	51.7	8.9	158.9	54.4	88.7	115.5	96.7	
1976-77	11.5*	162.7*	106.9*	60.1*	14.8	161.9	60.2	108.4	142.8	119.4	
1977-78	9.9	120.9	127.9	68.1	20.3	105.2	60.4	88.5	145.4	121.6	138.1
1978-79	8.7	169.7	111.5	61.1	23.9	123.1	91.0	107.8	134.2	112.3	86.6*
1979-80	1.7	133.6	87.8	45.5	89.2	141.4	126.0	141.5	140.9	117.9	97.1
1980-81	4.4				79.8	110.9					

*Reservoir did not fill. Deliveries limited by water supply.

a/ Hot weather crops actually grown were nil.
b/ Includes sum of two seasonal and perennial crops and seasonals
c/ Total of seasonals net from reservoir only.

of 96.2 percent of design land irrigated, implying that actual irrigation requirements measured at the main canal gates were about 28 percent higher than design allowances. On Pus, the total of all seasons during the seven year period (1973/74 - 1979/80) when comparisons were possible, average annual deliveries were 100.5 percent of design estimates but cropped irrigated area averaged only 58.0 percent. This indicated that estimated irrigation requirements were 73 percent too low.

The foregoing analyses show that, except for Pus, MIP kharif irrigation is an increasingly marginal activity in the projects examined but there is little evidence as to why this is so. Annual rainfall does not seem to be a factor. Pus, Ekburji and Adhala receive essentially the same rainfall, about 1,000 mm. Adhala is in the transition zone just east of the Ghats. Khelna is in the "assured" zone but receives only 650 mm and serves a drought prone area. Nazare is in the scarcity zone but has been in service only three years; utilization of kharif potential has been about 14 percent. Ekburji and Pus are in the moderately high rainfall zone in the eastern portion of the state only about 60 kilometers apart. Opportunity for perennial crops and groundwater development appear to correlate inversely with kharif irrigation. A substantial area of sugarcane receives canal irrigation in Pus. Groundwater serves more than twenty percent in Khelna and Adhala but only about two percent of the CCA of Pus and Ekburji. Increased yields and intensity of rainfed crops due to reduction of risks and more cash or credit for inputs may make rainfed kharif a more attractive system.

Other reasons for failure to utilize irrigation during kharif could be:

(a) inability of the system to respond effectively to kharif needs which would have peak demands;

(b) lack of economic incentives from the farmer's point of view;

(c) farm management difficulties such as non-availability of labor, difficulty of communication and travel during the monsoon, etc.;

(d) lack of suitable crops; and

(e) water rate structure and/or application procedure may discourage applications from farmers.

In Pus MIP, GOM/ID reported that farmers did not have reserve land available for rabi irrigation in part due to lack of short season kharif crop varieties to replace those extending into rabi.

Because of the general lack of kharif development, benefits claimed from kharif seasonal crops will not be included in economic analysis of qualifying subprojects except for MIPs in the moderately and high rainfall zones in the eastern part of the state and west of the Ghats. In the other zones, reservoir storage reserved for kharif can be used to increase rabi or hot weather irrigation.

Possibly kharif irrigation demands will increase in the future as new technologies become available and farmers have more resources. These demands can be met using excess monsoon flow-through water and would constitute an economic bonus. The apparent discrepancies between actual deliveries at canal head to those estimated emphasize the need to refine estimates of seepage and evaporation losses and to base water requirements on evapotranspiration estimates (modified Penman) with appropriate allowances for effective rain.3/ See section B2.

3/ Effective rainfall is the amount of rain available during the irrigation season which can be offset against plant evapotranspiration requirements thus reducing irrigation requirement. Light showers have little or no effect. Methods for estimating effective rain are included in standard irrigation literature.

B. Engineering and Construction

1. Staffing and Capability

Under this project the Central Water Commission (CWC) the GOI Ministry of Irrigation, will be responsible for appraising each of the subprojects and certifying that they are technically sound and comply with the project criteria and conditions as set forth in the Project Paper and loan agreement. The actual planning design and construction supervision will be carried out by the Government of Maharashtra Department of Irrigation (ID) and Department of Agriculture (AD).

The prestigious Central Water Commission with over 1000 graduate engineers sets design and construction standards and reviews designs for all irrigation projects exceeding 2,000 hectares in area. CWC is headed by a Chairman with equivalent rank of a secretary and four members with equivalent rank of Joint Secretary. A special foreign assistance division headed by a Director has been created and an Appraisal Committee will be appointed to appraise each of the AID funded MIP's. The personnel at CWC are experienced, knowledgeable and respected for their technical expertise.

The GOM/ID is headed by a Minister, who is assisted in his work by a Minister of State and two Secretaries, one for irrigation and one for Command Area Development on major projects. (Organization chart appended). The Secretary for Irrigation is supported by three central technical sections each headed by a Chief Engineer (CE). The State is divided into five regions each also headed by a Chief Engineer. Regional Chief Engineers have responsibility for much of the design and for construction and operation of projects in their regions. Headworks design, canal survey and planning and design of the irrigation distribution system down to the public outlets is undertaken by the Irrigation Department field units (circles) organized under five regional Chief Engineers. The circles also supervise construction and operation. Superintending Engineers (SE) are in charge of circle operations and normally supervise four divisions each. The Regional Chief Engineers have from three to seven circles under their direction.

Executive Engineers (EE) are in charge of divisional offices. They also hold all the powers of canal officers under the Irrigation Act, and are, therefore, primarily responsible as the Executive Officer for efficient management of and control over the irrigation works in their charge. The basic organizational unit is the subdivision. These are headed by a Deputy Engineer who reports to the EE. Subdivisions are added as needed depending on the workload.

The GOM/ID staff includes about 9,000 engineers, 2,760 of whom are graduate or post-graduate or post-graduate engineers and the remaining 6,240 are diploma holders. The GOM (ID) staff is highly competent in the fields of reinforced concrete and masonry design, hydraulics, hydrology, geology and soil mechanics.

The responsibility for carrying out the land development works rests with the GOM, Soil Conservation Division (AD/SC). The land development works under this project include all improvements from the eight ha outlet (ending point of the ID responsibility) down to and including improvement on the individual farmers fields.

The AD/SC has six field divisions and 30 subdivisions under the supervision of the Deputy Director of Agriculture (DDA) for carrying out land development works on medium and minor irrigation projects in Maharashtra.

SC technicians are diploma graduates (High School plus two years). Some have had up to six months in-house general soil conservation training but the majority of the field formations lack essential engineering/technical background. SC proposes that selected subdivision officers be required to take six weeks training at WALMI. These officers will then train the personnel in their respective subdivisions. In addition, the AD/SC has recently started a training program at Sholapur for training relating to communal and individual land development techniques and will open another center at Aurangabad in 1982. Training will be provided to subdivisional Officers, Agricultural Officers, Supervisors and Assistants. GOM and USAID will evaluate where additional training efforts may be required to insure satisfactory design and operation of watercourse and field channels. Training costs and needed consulting assistance will be fully reimbursable using AID grant funds.

Refer to Vol. II Chapter 3, Administrative Analysis, for a comprehensive description of the agencies involved in the implementation and operation of the MIP's.

2. Design of Subprojects

a. Water Supply

There are not enough stream gauges in the localities in proposed subprojects to provide direct estimates of water supply. Rainfall stations are common, however, and many have long term records. These are used to estimate runoff based on empirical correlation formulas developed over the past century. Annual water supply varies quite widely at any site. Commonly, design water supply is chosen as that which can be expected in 75 percent of the years (75 percent reliability); however, this is modified usually to 50 percent, for MIPs in water scarcity areas (below 750 mm precipitation). Reservoir records provide information about runoff and are used to verify estimates made from rainfall. An examination of reservoir records of four existing projects using the number of years reservoir did not fill as an index of reliability indicates that reservoir water supply estimates are reasonable.

Accuracy of water supply estimates would be enhanced by more actual stream gauging stations. The WB is supporting expansion of the State's network and GOI/GOM officials did not feel that AID assistance was needed in strengthening stream gauging under this project.

Groundwater, which may be augmented by surface irrigation in subprojects, provides an additional source of water to MIP command areas.

b. Water Budgets

Having decided upon the supply, this is allocated among the three cropping seasons. Except in high rainfall zones, MIP supplies are not usually allocated to hot weather seasonal crops nor perennials because of the high reservoir evaporation losses due to longer storage period and high water requirements. Reservoir storage is normally provided for the designed rabi and hot weather allocations and for 20 percent of the estimated kharif demands, see Table 4.

Seasonal water requirements are calculated based on cropping patterns provided by AD. Commonly in Maharashtra, irrigation requirements for various crops are computed using duty

of water, which is defined as the number of acres/hectares, which experience has shown can be irrigated with one cusec/cumec of flow delivered at the outlet.4/ One problem with using duty of water is knowing what this actually means at the crop root zone. One estimate made by USAID,5/ gave combined field channel delivery and field application loss at 51.8 percent, which is reasonable. Actual conveyance losses vary depending on physical length of the channel, seepage characteristics, system operating procedures and length of time canals and channels are operated. Field efficiency depends upon whether or not fields are properly graded and how water is applied. At the present time, the method used to determine the water and channel capacity requirements is based on a fixed duty in Cusec/Cumec per ha at the outlet or canal head. This figure is based on years of experience but may not adequately consider the peak delivery requirements at critical stages of crop growth nor adequately account for system and application losses.

For qualifying subprojects, irrigation requirements at the main canal will be computed using the modified Penman formula for crop requirements. To these will be added estimated losses in field channels and canals based on physical and soil characteristics and time of operation. Schedules showing timing of operation of channels will be included in feasibility reports. In any case, not less than 10 percent seepage losses will be assumed for unlined main and branch canals and 10 percent for unlined distributaries and minors. Not less than 5 percent will be assumed for lined main and branch canals and 5 percent for lined

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4/ For example, for rabi wheat, duty is commonly 150 A/cfs. The volume in cubic feet delivered by one cfs during a season (usually 122 or 123 days) is equal to the number of seconds in the season or 122 x 24 x 3600 = 10,540,800. Dividing by duty of 150 gives the number of cubic feet for an acre, 10,540,800/150 - 70,272. Dividing by square feet in an acre 70,270/43,560 = 1.61 feet, or 19.4 inches depth (the "delta").

5/ For Karwappa Nalla, water requirements were computed using duty and also by Penman's modified formula. This provides an opportunity to estimate water loss allowances implicit in duty allowance. Crop requirements computed by Penman's formula totalled 4.937 Mm^3/1000 ha; computing requirements by duty at the outlet and 8.158 Mm^3 or requirements at the main canal gate of 9.539 Mm^3/1000 ha. Thus, the actual estimated overall efficiency at the main gate 4.937/9.539 = 0.518.

distributaries and minors. Additional allowances for operational losses will be 15 percent for the unlined systems, 12 percent if only main and branch canals are lined and 10 percent if lining is provided to approximately 8 ha outlets. Field application efficiency may be taken as 75 percent and field channels from 8 ha as 90 percent if field channels are prepared and fields are leveled as described under Section B2e iii Land Development. Table 5 (p.17) illustrates procedure for preparing water budgets. The unlined case in Table 5 is based on an assumed loss rate of 16 cfs/ Msf which is the average reported in Maharashtra. Using the above estimated loss percentages, the overall irrigation efficiency becomes 36 percent for a new unlined system and 54 percent for a system lined down to the eight ha level. Actual estimates of seepage loss rate will be used in preparing subproject water budgets.

c. Dams and Reservoirs

i. Dams: GOM/ID has had many years successful experience in design and constructing dams and spillways of all sizes and GOI/CWC has developed excellent design standards.6/ In CWC's review of MIPs, particular attention is given to dam safety and utility including protection against overtopping by waves for winds based on 50 year rainfall return interval. Spillways are designed to pass 100 year floods. No special USAID criteria are necessary for design of dams and spillways.

ii. Silt Storage: Silt production is estimated using empirical formulas. Allowance for silt deposition is provided by allocating reservoir storage volume below Minimum Draw Down Level (MDDL) sufficient to hold expected silt accumulation during projected lifetimes of the reservoir ranging between 75 - 100 years. This storage is controlled by the elevation of the main gate sill.7/ Much of the silt, however, will be deposited in the live storage section of the reservoir, thus decreasing effective live storage.

6/ Indian Standards (I.S.) 6512-1972 "Criteria for Design of Solid Gravity Dams", I.S. 826-1978 "Guidelines for Design of Large Earth and Rockfill Dams".

7/ Dead Storage is water below main gate sill. MDDL is elevation of main gate sill plus hydraulic head necessary to move water through the gates.

TABLE 5

EXAMPLES OF WATER BUDGETS
Mm^3/annum

	New Unlined	Main Canal Lined	Lined to .8 ha
1. Release at Main Canal Gate	25.0	25.0	25.0
2. Water losses to 8 ha			
a. Operational Losses	3.75	3.12	2.50
b. Conveyance Losses			
i. Main Canal	3.95	1.25*	1.25*
ii. Distributaries	3.95	3.95	1.19**
iii. Subtotal of Conveyance Losses	7.90	5.20	2.44
iv. Conveyance Efficiency %	68.4	79.2	90.2
3. Available at Outlets	13.35	16.68	20.06
4. Field Channel Losses	1.34	1.67	2.01
	12.01	15.01	18.05
5. Available to Crop	9.00	11.26	13.54
6. Overall Efficiency %	36.0	45	54.2

1. Delivery of 5000 m^3/ha for 5000 ha
2b. Assumptions: Wetted Perimeter, 62,500 m^2, canals operated 150 days.
* 5 percent of 25.
2c. Wettered perimeter 62,500 m^2, distributaries operated 150 days.
**5 percent of 23.75

Unlined - assumes loss rate of 16 cfs/Msf which is the average reported in Maharashtra.

No account is taken of this. GOM/ID has a program for measuring silt accumulations in some existing reservoirs and silt samples are taken at stream gauging stations. This information will be used to refine estimates of needed silt storage. Since silt production in relation to volume of runoff is several times greater in the low rainfall zones than in higher ones, attention needs to be given to rainfall zones below about 1000 mm. (GOM/AD/SC) has an ongoing statewide watershed treatment program which can be expected to impact on MIP watersheds generally. This program consists of contour and graded bunding, nulla bunding, nulla training, and aforestation of degraded areas and also impacts on thousands of small tanks and major irrigation watersheds. It is basically owner-financed utilizing institutional credit with subsidies ranging from 25 to 100 percent. It did not seem practical or equitable for USAID to request special consideration by this program on subprojects financed under the loan. However, during the design of the upcoming USAID supported social forestry projects ways and means of providing additional impacts on the subproject watersheds will be explored.

iii. Operations Studies: Reservoir operations studies in subproject proposals reviewed were on annual or seasonal basis using rainfall records and runoff correlation techniques for estimating seasonal runoff. For candidate subprojects, a monthly operations study will be prepared using not less than 20 years of historical information.8/ Existing formulas based on rainfall predict only seasonal yields for runoff. This can be converted to monthly values by correlation with existing stream gauging stations. Fortnightly irrigation requirements will be computed using Penman's Modified Formula with appropriate allowances for conveyance and operational losses as described in Sec. B 2b. USAID understands that computer facilities for conducting such studies are available to GOM/ID. Results would be used to determine the reliability of the water supply for each season, sizing of canals to meet peak demands, and the average availability of water for use in the economic analysis.9/Support will be provided for U.S. training of two mid-level and one senior officer in reservoir operations methodology.

Special studies of alternative water allocations will be made utilizing four subprojects, one in each major climatic zone. The operations studies described above automatically give priority to meeting kharif needs. The special

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8/ Presently no operation studies are carried out on MIP's.

9/ See Vol II, Chapter 1 Section F.

studies will: (a) give priority to full reservoir at beginning of rabi and (b) to varying the reservoir size (percent of storage reliability). They will be completed within 22 months or project implementation date and will provide information for economic studies outlined in the section on Economic Analysis. As soon as practical after selection of the study subprojects a stream gauging station and meteorological station with rain gauge and standard evaporation pan will be established at or immediately below each of the four damsites. Information will be used to verify monthly distribution of runoff, yield estimates, for calculating reservoir evaporation and for providing information on rainfall. A preliminary report of these studies with conclusions will be prepared with copies to USAID within 27 months of project implementation report. This report will be reviewed at mid-term project evaluation.

d. Canals and Distributaries

i. General Description and Criteria: Irrigation water is conveyed through a treelike branching system of canals, branch canals, distributaries, minors, subminors, watercourses and field channels. In most of Maharashtra MIPs the full hierarchy of channels is not present. See Map G4 Vol. I. Main canals frequently pass directly to minors or subminors. Conveyance systems and their parts are critical to effective operation of surface irrigation projects. They need to be designed and operated so that water can be delivered in equitable fashion at any point within the distribution system with minimal waste of water. The longer the canal the more is the hazard that a fully supply will not be delivered. Because of their importance and relative lack of attention, improvement of the effectiveness of delivery systems within the limits of economic feasibility is a major objective of this project. A major factor in the failure of canal structures is lack of proper compaction of earthwork.

