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DEPARTMENT OF STATE

AGENCY FOR INTERNATIONAL DEVELOPMENT

Washington, D.C. 20523

PROJECT PAPER

INDIA

MAHARASHTRA MINOR IRRIGATION

(386-0490)

USAID/INDIA

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MAHARASHTRA MINOR IRRIGATION PROJECT PAPER

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Index of Key Terms and Acronyns

AD - Agriculture Department

CADA - Command Area Development Authority

CCA - Culturable Command Area

CCF - Construction Cost Factor

CDSS - Country Development Strategy Statement

Chak - Area of about 40 hectares served by a single canal outlet

Conjunctive Use - Combined use of surface and groundwater in order to meet crop water requirements. Groundwater not only supplements surface water, it also reduces the risk of waterlogging.

Created Irrigation Potential - The areas within the command area of existing irrigation systems and thus having theoretical access to irrigation water.

Cropping Intensity - Total area cropped in a year (all seasons) expressed as a percentage of CCA.

DEA - Department of Economic Affairs

Diagnostic Analysis - On-site multidisciplinary examination of all aspects of an irrigation system, concentraing on the productive end and including agricultural engineering, economic, educational, social and other factors to identify and address the constraints to an optimally efficient operation.

EGS - Employment Guarantee Scheme

ERR - Economic Rate of Return

FRR - Financial Rate of Return

GOI - Government of India

GOM - Government of Maharashtra

ID - Irrigation Department

Kharif - Rainy Season, June to October

MIC - Minor Irrigation Committee

Rotational Water Supply System (RWS)	- A water allocation system whereby the guarantee is in respect to a given volume of water to be supplied at a pre-established time. The farmer can allocate as much land as he chooses with his water allocation; however, if he does not irrigate his farms within the specified time, his turn is missed until the next rotation.
MDU	- Modeling and Data Unit of SAEC
MESU	- Monitoring, Evaluation and Survey Unit of SAEC
O&M	- Operation and Maintenance
PACD	- Project Assistance Completion Date
Part I Works	- Construction of water channels and appurtenant structures from the 40 hectare outlet.
Part II Works	- On-farm land development, e.g., land leveling
PVO	- Private Voluntary Organization
Rabi	- Winter season, November to February
RMIC	- Regional Minor Irrigation Cell
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 requirments of the crops he indicated in his application that he would be growing each season. the system is extremely flexible because the time during which irrigators may take water is not limited
SMS	- Subject Matter Specialist (water management), Agriculture Department
SAEC	- Special Analysis and Evaluation Cell
SASC	- Special Appraisal and Supervision Cell
SSPU	- Special Studies and Pilot Unit of SAEC
VEW	- Village Extension Worker, Agriculture Department
WALMI	- Water and Land Management Institute
WMSP II	- Water Management Synthesis Project II
WOP	- Without Project
W/P	- With Project

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: 386-0490

4. BUREAU/OFFICE: ASIA [04]

5. PROJECT TITLE *(maximum 40 characters)*: Maharashtra Minor Irrigation

6. PROJECT ASSISTANCE COMPLETION DATE (PACD): MM 09, DD 30, YY 90

7. ESTIMATED DATE OF OBLIGATION *(Under 'B.' below, enter 1, 2, 3, or 4)*
A. Initial FY 84 B. Quarter 4 C. Final FY 86

8. COSTS ($000 OR EQUIVALENT $1 = Rs.10.95)

A. FUNDING SOURCE	FIRST FY 84: B. FX	C. L/C	D. Total	LIFE OF PROJECT: E. FX	F. L/C	G. Total
AID Appropriated Total						
(Grant)	(750)	(250)	(1,000)	(2,500)	(1,500)	(4,000)
(Loan)	( )	(24,900)	(24,900)	( )	(46,000)	(46,000)
Other U.S. 1.						
Other U.S. 2.						
Host Country		1,500	1,500		42,600	42,600
Other Donor(s)						
TOTALS	750	26,650	27,400	2,500	90,100	92,600

9. SCHEDULE OF AID FUNDING ($000)

A. APPROPRIATION	B. PRIMARY PURPOSE CODE	C. PRIMARY TECH. CODE 1. Grant	C. 2. Loan	D. OBLIGATIONS TO DATE 1. Grant	D. 2. Loan	E. AMOUNT APPROVED THIS ACTION 1. Grant	E. 2. Loan	F. LIFE OF PROJECT 1. Grant	F. 2. Loan
(1) FN		064	064			4,000	46,000	4,000	46,000
(2)									
(3)									
(4)									
TOTALS						4,000	46,000	4,000	46,000

10. SECONDARY TECHNICAL CODES *(maximum 6 codes of 3 positions each)*: 022 | 050 | 091

11. SECONDARY PURPOSE CODE:

12. SPECIAL CONCERNS CODES *(maximum 7 codes of 4 positions each)*
A. Code: BR | BRW | BS | LAB | TECH
B. Amount:

13. PROJECT PURPOSE *(maximum 480 characters)*

To increase irrigation efficiency in Maharashtra by improving the management and physical infrastructure of irrigation systems and by improving the distribution, application and utilization of water below the public outlet.

14. SCHEDULED EVALUATIONS
Interim MM 09 YY 87, MM 09 YY 89; Final MM 07 YY 90

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: [signature]
Title: Owen Cylke, Director, USAID/India
Date Signed: MM DD YY

18. DATE DOCUMENT RECEIVED IN AID/W, OR FOR AID/W DOCUMENTS, DATE OF DISTRIBUTION
MM 05 DD 21 YY 84

PROJECT AUTHORIZATION

INDIA

Maharashtra Minor
Irrigation Project
Project No. 386-0490

1. Pursuant to Section 103 of the Foreign Assistance Act of 1961, as amended, I hereby authorize the Maharashtra Minor Irrigation Project (the "Project") for India (the "Cooperating Country") involving planned obligations of not to exceed Forty Six Million U.S. Dollars ($46,000,000) in Loan funds and Four Million U.S. Dollars ($4,000,000) in Grant funds over a three 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.

2. The Project is intended to increase irrigation efficiency in Maharashtra by improving the management and physical infrastructure of irrigation systems and by improving the distribution, application, and utilization of water below the public outlet. Funds hereby authorized will finance the construction of approximately 90 minor irrigation schemes, including the rehabilitation of approximately 12 existing minor irrigation schemes, bringing 31,000 hectares of land under irrigation; research and technology development including special studies, pilot activities and diagnostic analyses; training for appropriate agencies, associations, and community organizations as well as individual farmers and irrigation and agriculture professionals; a strengthening of the minor irrigation organizational structure within the Agriculture and Irrigation Departments; and the establishment of approximately 52 hydrological stations.

The Cooperating Country will contribute the equivalent of $42,600,000 to the Project.

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.

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 for Grant funds, their source and origin in the Cooperating Country or the United states, and for Loan funds, the Cooperating Country or 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. Conditions Precedent to Disbursement

Prior to the first disbursement of loan funds, the Cooperating Country shall provide or cause to be provided evidence that the State of Maharashtra has established a Special Appraisal and Supervision Cell, a Special Analysis and Evaluation Cell, and Six Regional Minor Irrigation Cells within its Department of Irrigation, and sanctioned adequate staff for each of these cells.

d. Covenants

1. On-Farm Land Leveling and Shaping (Part II Works). Except as the Parties may otherwise agree in writing, the Cooperating Country agrees to make all reasonable efforts to assure the availability of sufficient funds to the Agriculture Department to complete the on-farm Part II works in accordance with the schedules to be established by the GOI and USAID for that work.

2. GOI Project Staffing. Except as the Parties may otherwise agree in writing, the Cooperating Country agrees to establish an adequate number of positions, and post experienced, qualified staff to these positions as necessary to effectively implement all Project activities in accordance with Project schedules and budgets to be established, from time to time, by the GOI and USAID for the approved schemes.

3. Water Users' Organizations. Except as the Parties may otherwise agree in writing, the Cooperating Country agrees that within two years from initiation of the Project, a plan shall be submitted, satisfactory to A.I.D. in form and substance, describing the organization, authorities, and responsibilities of water users'

committees at the outlet level, and a schedule for activation of such committees in those areas involved in the Project. A.I.D. reimbursement for costs connected with completion of irrigation schemes shall take into account activation of such committees in an appropriate number of Project areas.

4. Post Training Employment. Except as the Parties may otherwise agree in writing, the Cooperating Country agrees that all persons trained abroad under this Project be required, immediately upon completion of, and return from, said training, to work in irrigation related activities for a minimum period of not less than two (2) times the length of the training abroad. A.I.D. reserves the right to disallow costs for training abroad for those persons who, without good cause, do not work in irrigation related activities in accord with the terms of this covenant.

Signature [signature]
for M. Peter McPherson
Administrator

July 13, 1984
Date

Clearances:	Initial	Date
Charles W. Greenleaf, AA/ASIA	CG	6/29
Richard A. Derham, AA/PPC	[initials]	[illegible]
for Howard M. Fry, GC	[initials]	7/6/84

III. Project Summary, Rationale, and Description

A. Summary

The project will increase irrigation efficiency in Maharashtra by improving the management and physical infrastructure of irrigation systems and by improving the distribution, application, and utilization of water below the public outlet. AID will contribute $46 million in loan funds and $4 million in grant funds over the six year project life to support the planning, design, and construction of approximately 90 new minor irrigation schemes; the rehabilitation of 12 existing minor irrigation schemes; research and technology development including special studies, pilot activities, and diagnostic analyses; training for appropriate agencies, associations, and community organizations as well as individual farmers and irrigation and agriculture professionals; a strengthening of the minor irrigation organizational structure within the Agriculture and Irrigation Departments; and the establishment of 52 hydrological stations. The Government of India will contribute the equivalent of $42.6 million to the project effort.

Conceptually, the project defines the problems of irrigation efficiency in term of those above the public outlet and those below although the proposed work plan itself is integrated. When USAID undertook its first irrigation project in 1978, the widely shared belief was that irrigation efficiency could be increased by improving the design standards and construction practices for irrigation systems. This above-the-outlet approach dealt primarily with technical concerns or, more specifically, water delivery. USAID and the GOI, along with the World Bank, can take considerable credit for creating an awareness of the need to upgrade engineering standards and for the ensuing improvement in the design and construction of tanks and canals, with enhanced efficiency in the delivery system. The problem has proved, however, to encompass more than water delivery and its associated design and construction.

The asumption had been that once water was delivered to the outlet on a reliable and timely basis, the farmers and agencies that work with farmers would be capable of distributing water efficiently and equitably. It was also assumed that the knowledge and incentives required for the efficient application and utilization of water were or would soon be in place. Experience has shown these assumptions to be invalid. While the Government of India and USAID continue to believe that well designed, well constructed schemes are critical to irrigation efficiency, we now recognize that addressing constraints below the outlet, such as water distribution, application, and utilization, is equally essential to irrigation efficiency and substantially more difficult. This change in perception is reflected in the evolution of USAID's irrigation portfolio. It was first evident in the PID for the Rajasthan Command Area Development Project submitted to Washington in July 1981. The Maharashtra Irrigation Technology and Management Project authorized in FY 1982 and the Madhya Pradesh Minor Irrigation Project authorized in FY 1983 both reflect a recognition of below-the-outlet constraints. Appreciation of those constraints and development of an approach to address those constraints culminated in the Irrigation Management and Training Project authorized in FY 1983.

The GOI clearly recognizes that a broader range of organizations needs to be concerned with water distribution, application, and utilization, including, among others, the state agricultural departments, the state rural development departments, and the National Bank for Agriculture and Rural Development. Perhaps more importantly, there is a new awareness of the institutional complexity below the outlet. The role of communities, water user associations, and farmers in the distribution, application, and utilization of water must be better defined and relationships to pertinent government agencies rationalized. The role of the agricultural regime itself and its relationship to irrigation development must be fine-tuned. Credit, knowledge, and extension systems must be better understood and applied. The GOI's awareness of the constraints below the outlet and its commitment to overcoming those constraints are manifest in recent institutional and policy adjustments at the centre and in the states. Among these is a policy extending the state's responsibility for construction of irrigation channels to the eight hectare block,* thus making the area below the outlet more manageable. While this may or may not be the final word on the issue it does indicate the high priority being placed on irrigation development and accurately reflects the existing inability to mobilize organizations and institutions to meet the delivery system further up the watercourse. Another GOI effort to increase irrigation efficiency below the outlet has been the introduction of the Command Area Development Authority (CADA) concept whereby various government agencies coordinate to ensure that all inputs and services necessary for optimal crop production are available to the farmer. CADAs were initially envisaged only on major irrigation schemes covering at least 100,000 hectares. They are now being established on smaller schemes in some states. The GOI is also supporting the establishment of Water and Land Management Institutes in key irrigation states to propagate the principles of water management. These initiatives reflect a revolution in thinking in regard to irrigation. It becomes much more clearly a support system to agriculture and thus a piece of a larger picture rather than a free-standing technical intervention and an end in itself.

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*Maharashtra has gone even further than the GOI policy requires and extends Government responsibility for the construction of field channels to the two hectare block or the farmgate.

The Maharashtra Minor Irrigation Project is concerned with maintaining the momentum created to upgrade engineering standards to ensure efficient water delivery but it also seeks to identify and address constraints to efficient distribution, application, and utilization of water and to support the State's nascent commitment to deal with these issues. The approach to addressing these latter constraints which we are defining as below the outlet constraints is not, at this point, fully defined, and it is the objective of this project to build knowledge that can lend definition to the problem, test pilot approaches, and develop effective strategies for below the outlet.