In the recent past, the distribution system has been designed to deliver a stream of 28 liters/sec (one cusec) to the outlet serving approximately 40 hectares. Water measuring devices were only provided at the head of the distributary offtaking from the main canal. The resultant flows at the eight hectare turnouts, after accounting for losses were considerably less than 28 liter/sec.

The distribution system on the USAID supported subprojects will be designed to deliver a stream of not less than 28 liters/sec (one cusec) on a rotational basis to gated outlets serving approximately 8 hectares. All channels will be designed to meet peak semi-monthly crop requirements described in Sec B 2b. Main and branch canals will be designed to permit full deliveries at offtakes when operated at 50 percent of design flow. All channels will

be provided with sufficient control structures such that they can supply all required diversions throughout their entire lengths and service ranges. Minors or other channels serving outlets to watercourses and/or field channels will be provided with sufficient regulation to maintain fully supply levels at operating outlets under all delivery schedules. Measuring structures and gates will be provided at all outlets down to approx. 25 ha and at turnouts to watercourses and field channels so that water may be fully controlled and measured in each element of the system. The delivery system shall be fully protected from storm drainage by adequate cross drainage structures, or where feasible, drainage inlets. Wasteways will be provided at the ends of canals and as needed at critical points in the alignment. All canals and minor channels and backfill for structure shall be fully compacted at or near optimal moisture content to standard specifications of GOM/ID.

Where constructued in expansive soils, canal structures including lining shall be protected and channels stabilized by replacement of surrounding soil with cohesive non-swelling soils utilizing technology developed at Indian Institute of Technology, Bombay.[10/]

ii. Lining: In order to meet peak demands, canals are designed with peak capacity higher (about twice) than that required to pass average flow. For example, Shivna RBC design capacity is 4.4 M^3/s (157 cfs) to deliver 24.836 Mm^3 during rabi and 6.274 Mm^3 during kharif periods of 123/122 days each or an average flow rates of 2.34 m^3/s during rabi and 0.595 m^3/s during kharif.

The actual average flow depends upon the number of days the canal is operated. Canals may be shut down periodically if water demands are met. Although this often is avoided because of structural damage during unwatering. Reducing the flow does not reduce seepage losses proportionately. Assuming a seepage loss rate of 8 cfs per million square feet of wetted perimeter (cfs/Msf), losses at the average design flow for the 62 km Shivna RBC are calculated

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10/ "Katti, R.K.,E.S. Bhangale, U.V. Kulkarni, and D.G. Divaskhikar. Shear Strength Development in Expansive Black Cotton Soil Media With and Without a Cohesive Non-swelling Soil Surcharge. Applications to Stability of Canals in Cuts and Embankments. Central Board of Irrigation and Power. Technical Report No. 28 New Delhi, March, 1980. This technology is not currently being applied to MIPs."

by GOM/ID at 1.066 m^3/s (35.525 cfs), or 22.6 percent of flow. However, under an assumed 100 day operating schedule for rabi, losses would approach 35 percent.

Total seepage losses also increase with canal length under the assumptions made above. For Shivna, total seepage loss increased about 0.5 percent per kilometer. Not only do seepage losses increase with length but so does cost. The length of canals is dependent on the configuration of the command area, however, canal length can be reduced by increasing seasonal irrigation intensity and reducing command area. This must be balanced against the social and economic objectives of the project. See Vol.II Chapter 1 Sec. F5.

Black cotton soils are dominant in most of Maharashtra east of the Ghats. In these soils maintaining channel shape rather than seepage loss appears to be the principal problem. This is because the soils are quite impermeable and unstable when wet. See Chapter 6 Sec. A2. In the upland watershed areas where MIPs are most apt to be located, black cotton soils may be relatively shallow and intergraded with other non-swelling and more permeable soils. Larger channels especially in cut often penetrate through the soil layer into the subsoil or weathered rock substrata, which are quite permeable. Under these and possibly other conditions, such as when expansive soils are stabilized by replacing swelling soils with non-swelling ones, lining may be needed.

Estimating seepage losses in advance of construction and operation is a major difficulty in determining water available to crops, when lining is justified and if waterlogging may be a hazard. Lining costs are increasing and scarcity of portland cement is a problem. One solution would be to defer lining until after the subproject is in operation and seepage losses can be evaluated. This would cause programatic and budget problems and would involve obligations extending well beyond the completion date of this project. The high cost of lining argues strongly that some effort be made to find a better approach to estimating seepage losses in advance than now exists. Seepage losses vary with time. When canals are first filled seepage losses are highest because of extra absorption required to fill the soil pores. These decrease with time and eventually become essentially constant. Basic limiting parameters involved are the saturated hydraulic conductivity 11/ of the material

11/ The procedure outlined in Attachment 1 gives hydraulic conductivity in feet per day. To change to cfs/Msf this result must be multiplied by (10^6/86,400). This value must be converted to seepage rate by multiplying by a factor defined by the correlation studies.

in which the canal is built, the wetted perimeter of the canal and the water table slope and thickness of the free aquifer beneath the canal:

The following approach is suggested for main canals and other major channels on qualifying subprojects. Test pits will be dug at not more than 500 meter intervals along the canal alignment to a depth equal to the proposed level of the canal bed. Measurements of hydraulic conductivity at bed level will be made following the procedures set forth in Attachment 1. GOM/ID will make studies to establish correlation of hydraulic conductivity to actual seepage loss rates in order to estimate seepage loss rates in subproject canals. Hydraulic conductivity tests could be correlated with reaches of canals where seepage losses have been measured or with water management studies carried out on existing MIPs. Efforts will be made to correlate seepage loss rates with the Unified Soil Classification System for Engineering (IS:1498-1970). Studies will lead to recommendations to the Secretary of Irrigation, GOM resulting in guidelines for design. Four months U.S. training in seepage loss hydrology and canal lining technology for two mid-level officers will be provided.

e. Watercourses and Land Development

i. Surveying and Mapping: GOM/ID uses topographic maps prepared by the Survey of India for general appraisal and layout of subprojects. While satisfactory for this purpose, these are not sufficiently accurate for locating minors, distributaries, outlets and field channels where vertical tolerance between FSL and land to be served must be within about 0.15 m (6 inches). For land development, including field channels, AD/SC specifies 1/1,250 scale maps with 0.30 m contours based on a 15 meter grid. These are suitable for watercourse and field channel location. These shall be used on qualifying projects for final location of outlets, watercourses and field channels.

ii. Watercourses: Between the reservoir outlet and the watercourse, which serves about 40 ha, the stream of water is divided flow wise according to the needs of the various branches of the distribution system. For the watercourses, the stream is rotated timewise to field channels which serve approximately 8 ha although sometimes this stream may be further subdivided. Until October 1978, irrigation departments constructed channels at project expense only to watercourse outlets (40 ha outlet). Watercourses, field channels and drains linking fields to the central drainage system was the farmers' responsibility, with technical assistance by AD/SC. Since

these communal channels were privately financed, AD faced the difficult problem of getting farmers to agree to underwrite credit programs for construction. This difficulty is aggravated by the fact that a high proportion of farmers are ineligible for credit because of lack of clear land title, default or credit ceilings. To solve the financing problem, GOM has now decided that the community watercourses and field channels will be constructed to the last survey number (each farmer's field) with public financing construction of watercourses (40 ha to 8 ha) will be done by ID at project expense and will be eligible for reimbursement under the AID loan.

iii. Land Development: Land development works include all improvements from the eight ha outlet down to and including on-farm improvements and is the responsibility of AD/SC. These works are being implemented in two stages:

The first stage of development, called Part I works, include all communal items serving more than one farm. For example, irrigation channels with allied control structures, surface drainage network within the outlet command and installation of graded bunds for diverting excess runoff from within the outlet command to the natural drainage system. The communal irrigation channels will be constructed from the eight ha turnout to the last survey number (each farm gate).

The Maharashtra Irrigation Act of 1976 specifies that the benefitted farmers will be responsible for maintenance of Part I works. If the community items are not properly maintained the ID is empowered to carry out the maintenance and recover the costs from the individual beneficiaries. On qualifying subprojects construction of field channels will be started not later than three years before completion of construction of major works and completed within four years.

The works under Part I are necessary for affecting uniform distribution of irrigation water, are provided at project costs, and will be eligible for reimbursement under the AID loan.

The second stage of development called Part II works is improvements on individual farmer's fields. Improvements include land shaping/leveling based on topographic considerations, on-farm distribution channels, water control structures and bunding. As per the GOM resolution No. ADP 1080/222/51 dated May 26, 1980, a farmer desiring implementation of Part II works shall have to give his consent within a period of three months from the date of completion of Part I works in his field/outlet command. This step has been necessitated to restrict the land development (Part I and II)

period to about four to five years and to enable the SC field units to move into the further areas. Farmers who do not consent to Part II works during the "preferred time" will have more difficulty in completing this works at a later date since the field units would have moved from the area. The Part II works will be financed by GOM and the recovery mechanism to recover the costs from the beneficiaries will be worked out by GOM at a later date.

Reasonable utilization of water can be achieved only if fields are suitably prepared. Uneven land results in low irrigation application efficiency and substantially reduces average yields because of dry or wet spots thus decreasing efficiency of fertilizer, pesticide applications and tillage efforts. Level-bed irrigation is satisfactory under some conditions, e.g. for rice or for very small fields but requires precision leveling to 1.5 cm tolerance. Grading land to appropriate slopes enhances drainage of monsoon rainwater and does not require that levels be as precisely controlled as for level-bed irrigation, thus saving costs and increasing the likelihood of more efficient operation.

Recently AD/SC prepared draft instructions (LD instruction) for design and construction of communal channels and land development on individual farms. These have been reviewed by USAID and found satisfactory.

For qualifying subprojects,watercourses, field channels and drains will be constructed to proper grade and provided with turnouts and check structures in accordance with LD instruction. Minors shall provide not less than 0.15 m operating head to watercourse outlets and watercourses shall provide not less than 0.15 m to field channels. Field channels shall be located and designed so that service operating water level is not less than 0.15 m higher than the highest point of the fields to be served. Gates and standing wave flumes or other measuring devices shall be installed at all outlets serving watercourses and field channels. All channels in fill will be fully compacted at optimal moisture to standard GOM/ID specifications for earthwork.

At the time minors, watercourses and field channels are being planned for any chak and prior to construction, ID and AD subdivision officials will assemble and meet concerned farmers explaining the plans for locating and constructing these channels and will consider their views on location and construction, within technical limitations. Commonly, at present, grass stabilization is installed in watercourses and field channels. These techniques appear promising at least for black cotton soils (BCS) but there may be better alternatives including simply more inten-

sive maintenance and/or the development of ditch-forming equipment (v shaped drag ditcher scrapers, for example). Field channel construction and operation is being studied at several locations (Mahatma Phule University, and pilot projects in Jayakwadi, Bhime, Mula, Girna and Kukdi irrigation projects. There is an opportunity to improve significantly the design of small channel structures. Much has been done in this field which needs to be reviewed and evaluated. Underground pipe could be a substitute for small channel lining. GOM/ID, AD will compile and evaluate existing information regarding these techniques under study at various institutions, including ditch forming implements.

As part of its quality control program on qualifying subprojects, GOM/ID with AD assistance will monitor the adequacy of watercourse and field channel design and construction for sample chaks chosen at random but constituting not less than 10 percent of all chaks in a subproject. Review will include grade and cross section, structures such as outlet gates, measuring devices, turnouts and drop, compaction of earthworks, and elevation relative to subsidiary channels and fields to be served. These reviews will be monitored by the CWC/AC and summarized in their progress reports.

At least one of the first five chaks completed in each subproject will be monitored during the first three months after watercourse and/or field channel construction are started. Any necessary remedial action will be taken immediately. An initial progress report will be filed with the Appraisal Committee within six months.

In heavy soils, especially BCS, land is often left fallow during monsoon because of difficulty in tillage. GOI/ICAR, Coordinated Research Program on Semi-Arid Lands and ICRISAT have developed techniques for managing kharif crops on these soils which promise significant economic rewards. These were developed for rainfed conditions but should be applicable under seasonal rainfed cum irrigated systems. Pilot studies to test this system for application on MIPs under Maharashtra soil and climatic conditions will be implemented as part of the Water Management Improvement Program supported under the project.

iv. Water Allocation and Rotation: Water allocation and rotation is governed by the Maharashtra Irrigation Act of 1976. The Act is quite detailed and deals with the functions and powers of canal officers, construction and maintenance, field channels, land acquisition, sanction of water applications, water rates, and all manner of rules, provisions, penalties, etc. concerned with the use and conservation of irrigation water by individuals and organ-

izations.

Unlike northern India, where water rights go with the land or are compulsory for paddy as in Andhra Pradesh and Tamil Nadu, irrigation is optional within the command and is sanctioned by the Irrigation Department based on applications made by farmers for seasonal as well as annual crops. The Act also provides for long-term sanctions for perennials, horticultural and other garden "blocks".

During the monsoon season every Executive Engineer in charge of management of an irrigation system prepares a preliminary irrigation program for each irrigation project under his control. This program is intended to fully utilize stored water taking into account river gains, which usually provide most of the kharif water and often some rabi crop irrigation requirements. After preparation of the preliminary irrigation program, if available water and canal capacities can accommodate sanctions in addition to long-term block commitments, public notices are issued calling for applications for temporary seasonal sanctions. If demand for seasonal sanctions exceeds availability, area sanctioned is determined on a pro-rata basis or by drawing lots.

The system of allocation under the Act along with its implementation through formal rotations procedures is called the "Shejapali" system in contrast to the Warabundi system of northern India under which water is allocated in proportion to land holdings. Based on sanctioned applications water requirements for each rotation for each canal subdivision are calculated and distributed among the various sections. The section officer divides the quota among the various canal inspectors who are responsible for distribution to distributaries and outlets. Normally rotations are 14 days but this is being varied in some commands with perennial crops receiving water each rotation and seasonals on alternate ones. Under the Shejapali system it is assumed that a one cusec (28 liter/sec) stream at the distributary head will provide four acre inches per acre (10 cm irrigation) at the farm gate. This assumes an average loss rate of 33 percent from the distributary head to the farm gate. The above 12/ assumptions provide the basis for individual timings on field channels.

12/ A 28 liter/sec (1 cfs) stream will deliver one acre inch per hr. For a 10 cm (4-inch) irrigation (delta) a farmer irrigating 1.5 ha (3.75 acres) would receive the stream for 15 hours then the stream would pass to the next irrigator and so on until all irrigators are served at which time the outlet is closed until the next rotation. Rotation to outlets on minors is similar. For example, a 0.14 cumec (5 cfs) minor could provide water to five 28/liter/sec outlets at a time but may serve two or three times that many during a rotation period. As rotation is completed at one outlet, it is closed and another one opened. This process is continued until all the subscribing fields have been served.

Based on sanctioned allocations, the Canal Inspector in charge prepares a schedule for each outlet giving the date and timing for each individual's turn. This information is given to sanction holders at a meeting convened by the Inspector under the Shejpali system, unlike the warabundi system of north if the irrigation supply is interrupted the individual irrigators do not miss their turn, but it is delayed.

The Maharashtra Act provides wide scope for farmers to take over managemnet and distribution of water at some level. Where a suitable measuring device exists and where occupiers of 51 percent of the land or 51 percent of the holders of lands to which water has been sanctioned agree, water may be taken on a volumetric basis and administered by a Water Committee consisting of a Sectional Officer or nominee and four persons appointed by the holders of the lands so sanctioned. The Water Committee receives the measured water and insures its proper apportionment; receives and enquires into complaints regarding distribution of water and attempts to set them right; makes all efforts to prevent unauthorized use of waste of water; assists the canal officer in his duties and in detecting unauthorized use of water; and insures that only sanctioned crops and areas are brought under irrigation. In addition under provisions of the irrigation act, where canals serving 200 hectares or less a draft scheme for handing over the management of the canal and distribution of water to a Water Committee may be developed by the appropriate authority (ID). The Act specifies the content of the draft scheme and duties of the Committee. The draft scheme is published in the Official Gazette. Objections and suggestions may be filed within three months and after making due inquiries the appropriate authority may sanction the draft scheme with or without modification or reject it.

v. Agricultural Water Management Studies: Water management studies consisting of several sub-studies will be initiated in three existing MIPs. The studies will include, but not be limited to:

(1) Measurement of water delivery and field application losses in three representative chaks at head, middle and tail reaches from canal headworks in each MIP. Water loss measurements will be made using calibrated weir or measuring flume under operating conditions;

(2) Obtaining survey information on cropping patterns and cropping irrigation intensity;

(3) Compile and evaluate available information

on alternative designs, operation and maintenance of small structures, watercourses and field channels including methods of stabilizing and reducing seepage and operational losses such as lining, underground pipe and other structures; and

(4) Evaluate the current irrigation application process, the Shejpali system of water distribution including the effect on equity of distribution among different farmer size groups and the organization and effectiveness of farmer water committees functioning in the study MIPs.