Increased farmer participation is important but the remedy goes beyond that. An environment conducive to cooperation among government agencies, non government organizations (including business concerns, private voluntary agencies, water user associations, community organizations and cooperatives), educational institutions and farmers must be created. Delivery, distribution, application, and delivery of water must be related to particular agricultural, cultural, and political regimes. Perhaps most importantly, farmers must be exposed to the benefits of applying water management principles and policies that encourage and reward efficient water management practices must be in place.

This project includes a research and technology development component which will finance 12 long term interdisciplinary diagnostic analyses and several studies to increase the understanding of constraints below the outlet. Particular attention will be focused on determining institutional and policy constraints and on identifying incentives for farmers to apply water management principles. Alternative policies and new technologies will be tested on pilot schemes.

The project will involve farmers and define the role of communities and water user associations in planning water distribution systems below the outlet, determining water allocation patterns, and operating and maintaining water channels. To learn more about farmer mobilization and what makes it happen, the project will finance a study on experience to date in organizing irrigators in India. The study will be completed in the second year of the project so that lessons learned can be applied. Approximately two years prior to the scheduled completion of the irrigation system, a village extension worker (VEW) will be assigned to each A.I.D. financed scheme, as appropriate. He will have been trained under the project and his responsibilities will include helping farmers organize outlet committees and familiarizing farmers with water management principles. Farmers need to understand the soil-plant-water relationships and must learn to apply the proper amount of water at the proper time. The move from dry to wet farming is not axiomatic. The importance of on-farm land development and proper use of complementary inputs must be emphasized to maximize irrigation efficiency. The VEW will be assisted by a subject matter specialist (SMS) in water management which the Agriculture Department has agreed to appoint to each district with an A.I.D. financed scheme. The lessons taught by the VEW and the SMS will be visually reinforced by the establishment of two demonstration chaks in each scheme. Finally, to further enhance the farmers' understanding of irrigation technology and their grasp of the potential that the technology creates, special workshops, field days, and short training sessions will be sponsored for farm families.

To increase cooperation among the various relevant government agencies, the project proposes an institutional structure that encourages communication as well as joint planning and implementation. The project also provides joint training opportunities that include representatives from private organizations when appropriate. This is the first state specific project to solicit the active participation of the agricultural universities.

Finally, recognizing that both irrigation technology and social science intervention must be rooted in a firm understanding of the resource base, the project includes provision for the establishment of 52 hydrological stations.

B. Rationale

1. AID Irrigation Strategy

USAID's approved assistance strategy for irrigation in India is based upon irrigation's key role in accelerated agricultural growth and poverty alleviation and the high priority attached by the Government of India (GOI) to irrigation development. India's population of nearly 750 million is growing at over two percent annually, or by 15 million or more each year. To feed and clothe this growing population and gradually reduce unemployment, poverty and malnutrition, agricultural production will have to grow by nearly 4 percent per year for the remainder of the century, as compared with historical growth rates of under 3 percent. Since very little additional land can be brought under cultivation, production increases will have to come primarily by raising cropping intensities and yields, both of which depend heavily on reliable water supplies. The scope for yield increases is indicated by the estimates that actual average foodgrain yields are 0.7 metric tons per hectare (MT/ha) on unirrigated land and 1.7 MT/ha on irrigated land. Moreover, foodgrain yields with available seed varieties can be increased to 4-5 MT/ha annually with good water management and appropriate fertilizer applications.

About 30 percent of India's cultivated area of 140 million hectares receives enough rainfall to produce at least one crop per year. Given the seasonal rainfall pattern characteristic of India's monsoon climate, irrigation is needed in these areas to permit double and triple cropping. Another 25-30 percent of the net cultivated area receives low rainfall but can be reached by irrigation. Thus irrigation can ultimately cover about 55-60 percent of net sown area. To date about half of this area has been reached. The GOI hopes to create the remaining irrigation potential by the year 2000 or shortly therefore. This implies a growth rate of irrigated area of over four percent annually for the rest of the century.

Irrigation water can be provided from surface sources (rivers, reservoirs, "tanks") or underground sources ("groundwater"), including dug wells and drilled wells ("tubewells"). Surface irrigation in India is classified as "major" (covering over 10,000 hectares of irrigated area), "medium" (2000-10,000 hectares) or "minor" (under 2,000 hectares). As of 1981-82, India had developed about 61.5 million hectares (ha) of the 113.5 million ha of "irrigation potential" (area irrigated times cropping intensity). Surface irrigation accounts for over two thirds of this ultimate potential, and for about 60 percent of the potential developed thus far. USAID's irrigation assistance has concentrated thus far on surface irrigation, since the problems in surface irrigation development (in India as elsewhere) are especially challenging. Groundwater irrigation generally involves wells controlled by an individual farmer or small group of farmers and provides water for a small area. Water supply and use can be regulated relatively easily, and water use efficiencies as well as crop productivity levels are generally high. Surface irrigation, on the other hand, involves the management of larger and more complex systems, and water use efficiencies (the proportion of the water diverted from its source that actually reaches the plant) have generally been low (i.e., in the 25-30 percent range rather than the 50-55 percent range anticipated). Crop productivity under surface irrigation is often correspondingly low. Unless the efficiency of both existing and new surface irrigation systems rises closer to its potential, the prospects for achieving India's food production growth targets are poor.

The supply and use of water in surface irrigation systems may be regarded as two distinct parts: the system of reservoirs and canals built by the state irrigation departments, extending down to an outlet covering an area ranging up to 200 ha, but often averaging 40 ha; and the area below the "public outlet," where farmers are responsible for distributing water among themselves to reach their fields. In most states the Agriculture Department is responsible for assisting farmers in constructing the necessary field channels below the outlet and adopting the practices appropriate to irrigated agriculture. In the past decade the problems of irrigation water management in both parts of the system have received a great deal of attention from the GOI and others. Given the complexities characterizing the interactions among technical, biological, administrative and social systems in surface irrigation, the constraints to improved water management and increased irrigation efficiencies are numerous and varied. However, the basic problem is that too few farmers in surface systems receive adequate supplies of water from the public outlet with the degrees of reliability necessary to make it attractive to shift to scientific intensive agriculture.

At the technical level, designs are often inadequately adapted to site conditions and do not include the control structures required for precise management of water flows within the main system. Little data is available on actual system performances. Below the outlet, technical guidance for construction and maintenance of field channels and drainage works by farmers or contractors is not generally available; irrigation departments feel that their technical responsibilities end at the outlet,* and agriculture departments do not have sufficient staff trained in on-farm irrigation development. This bifurcation of bureaucratic responsibility also results in a fragmented understanding of irrigation and related farming system problems and poor coordination between irrigation activities and complementary agricultural activities such as extension, input supply and marketing. These institutional shortcomings are compounded by the failure of public sector agencies to involve farmers in assessing and solving system problems, and by the absence of private sector alternatives to complement or perhaps compete with public sector irrigation services.