The results of the above studies, along with the results of the studies carried out for canal seepage loss predictions (See Sec B2 d) and groundwater utilization (see Sec B2 h), will provide information to develop recommendations for improving the design and utilization of the MIPs being planned and/or constructed in Maharashtra. It is anticipated that some of the recommendations will require testing on a pilot basis before being applied to MIPs in general. Examples of recommendations that may be developed could include:

(1) Procedures for improving the efficiency and equity of distribution at system and farm level and for consideration of water allocation procedures favoring small and marginal farmers.

(2) Procedures for maintaining and operating portions of the irrigation system utilizing farmer organizations. Variables will include several levels of farmer organizational responsibility in relation to GOI/ID and possibly different organizational arrangements. Various sizes of physical control by the farmer organizations such as the operation and/or maintenance of eight ha blocks, 40 ha blocks and minor level units will be considered. Consideration will also be given to possible contractual arrangements with farmer organizations for purchasing and delivering water on a volumetric basis as provided under Chapter III of the Maharashtra Irrigation Act of 1976.

(3) Ways and means of increasing the utilization of kharif irrigation and for testing economical low investment low risk kharif crops.

The various sets of recommendations resulting from the above studies will be tested on a pilot basis on the selected three existing MIPs. It is anticipated that the initial recommendations could begin to be tested during the second year of the project and continue to be evaluated and refined throughout the remaining project period. Based on results of the pilot studies,

the most promising approaches will be implemented on qualifying projects during the remaining period of the project agreement. The design of portions of the above studies would benefit from assistance of an internationally qualified social scientist and water management specialist with experience in irrigation water user organizations. AID will support, with grant funding, the above studies, required expertise, and training for officers in agricultural water managemnet who will be responsible for implementing improved water management in subprojects.

f. Drainage, Waterlogging and Salinity

Surface drainage facilties capable of removing excess surface water from individual fields and delivering it into natural drainage channels will be provided. The facilities will be such that all rainfall and excess irrigation water is readily removed and does not stand stagnant in any undrained area. Natural drainage channels will be cleared and bridges and culverts provided so that surface infrastructure such as railways, roads and canals do not impede drainage. Field and collector drains will be sized to remove rainfall intensities of five years recurrence intervals occurring simultaneously with irrigation rapidly enough to avoid crop damage.

GOM/ID (DIRD) makes semi-annual field surveys of waterlogging and salinity on major irrigation projects. These show that about six percent of the irrigated area suffers or is threatened from some degree of waterlogging. Properly designed surface water drainage, improved water distribution and development of groundwater on subprojects will greatly reduce waterlogging hazard. GOM/ID will extend its water logging surveys to include subproject MIP's. Where water logging hazard develops remedial drainage plans will be developed and implemented by GOM/ID. AID will provide support for four months U.S. training of two mid-level drainage engineers.

g. Soil Surveys

Soil surveys provide important information for planning land use and development of irrigation, avoiding water logging problems, deciding on cropping patterns and recommending other agricultural practices. Not only should they be available to subproject planners but they should be used more effectively. DIRD reports that detailed soil surveys are made for all major and medium MIPs. Examination of design reports did not indicate that these had been utilized fully. Detailed soil surveys conducted according to the recommendations of the National Bureau of Soil Survey and Land Use Planning, Nagpur, will be completed within two years of initiation of construction and prior to initiation of Part I land development operations on all subprojects. Surveys will be used for developing re-

vised cropping patterns, land leveling and grading and location of drains. Soil survey support at the Directorate of Irrigation Research and Development laboratories in Pune and Nagpur will be strengthened by adding a soil chemist (MSc level) and upgrading equipment.

GOM/ID and AD will make an organized effort to compile information on improved utilization of soil surveys in planning and management of MIPs. Research information related to crop production and land management will be compiled and evaluated. Efforts will be made to insure that applied research experiments are related to soil types. Recommendations for more effective use of soil surveys will be made to Secretary GOM/ID and CWC. Within six months after project implementation, GOM/ID in collaboration with GOM/AD and with USAID review, will develop a plan for carrying out these activities.

AID will provide support for six months U.S. training of four mid-level soil survey scientists and for a six week U.S. study tour for two senior soil scientists (see Sec. B3d) and acquisition of required imported equipment and consultant services as may be needed to recommend on the laboratory program.

h. Groundwater Development

The State of Maharashtra is underlain by massive basaltic and granitic rock formations. Overlying this substratum is a zone of unconsolidated material consisting of fractured rock of variable thickness. This layer, usually, is several meters or more in thickness and provides a free aquifer (in contrast to an artesian aquifer which is under pressure) of limited capacity. However, this limited aquifer does provide significant potential for economical exploitation for irrigation in MIPs.

Exploitation of these aquifers with tube wells is not possible because of the low water transmission capacity of the aquifer. In contrast, dug wells several meters in diameter and up to 15 - 20 meters deep are used. These yield 15,000 - 20,000 m^3 annually, enough to irrigate about 2 hectares of crops. Water may be pumped by mechanical means, electric or diesel, or by using animal or human power. The extent of mechanization varies greatly. For example, more than 90 percent of the wells are modernized in Amravati District (Shahanur Subproject) while less than 5 percent in Raigad (Hetavne subproject) west of the Ghats.

Aquifers are recharged primarily by rainfall and land development increases rainfall recharge through increased percolation. Deep percolation from reservoirs, irrigation canals and irrigated

fields also adds substantialamounts. A study by Maharashtra Groundwater Survey and Development Agency (MGSDA) of more than 100,000 wells in three districts in central Maharashtra showed that wells in irrigation command areas each produced about 25 percent more water on an average than those not in command areas. In addition to increased discharge the number of wells that can be supported in irrigation command areas is greater.[13/]

Except in high rainfall areas, MIPs do not provide water for the more remunerative perennial or hot weather crops like sugarcane, long staple cotton or hot-weather groundnuts. Groundwater which can be used for such cash crops provides a very valuable complement to a farm household economy, especially to the monetary part. Conjunctive use of groundwater is thus a powerful factor in accelerating development in irrigation commands. Full well development within the command area will essentially eliminate any potential water logging hazards.

Reports of MGSDA verify that exploitation of aquifers exist in all 13 proposed subprojects with many wells already in existence. Based on watershed level groundwater balance information furnished by MGSDA and following their guidelines, GOM/ID have estimated (Table 6) that in the 87,000 ha CCA about 12,000 ha gross cropped area could be irrigated from groundwater alone if no surface irrigation system were built. With the establishment of MIPs this potential would be raised to 18,000 ha or 21 percent of the CCA. At present an estimated 3,800 ha (four percent of the CCA) is being irrigated with groundwater. Each well could irrigate about 2 ha; 0.75 ha of sugarcane and 1.25 ha of seasonal crops.[14/]

These estimates are conservative because they are interpolated from average watershed data. MIP commands are in the lower parts of watersheds where aquifers will be better than average. Moreover, GOM/ID's estimates of the amount of recharge provided by

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13/ During the 17 years since Khelna MIP was constructed, the number of wells in the command area increased from 144 to 304. The average area irrigated per well increased from 0.78 ha to 2.01 ha.

14/ This is, by convention, 2.0 hectares gross cropped area. Actually, perennials must be irrigated all three seasons; thus the seasonal irrigated area would be 1.25 + 3 x 0.75 = 3.50 ha.

TABLE 6 ESTIMATED GROUNDWATER DEVELOPMENT IN CANDIDATE MIPs

Potential Subproject	Cultural Command Area	Planned Surface Irrigation	Groundwater Potential a/ WO/P	Groundwater Potential a/ W/P	Estimated Present GW Development b/
	(in ha)				
Uramodi	6,704	9,030	1,328	2,426	372
Hetavne	7,456	12,831	1,054	2,260	40
Dehli	5,242	4,353	652	884	83
Sonwad	3,890	2,362	448	616	227
Panzan	2,893	2,011	700	842	341
Khairi	2,275	2,241	414	562	184
Sina	10,522	7,214	1,922	2,202	884
Sankh	3,543	2,834	320	528	135
Bori	8,700	7,657	932	1,366	278
Shivna	8,992	7,487	1,452	1,908	783
Mun	9,755	10,770	1,222	1,756	247
Shahanur	9,332	4,175	320	954	193
Karwappa Nalla	8,048	5,252	1,238	1,668	49
Total	87,352	75,317	11,842	17,972	3,816

a/ Gross cropped area.
b/ Estimated by USAID from GOM/ID information.

irrigation are admittedly conservative; only 15 percent of the water delivered over the canal sill with 50 percent of that considered recoverable or 7.5 percent of canal deliveries. In its Economic Analysis, USAID, as does World Bank, assumed that half of the conveyance and farm application losses as calculated from a water budget would be recoverable.

Surface water quality (salinity) in Maharashtra is generally very good. Since water in MIP aquifers is essentially recycled annually ground water quality is not expected to be a problem. GOM/ID, however, will supply AID with groundwater quality information on MIPs, showing variation over time. ID/DIRD maintains groundwater quality and water level surveys in wells on new MIPs up until five years following initiation of construction. This will be extended on subprojects through the entire development period for upto 20 years with MGSDA collaboration as appropriate in order to provide information on recharge, groundwater use and quality changes under canal irrigation. Information on groundwater irrigation, including costs and returns, will be included in socio-economic baseline surveys required under the project.

In order to develop and facilitate conjunctive use of groundwater, refresher, training, possibly at the Staff Training College, will be provided in groundwater hydrology, well hydraulics and economic analysis of conjunctive use to mid-level officers and others responsible for subproject design (See Sec. B3e). Groundwater balance studies will be made using historical data on ground and surface water use and at least two years of additional data collected after the project's implementation on at least existing MIPs, one of each in the low, medium and high rainfall zones. A report for use in planning and evaluating conjunctive use will be prepared and distributed with copies to USAID not later than 27 months after the project agreement is signed. This report will be reviewed during mid-term project evaluation.

Demonstrations of conjunctive use of groundwater will be implemented on qualifying MIPs by the GOM/ID with the assistance of MGSDA. This may be done on farmer's fieldsutilizing existing wells, if any, on GOM demonstration farms, or as special demonstration. Information on developmnt of groundwater including technical information and financing will be developed and made available to farmers,agricultural officers and extension subject matter specialists in qualifying subproject areas. GOI/GOM provides subsidies of 25 percent of the costs of wells and well equipment to small and marginal farmers. This is increased to 50 percent for wells developed jointly by a group of farmers. AID will support U.S. training for mid-level or senior officers in conjunctive use of water (See Sec B3d).

3. Water Management Improvement Program

a. General:

The technical analyses for this project identified a number of areas where critical information needed for improved management of MIPs was not available. Where practical, the project will initiate collection of this information. Much of this activity will require field studies. These can be developed as demonstration units in most cases.

Several other needs, particularly training, were also identified. These studies and activities will be integrated administratively under a "Water Management Improvement Program". GOM/ID/PPC will establish a special cell who will be responsible for this work and provide personnel and other resources necessary for its administration. In many cases, the work will be carried out by other entities including AD agencies. The administrative unit will be responsible for finalizing plans in consultation with USAID, GOI/Irrigation, GOM/ID and AD officials, for maintaining schedules and for expediting the work.

b. Field Studies:

Field studies and demonstration may be carried out on existing MIPs, participating subprojects or elsewhere. Studies identified in previous sections of this Chapter and Chapter I to be carried out on existing MIPs include:

(1) Seepage loss studies (Sec. B 2d).

(2) Agricultural Water Management Studies (Sec B 2e.v.)

(3) Groundwater utilization and water balance studies (Sec. B 2h).

(4) Utilization of ICAR/ICRISAT improved kharif cropping techniques (Sec. B 2e.iv).

(5) Reasons for apparent low utilization of kharif irrigation potential (Sec B 2b of this chapter and Sec. F of Chapter I) and

(6) Hydrological/climatological and reservoir operation studies (Sec. B 2c iii).

These studies are somewhat interdependent and logistic and administrative support would be simplified if they were conducted on the same sites. Insofar as possible GOM/ID in consultation with USAID will select three representative MIPs for conducting these studies.

Correlation of hydraulic conductivity and canal seepage loss rates (Sec. B 2d) may be done wherever seepage loss measurements have been made. Information concerning similar studies, if any, being carried out on the CAD projects in Maharashtra should be compiled and taken into account when designing and carrying out the above studies.

In addition to the above studies, the following more generalized studies will be carried out based on statewide or project site specific data other than the three selected existing MIPs:

(1) Improved utilization of soil surveys (CHapter 6 Sec A4i).

(2) Socio-economic baseline studies on some of the MIPs to be implemented under this project (Project Paper Sec VII B 2).

(3) Economic analysis of labor use in construction and optimization of subprojects (Chapter 1 Sec F)

(4) Alternative water allocation studies (Sec B 2c.iii)

The above list of ten studies is not necessarily all inclusive. As existing information is compiled and scopes of work are prepared on the above identified ten studies, some may be modified or additional questions raised that will require expanding the number of studies.

c. U.S. Training:

U.S. training is provided for the following:

(1) 2 mid-level officers to study seepage loss and lining methodology for four months (Sec. B 2d).

(2) 15 mid-level officers in agricultural water management for three months (Sec B 2e).

(3) 6 senior officers for six weeks in irrigation systems management and operations (Sec. B 2e v)

(4) 5 mid-level or senior officers in conjunctive groundwater development for three months (Sec B 2h).

(5) 2 mid-level engineers in reservoir operation studies for three months (Sec B 2b).

(6) 4 mid-level soil survey or scientists, for six months (sec B 2g)

(7) 2 drainage engineers for six months (Sec B 2f)

(8) 2 Senior soil scientists for six weeks (Sec B 2g)

(9) 6 mid-level officers in economic analysis for three months (Chapter I Sec E).

(10) 30 junior and mid-level officers and one senior officer in water resources systems analysis and management (Sec B4).

d. Incountry Training and Workshops

Workshops for in-service training, including dissemination of information from the studies being carried out under the project will be provided as needed. The following are tentatively suggested for planning purposes. Final plans and details will be worked out by GOI/GOM and USAID.

(1) Agricultural Water Management - three - two weeks each.

(2) Design and Construction of Small Channels and Structures - two - two weeks each.

(3) Utilization of Soil Surveys - two - one week each.

(4) Workshop on Economic Analysis - one - four weeks.

(5) Groundwater hydrology and conjunctive use - one - two weeks.

e. Planning:

Scope and objectives of studies and other activities have been defined in the project paper and its appendices. In some cases, specific plans and methodology need elaboration. GOM/ID with USAID collaboration will develop appropriate plans and methodologies. Consulting assistance for planning will be provided as needed. Where appropriate contracts with or grants to appropriate collaborating Indian universities may be negotiated.

f. Reporting:

Studies are useless unless their findings are utilized. The ID/PPC special cell for coordinating the studies will have the responsibility to promptly report findings and recommendations to the Secretary GOM/ID with copies to CWC and USAID. The approximate schedules for the various studies are outlined in previous sections of this Chapter. In general it is planned that the studies be completed and the results published prior to the mid-term review (30 months from the signing date of the Agreement) of the project. The recommendations from the studies will be used to implement pilot demonstration and testing programs on the three existing MIPs that have been studied. In addition, those recommendations that are implementable on the new MIPs can be incorporated prior to the first delivery of water which will not take place until approximately the fourth year of project implementation.

g. Reimbursement:

AID will support 100 percent of the cost of activities under the Water Management Improvement Program using grant funds including costs of liaison and coordination, incountry training, U.S. training, needed equipment, international consultants, and other foreign exchange and host country expenses. Sec. V C of the Project Paper presents a representative budget for the items included in the Water Management Improvement Program.

4. Training for Water Resources Systems Analysis and Management

a. Background:

Coherence, i.e. the strength of the linkage network adding integrity to USAID's irrigation sector strategy is enhanced through support of integrative efforts in technology development at interstate or national level such as represented by the proposed Water Management and Training Project. Development of the Narmada Peninsula, India's largest westward flowing river, concerns and benefits exactly the four constituent states in USAID's irrigation strategy: Rajasthan, Gujarat, Maharashtra and Madhya Pradesh.

Narmada rises in the Maikala range in eastern Madhya Pradesh at an elevation of about 900 m. Its drainage basin covers an area of about 98,000 sq. km. in the three states of Madhya Pradesh, Maharashtra and Gujarat. After flowing through Madhya Pradesh for approximately 1,077 km, the river forms the boundary between Maharashtra and Gujarat for 74 km and then flows for 161 km through Gujarat before discharging into the Gulf of Cambay.

The average annual flow of Narmada is about 41 billion cu. meters, greater than the combined average annual flows of the major rivers feeding the Great Indus Basin system in Punjab, Haryana and Rajasthan. Ninety-two percent of the annual flow occurs during the monsoon (kharif) season, about 5 percent in the rabi and 3 percent in the hot weather. The year to year variability is also quite considerable; the 30 year record of annual stream flows (1949-79) measured at Garudeshwar in Gujarat show a range from 10.152 to 63.486 MAF/year.

Because the riparian States could not agree on the sharing of the Narmada waters, the river basin remained for a long time largely underdeveloped for irrigation, power generation and flood

control. In October 1968, the Government of India constituted the Narmada Water Disputes Act of 1956. The litigation lasted approximately ten years and culminated with a set of Tribunal decisions in August 1978 followed by the final award in December 1979.

Currently thirty major projects are contemplated for the development in the Narmada Basin in Madhya Pradesh and Gujarat, ten on the main stem of Narmada (nine in Madhya Pradesh and one in Gujarat), five in the right bank Tributaries and fifteen on the southern effluents.

Together the projects envisage irrigation of about 5.0 million hectares, spread more or less equally between Madhya Pradesh and Gujarat and have a total installed power generating capacity after full development of over 3,000 MW. In addition, construction and integrated operation of this chain of reservoirs is likely to result in saving large areas in Broach District in Gujarat from flood havoc which is almost an annual feature. Negotiations for World Bank assistance on major works is well along.

Development of Narmada is planned centrally by a special Planning and Program Cell set up in GOI/Ministry of Irrigation. Construction of works will be by concerned states. Other responsibilities will be allocated among states as appropriate. Overall responsibility for insuring operation according to the Tribunal's decisions are vested in a newly created Narmada Control Authority. Successful planning and efficient operation of Narmada will require highly sophisticated system analysis and management techniques.

b. Training Requirements:

During the past 18 months, GOI officials have discussed assistance in developing Narmada systems analysis capability with USAID. The concept was endorsed by the Indo-U.S. Joint Subcommission on Agriculture in September 1980 and was included in the PID for the Maharashtra Medium Irrigation Project.

As a first step, the Narmada Authority has suggested that AID support 12 months U.S. training for 30 junior and mid-level officers in water resource systems analysis and management. Responsibility for this aspect of the project has been given to Madhya Pradesh Pradesh. The training will be interdisciplinary but will include personnel with basic professional training in water resources engineering, statistics including systems analysis, water resource development, economic, agronomy and environmental specialists. The need for U.S. assistance and the nature of the systems program are described in the attached letter from Chairman, Narmada Control

Authority (Attachment II to this Chapter). All travel and offshore costs of training including consulting assistance as needed and travel to U.S. for two trips for one senior official to participate in selection of training institutions and review progress will be paid by AID using grant funds.

This activity is proposed to be supported under the Maharashtra MIP instead of under the Water Management and Training or the Madhya Pradesh Minor Irrigation Project for a number of reasons. The more practical one being that timing is urgent. FY 1982 funding is very important to begin to get systems analyses capability developed for Narmada, since it is urgently needed for project design and development which is going on apace.

Since this activity is emminently consistent with USAID strategy and could be funded under any part of the Mission's irrigation portfolio, USAID desires to make a timely response which will maintain AID credibility in this important sub-sector. The activity has the very attractive advantage that AID, at relatively very modest cost, can support a technology transfer and innovation effort that could have a profound impact on an immensely large irrigation infrastructure project financed by World Bank.

A lesser, but still very important reason for including it in the Maharashtra Project is tactical. The proposed systems training activity has been well staffed by GOI and USAID and is ready to go ahead. GOI and USAID would prefer not to repeat the exercise from scratch in a future design effort.

HYDRAULIC CONDUCTIVITY TEST

Test Pit Method

a. Introduction - There is no exact method for determining the hydraulic conductivity above a water table in soils of coarse gravel and cobbles with matrices of finer materials. The following procedure, equations and sample computations describe one method which is considered sufficiently accurate to give a reasonable hydraulic conductivity when applied to field problems.

The test pit can be of three different shapes: (1) a circular test pit of diameter, a. (2) a square test pit with side dimensions of a, and (3) a rectangular test pit with side dimensions a by 2a.

The test should be conducted in only one textural classification such as a cobbly, coarse gravelly or loamy sand. A backhoe, power auger, or hand tools can be used to excavate down to the test zone. The test pit is then carefully excavated to the desired shape and depth by hand. For the different shaped pits, an a value of 1 foot should be adequate. Larger sizes can be used, but the larger the pit, the more water that will be required. Small cavities left when cobbles are removed or a few small cobbles sticking out into the test pit or in the average diameter of a circular pit or in the side dimension of a square or rectangular pit.

Matrices with textures such as fine sands, silts, silt loams and very fine sands tend to slough into the pit when saturated. For these conditions, the pit should be filled with a clean (washed) fine gravel before water is applied.

b. Procedure - After the test pit has been excavated and, if required, backfilled with fine gravel, it is filled to a predetermined depth with clean water. All water entering the pit should be filtered to remove the suspended silts and clays. The depth of water in the hole can be maintained by using bypass hoses and a large carburetor for the finer regulation to keep the water depth reasonably constant. The carburetor can be installed by placing it in a perforated tin can located in the middle of the test pit. This test normally takes only a short time to run, so the water depth in the pit can be maintained by hand if a carburetor is not available. A clear plastic cover should be placed over the pit to keep material from blowing in.

c. Calculations - The following equation is used to compute the hydraulic conductivity.

$$K = \frac{1{,}440\ Q}{CaD}$$

Where:

K = hydraulic conductivity (feet per day)
a = diameter of a circular pit, the side dimension of a square pit, or the a dimension of a rectangular pit that is a by 2a
Q = quantity of flow per unit of time (cubic feet per minute).
D = depth of water maintained in the test pit (feet) and
C = conductivity coefficient from the following tabulation

$\frac{D}{a}$	Circular test pit of diameter a	Square test pit of dimenstions a . a	Rectangular test pit of dimenstions a . 2a
1	492	549	735
2	692	768	989
3	878	970	1218
4	1065	1161	1444
5	1239	1354	1659
6	1409	1533	1862
7	1587	1715	2068
8	1752	1895	2281
9	1922	2074	2482
10	2072	2251	2687

A sample data and computation sheet is shown on figure 1 Sufficient time must elapse after filling the test pit and before taking measurements to permit establishment of a relatively steady state of flow. A comparision of values of C obtained by an electric analog study with K values determined analytically showed the analog values to be about 30 percent lower at a ratio of $\frac{D}{a} = 3$ and about 10 percent lower at a ratio of $\frac{D}{a} = 10$ than the analytical study. Whenever possible, the test pit method should be checked against some other method of determining hydraulic conductivity.

Figure - 1

Location _____

Observers _____ Date _____

Texture of text zone _____ Structure of test zone _____

Type of pit: circular with diameter a

D = 2 feet

a = 1 foot

$\frac{D}{a}$ = 2 feet

C = 6.92

Time		Time	Tank reading ft^3		Q	Hydraulic conductivity, K
Initial	Final	Min	Initial	Final	ft^3/min	ft/day
0800	0810	10	0	5.10	0.510	53.5
0810	0820	10	5.10	9.98	0.488	50.8
0820	0830	10	0	4.20	0.420	43.6
0830	0840	10	4.20	8.36	0.416	43.4
0840	0850	10	8.36	12.51	0.415	43.2

Calculations: $K = \frac{1440\ Q}{C\ a\ D}$

$$K = \frac{1440\ Q}{(6.92)(1)(2)} = 104.05\ Q$$

From Drainage Manual, U.S. Bureau of Reclamation, 1978

Attachment - II

COPY

NARMADA CONTROL AUTHORITY

D-37 South Extension Part I

New Delhi
D.O.No.CH/NCA/NS/81

Dated : 11th June 81

SHRI M.N. VENKATESAN,
CHAIRMAN.

Dear Shri Iyengar:

As you are aware the economy of Madhya Pradesh is largely interlinked with the optimum development of the vast water resources of Narmada basin. It is necessary for us to train adequate persons from Madhya Pradesh in systems engineering and planning methods as applied to Water Resource Projects. This technology would include problems in water resources engineering, hydrology, agronomy, econometrics and perspective planning to arrive at a proper development and regulation of the Narmada basin. It is absolutely necessary that suitable State Government officers of different disciplines should be fully associated and be in charge of such studies so as to ensure the maximum benefit to the State from Narmada basin. This will mean setting up an inter-disciplinary organisation in due course capable of conducting systems engineering studies not only for Narmada but also for the other basins in the State of Madhya Pradesh.

At present there is very little expertise of this kind available in this country. Various advanced countries like USA, Canada etc., have carried out such studies on river basins similar and larger in size to Narmada such as Tennessee, Columbia and Missouri etc. It would be necessary for us to take advantage of their experience to develop similar or improved methodology in our country in general and Madhya Pradesh in particular. This will mean that we will have to pick out the talent from the Departments, Educational Institutions and open market who will have to be afforded the right type of training in USA, Canada etc. so that on their return they may constitute the nucleus of the systems engineering organisation.

I have discussed the possibility of developing this expertise by training of our personnel with the USAID who are willing to offer the necessary help in the matter. It will be necessary for us to select about 30 persons from the various disciplines who will be trained for a period of 12-18 months abroad and who would on return constitute the nucleus for our systems engineering organization. The training will be followed by a full scale project analysis with the assistance of foreign experts for a period of 3 years.

I have enclosed herewith a brief write up of the proposal to enable you to take it up with your Government and get their clearance in principle. It would be then possible for you to approach the Government of India for

Contd...

necessary permission to go ahead with the project with assistance from international agencies. I need not tell you that it is imperative we make a start now so that we have a fully developed team capable of working on systems engineering problems within the next 5 to 6 years.

I would like to discuss with you and furnish any clarifications you may need for processing the case. I have no doubt your progressive Government would only welcome a project proposal of this nature.

With regards,

Yours Sincerely,

(M.N. VENKATESAN)

Encl: As above.

To

Shri H.V.K. Iyengar,
Secretary, Irrigation Department,
Government of Madhya Pradesh, BHOPAL

Copy to Shri V.M. Chitale, Engineer-in-Chief, Irrig. Dept.,
Government of M.P., BHOPAL - 462 005,
Shri L.A. Panjwani, Chief Engineer (P&M), Narmada Bhawan,
with encl. Tulsinagar, BHOPAL-5
for information and necessary action.

Copy with copy of enclosure to Mr. Dean Peterson, USAID, American Embassy, Chanakyapuri, NEW DELHI, for information.

(M.N. VENKATESAN)
Chairman

SYSTEM STUDIES OF NARMADA

The Narmada River System:

Narmada, the fifth largest river in India and the largest west-flowing river of peninsular India, rises near Amarkantak in the Shahdol District of Madhya Pradesh, at an elevation of about 900 m in the Maikala range. The total length of the river from its origin to its outfall in the the Gulf of Cambay is 1312 km. The river flows through Madhya Pradesh for 1077 km and then forms the boundary between the States of Maharashtra and Madhya Pradesh for 35 km. The next reach of 39 km is the boundary between Gujarat and Maharashtra. The river has 41 tributaries of which 22 are on the left bank and 19 on the right. The quantity of water in Narmada of water in Narmada available for 75% of the years has been assessed at 28 million acre feet.

The Narmada Water Disputes Tribunal:

To arrive at a mutually agreed settlement in regard to the distribution, control and use of the Narmada waters and the height of the Navagam Dam, the Government of India constituted the Narmada Water Disputes Tribunal which considered at length the issues raised by the various party States viz., Gujarat, Madhya Pradesh, Maharashtra and Rajasthan and gave its award in December 1979.

Approach to the Plan of Narmada Development

The basic guidelines in drawing up the Master Plan for the optimum and integrated development of the Narmada Water Resources shall be:-

(1) National interest shall have overriding priority. The plan should therefore provide for maximum benefits in respect of irrigation, power generation, flood control, navigation etc. irrespective of State boundaries.

(2) Rights and interests of party States should be fully safeguarded within the framework of the Orders of the Tribunal.

(3) Requirements of irrigation should have priority over those of Power.

(4) Irrigation should be extended to the maximum area within physical limits of command irrespective of State boundaries subject to availability of water; and in particular to the

arid areas along the international border with Pakistan both in Gujarat and Rajasthan.

(5) All available water should be utilized to the maximum extent possible for irrigation and power generation and when no irrigation is possible, for power generation. The quantity going to the sea without doing irrigation or generating power should be kept to the unavoidable minimum.

Development Objective:

The demand for water is increasing and systematic planning for utilizing the available water resources of the Narmada river system will become a challenging task. Water resources planning processes have become exceedingly complex and will become more so in the future. A most urgent need in water resources planning, development and management is a sound appraisal of current and anticipated demand for water by the various disciplines and sections. Water Resources Management systems have to be considered as integral components of other complex systems covering the economy of the country as a whole. As a sub-system of a larger economic system, water management has to be coordinated effectively with the national economy.

There is ample scope of triggering the economy, efficiency and productivity of the water utilization projects and to see that they turn out to be optimally efficient when an integrated view is taken from various (and many times conflicting) considerations of power, irrigation , flood control, water supply, pisciculture, recreation, pollution, environment etc. This can be achieved by the application of systems engineering techniques to the river basins for optimal planning, identification of objectives and tradeoffs in multi-objective planning and optimal operations. The main objectives of the present project are:-

(1) To maximise the benefits from the existing and other projects taken up for construction by improving the water utilization systems, reservoir operations, hydal power production, crop pattern, water requirements of crops and optimum application under irrigated agriculture etc.

(2) To plan the future projects in the Narmada basin for the development of the available water resources in a rational and integrated manner to ensure economic and full utilization to meet the increasing demands of water for agriculture, hydal power generation, industry, domestic and municipal requirements etc.

Activities to be undertaken:

The main activities to be undertaken for carrying out the Systems Studies of Narmada basin are mainly as below:-

(1) Strengthening of data collection and compilation.

(2) Training in computer programming.

(3) Training in various aspects of system engineering.

(4) System Studies of Narmada basin.

Disciplines involved:

The following disciplines will be involved in the multi-disciplinary team to work on the project:-

(1) Water Resources Engineers

(2) Statisticians including System Analysis

(3) Water Resource Development Economists

(4) Agronomists

(5) Environmental Specialists.

Methodology:

Since the subject of Systems Studies of river basins is now to the country, the availability of experienced personnel will be practically nil. It is therefore necessary to select a batch of officers from the different disciplines and give them a basic training in the United States on basins such as Tennessee, Columbia or Missourie where similar work has been done. On return the officers would be formed into an inter-disciplinary team for working on the Narmada basin.

Period of Training:

The period of training will normally be twelve to eighteen months.

Number of Officers:

It will be necessary to have at least 3 senior and 3 junior officers in each disciplines. Thus 30 officers can be trained in different disciplines.

CHAPTER 5

ENVIRONMENTAL ASSESSMENT

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2. Walterlogging, Salinity, Alkalinity	5-2
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ATTACHMENT 1: Approval Cable	5-4
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CHAPTER - 5

Environmental Assessment

A. Background

The Environmental Assessment (EA) for the project was based on an in-depth examination of selected issues that were identified as having the potential for adverse environmental consequences. The issues were identified by a Scoping Committee and documented in a Scoping Statement that was approved by AID/Washington. See Attachment I to this chapter for the approval cable. The Scoping Statement, which identifies issues needing further analysis as well as those that do not, is consistent with the new environmental regulations which require environmental assessments of all surface irrigation projects.