The GOI recognizes the need for qualitative improvements in irrigation as well as continued system expansion, and has introduced several reforms. In order to deal with the issue of coordination between irrigation and agriculture departments in addressing water use problems below the outlet, the GOI introduced the Command Area Development (CAD) program for major irrigation projects. More recently, the GOI reduced the size of the block ("chak") to be served by each public outlet from 40 ha to 8 ha, thus reducing the magnitude and complexity of the task facing farmers in field channel construction. The GOI is also encouraging the introduction of the rotational water supply (RWS) or "warabundi" systems of northwestern India (Punjab, Haryana and western Uttar Pradesh) to surface irrigation systems throughout India. Under this system, each farmer within a block receives an amount of water proportional to his holding, according to a predetermined schedule which is strictly followed. This system has the advantage of administratively established scarcity

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*Until 1980, the GOM was responsible for completing the distribution system to the 40 hectare outlet. Further work of constructing field channels was left to the irrigators. Since 1980, the GOM has had responsibility for completion of field channels up to the 8 hectare block.

as well as predictability, and encourages efficient water supply and use. This contrasts sharply with surface systems prevalent elsewhere in India, which generally have no organized procedure for water distribution among outlets or below the outlet. In addition, the Sixth Five Year Plan called for increased emphasis on 1) analysis of water losses in various parts of the system and development of appropriate corrective measures; 2) coordinated use ("conjunctive use") of surface and groundwater sources; 3) higher water charges; 4) improved monitoring of system performance; 5) irrigation research by agricultural universities; and 6) training of irrigation staff in efficient operation of completed systems.

AID shares the GOI's objectives of increased food production and rural employment through irrigation development. Limited resource availabilities, however, dictate that AID concentrate its efforts on selected aspects of the GOI's irrigation development program. Within that program, returns to efforts to increase efficiencies on existing and new surface irrigation systems are likely to be especially high, since efficiencies with current designs and management approaches are quite low, as noted above. Thus USAID's subsector goal is to assist the GOI and selected states to bring about a gradual rise in overall surface irrigation efficiencies, from perhaps 25-35 percent at present to 50-55 percent on a significant number of systems by the year 2000. Improving efficiencies at this rate will require continuous improvements in water management through state-level implementation of policy reforms, mobilization of the creative energies of farmers and private sector suppliers of irrigation expertise and services, adoption of better technical solutions to problems of water supply and use in surface irrigation systems, and a reorientation of the irrigation establishment toward more systematic management approaches to problems. Establishing the human resource base to bring about long-term changes of this magnitude affecting tens of millions of hectares of irrigated land in many states will in turn require a sustained program of water management training for professionals and farmers, based on the design, construction and operation of actual systems. This implies a package of AID inputs combining investments in construction of new or rehabilitated irrigation systems with technical collaboration and training, all focused on the four strategy elements of policy reform, private sector mobilization, research and technology development, and institutional reorientation. Given the scale and construction times of surface irrigation projects in the "major" category, AID must limit itself to direct involvement with medium and minor surface irrigation; similarly, AID cannot work directly with more than a limited number of India's states at any one time.

The approved assistance strategy for AID support of GOI and state irrigation development efforts covers a portfolio of five existing projects and three projects scheduled for authorization in FY

1984 or FY 1985 (one of which, Rajasthan CAD, will probably be an amendment to an existing project). The five existing projects are the three state medium irrigation projects (Gujarat, Rajasthan and Maharashtra), the one state minor irrigation project (Madhya Pradesh), and the Irrigation Management and Training (IM&T) project. The IM&T project supports irrigation studies and training in the four above states and in Tamil Nadu (as well as similar efforts at the center), and is the "core" project for AID's irrigation assistance in India. The Hill Areas Land and Water Development and Maharashtra Minor Irrigation projects proposed for FY 1984 add two more minor irrigation programs to the portfolio, and each provides important new opportunities to work with state governments on key technical and institutional problems in irrigation. The Rajasthan Command Area Development (CAD) amendment proposed for FY 1985 will extend the CAD approach (which has heretofore been confined to "major" projects) to medium irrigation.

USAID is not proposing any irrigation projects for authorization in FY 1986. AID assistance to irrigation development for the period FY 1987 and beyond will be the subject of an assessment to be carried out by outside irrigation experts in late FY [illegible]. This assessment will review experience thus far under existing projects, analyze prospects for progress with respect to each of the four strategy elements, and recommend future directions for collaboration between AID, the GOI, and the states in helping irrigation realize its outstanding potential contribution to accelerated agricultural growth and rural poverty alleviation.

2. Opportunities in Maharashtra

The state of Maharashtra covers an area of 30.8 million hectares and has a population of approximately 62.8 million people, making it India's third largest state in terms of land area and population. In terms of population, Maharashtra ranks as the fourth largest recipient of A.I.D. development assistance, behind India itself, Indonesia, and Bangladesh. Although Maharashtra is India's most industrialized state, two thirds of the labor force are employed in agriculture.

During the period of 1960-61 to 1978-79 Maharashtra had an average annual growth rate of 1.77 percent in foodgrain production. This was well below the all-India average, coming far closer to the low of 1.19 percent in Orissa than to the high of 8.01 percent in the Punjab. Moreover, during the same period, the average population growth rate of 2.19 percent per annum outstripped the foodgrain production growth rate, resulting in a substantial foodgrain deficit. In 1981-82, Maharashtra accounted for 11 percent of India's area under foodgrain cultivation and 34 percent of its cotton area. Yet, foodgrain production was only 8 percent of the national total and cotton only 19 percent. The average cropping intensity of 107 percent is one of the lowest in India. Given the concentration of rainfall during the short monsoon season and the scarcity of rainfall in many regions of the state, the intensity of cultivation in Maharashtra cannot be significantly increased without irrigation.

Currently of the 22.7 million hectares of cultivable land in Maharashtra, 1.9 million hectares or about 8 percent are irrigated. A 1962 government survey indicated that if all water resources were developed, seven million hectares or about 30 percent of the arable land would be under irrigation. More recent estimates of ground water supply may expand the total to over eight million hectares.

As indicated above there is considerable scope for improving agricultural production in Maharashtra and for increasing the number of irrigated hectares. Moreover, the institutional climate in the state is such that USAID believes it possible to have a substantial impact on the Agency objectives of technology transfer, institutional development, policy dialogue, and private sector initiative.

Technology Transfer: The GOM has a high interest in qualitative improvement as well as quantitative expansion in its irrigation sector and has repeatedly shown itself open to considering changes that hold promise for increased productivity of land and water. In dealing with the Irrigation and Agriculture Departments, both USAID and the World Bank have been impressed with their willingness to consider new ideas objectively and accept or reject them on the merits. Under this project, irrigation practices not yet widely applied in Maharashtra will be tested and demonstrated on 90 AID-financed schemes. There are 30 districts in Maharashtra and USAID intends to finance at least one scheme is each district in order to involve all climatic zones and ensure the widest possible dissemination of technology and approach. Also, new designs and analytical procedures for minor irrigation schemes will be developed taking joint Indo-U.S. experience into account. Indo-U.S. collaboration will be fostered through study tours, jointly sponsored workshops, and U.S. and Indian technical assistance.

Institutional Development: Both the Irrigation Department and the Agriculture Department have an active interest in increasing the effectiveness and efficiency of their programs. Maharashtra has been in the vanguard of analyzing deficiencies in irrigation systems and moving decisively to address those problems. The state's irrigation commission published a report identifying the chronic problems associated with irrigation a decade before the All Indian Commission undertook a similar exercise. When the GOI introduced the concept of Command Area Development, the GOM rapidly adopted the idea and created CAD authorities to enhance coordination between irrigation programs and agricultural support services. More recently, the GOM has begun a major in-service training program geared toward familiarizing officials with the perspective from the farmers field up as opposed to that from the reservoir down. Toward this end, the Water and Land Management Institute (WALMI), established in Aurangabad with World Bank assistance and supported under the AID financed Irrigation Management and Training Project, has become the prototype for similar institutions in several other Indian states.

Institutional development is a primary thrust of this project. Activities set forth in the project description are designed to enhance the government's grasp of the technical, managerial, and social problems that exist in the irrigation sector and develop the capability to address those problems in an efficient, economical, equitable manner. Organizations to receive attention under the project include the Irrigation Department, the Agriculture Department, the Groundwater Survey and Development Agency and selected agricultural universities. Less formal and non-governmental associations of farmers and community institutions will be identified, engaged, and nurtured.

Policy Dialogue: The history of active public sector involvement in irrigation development reaches back to the 1876 famine fund. At that time, irrigation was seen as a means to ensuring the availability of water during periods of drought with the driving objective being to stablize rather than increase foodgrain production. Many of the existing policies and practices can be directly traced to that early objective of assuring foodgrain production. One of the most obvious examples is the government policy of designing minor irrigation reservoirs on the basis of 50 percent reliability. Another example is the policy of controlling the types of crops grown with surface irrigation water and exercising that control to favor the production of food grains over the production of cash crops. This policy has induced many farmers with adequate capital to invest in wells and lift schemes and use the publicly controlled surface water selectively, as a complement to their own reliable, unfettered source of water. Pilot activities will demonstrate the impact of alternative policies in regard to optimal sizing of reservoirs, farmer determination of cropping patterns, and other issues. The conjunctive use of groundwater will be studied to help the GOM identify policies that will promote the equitable distribution of the benefits of conjunctive use. Other pilot activities, studies, and diagnostic analyses will be undertaken to assist the GOM explore its policy options and assess the impact that various policies have or could have. Professional development activities will also enhance the GOM's capability to identify and assess policy options. Finally, USAID and the technical assistance team will maintain the dialogue which began with the GOM during the project design stage on all aspects of irrigation policy, procedures, and practices.

Private Sector Initiative: Irrigation projects represent an investment in India's most important small businessman, the farmer. By helping him to gain access to a reliable water resource, this project will enable the farmer to maximize the efficiency of his land and labor resources and thus increase the productivity and profitablity of his enterprise. The project also supports the formation of water user associations and, through them, the "privatization" of public functions. Local private sector construction contractors will benefit not only from the increased demand the project will create for their services but from the opportunity the project affords them to upgrade their technical skills and increase their familiarity with improved construction practices. The experience and expertise of PVOs may be drawn upon to participate in several of the studies and pilot activities supported under the project.

In addition to the opportunities it holds for technology transfer, institutional development, policy dialogue, and private sector initiative, Maharashtra has a demonstrated commitment to alleviating rural proverty. In this campaign, the Government has established two fronts. The first is an effort to extend irrigation and introduce new agricultural technology to areas most vulnerable to drought, often by-passing areas which offer a potentially higher financial return to do so. The second is a bold program guaranteeing work to all those who seek it called the Employment Guarantee Scheme (EGS). By 1977, this program had created an estimated 390,000 person years of employment for adults at the base of the socio-economic pyramid --- the landless, the unskilled, women, tribals, and those of scheduled castes. Included in this program is the construction of irrigation tanks and their distribution networks.

Minor irrigation projects in particular have a positive impact on equity. They focus activity in remote areas of the upper reaches of the watershed were, because of poor land conditions and limited water availability, farmers tend to be on the bottom rung of the socio-economic ladder. Often, the beneficiaries are tribals or members of the scheduled castes. Moreover, the benefits of minor irrigation are realized in a relatively short time. A generation of farmers may pass from the scene in the time elapsed between the preparation of a blueprint for a major dam and the first release of water. For minor schemes, the gestation period is only three to five years. Relative to major and medium schemes, minor irrigation schemes offer more scope for innovative and user oriented design and provide greater opportunity for operation and management by users. While canals for the larger schemes traverse many communities, inhabited by villagers who do not know or trust one another, the scale of minor projects is such that participants have long-established patterns of interaction.

This project will develop direct linkages with the special studies and training programs currently being implemented in Maharashtra under the Maharashtra Irrigation Technology and Management (MIT&M) Project (386-0481) and the Irrigation Management and Training (IM&T) Project (386-0484). The studies and pilots proposed under this project complement those being carried out under the above two projects. A concerted effort will be made to ensure that the results are applied to both state specific irrigation projects and transferred through the Technology Transfer Unit being established under the IM&T Project. For example the groundwater studies recommended by the Maharashtra Minor design team will be incorporated in the proposed groundwater utilization and water balance studies being carried out under the MIT&M Project. The training workshops proposed under both irrigation projects will be combined whenever appropriate. In addition it is proposed that some of the training activities be carried out at WALMI or that WALMI provide trainers for the on-site workshops to ensure that there is uniformity and consistency in the approaches and technologies recommended. WALMI is receiving AID support under the IM&T Project. Other agencies such as the engineering staff college of the GOM and the agricultural universities will also provide training support.

3. Other Donor Activities in Maharashtra

With two active loans totaling $280 million, the World Bank is Maharashtra's largest single donor in the irrigation sector. The Bank's projects concentrate on the construction of major irrigation projects, the modernization of roads in the command areas of the projects, and the provision of vehicles and equipment required in relation to the projects. With a contribution of $50 million the International Fund for Agricultural Development is collaborating with the Bank on one of its projects. Total Bank and IFAD support will bring approximately 620,000 hectares of land under irrigation.