The issues identified for further study were based on a comprehensive review of the two AID-financed EAs of the Gujarat and Rajasthan medium irrigation programs that are also AID-funded. The EAs were conducted by an Indian firm over a period of eight months beginning in January 1980. Their analysis relied on the development of a model that was used to identify key components in an irrigation system (starting with the catchment area and extending to the command area) that are susceptible to environmental impact. A comprehensive list of potentially negative impacts was prepared and an analysis of each impact was undertaken. The EAs for the Gujarat and Rajasthan MIPs concluded that on the whole those projects would not have an adverse impact on the environment.

In addition to the Gujarat and Rajasthan EAs, discussions with various officials at the Ford Foundation and World Bank offices in New Delhi as well as with officials in the Indian Institute of Technology, Bombay and with Maharashtra irrigation engineers aided in the final selection of environmental issues to be studied for the Maharashtra Irrigation Technology and Management Project. These discussions were further supplemented by observations made during site vists by USAID staff during PID preparation. The methodological approach used in completing this EA was based on the expertise of various design team members whose scope of work included specific issues warranting further investigation.

In documenting the findings of the design team, the Scoping Statement indicated that the results of the environmental analysis would be incorporated in the Project Paper's technical analysis sections according to a suggested format. This format would, among other things, include statements concerning major conclusions of the issues examined and a description of the consequences of the affected environment and corrective measures to be taken. The section below provides a summary discussion of the conclusions reached on each of the issues identified for study. Detailed analyses are contained in specific

sections of the technical annexes as referred to below.

B. Conclusions

1. Land Capability and Use of Vertisols. The design team noted that there could be a significant impact on land use and cropping patterns on vertisols because of their special physical characteristics when subjected to moisture. For example farmers avoid cultivating kharif crop during the monsoon because tillage is difficult, temporary flooding reduces crop yields, and because farmers believe that sufficient moisture reserves would not be available for the rabi season. However, the team also noted that assured irrigation under controlled conditions such as those contemplated for the project will tend to encourage farmers to plant high value rabi crops such as wheat maximizing irrigation potential with minimal adverse impact on soil conditions. The design proposed for the Maharashtra medium irrigation systems will also include provisions for kharif crops. Irrigation during the kharif season will be of importance particularly during periods of low or no rainfall. Accordingly control measures would be introduced thus inducing farmers to plant kharif crops. While the constraints of temporary flooding due to excessive monsoon rains may still occur, this project is not expected to exacerbate this situation. Instead, flood control is expected as a result of the construction of dams. For a more detailed discussion of the issues related to vertisols, see Volume II, Chapter 6, pp. 2-6.

2. Waterlogging, Salinity, Alkalinity. As an integral component of the design of individual subprojects, there will be surface drainage facilities to remove excess irrigation water from farmer's fields. A number of measures such as design criteria, waterlogging surveys of medium irrigation projects, and AID-financed training in the U.S. of drainage engineers will be incorporated to mitigate the incidence and impact of waterlogging, salinity, and alkalinity of medium irrigation projects in the Maharashtra program. For more details see Volume II, Chapter 4, p.29.

3. Conjunctive Use of Groundwater. The project proposes the introduction of groundwater irrigation in subproject command areas for several reasons. Chief among them is the added potential that can be realized from irrigation sources within command areas of surface irrigation systems. Groundwater levels in such areas are augmented by the deep percolation process traceable to reservoirs, canals, and irrigated fields. The use of conjunctive water will also aid in mitigating any unanticipated waterlogging problems. In introducing this method of complementary irrigation, care will be taken to maintain optimum water table balances through studies that are required as a part of the planning process of conjunctive irrigation. See Volume II, Chapter 4, pp. 30-33 for further discussion of this issue.

4. Water Losses and Canal Operations. Of special concern in the irrigation systems proposed is the problem of canal seepage losses and alternative measures to control them in the interest of attaining economic and environmental objectives. Canal lining is generally acknowledged as an acceptable technical solution in reducing seepage loss rates which in turn can mitigate the problem of waterlogging. However, lining in black cotton soils poses a separate problem for canals to maintain their original shape over time. In light of these problems, rather than line all canals, field tests will be made to determine seepage loss rates in sections of the canal distribution system. In this regard, data collected will serve the basis of deciding where in the system lining is technically, economically and environmentally feasible. See Vol.II, Chap.4, pp.20-21 for a more detailed discussion on this issue.

Based on the analyses of the issues listed above and the recommended measures for minimizing their impact on the environment, the project will not have a significant adverse impact on the environment.

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Attachment 1

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AIDAC, FOR J. MALICK

Proj. 386-0481

EO. 12065: N/A

TAGS:

SUBT: SCOPING STATEMENT FOR MAHARASHTRA MEDIUM IRRIGATIONPROJECT (386-0481)

REF: MALICK-STANLEY LETTER, DATED 7/27/81

1.) ASIA BUREAU ENVIRONMENTAL OFFICER APPROVES SUBJECT SCOPING STATEMENT.

2.) SECTION OF PP THAT ADRESSES ENVIRONMENTAL CONSIDERATIONS SHOULD DISCUSS (A) WHY ISSUES LISTED IN SECTION II OF SCOPING STATEMENT REQUIRE FURTHER ENVIRONMENTAL ANALYSIS;

(B) RESULTS OF FURTHER ANALYSES; (C) PROPOSED MEASURES TO ELIMINATE OR MITIGATE ANY SIGNIFICANT ADVERSE ENVIRONMENTAL IMPACTS. HAIG
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SCOPING STATEMENT

ENVIRONMENTAL ASSESSMENT

MAHARASHTRA MEDIUM IRRIGATION PROJECT (MIP)

I. Introduction

1. Background

USAID/New Delhi prepared a PID on January 30, 1981 for this project to be located in Maharashtra State. An Environmental Assessment (EA) is required of irrigation or water management projects as stated in AID's environmental regulations 22 CFR 216.3 (3) d. Accordingly, a scoping statement consistent with the procedures outlined in 22 CFR 216.3 (a) (4) has been prepared.

2. Scoping Process

The scoping statement was based on the following: (a) a comprehensive feview by USAID of the EAs for AID-funded MIPs in Gujarat and Rajasthan states; (b) discussions with various specialists with Ford Foundation, World Bank and the Indian Institute of Technology, Bombay; (c) GOI and Maharashtra officials; (d) field observations to potential sub-project sites preparatory to PID development; and (e) a USAID Scoping Committee specially constituted to review and finalize the scoping statement. (A list of committee members is provided in Attachment 1). As a result of these efforts environmental consequences having greatest potential for adverse impacts were identified for further examination as listed in Section II below. Further environmental consequences of minor significance requiring no further study have also been delineated as presented in Section III below.

II. Adverse Impacts

A. Land Resources

1. Land Capability and Use of Vertisols (Black Cotton Soils)

These soils are very susceptible to swelling and shrinkage under wetting and drying and are generally quite impermeable and unstable when wet. They occur widely in Maharashtra. Because of their peculiar physical characteristics they could have a significant impact on land use and cropping patterns under irrigation.

2. Waterlogging, Salinity and Alkalinity.

Discussions with Maharashtra irrigation officials indicate that 5 to 7 percent of areas under surface irrigation in Maharashtra need special protection from poor drainage. The State monitors projects for waterlogging and salinity and designs and implements remedial measures. During project design, procedures and standards by which waterlogging and salinity are brought under control will be examined in depth to determine their adequacy.

B. Water Resources

1. Conjunctive Use of Groundwater

Under prevalent geological conditions in Maharashtra, groundwater recharge from monsoon rains and river discharge is small, and is substantially increased when surface irrigation is provided thus both conjunctive use and conjunctive supply have possibilities. This will have implications for waterlogging control and also for increasing multi-seasonal land use.

2. Water Losses

A related issue is loss of water from irrigation channels because of seepage and operational losses. These losses may range in the order of 40-60 percent. Impact of water losses relating to project economics, waterlogging, groundwater recharge and system operation will be examined during project design.

3. Canal Operation - Instability and Erosion

Instability of canals, lined and unlined and of small structures in vertisol areas may call for special engineering treatment in order to assure economical and effective operation of systems.

III. Issues to be eliminated from In-Depth Analysis

A. Land and Soil Resources

1. Soil Erosion in the Watershed

The Gujarat and Rajasthan EAs noted that increased pressure on the watershed could result from construction activites. Control of human intervention and afforestations of these areas were recommended mitigation measures. During PP development discussions will be held with Maharashtra forestry officials to determine whether the same problems prevail around damsites in Maharashtra and what corrective measures are being taken as solutions.

2. Sedimentation in Reservoirs

Maharashtra has a program of measuring time changes of volumes of sediment in reservoirs which will lead to better quantification of this impact. Reservoir design in India invariably allows for decrease

in reservoir capacity over time by allocation of sediment storage space in the reservoir. Although available data concerning this aspect of design of dams suggest that currently used criteria are acceptable, during the course of project design the Appraisal Team will examine current design criteria to see if they adequately take into account sedimentation deposits.

3. Construction Activities

USAID pre-PID inspection of four completed MIP sites in Maharashtra revealed that construction areas around dams are being planted and landscaped successfully to control soil erosion.

4. Cropping Pattern

Maharashtra officials are aware of the potential for the depletion of soil nutrients as a result of increased crop diversification, and accordingly agronomists take this factor into account when considering land capability classification for irrigation purposes. The Irrigation Department also withholds water for certain crops on sensitive soils. Cropping pattern soils capability procedures will be reviewed by the Appraisal Team and appropriate project criteria, if needed, identified.

5. Bed Cultivation

The Gujarat EA discussed the effects of agrochemical use on recession cultivation of reservoir beds and cautioned against the use of organic fertilizer in order to avoid eutrophication.

B. Water Resources

1. Streamflow Characteristics

Installation of a reservoir and distribution of water to irrigated land changes downstream flow characteristics. While total flow is reduced, flood peaks and often low flows are moderated. The monsoon-generated smaller rivers of Maharashtra where MIPs are normally sited have similar characteristics to those of Gujarat and Rajasthan so similar modifications can be expected. Reservoir operation studies required for each qualifying MIP under the project will reveal most of the downstream flow effects.

2. Floods

Reservoirs reduce flood peaks and consequent damage levels. If dams fail, flood peaks are greatly increased, thus the main consideration is dam safety. In practice, design for dam safety is site specific. Central Water Commission and State officials are highly aware of the need for safe dam design criteria and utilize the most advanced techniques for guarding against failure.

3. Water Quality

The Gujarat EA identified the spectrum of considerations in assessing the effect of MIPs on water quality and of water quality upon agriculture. The Rajasthan MIP stressed the need for quality measurements of river water supplies. Standards for irrigation water quality are well developed and used worldwide. Pre-PID discussions with Maharashtra officials and inspection of the Irrigation and Research and Development

Laboratory in Pune revealed that these are made routinely and monitored by satisfactory laboratory analysis. The project design team will examine water quality criteria for Maharashtra MIPs and make appropriate recommendations where required.

4. Drainage

The potential for poor or inadequate drainage will be mitigated by the use of drainage criteria for MIPs. The adequacy of such criteria will be examined during the course of PP development and recommendations made if necessary.

C. Health

1. Agro-Chemicals

Both the Rajasthan and Gujarat EAs examined the impact of pesticides. The latter stated that the problem of pesticide contamination is "not serious at all". This conclusion can be extrapolated to Maharashtra since pesticide use is associated with intensity of cropping. Data for pesticide use by states is being sought but has not yet been made available; however, the following shows comparisons between the three states:

	Maharashtra	Gujarat	Rajasthan
1. Percent of total area cropped	59	49	44
2. Percent of total area irrigated	5.8	7.2	7.4
3. Percent of cropped area irrigated	9.8	14.7	16.8

Irrigation potential is a useful proxy indicator of agricultural intensity. Information on statewise pesticide use, when received, will be examined to see if they support the same conclusions with regard to Gujarat and Rajasthan.

2. Water-borne Diseases

The effects of irrigation on incidence of water-borne diseases and diseases spread by water associated vectors such as malaria and schistosomiasis and toxicity hazard were examined by the Gujarat and Rajasthan EAs. The Rajasthan EA compared geographical incidence of water-borne diseases by districts to irrigation and concluded that some positive relationships exist but no rigorous statistical analysis was possible. Further the relationship was not evident for typhoid, paratyphoid or other salmonella infections. With regard to malaria, geographical incidence was higher than normal in several districts with irrigation and high rainfall, but was also higher in three districts which have neither irrigation nor high rainfall.

With regard to schistosomiasis only one outbreak has been reported in India in Ratnagiri district, Maharashtra in 1955. There has been no further incidences reported. Sustained constant water levels needed for snail vector population is quite limited in MIP reservoirs and canals because they operate intermittently.

D. Biological Resources

1. Fisheries

The impact of reservoirs on migratory river fishes on the ephemeral rivers of the states was explored by the Gujarat and Rajasthan EAs which also reported the greatly offsetting benefits of development of reservoir fisheries. Maharashtra MIPs impound small rivers, all

depending on monsoon rain with consequent dry or minimal flows during most of the year. These rivers are not very productive fisheries and similar opportunities for development of reservoir fisheries can be expected in Maharashtra.

2. Flora

The Gujarat and Rajasthan EAs discussed the impact of development generally on native flora, which is reduced as agricultural cultivation becomes more intensive. Conceivably, large major irrigation projects could have a significant adverse effect on specialized species but this would not apply to scattered MIPs with areas averaging less than 5,000 hectares each. Increased water supply around reservoir area and in irrigation commands will have a beneficial effect.

3. Fauna

A generally very positive effect on fauna, especially wildfowl was reported by the Gujarat EA. The Rajasthan EA pointed to a decrease in the population of larger predators and game animals but attributed this primarily to increased hunting pressure which is only very indirectly linked to MIP development. Maharashtra's national park and six wild life preserves (1,074 sq.km.) would not be encroached by MIPs.

4. Livestock Diseases

Both Gujarat and Rajasthan EAs point to a possible rise in transmission of certain animal diseases due to grazing in waterlogged or continuously moist areas. Waterlogging will be minimized by MIP design in Maharashtra. See Section II.2 above.

IV. Timing and Decision Making

A project preparation team is tentatively scheduled to conduct project feasibility studies and appraisal during early summer 1981 for a period of six to eight weeks. As indicated in the scopes of work (Attachment 2), the team's terms of reference will encompass the environmental issues to be examined in detail. Based on the team's report, USAID/India plans to prepare a PP detailing findings including project recommendations by September 1981 thus providing sufficient time for any further review and analysis prior to project approval.

V. Analysis, Methods and Staffing

1. Methodology

The project design team and scopes of work will focus on the issues identified in Part II above as part of overall project appraisal efforts. It is anticipated that sufficient data are available with the Maharashtra Irrigation Department that will permit analysis of the environmental issues and enable recommendations to be made. Data collection and analysis will be further supplemented by site visits to selected project areas and planned discussions and meetings with key Maharashtra irrigation, agricultural, and forestry officials.

2. Staffing

The project design team will consist of qualified individuals with expertise encompassing a broad range of subjects relevant to analysis of the environmental issues delineated above. Team members will include (a) an irrigation engineer experienced in groundwater and surface hydrology, (b) a water management specialist, (c) an agronomist/soil scientist,

(d) an economist and (e) a social scientist. This team will be supplemented by USAID staff experienced in related disciplines.

3. Format

USAID envisions a concise statement of its review of the key environmental issues to be incorporated in the text of the Technical Section of the Project Paper. The statement will present (a) major conclusions concerning the issues examined, (b) description of the affected environment, (c) description of environmental consequences and corrective measures to be taken, and (d) a description of project alternatives. In addition to the foregoing, an appendix that lists participants involved in the EA will be prepared.

Attachment 1

Scoping Statement Committee

Jeffery Malick, Chairman, Project Officer, USAID

Dean Peterson, Agricultural Research Officer, USAID.
Irrigation Engineer/Hydrologist

Edwin Stains, Engineering Advisor, USAID.
Irrigation/Agricultural Engineer

John Westley, Deputy Program Officer, USAID
Development Economist

George Belt, Forestry and Natural Resource Specialist, USAID

P. Diesh, Public Health Specialist and Consultant, Malaria, USAID.
M.D.

Attachment 2

Scope of Work - Appraisal Team

A. General: The purpose of the appraisal is to assist USAID and GOI/GOM in determining the scope and nature of AID assistance to the medium irrigation program in Maharashtra, i.e. to settle on basic design criteria for the project and address the complex issues relating to complementary on-farm development and extension and agricultural support services. The appraisal team as a group will produce a report on the feasibility of the proposed Maharashtra Medium Irrigation project which will be used as the basis for a project paper.