Under the Bank's projects, support is also being provided to the Water and Land Management Institute (WALMI) located near Aurangabad. USAID is working closely with the World Bank and the GOM under the Irrigation Management and Training Project to expand WALMI's capabilities and to develop a curriculum at WALMI that promotes water management concepts and communication among irrigation officials, agriculture officials, and farmers.

C. Project Description

1. Sector Goal and Purpose

USAID's goal in the irrigation sector is to increase food production and rural employment.

The purpose of this project is to increase irrigation efficiency in Maharashtra by improving the management and physical infrastructure of irrigation systems and by improving the distribution, application, and utilization of water below the public outlet.

2. Project Components

a. Construction and Rehabilitation of Irrigation Schemes

The project will support the construction of an estimated ninety new minor irrigation schemes, bringing approximately 31,000 additional hectares of land under irrigation. Twelve existing schemes will be renovated. Each scheme represents an opportunity to inculcate the value of improved design criteria, increased user participation, and increased coordination among the various relevant organizations. Design standards for A.I.D.-financed schemes can be found in the technical analysis. All schemes will be equipped to measure daily wind run, solar radiation, minimum and maximum daily temperatures, rainfall, relative humidity, evaporation, and the water levels of tanks. Two demonstration chaks will be established on each scheme to expose farmers to tested land development and water utilization practices. Village extension workers and subject matter specialists will be assigned to each A.I.D.-financed scheme as appropriate to assist farmers in organizing outlet committees and to impart to farmers an understanding of water management principles. Eight of the new schemes and all of the rehabilitated schemes will serve as sites for studies and pilot activities. Twelve schemes will be selected for diagnostic analyses case studies.

b. Institutional Development

Under this component, AID will support studies, pilot activities, and training to enhance the knowledge and skills of individuals with a role in irrigation development and an institutional reorganization and the establishment of a computer data management competency to enhance the capabilities of institutions with a role in irrigation development.

1.) Studies and Pilot Activities

To acquire a better understanding of water management issues and to test proposed solutions to the problems identified, AID will grant finance a number of studies and pilot activities. Several of the studies will be exercises in the collection and analysis of data, including baseline data. Twelve will be long-term case studies of existing schemes designed to identify constraints to irrigation efficiency. The case studies will employ the diagnostic analysis approach whereby a comprehensive interdisciplinary analysis is undertaken on an operational irrigation system. An underlying assumption is that known technical problems are often symptoms of more fundamental problems embedded in the institutional and social fabric and that solutions will have to include institutional as well as technical modifications while taking social issues into consideration.

Recognizing the tremendous cost of operating and maintaining irrigation schemes in terms of manpower and financial resources, the Government of Maharashtra is interested in exploring ways of shifting these responsibilities over to farmer organizations. There exist a few long-standing farmer group-managed irrigation systems in Maharashtra, but, very little information is available on how and why these systems work. The project will finance a study to determine the management elements which could be applicable to publicly owned irrigation schemes.

An illustrative list of the types of topics on which the project will support other studies includes farmer participation on government financed schemes, the effectiveness of different water allocation systems, rate of silt load accumulation, the optimal sizing of the reservoir and command area, and the cost of sprinkler systems as opposed to the cost of land leveling and sloping.

Pilot activities will be launched on selected schemes to test the recommendations of studies financed under the Irrigetion Management and Training Project, the Maharashtra Irrigation Technology and Management Project, and this project. In addition, several pilots proposed by the project design team have been approved for support by USAID and the GOI. These include testing new technological innovations, e.g., a closed distribution system; experimenting with demand scheduling of irrigation water deliveries; involving farmers in determining crop mix; involving farmers in construction below the outlet; introducing catchment treatment interventions; and emphasizing the inclusion of women in extension programs. To explore ways to optimize the conjuntive use of ground and surface water, pilot activities will be coordinated with pilots supported under the Maharashtra Irrigation Technology and Management project. All pilot activities will promote increased farmer participation in the decision making process and increased interaction among irrigation professionals and farmers.

Pilot activity planning and monitoring will be the responsibility of committees created for each separate pilot activity. Leadership of the committee will depend upon the nature of the activity. For example, an activity testing land development procedures will be led by an official of the agriculture department whereas an activity designed to optimize conjunctive use of water will be under the leadership of the Groundwater Surveys and Development Agency. All committees will be interdisciplinary and will include representatives from the relevant government agencies, agricultural universities, representatives from other participating organizations, and farmer irrigators. Other participating organizations could include private voluntary organizations.

To ease the project implementation and monitoring burden, the pilot activities will be concentrated in two of the Maharashtra Irrigation Department's six administrative regions. Eight new schemes and two existing schemes will be involved. About 30 separate investigations will be conducted and reported on (some schemes will serve as the site for more than one pilot).

2.) Training

Short courses, workshops, and seminars will be sponsored in India for officials of the Irrigation Department, Agriculture Department, and the Groundwater Survey and Development Agency. PVOs, private firms, and the agricultural universities will be invited to send participants when appropriate. These activities will supplement and be coordinated with the larger multi-state professional development program of the Irrigation Management and Training project. The training will be coordinated by WALMI or by U.S. and Indian consultants and will be designed to sharpen the water management knowledge and skills of participants and to encourage productive communication among the representatives of the various organizations. An illustrative list of the types of topics that will be covered includes computer simulation modeling and information management; irrigation systems management; field irrigation management; diagnosis, prevention, reclamation, and management of soil salinity; methods for designing and implementing pilot activities; and farmer organization models.

Special workshops, field days, demonstrations, and short training sessions will be held for farm families on topics such as water management practices, the application of fertilizer and pesticides, and land development. The objective of these programs will be to increase the productivity of water, land, and labor, and to increase interaction between farmers and irrigation and agriculture professionals.

Opportunities for short term training and study tours in the U.S. and possibly other Third World countries will also be available under the project. In addition to enabling the participants to acquire topic specific knowledge, these trips will expose participants to the strengths and weaknesses of other irrigation systems, heighten their awareness of what is being done outside of India in the irrigation field, and encourage them to sort through new ideas to determine those which can be adopted in India.

Following is a summary of the project's training plan.