The report will include background material, analysis and recommendations on agriculture and irrigation development, water supply and engineering, economic and farm budget analysis, financial analysis, organization and administration, social analysis, project implementation, and technology transfer, with appropriate illustrative annexes.

It will contain an analysis of a selected sample of representative completed and proposed medium irrigation projects (MIP's) in Maha- htra and the team's recommendations on organizational, technical, economic and social aspects of the medium irrigation program generally and on needed training and special studies. The team, based on its reviews as outlined below and such other reviews as it chooses to make, will recommend criteria for qualification of sub-projects for the proposed AID Loan and grant project. The final draft report will be given to USAID prior to the team's departure from India. The report will be made available to GOI and GOM officials but will not be published for general distribution.

B. Specific Duties: The team will conduct organization, technical, economic, financial and social analysis of the Medium Irrigation program generally. Studies will define all benefits and costs with and without MIPs.

The analyses will consider but not be limited to the following topics:

(1) Evaluation on an area-wide basis of the organizational and administrative capabilities of the GOM to carry out the envisioned projects. Special attention will be given to the planning, implementation and maintenance of the physical and non-physical inputs within irrigation commands. Analysis will include examination of the available skilled personnel to design watercourse systems, the effectiveness of the training and visit system of extension initiated in Maharashtra in major irrigation projects and now proposed for extension statewide, and distribution mechanisms for agricultural production inputs such as fertilizer, seeds and pesticides.

(2) Examination of planning, design and economic procedures used for MIP design, including but not limited to the adequacy of the hydrologic data series used for dam and spillway design, relation of system design water availabilities to actual water available; suitability of soils data for determining the cropping pattern in the command area; procedure for determination of crop water requirements, crop yield and production cost data, etc.

(3) At state and regional level, analysis and compliation of background, policy and legal information on agriculture and its support, allocation and use of water, water rates, land acquisition for reservoirs

and rights of way, status of irrigation, responsibilities of irrigation department and related departments, fiscal and budgeting procedures, agricultural and land betterment taxes and available revenues for irrigation investment.

(4) Detailed analysis will be carried out on at least the following critical project design items considering past and likely future performance with and without the project. (A) Time and rate of transition to (1) full utilization of irrigation, (2) cropping patterns, (3) yields of principal crops; (B) development of Groundwater with and without lining including transition and comparative economic analysis, (C) water logging and salinity; (D) insuring of agricultural support for inputs and extension; (E) engineering implications of black cotton soils; (F) social and administrative arrangements for allocation and distribution of irrigation water, (G) seepage and operational losses and channel lining strategy and criteria.

(5) Analysis of the performance of an agreed upon number (3-6) completed MIP irrigation systems including: (A) water supply and delivery: anuual area actually irrigated each season compared to design area; annual actual water deliveries, including quantity and timing compared to design schedules; actual coverage of individual fields by field channels within the chaks - areas short of water and areas waterlogged due to excess water; adequacy of construction, regulation, operation and maintenance of main and distributary canals and field channels and watercourses. Estimate

of watercourse deterioration since construction; estimates of delivery efficiency at canal head, public canal outlets, field gates and crop root zone; methods of distributing water in canals and below public outlets and their adequacy; adequacy of canal/watercourse maintenance programs; groundwater relationships to surface development and history of groundwater development. (B) Evaluation of agricultural performance: design cropping patterns compared to crops actually being grown; design crop yields compared to actual. Relate this to usual practice of optimizing returns to water rather than returns to land and to level of production inputs; availability of inputs - fertilizer, seeds, credit, effectiveness of extension services, etc; irrigation field application techniques; adequacy of soil survey, soils conditions and their suitability for cropping patterns and production, soil erosion, waterlogging and salinity, land forming and engineering suitability for small structures and lining. Economics of irrigation with farm budgets for tupical farms. (C) Performance of organizations: (1) evaluate the water management and control system. What is farmers' Role ? What is the government's role? (2) Describe the organizational arrangements for maintenance of canals/watercourses. How effective is system? (3) Review and evaluate performance of farmers organizations and process for water allocation, distribution and agricultural support. Analyze extent of farmer participation in design and operating stage, and role of farmer and government in water allocation and distribution. (D) Social performance: (1) Analyze farm size and if possible income distributions as affected by irrigation.

(2) Review and analyze impact of reservoir displacements and document regulations, laws and procedures used for resettlement.

(E) Economic performance: (1) Review annual economic performance including identification of direct and indirect costs and benefits in comparison to design plan. (2) Document information on yield increases, shift in crop patterns, production input and labor use, and farm budgets as irrigation developed. (3) Review and analyze all factors - technical, economic, social and political - bearing on the choice of Extensive Vs. Intensive irrigation.

(6) Analysis of proposed sample (3-6) new MIP's. The team collectively or as separate specialists as appropriate will examine and analyze projections by feasibility reports, but not be limited to, the following:

(A) Hydrological data base, selection of reservoir size, spillway capacity, canal and water channel design including adequacy of regulation and safety for water delivery, procedures for engineering design, construction schedules and cost estimates. An estimate shall be made of water delivery efficiencies that can be expected at various points in the system. Special attention will be given to soil conditions in relation to structural stability for small structures and for lining.

(B) Procedures for estimating irrigation requirements and how these are related to project water supply and delivery efficiencies; water management and distribution including responsibility and organization below the outlet and on farms.

(C) Cropping patterns in relation to soils, potential markets and availability of production inputs, means of insuring and integrating agricultural support, extension and training, adequacy of soil information, drainage infrastructure.

(D) Expected yields and production costs at alternative levels of development, estimated agricultural transition time, farm budgets by farm size class, economic evaluation procedures, direct and indirect public revenue generation, water charges, employment generation, roads and market access. Economic rate of return with sensitivity analysis of investment rate and level, development period, yield and irrigation efficiency shall be calculated for a sample set of proposed MIPs.

(E) Farm size distribution, farm tenancy, landless people, labor force, non-farm and farm income generation, impact on poverty, benefit distribution, disadvantaged tribes and castes, reservoir oustees, irrigation and related organizations, general demographic information, roles and interaction of various public agencies.

CHAPTER 6
AGRICULTURE

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CHAPTER 6
AGRICULTURE

A. Physiography and Climate: Maharashtra, the third largest state in India, has a geographical area of 30,770,000 ha comprising approximately 10 percent of the total land area of India. The State lies within the semi-arid tropics and is subjected to monsoon rainfall. Annual rainfall varies from 500 - 4,000 mm across the state. Most (80 percent) falls within a 60-90 day period. The rainy season is dependent on the southwest monsoon which usually lasts from June-October (kharif season). The winter (rabi season) is from November to February and the summer (hot weather season) is from March to May. Because of the uneven distribution of annual rainfall, much of the agricultural land suffers from water scarcity during the dry season, while excessive water causes runoff and erosion during the rainy season. The state is divided into nine agro-climatic zones (see Figure map G3 Vol.I).

In the western portion of the state, the Sahyadri mountain range (western Ghats) rises from 40 - 80 kms east of the Arabian Sea. Here the elevation averages 1,200 m above mean sea level (MSL). West of the Sahyadri range high rainfall (2,500 - 4,000 mm) predominates, and agriculture consists primarily of paddy rice culture grown on bench terraces and some fodder crops grown on land cleared of forest.

In the west-central portion of the state, land forms are less dissected with slightly lower plateaus, elongated valley bottoms and eroded piedmont surfaces. Occasional sharp hills and buttes flank the river valleys. This area (12 of 28 districts in the state) receives an average of 500 - 750 mm annual rainfall and is considered a highly drought prone area (scarcity zone). Besides having a low annual rainfall, abnormalitiies in the weather can often cause delayed onset of the monsoon, long drought spells during the monsoon or an early termination of the monsoon. Usually, only one crop per year is possible without irrigation because of the limited rainfall.

The remaining portion of the state, east of Aurangabad, has generally similar topography to the west-central portion except for the far eastern region where the landscape becomes gently rolling. The elevation drops to about 300 m and the annual rainfall increases to about 1,250 mm in the Nagpur area. Differences in annual rainfall provide the basis for dividing this area agro-climatically into assured rainfall (700 - 900 mm) moderate rainfall (900 - 1,200 mm) and high rainfall (1,200 - 1,700 mm) zones. These higher rainfall zones have less overall drought risk as compared to the scarcity zone, however, except for limited rabi crops dependent on residual soil moisture, irrigation is necessary for cropping during the rabi and hot-weater seasons. Monsoon seasonal rainfall in conjunction with special soil management considerations accounts for a low

cropping intensity (107 percent) throughout Maharashtra.

The major river systems draining the state are the Krishna, Godavari and Tapi. The Krishna and Godavari river systems drain over 80 percent of the State (the Godavari accounts for 50 percent) and flow toward the southeast into the Bay of Bengal. The Tapi drains the far northwestern portion (about 20 percent) and flows westerly toward the Arabian Sea. A small portion in the northwestern corner is drained by the Narmada and in the northeastern portion by the Mahanadi river systems. Eight major irrigation projects utilizing the waters of these rivers are completed or in various stages of completion. Medium irrigation projects impound waters on tributaries or minor rivers generally on the upstream watersheds.

B. Soils: The major soils of Maharashtra are: (1) coastal alluvial soils and alluvial soils along major river systems, (2) shallow, medium and deep black cotton soils (vertisols) developed from basaltic rock, (3) light to medium textured red and brown soils developed from sand stones, slates or granite and (4) laterite soils.

An important geologic feature of significance to agriculture in Maharashtra is the Deccan trap. This formation consists of successive layers of basaltic substratum extending from the Sahyadri range and underlying most of the central and eastern portions of the state. The remainder consists of the massive granite rocks of the Deccan shield. Embedded layers of unconsolidated material occur between the consolidated basalt rock and often provide aquifers for groundwater. Overlying the basaltic rock is usually a weathered zone of stony, gravelly material (murum) on which soil development has taken place. The weathered zone also provides a local aquifer which is replenished by rainfall and irrigation.

The greatest expanse and most important agricultural soils are the vertisols.1/ (black cotton soils or black soils) which have developed on relatively flat plateaus, alluvium and piedmont surfaces. These soils occupy approximately 84 percent of the total geographical area of Maharashtra2/ They vary from a few centimeters to several meters in depth and normally overlie murum which in turn overlies basaltic substratum. Vertisols

1/ Classification according to the USDA soil classification scheme (7th approximation) and adopted by India.
2/ Data from National Soil Survey and Land Use Planning, Nagpur.

are commonly deep on valley bottoms and flat plain surfaces and gradually decrease in depth in the upper reaches of the watersheds. An important agronomic criteria for their characterization is depth and they are classified as deep (>150 cm), medium (50 - 150 cm) and shallow (< 50 cm).

Vertisols contain high amounts of montmorillinitic clay (30 to 60 percent) which gives rise to high exchange capacities rich in bases of calcium, magnesium and potassium. The pH ranges from 7.0 to 8.5 and free lime is normally present within the profile. Organiz matter, nitrogen, phosphorus and in some cases micronutrients are low but can easily be corrected by proper fertilizer use. No special fertility problems such as high acidity, fixation or low base status limit crop production. Nevertheless, certain technical considerations must be related to the management of vertisols. To a great extent, clay content, soil depth and landscape position determine infiltration rates, drainage characteristics, erosion problems and engineering properties. These factors affect tillage operations, construction methods and cropping patterns.

Low infiltration rates are associated with vertisols as a function of the high clay content. This gives rise to easily saturated conditions, often leading to waterlogging and salinity problems. Normally waterlogging and/or salinity only becomes a problem in deep vertisols with depressional topographic relief and excessive water use. The shallower vertisols having better drainage characteristics are much less prone to waterlogging.

Soil erosion and loss of water through runoff can be significant during periods of intensive rainfall. Without adequate ground cover, fine clay particles are easily suspended and transported with runoff water.

The high content and nature of montmorillinitic clay accounts for extensive cracking when dry and swelling when wet. Swelling characteristics and the sticky nature of the soil surface when wet leads to difficulties in managing both tillage operations and construction practices.

Tillage operations are often reduced or avoided during the rainy season because of this difficulty. In part, this is one of the reasons for the traditional practice of fallowing which prevails in many parts of the state where vertisols occur.

The effects of high montmorillinitic clay on engineering properties of vertisols is well documented in India and methods have evolved to deal with construction alternatives[3/].

3/"Katti, R.K., E.S. Bhangale, V.V. Kulkarni, and D.G. Divashikar. Shear Strength Development in Expansive Black Cotton Soil Media With and Without a Cohesive Non-swelling Soil Surcharge. Applications to Stability of Canals in Cuts and Embankments. Central Board of Irrigation and Power. Technical Report No. 28 New Delhi, March, 1980".

In relation to medium and major irrigation projects, technical engineering problems associated with vertisols are: (a) when saturated, vertisols are very unstable so that banks cave and soil particles are readily transported. This results in difficulty in maintaining channel shape and preventing clogging of downstream reaches from upstream erosion, (b) expansion under wetting causes displacement of structures particularly those resting on the soil surface such as precast concrete tiles.

In general, the adverse effects of vertisols are most pronounced with the deep vertisols. These have the highest clay contents and are apt to occur in poorly drained areas.

More importantly, because of the nature and high clay content, vertisols have high water holding capacities, are responsive to intensive management and in general can be highly productive agriculture soils. Their characteristics, however, require special considerations in relation to crop and water management. A comparison of soil characteristics between vertisols (heavy soils) and Alfisols (light to medium soils) illustrates the need to apply different management. For example, saturated hydraulic conductivity of vertisols is very low compared to Alfisols. Thus, runoff and surface erosion through runoff will be great for vertisols under saturated conditions. However, in practice, saturated conditions of vertisols can usually be avoided with proper management (i.e. crop cover and proper soil management practices)..

At the onset of the monsoon, the water intake of vertisols is quite high owing to deep cracks and the initial capacity of the soil to absorb water. This can be enhanced by proper tillage. With Alfisols, high initial infiltration rates are also apparent but this is usually markedly reduced in a short period of time caused by surface sealing from rain drop dispersion. Thus, surface runoff is often greater for Alfisols than for vertisols during the early monsoon.

The vertisol surface dries and cracks quickly between rains or irrigation and hence becomes receptive for a repeated cycle of high infiltration as described above. Saturated conditions occur only for short periods of time, particularly in the early part of the monsoon. Later in the monsoon season, the vertisols profile becomes more prone to saturation and is enhanced under fallow conditions. Thus, surface runoff is more serious in the latter part of the monsoon.

Alfisols and in some cases shallow vertisols have lower water holding capacities as compared to medium and deep vertisols, so that moisture stress can develop more quickly when supplemental water is not available.

Besides the vertisols, other light to medium textured soils are found in Maharashtra usually where greater relief predominates or major geologic changes are evident. In central Maharashtra, these soils are reddish brown and normally occur in mixed association (intergrades) with shallow vertisols in upper reaches of watersheds. They have developed over unconsolidated murum, are shallow and show less soil development than vertisols.

In the far eastern potion of the state (Chandrapur and parts of Bandura districts), brown to reddish brown soils predominate over a gently rolling landscape. These soils (Alfisols) are medium textured and have sufficient relief to provide good drainage and infiltration rates well suited to agricultural practices. Erosion can be serious without adequate vegetation or crop cover. Base saturation is high (80 percent) and pH ranges from 5.5 - 6.5. They are low in organic matter, nitrogen, phosphorous and often zinc.

To the southwest of the Sahyadri range, soils are red to reddish yellow and predominatly lateritic. They are acidic, have low base saturation and low water holding capacities. These soils will support forest and some grazing but are not well suited to agriculture. At lower elevations, lateritic soils grade into coastal alluvial soils of greater depth and higher productivity.

Alluvial soils of the coastal plain and those bordering major river systems are dark, medium textured soils with good physical properties. They respond well to intensive agriculture and usually present no special problems if managed properly.

Generally, soils in the higher reaches of watersheds are apt to consist of medium to shallow vertisols, vertisol-alfisol intergrades or Alfisols. This represents the conditions under which most medium irrigation projects are implemented in contrast to major projects which are located on deep vertisols in the larger river basins. Nevertheless, the exact nature of soil properties and expected response to irrigation requires a knowledge of their behavior on a site specific basis.

C. Crops and Cropping Systems: About 18.3 million ha of land are cropped in Maharashtra (net sown area) with approximately 20 million ha representing the gross cropped area. Of this, the food grains of sorghum, rice, wheat and pulses are grown on 6.4, 1.5, 1.1 and 2.8 million ha respectively. Cotton, groundnut and sugar cane are the important cash crops and they cover about 2.1, .92, and .24 million ha. Other crops grown on comparatively smaller hecterage include potatoes, minor oilseeds, jute, condiments, spices and vegetables[4/].

[4/] Statistics from Directorate of Economics, 18th Edition, for year 1976-77. (Net sown area represents actual land area cropped no more than once per year as contrasted to gross cropped area which accounts for double cropping and thereby represents total hectarage of harvestable crops per year.)

Traditional agricultural practices include a wide variety of cropping patterns adapted to local soil and climatic conditions. Many of the traditional cropping patterns and choice of crops have evolved as a means to minimize risk and provide a self sufficiency, non-market oriented approach to farming. Thus, a number of relatively low economic value crops comprise a part of the present day systems.

In recent years, the increasing population has placed additional pressure on the land to produce more food. Cultivation is being extended into marginal areas resulting in deforestation and increased hazards of soil erosion. To meet the increasing demand for food grains, more effort is needed to increase both the cropping intensity and the production output per unit of land.

The distinct wet and dry season climate as well as the undependable nature of the monsoon impose major limitations to higher crop production. Yields for most cereals remain low (500 - 1,000 kg/ha) and cropping intensities are among the lowest in India (107 percent).

On many of the vertisols where rainfall ranges from 800 - 1,500 mm, cropland is commonly fallowed during the monsoon. The land is kept free of weeds during this period but not cropped in preparation for rabi planting. Although two crops a year could be grown in many cases, farmers avoid kharif cropping because (1) tillage and cultivation of the vertisols are difficult during the monsoon, (2) temporary flooding during heavy rains reduce yields and (3) soil moisture reserves needed for the rabi crop are reduced by cropping during the kharif season.

Recent studies by ICRISAT show that cropping during kharif does not substantially decrease soil moisture reserves which would otherwise be available for the rabi crop. In fact, these studies indicate that the loss of water through runoff and evaporation can be as much as 50 percent of the total rainfall when rainy season fallowing is practiced. Cropping during the rainy season effectively reduces runoff and therefore improves the efficiency of available water use. The major constraint to cropping during the kharif season is primarily related to points (1) and (2) mentioned above.

Providing supplemental irrigation on vertisols tends to encourage planting of high value crops such as wheat during the rabi season. Assured irrigation during this period with little to no risk of flooding allows more management control by the farmers. Where fallowing has been previously practiced during kharif, more attention is needed to overcome the constraints imposed by tillage problems and temporary flooding. This would provide a means to double crop and maximize the benefits of irrigation.

In areas where rainfall is low (<500 mm) and shallow to medium vertisols predominate, cropping only during the rainy season is traditionally practiced. Soil moisture reserves are insufficient to carry over for a rabi crop and thus fallowing is not practiced. Providing supplemental irrigation to these areas encourages rabi cropping in addition to the kharif crop. Because tillage and temporary flooding are less of a constraint to kharif cropping in these areas, irrigation should provide an effective means to double crop.

On alluvial soils and deep vertisols where major irrigation projects provide year round water, sugarcane production is preferred. Since medium projects do not normally provide water during the hot weather season and only to a limited extent during kharif season, sugarcane cropping is not encouraged except where conjunctive use allows the farmer to supplement canal irrigation with well irrigation.

The availability of improved hybrids, especially sorghum, pearl millet, wheat, pigeon pea and chickpea have helped to boost yields in recent years. Irrigation has provided a means to realize higher yields, particularly for rabi crops. For example, about 50 percent of the wheat (rabi crop) in Maharashtra is irrigated. Although, sorghum is a major crop in the state, only about 5 percent of its area is currently irrigated. Sorghum is grown during both the kharif and rabi seasons and being drought resistant is better adopted to dryland agriculture. Nevertheless, HYV's of sorghum are increasingly being grown under rabi irrigation. Other crops such as millets, cotton and groundnuts are grown during kharif and hot weather seasons. These crops can benefit from irrigation provided it is available during this period.

In general, the availability of irrigation during each of the growing seasons largely determines the cropping patterns. Where water is available year round, farmers favor sugarcane production. With limited irrigation (medium projects), cropping patterns are selected which provide the best economic returns. Research is needed which demonstrates suitable alternatives to low value crops and provides a basis for increasing cropping intensities. Soil and water managment practices will vary depending on location of projects.

D. Agricultural Services in Maharashtra

1. Functions and Organization of Agriculture Department (AD): Agricultural services covering (1) technical extension, (2) planning/monitoring of input requirements and distribution and (3) soil conservation/land development works are the responsibility of the AD. In addition, a number of state sector schemes such as horticulture, livestock, cash crops, etc are employed by the AD. At the state level,

these agricultural services are coordinated to serve area specific or project specific programs such as Command Area Development Authorities (CADA) or Drought Prone Area Programs (DPAP). However, for development projects such as medium and minor irrigation, agricultural services operate through the normal organizational network of the AD. In the latter case, agricultural services are strongly influenced by Local Government participation in the planning process (Sec D.3).

The AD consists of seven regional divisions covering extension and input planning and an additional five divisions devoted to soil conservation/land development (Organization Chart, D.10). These divisions are responsible for agricultural services on all MIPs as well as rainfed areas throughout the state. Divisions are headed by the Director of Agriculture who reports directly to the Secretary of Agriculture. Regional divisions cover three to four districts and are headed by Joint Directors of Agriculture (JDA's) assisted by Deputy Directors of Agriculture (DDA's) and Superintending Agriculture Officers (SAO's). Below this level, responsibilities are coordinated with district, block and village level councils. Planning/monitoring of inputs operates through the Agricultural Development Officers (ADO's), Block Development Officers (BDO's) and Agriculture Extension Officers (AEO's). AEO's are field level workers and are nearly synonomous with the Gram Sevaks who are multi-purpose village level workers. Technical extension operates through the Principal Agriculture Officer (PAO), Sub-divisional Agriculture Officer (SDAO) and AEO's.

2. Technical Extension

Maharashtra's extension services are currently being intensified (beginning 1981) and reorganized through a World Bank assisted project (total cost U.S. $ 33.3 million). The methodology follows the Training and Visit System which has already been adopted in several other Indian states over the last four or five years. The WB project emphasizes increased staffing with Subject Matter Specialists (SMS) and Village Extension Workers (VEW), systematic farmer contacts and linkage with research institutions for training and improved technological transfer. Farmers would be provided advice on proven farming practices best suited to their specific conditions.5/

The introduction of the T & V system will focus attention on the technical aspects of agriculture and will be implemented through the PAO/SDAO/AEO chain of command (see

5/ Maharashtra Agricultural Extension Project, World Bank Staff Appraisal Report 3299-IN.

Organization Chart D.10). The ADO/BDO/AEO/Gram Sevak organization functioning through the district and block level councils will essentially remain unaltered. This latter channel of command will continue to be responsible for planning and monitoring of agricultural inputs.

An Additional Director of Agriculture Extension, (ADA, Extension) has been appointed (August 1981) to manage and implement the new T & V system. He will have a technial support staff of four subject matter specialists (SMS) at the rank of Joint Director of Agriculture (JDA). The major subjects of technical expertise are plant protection, horticulture, farm management and demonstrations/training. Similarly, SMS will be added at the district and subdivisional levels to provide additional technical support for the Principal Agricultural Officers (PAOs) and Subdivisional Agricultural Officers (SDAOs). Other SMS will be provided at the district level to cover specializations not covered at the subdivisional level and which are significantly important for a particular district. This could include water management specialists in irrigated areas and/or other required technical specialists.

Implementation of the T & V system is planned for completion in three years and will cover all districts. Incremental staff additions at the various levels are shown in Table 1. Nearly all of the additional manpower is allocated to SMS and VEW which deal exclusively with technical matters and farmer contacts. VEW's will be added as Agricultural Assistants (AAs), Agricultural Supervisors (ASs) and Agricultural Extension Officers (AEO's). New positions will be added at the JDA level and the Assistant Subdivisional Agricultural Officers (ASDAO) level to supervise VEWs.

Table 1 EXTENSION STAFF REQUIREMENTS*

	Total Required	Number Available	Incremental Requirements
Agriculture Assistant (AA)/ Agricultural Supervisor (AS)	6,000	3,075	2,925
Africulture Extension Officer (AEO)	747	331	416
Subject Matter Specialist (SMS)/Sub-division (SD)	180	45	135
Subdivisional Agricultural Officer (SDAO)	90	88	2
Assistant Subdivisional Agricultural Officer (ASDAO)	18	--	18
Subject Matter Specialist (SMS)/District	32	--	32
Principal Agriculture Officer (PAO)	25	25	--
Joint Director of Agriculture (JDA)	7	--	7
Subject Matter Specialist (SMS)/Headquarters	4	--	4
Additional Director of Agriculture (ADA)/Extension	1	--	--

*reproduced from WB Report 3299-In

3. Planning/Monitoring of Input Supplies and Distribution

The system of providing agricultural services in Maharashtra is strongly integrated within and dependent upon the local district and block level government structure. All matters relating to planning and distribution of agricultural input supplies, determining credit requirements and current agriculture extension activities[6/] operate through the Zilla Parishad (district council) and Panchayat Samiti (block council).

6/ In the future, technical agricultural extension activities will operate outside the purview of district and block councils as described in Sec D.2.

The district and block level councils include as their members the Chief Executive Officer (CEO) and Block Development Officer (BDO) who are responsible for agricultural activities and provide liaison to the State Governments (see Organization Chart D.2.). The CEO administrates a number of departments at the district level for certain state sector schemes such as cash crop programs, hybrid seed and certification programs, statistics and census information. Each of these schemes maintain a cadre of technical Agriculture Assistants (AA's) who operate outside the responsibility of the block council. In addition, the CEO in conjunction with the district and block councils and the ADO/BDO formulate the requirements and supervise the distribution of agricultural inputs. They are assisted by a multi-purpose village level extension worker (Gram Sevak) who receives guidance from the Agricultural Extension Worker (AEO). Contacts with farmers are through the AEO and Gram Sevak who are directly responsible both to the block and district councils.

Estimates of input requirements (fertilizers, seed and pesticides) are prepared by special committees at the district, block and village level. Membership in these committees are shown in Table 2.

Table 2

COMPOSITION OF DISTRICT, BLOCK AND VILLAGE COMMITTEES

District Level Committees

1.	President, Zilla Parishad (ZP)/Chairman Agriculture Committee	Chairman
2.	Chairman Agriculture Committee ZP	Member
3.	District Collector	Member
4.	Chief Executive Officer ZP (CEO)	Member
5.	Chairman or representative of District Central Cooperative Bank	Member
6.	Chairman or his representative District Sales and Purchase Organization	Member
7.	Executive Engineer, Irrigation Department (ID)	Member
8.	Representative of Irrigation Development Corporation of Maharashtra	Member
9.	Deputy Registrar of Cooperative Institutes	Member
10.	Deputy Director of Agriculture	Member
11.	Divisional Soil Conservation Officer	Member
12.	Agriculture Development Officer (ADO), ZP	Secretary

Table 2 (con't)

Block Level Committee

1.	President, Panchayat Samiti	Chairman
2.	Agricultural Development Officer (ADO)	Member
3.	Block Development Officer (BDO)	Member
4.	Deputy Engineer, Irrigation Department	Member
5.	Manager Central Cooperative Bank/Local Nationalized Bank Branch	Member
6.	Representative of District Deputy Registrat Cooperative Societies	Member
7.	Representative of Taluka Purchase and Sale Organization	Member
8.	Extension Officer (Agriculture)	Secretary

Village Level Committee

1.	Sar Panch (elected head of village committee)	Chairman
2.	Secretary, Cooperative Society	Member
3.	Canal Inspector (ID)	Member
4.	Village level worker	Secretary

Input requirements for both irrigated and non-irrigated crops are reviewed by the committee of which representative members of the Irrigation Department and the Agriculture Department concur. Primary responsibility for fixing these requirements rests with the AD as they are responsible for planning cropping patterns on both irrigated and non-irrigated land.

After input requirements have been determined, the district level committees then release the estimates to the various agencies and organizations for procurement and distribution.

a. Seed: Although many farmers still retain and trade their own seed supplies, the use of HYV's is increasing due to a workable and responsive system for generating Breeder, Foundation and certified seed. Breeder and Foundation seed is produced by the universities at select seed farms. The seed is then multiplied on a commercial basis for certification through the Maharashtra State Seed Corporation (MSSC), and the Maharashtra Agricultural Industry Development Corporation (MAIDC). The MSSC and MAIDC operate through a network of sales centers, private dealers, and Taluka (block) seed farms. Seed certification is carried out by the Maharashtra State Seed Certification Agency by order of the Seeds Act of 1966.

District and block level seed requirements are determinted by the district committees and demands are usually met through the local taluka seed farms. The district councils purchase seeds at a fixed rate set by the SAO. Surplus seed is sold in the open market.

Table 3

ORGANIZATIONS RESPONSIBLE FOR CERTIFIED SEED

Name of the Organizations	Districts to be covered
1. Maharashtra State Seeds Corporation (and its authorized sale points)	Akola, Buldana, Amravati, Jalgaon, Parbhana and Nanded
2. Maharashtra Agricultural Industry Development Corporation (and its authorized sale points).	Dhule, Nasik, Thane, Kulaba, Ratnagiri, Pune, Ahmednagar, Sholapur, Kolhapur, Satara, Sangli, Aurangabad, Beed, Wardha, Usmanabad, Yeotmal, Nagpur, Chandrapur and Bhandara

b. Fertilizers and Pesticides: Fertilizer and pesticide requirements like other inputs, are planned in advance of the growing season by the district committees in conjunction with AD officials. Fertilizer coordination committees are set up at the village level to insure sufficient supplies and distribution outlets.

Chemical fertilizers are channelled through the Maharashtra State Marketing Corporation (MSMC), the MAIDC and Vidarbha Cooprative Marketing Societies. Local sales points, agricultural centers and private dealers bring supplies into contact with village farmers.

Fertilizer use averages about 19.4 kg.ha of the gross cropped area. This ranges from 4 kg/ha in less developed areas and under dry land farming conditions to more than 150 kg/ha for areas of more intensified irrigated farming. Estimates by the World Bank suggest that nearly 55 percent of fertilizer use occurs on irrigated land. Total fertilizer consumption for Maharashtra was 380 thousand tons as of 1978/79.

The import, manufacture, sale, transport, distribution, use and quality of pesticides is regulated by the

Insecticides Act of 1969. Manufacturing of pesticides is concentrated in the Bombay area. Distribution is through MAIDC from which local sales agents and Zilla Parishads obtain supplies. Pesticides are used primarily on improved varieties and cash crops like cotton, sugarcane, hybrid sorghum and wheat. Very little pesticide use is evident on traditional low yielding crops.

4. Agricultural Production Strategy-Maharashtra State:[7] Responsibility for planning production strategies in the State of Maharashtra is vested in the AD and district councils. The strategy requires coordination between officials of the AD, District Administration, Credit lending banks, village Panchayats, district and village level coordination committees and the agricultural extension units down to the village level.

The AD, in consultation with its regional and district offices and district level coordination committees, and on the basis of experience, success and constraints encountered during the preceeding years, prepares annual Agricultural Production strategy programs for each of the growing seasons (hot weather, kharif and rabi season). The program for each season normally covers the following:

a. Projections of the area coverage for different crops under hybrid or high yielding varieties (HYV's). Thrust is made on the main crops. Area coverage is decided on the basis of performance during the preceeding year. Similarly projections are made for horticulture development.

b. Requirement of hybrid and high yielding varieties of seeds, fertilizer, pesticides, etc. and organizations responsible for their distribution.

c. Credit requirements (crop wise) for seeds, fertilizers and pesticides and organizations responsible for credit lending.

d. Training requirements of the officials concerned/involved with the program. Officials from the AD, district level administration and agricultural extension are required to undertake training on specialized subjects/topics which have direct bearing on increasing crop production during that season. Decision is also made on assigning responsibilities to agricultural universities and colleges to cover districts in their region.

e. Requirement of crop demonstrations, their number and area under demonstration.

7/ For the responsibilities of the AD/SC for the implementation of Part I and II works refer to page 4 - 23.

f. Responsibility of agricultural extension for stressing needs for increasing production through improved cultivation techniques, optimum dates of sowing, use of plant protection measures, seed rates, suitability of varieties on regional basis, etc.

g. Other miscellaneous activities like distribution of biogas plants, etc.

h. Beginning 1980-81, emphasis will be directed toward efficient utilization of stored water for high yielding kharif food crop.