SUMMARY TRAINING PLAN

	Description of Training	Target Audience	Person Months of TA
a.	Short course on computer simulation modeling and information management (Three weeks)	Irrigation Department 5 (state) 10 (region) Agriculture Department - 5 Groundwater Survey and Development Agency - 5 University - 5	2
b.	Short course on operation of minor irrigation model (Four weeks)	Irrigation Department - 15 Agriculture Department - 5 Groundwater Survey and Development Agency - 5 University - 5	
c.	Short course on irrigation system management under demand scheduling (Two weeks)	Irrigation Department 10 (state) 30 (region)	1
d.	Short course on field irrigation practices like flow measurement, computing and measuring crop water requirements, and evaluation of on-farm water management practices (One week)	Irrigation Department - 50 Agriculture Department - 50 University - 10	1
e.	Workshop on irrigation methods (ID-1/pilot; AD-2/pilot; farmers-3/pilot) (One week)	Irrigation Department - 10 Agriculture Department - 20 Farmers - 30 University - 5	6
f.	Planning and layout of minors, water course and field channels (20-10 day workshops for 20 participants each)	Irrigation Department - 100 Agriculture Department -300	6

	Description of Training	Target Audience	Person Months of TA
g.	Short course on soil fertility and soil moisture interactions in crop yield; as well as diagnosis, prevention, reclamation, and management of soil salinity (2 subject matter specialists/district = 60) (Two weeks)	Agriculture Department - 60 University - 10	
h.	Train subject matter specialists (SMS) in on-farm water management Long-term course at WALMI	30	
i.	Workshops on farmer organization	Irrigation Department - 50 Agriculture Department -10	2
j.	Workshops for training trainers for agricultural development chaks (30 districts x 5 Agriculture Department and 1 Irrigation Department = 180 (Two weeks)	Irrigation Department - 30 Agriculture Department -150	-
k.	Workshop for training farmers at each scheme (10 x 100 schemes) (One week)	Farmers - 1000	-
l.	Train field level extension staff for water management (One week)	100	
m.	Train field level extension staff capable of working with and assisting female farm operators. (10 participants - One week)	Agriculture Department - 10	
n.	Train local contractor and Irrigation and Agriculture Departments supervisory staff	360	3

Description of Training	Target Audience	Person Months of TA
in proper construction methods, quality control, and so forth, particulary in Part I and Part II works (3 regional level workshops = 18 workshops x 20 participants = 360 participants - One week)		
o. Observation tours for mid-level and senior officers in the U.S. and other countries to observe irrigation water management	Irrigation Department - 20 Agriculture Department - 5	

3.) Institutional Reorganization

Within the irrigation establishment of the Government of Maharashtra, priority is assigned to matters concerning major and medium irrigation schemes. The central apparatus set up by the state to plan, implement, and monitor minor irrigation schemes does not have the staff to perform satisfactorily all the tasks for which it is responsible. Its linkages to the operation level are tenuous and no mechanism is in place to ensure communication within the state wide minor irrigation network. To increase the GOM's capability to manage its minor irrigation portfolio, this project will strengthen one existing unit and form one new committee and eight new units. Many of the positions in the new units will be filled by reassigning existing staff.

i. Minor Irrigation Committee

The Minor Irrigation Committee will be chaired by the Secretary for Irrigation with membership consisting of representatives from the Irrigation Department, Agricultural Department, Rural Development Department, Financial Department, Planning Department and other agencies as appropriate. The committee will provide overall operational guidance and be the final authority for the approval of schemes under this project. It will also make recommendations in regard to budget and staffing requirements.

ii. Special Appraisal and Supervision Cell

This cell will be headed by a superintending engineer, assisted by two executive engineers, four assistant engineers, one economist, one statistician, two deputy directors from the Agriculture Department, and supporting staff. It will be responsible for:

preparing appraisal reports of individual minor irrigation schemes and forwarding them to the Minor Irrigation Committee for approval;

coordinating the planning and design of minor irrigation schemes in accord with project paper criteria;

monitoring and supervising the implementation of the project and conducting periodic project reviews;

maintaining a quality control program for project financed schemes;

maintaining liaison with the implementing agencies and USAID and the GOI;

developing and monitoring the training program;

This cell will have three separate units. Two units will be responsible for schemes appraisal/approval, supervision, and implementation. The other unit will be responsible for the training program.

The superintending engineer of the cell will serve as member/secretary of the Minor Irrigation Committee.

iii. Special Analysis and Evaluation Cell

This cell will be headed by a superintending engineer, assisted by three executive engineers, five deputy engineers, two economists, two agronomists, two statisticians, one sociologist, and supporting staff. One of the five Regional Chief Engineers will be designated to act as the Coordinating Chief Engineer for the project and this cell will report to him. Three units will be created within this cell.

The Special Studies and Pilots Unit will be responsible for: (1) special studies, (2) pilot schemes planning and design, including preparation of scheme report, and (3) the twelve diagnostic analyses.

The Modeling and Data Unit will be responsible for: (1) development of the minor irrigation system model, and (2) data collection and model application.

The Monitoring, Evaluation and Survey Unit will be responsible for: (1) benchmark and follow-up surveys through contracts to the agricultural universities, (2) compilation and scrutiny of reports on the studies, pilot activities, evaluation, etc. to be sent to GOM/USAID, (3) monitoring of institutional and socio economic variables, and (4) preparation of claims for reimbursement.

iv. Regional Minor Irrigation Cell

A Regional Minor Irrigation Cell will be created in each of the six administrative regions of the Maharashtra Irrigation Department. Each cell will be headed by an executive engineer assisted by two deputy engineers, two sub-division agricultural officers, four junior engineers and support staff and will be responsible to the Regional Chief Engineer in the respective region. The cell will be responsible for:

monitoring project construction and assisting regular circles prepare scheme reports;

monitoring and coordinating soil and topographic surveys, distribution system planning, and land development work on the minor irrigation schemes in the region;

data collection and minor irrigation model application for preparation of scheme reports;