As an example, the agricultural production strategy during kharif 1980-81 stressed coverage under hybrid/high yielding varieties as illustrated in Table 4. This information shows proposed area coverage during kharif 1980-81, achievements during preceding year and the thrust of the types of crops:

Table 4

AREA TARGETS OF AGRICULTURAL PRODUCTION STRATEGY

Name of the Crop	Long Range Target	Program (kharif 79-80) Targets	Program (kharif 79-80) Achievements	Program 1980-81 Targets
	(area - million ha)			
High yielding paddy	1.43	1.00	0.85	1.04
Hybrid Jowar 1/	3.02	1.78	1.46	1.80
High Yielding Jowar	----	0.23	0.20	0.27
Hybrid Bajra 2/	1.78	0.38	0.41	0.70
Hybrid Maize	----	0.52	0.28	0.55
Hybrid Cotton	----	0.39	0.39	0.40
High Yielding Cotton	----	1.71	1.71	1.60

1/ Sorghum
2/ Pearl Millet

Above figures are a statewide summary. District-wide projections are also made for the purpose of micro-level thrust and for the guidance of district level administration.

Based on area wide estimates of cultivated areas, the required inputs are calculated according to norms adjusted to yield potentials, seeding rates and recommended fertilizer/pesticides dosage.

Current agronomic recommendations (Table 5) are general and for the most part represent average conditions of crop growth. They do not take into account site-specific

factors of production such as water management, soils or cropping pattern alternatives. Recommendations specific to conditions of irrigated areas in MIPs need to be tailored on a regional basis. This will require additional emphasis on designing appropriate farm trials/demonstration studies under different resource and management alternatives.

Table 5

AGRONOMIC RECOMMENDATIONS

Name of Crop	Input Requirements per ha				Output (Yield) per ha in quintals
	Seeds in Kgs.	Fertilizers		Insecticides*	
		Manure in Kgs.	Chemical in Kgs.		
Food Crops					
1. Jowar (Sorghum) (Kharif)					
a. Hybrid	10	1200-2500	120-200		40-45
b. High Yielding	10		120-130		25-30
Jowar (Rabi)					
a. Hybrid	10		175-250		25-30
b. High Yielding	10		175-250		20-25
2. Bajra (Pearl Millet) (Kharif)					
a. Hybrid	2.5 - 3	6000-7500	60-100		20-25
b. Local (improved)	3.0				10-15
3. Wheat (High Yielding)					
a. H.D. 2189	125-150	2000-3000	200-225		40-45
b. Kalayan-Sona	100	2000-3000	175-200		35-45
4. Paddy					
a. Taichung (local)	25-30	1000-2000	200-250		40-50
b. Kerja. 184	25-30	1000-2000	175-225		30-35
5. Maize					
a. Local	15	1000-1500	50		40-50
b. Hybrid	15	1000-1200	250-300		

Table 5 (con't)

Name of Crop	Seeds in Kgs.	Manure in Kgs.	Chemical in Kgs.	Insecticides*	Output (Yield) per ha in quintals
6. Sugarcane					
a. Adsali (18 month crop)	2500	4000-5000	740		1400-1500
b. Pre-seasonal	2500	3000-4000	680		1000-1250
c. Suru	2500	2000-2500	480		900-1000
7. Oilseeds					
a. Groundnut	80-100	5000-6000	75-100		6-10
b. Til	N.A.	5000-6000	40-50		1.5-2
c. Sunflower	10	5000-6000	120-140		6-10
d. Soyabin	75	5000	100		10-15
8. Cotton					
a. H-4	2.5-3.75	25000	175-200		10-12
b. Var-Laxmi	2.5-3.75	25000	140-160		10-12
9. Pulses					
a. Tur	12	6000	75-100		8-10
b. Mug	12-14		100		5-8
c. Udid	12-15	6000	100		4-8

Table 5 (con't)

Name of Fruit	No. of Trees/Ha	Fertilizers: Manure in Kgs.	Fertilizers: Chemical in Kgs.	Insecticides and Pesticides*	Yield/ha Year in Quintals
1. Lemon	250-400	At the time of plantation			
		1200-2000	750-1200		40-50
		After plantation from subsequent year			
		1000-1600	120-200		
2. Banana	4000-4400	Before or at the time of plantation			
		50000			
		After full growth or each tree every year			350
			8000-9000		
3. Mango	80-85	Before or at the time of plantation			
		800	160		
		From subsequent year till tenth year			
		400	25		60
		8000	480		
4. Pineapple	14000	Before or at the time of plantation			
		30000-35000	1000		100-150 (from third yr)

Table 5 (con't)

Name of Fruit	No. of Trees/Ha	Fertilizers: Manure in Kgs.	Fertilizers: Chemical in Kgs.	Insecticides and Pesticides*	Yield/ha Year in Quintals
5. Pomogranates	270-280	Before or at the time of plantation 5400-5600	270-280		
		From subsequent year after full growth of every tree 2700-2800			
6. Grapes	2000-2250	Before or at the time of plantation 20-25 kg/trench	3 kg trench		150
		After full growth 25 kg/trench	500 gms/trench		
7. Coconuts	204	Before or at the time of plantation 1000-1200	400		8000 No.
		After full growth of each plant	1400		

* Data not available for insecticides

Table 6 INFORMATION REGARDING THE TRIAL-CUM DEMONSTRATION FARMS UNDER THE CONTROL OF THE DEPARTMENT OF AGRICULTURE, AGRICULTURE UNIVERSITIES AND COMMAND AREA DEVELOPMENT AUTHORITIES IN THE STATE

Sr. No.	Name of the T.C.D. Farm	District	Name of the Irrigation Project (major)	Name of the Controlling Authority	Irri-gated	Dry	Unculti-vated	Total
1.	Khopoli	*Raigad	Koyana Tail Race Water	Agri. Dept.	5-10	1-17	8-33	14-60
2.	Pimpri	*Nasik	Gangapur	Agri. Dept.	21-50	--	3-49	24-99
3.	Garaj	*Aurangabad	Dheku	Agri. Dept.	15-35	5-29	0-13	20-77
4.	Bindusara	Beed	Bendsura	Agri. Dept.	13-75	--	3-50	17-25
5.	Ratoli	Nanded	Manar	Agri. Dept.	15-26	--	2-92	18-18
6.	Songiri	Osanabad	Khasapur	Agri. Dept.	18-20	0-40	5-33	23-93
7.	Shelapur	*Buldhana	Nalganga	Agri. Dept.	14-04	0-60	5-36	20-00
8.	Pailpada	Akola	Katepurna	Agri. Dept.	15-00	4-48	3-64	23-12
9.	Seloo	Wardha	Bor	Agri. Dept.	16-30	--	4-45	20-75
10.	Repoli	*Raigad	Kal	K.K.V. Dapoli	6-00	8-30	10-73	22-03
11.	Golegaon	Parbhani	Purna	M.K.V. Parbhani	60-00	12-04	18-72	90-76
12.	Kashti	*Ahmednagar	Ghod	CADA, Pune	14-16	4-10	5-45	23-71
13.	Bhadgaon	Jalgaon	Girna	CADA, Jalgaon	16-20	--	3-81	20-01
14.	Mhali	Bhandhara	Bagh	CADA, Nagpur	10-00	1-20	7-08	18-28
15.	Vihamandva	*Aurangabad	Jaikwadi	CADA, Aurangabad	(Information not available)			

*Districts where USAID supported MIPs will exist

5. Adaptive Research, Farm Trials and Recommendations:

Exrension methodology has a major focus on developing recommendations for specific agroclimatic zones. The recommendations should take into account cropping patterns, water management alternatives, farmers skills, farmers resources and soil/water resources. Whereas the universities and other research institutes are responsible for basic and applied research in various subject matter disciplines, extension exphasizes multi-locational verification trials which lead to site specific recommendations. Under the new extension T&V system, the farm trials program will be planned at district monthly workshops and subsequently executed by SMS and AA/AS on farmers fields. The university extension agronomist will take an active part in this process. Results of the farm trials will be analyzed at the monthly workshop and formulated into recommendations. Participating farmers would bear the cost of trials unless input costs are greater than his present practice in which case costs will be born by the AD.

The AD, working in conjunction with the agricultural universities and CADA's have initiated a number of trial-cum-demonstration farms in major irrigation project areas (Table 6). These demonstration farms represent fifteen different districts in Maharashtra of which seven will also have USAID supported MIPs. Information from these trial-demonstration farms should be useful and applied to MIP areas where possible. However, due to inherent differences between major and medium irrigation projects (landscapt location, cropping patterns and water delivery), agronomic recommendations may not necessarily be transferrable.

6. Linkage of Extension to Research: Linkage between research and extension has not been well coordinated in the past. This linkage will be strengthened under the T&V approach. Monthly district workshops will be utilized for systematic training of AA/AS as well as for formulating the farm trials program. The PAO and University extension agronomist will be responsible for organizing workshops. Workshops will include the participation of district/subdivisional SMS and university research staff.

In addition to monthly workshops, seasonal zonal workshops will be arranged at each of the four universities. The zonal workshops review past recommendations and assess technical priorities for the farm trials program. The Director of Research (university) and the ADA (extension) organize zonal workshops which include participation of zonal JDA's, PAO's, District SMS, Director of Extension, selected department heads, crop coordinators and extension agronomists.

7. Agricultural Research and Training: Basic and applied agricultural research are the responsibilities of the four main universities in the Maharashtra (Mahatma Phule Krishi Vidyapeeth at Rahuri, Marathwada Agricultural University at Parbhani, Konkan Krishi Vidyapeeth at Dapali and Punjabrao Krishi, Vidyapeeth Krishi Nagar at Akola). Most research in the past has been limited to rainfed agriculture conditions, selective crop schemes and other all-India coordinated programs. Research efforts have suffered from a lack of coordination between the universities resulting in some duplication of efforts and an inability to extend research results outside the immediate sphere of the station.

Recently, the universities have begun to focus more attention on integrated research and problems of irrigation. Currently a range of studies are directed toward specific aspects of irrigated agriculture such as crop water requirements, methods of irrigation, drainage, etc. There is, however, a tendency to conduct these studies only under idealized conditions. Considerable work is needed (adaptive research) which attempts to relate research findings to the dynamics of practical irrigation and crop production resource constraints under less than idealized conditions.

The universities maintain a network of about 20 main research stations and 30 substations. Here, most research is currently oriented toward crop improvement schemes (all India Crop Improvement Programs) such as wheat, sugarcane, oilseeds, sorghum, pearl millet, cotton and pulses. Considerable scope exists for developing the adaptive research focus at the station and sub-station level because resource constraints can be more clearly defined. A forthcoming statewide research review by the GOM/ICAR is expected to help clarify research priorities.

The four universities and six additional agriculutral colleges graduate about 1,000 students each year with B.Sc. degrees. Nearly 300 receive M.Sc. degrees. Presently, AA (extension workers) obtain two years of training at one of 25 agricultural schools. Gram Sevaks get six months training at five special training centers.

As part of the emphasis to strengthen the extension program (T & V System), additional training and eduction is being planned. Newly recruited subject matter specialists would be required to have M.Sc. degrees and AEO's to have B.Sc. degrees. Additional in-service training and special programs would provide avenues of regular advancement for extension personnel.

8. Credit/Marketing: Short, medium and long term loans are made available to farmers through cooperative credit societies and commercial banks. The Reserve Bank of India provides loans to the Apex Banks (lead Banks) at six percent which in turn lend to Central Cooperative Banks at 6.25 percent. The Central Cooperative Banks are district level banks where the amount of financing which is to be provided for crop loans is decided each year for each district. This is done by an "Experts Committee" composed of the District Agriculture Officer, Deputy Registrar of Cooperative Societies and a representative of the Central Cooperative Bank as Chairman.

Central Cooperative Banks lend to the Primary Agricultural Cooperative Credit Societies (PACS) at 8 percent. These primary societies number about 18,372 (1980) in Maharashtra and are the main sources of credit for short and medium term loans to farmers. Current membership is approximately 5,200,000.

Crop loans are given on a short term basis and must be repaid within one year (each 31st March) except for long season sugarcane which is 18 months. Short term loans consist of a cash outlay, permits for securing inputs (fertilizers, seed and pesticides) and possibly an additional amount for specific needs of an agricultural operation. These loans are provided to farmers at 11 percent. Credit limits for different crops are shown in Table 7.

Table 7

CREDIT LIMITS FOR DIFFERENT CROPS

Name of Crop	Credit in Kind			Credit in Cash	Total
	Seed	Fertilizer	Insecticides		
High yielding paddy	75	700	225	--	1000
Hybrid jowar (sorghum)	60	640	100	--	800
High yielding jowar (sorghum)	25	450	125	--	600
Hybrid bajra (pearl millet)	25	425	50	--	500
Hybrid maize	70	600	130	--	800
Pigeon Pea (pulse)	60	75	75	--	210
Moong (pulse)	60	75	75	--	210
Blackgram (pulse)	60	75	75	--	210
Groundnut	500	275	115	310	1200
Sesamum (oilseed)	25	300	25	50	400
Hybrid cotton (irrigated)	250	800	1150	500	2700
Hybrid cotton (unirrigated)	350	400	500	250	1500
Ordinary cotton	50	200	380	200	830

The definition of small, marginal and large farmers vary according to schemes (IRDP, DPAP, ARDC). The drought prone area development program (DPAP) defines small farmers as non-irrigated 3.30 - 7.20 acres and irrigated 1.35 - 3.30 acres; marginal farmers as non-irrigated 0 - 3.3 acres and irrigated 0 - 1.35 acres. Normally, small farmers are considered as those earning less than 3,500 Rs/year/family. The number of drought prone talukas covering 10 districts in Maharashtra is 87 (less than 750 mm rainfall/yr).

The amount of lending for irrigated crops (canal irrigation) is about two to three times higher than for non-irrigated. For example, a farmer can obtain about 1500 Rs/ha for non-irrigated cotton and 2700 Rs/ha for irrigated cotton. Generally, the additional amount loaned for any crop under irrigation is similar and does not depend on specific crop requirements.

Medium term loans are available for such items as small pump sets, electric motors, etc. and are to be repaid in three to five years. The rate of interest is 14 percent and requires no land mortgaging. These loans are also provided through the primary agricultural cooperative credit societies (PACS).

Long term loans, requiring repayment between 10 - 15 years and land mortgaging are available only through the Land Development Bank. The Land Development Bank has approximately 250 branch facilities in Maharashtra and loans are provided for such items as bullocks, tractors, pumps, digging of wells and land development costs.

Besides the PACS, there are non-agricultural credit societies, marketing societies, processing and production enterprise societies and multi-purpose cooperative societies. Altogether, these total about 57,352 (including PACS) cooperative societies with a member ship of 14,600,000.

Marketing of agricultural produce in Maharashtra operates through a network of regulated markets with individual traders (commission agents) and market societies providing wholesale/retail services between farmers and consumers. The Food Corporation of India sponsored by the GOI procures marketable surplus for the central pool and regulates public distribution.

The Maharashtra Agricultural Produce Marketing Act of 1963 established a means to regulate the market system and add new market centers as demands arises. The Act provides funds and powers to form market committees responsible for setting up new market centers. Market committees are delegated the authority to purchase lands and construct facilities (sheds, offices, sales, etc.) for operating local sales yards. Committees are represented by growers, traders, local and state government authorities. Normally, market committees serve several village units or a taluka (block).

Currently, there are 227 market committees having 227 market yards and 290 subsidiary market centers throughout the state. New market committees and market centers will be established in irrigated command areas as demand arises.

9. Soil Surveys: The Division of Irrigation Research and Development (DIRD) of the Maharashtra Irrigation Department conducts detailed soil surveys (series level) in all MIP command areas. Surveys are done according to procedures and methodology set forth by the National Bureau of Soil Survey and Land Use Planning. These surveys are completed prior to the initiation of Land Development Works. Copies are provided to the AD for use in developing revised cropping patterns, land leveling, grading and locating surface drains.

   In addition to pre-irrigation soil surveys, DIRD conducts biannual inspection of selected wells and checks suspected areas for possible waterlogging and/or salinity problems. In cases where waterlogging begins to develop sub-surface drainage schemes are designed and constructed by the irrigation circle responsible for the problem area.

   DIRD also undertakes specialized research studies pertaining to soil and water management problems within irrigation projects. Research studies are currently aimed at: (1) correlating soil survey information with irrigability classification, (2) the utility of percolation tanks, (3) improved design of drainage schemes and (4) crop water requirements. Increased staffing and training of DIRD would increase the benefits accrued from these research studies (See Volume II, Chapter 4, B.2.g. Soil Surveys).

   The AD/SC also carries out soil surveys in non-irrigated areas according to the same methodology used by DIRD. These surveys are used to develop cropping patterns and other land use priorities.