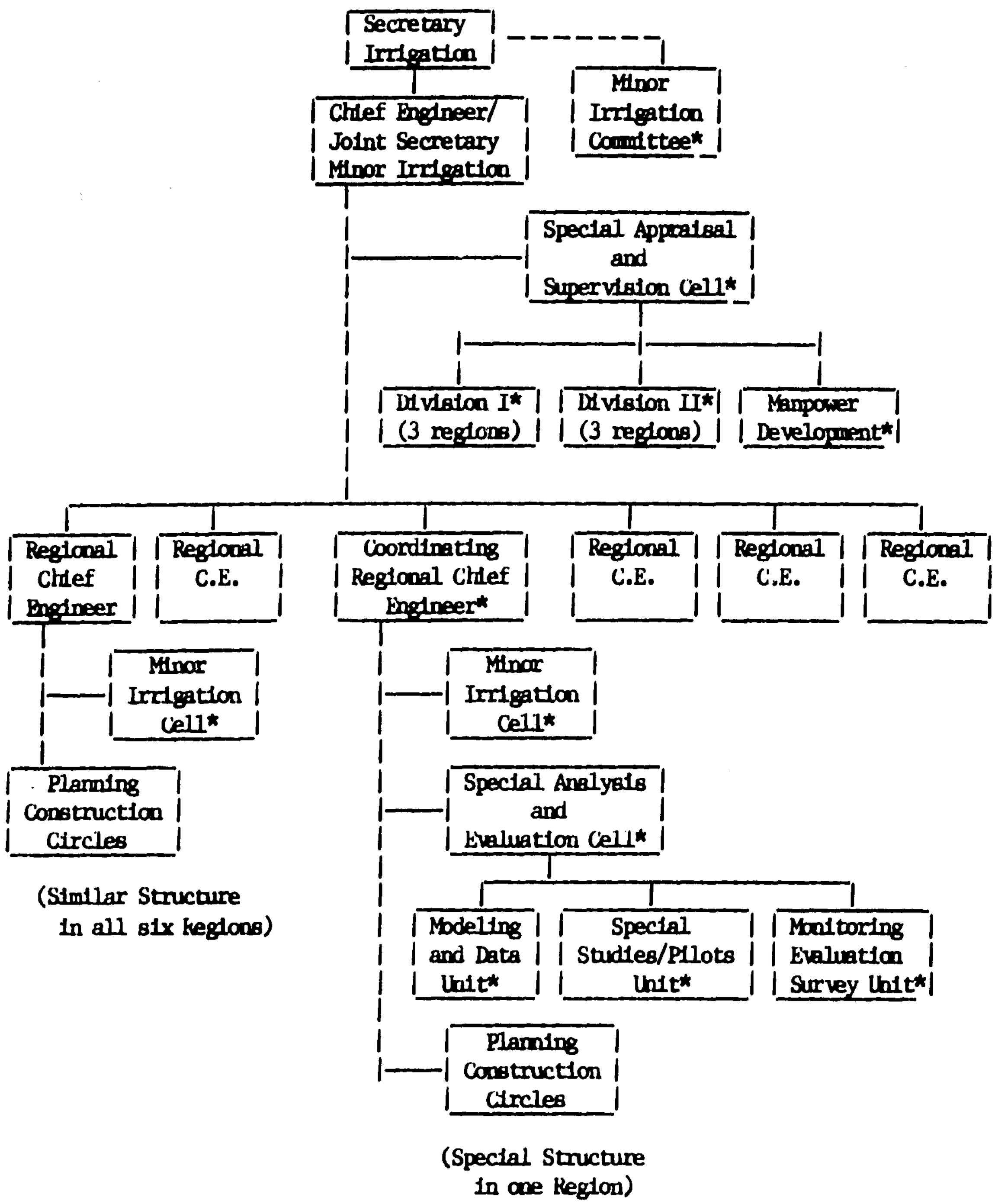
quality control on minor irrigation schemes;

monitoring and evaluation of minor irrigation schemes in the region.

v. Existing Circles

The existing circles under the regional chief engineer which are currently responsible for planning and construction will construct all of the minor irrigation schemes. The planning and design of pilot schemes will be done by the Special Analysis and Evalutation Cell. The existing circles will plan and design all non-pilot schemes, assisted by the Regional Minor Irrigation Cells.

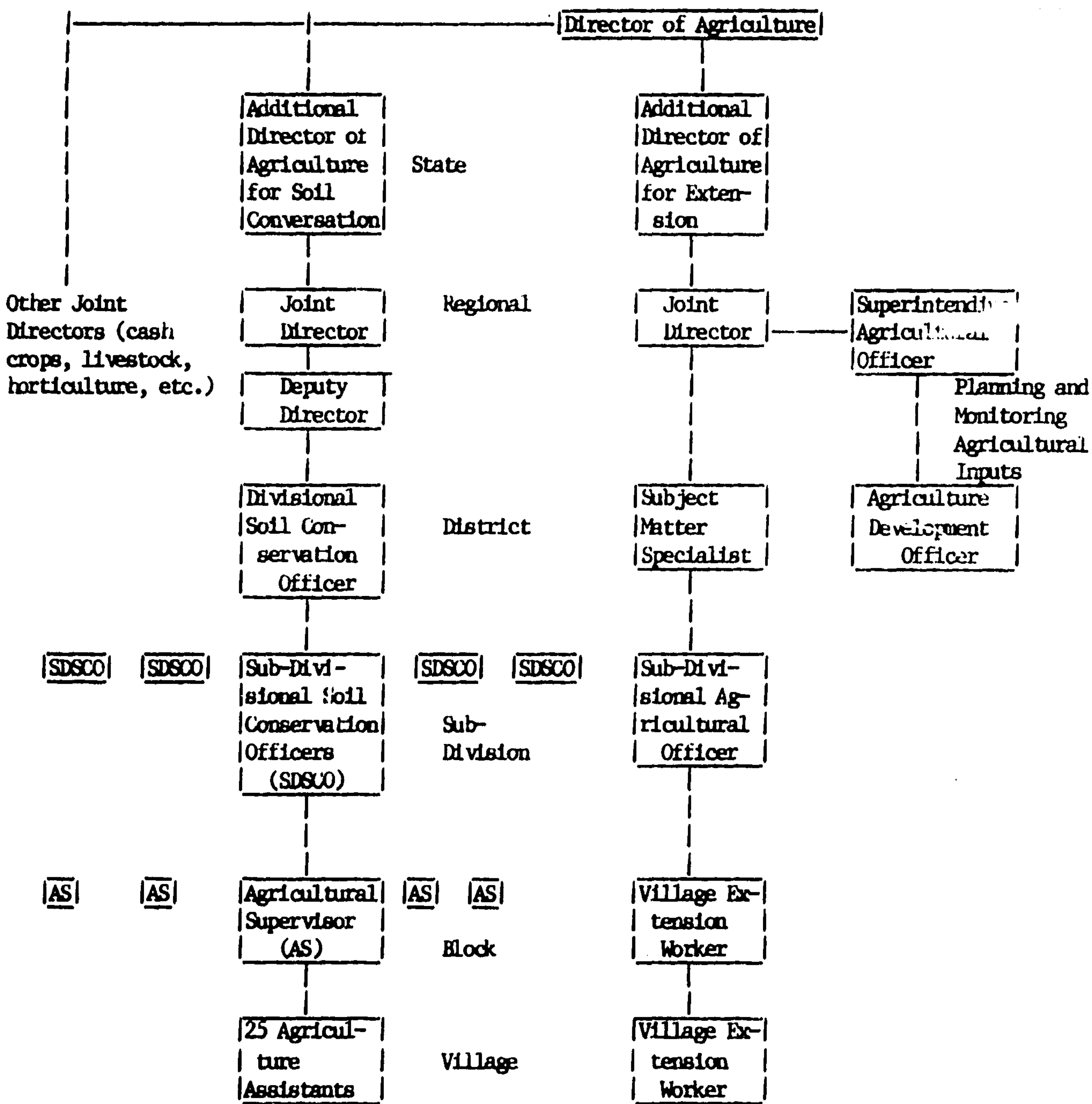
PROJECT PROPOSED
IRRIGATION DEPARTMENT ORGANIZATION FOR MINOR IRRIGATION



*Created under project

EXISTING AGRICULTURE DEPARTMENT ORGANIZATION

(Direct responsibility for construction below 40 hectares begins with subdivisional soil conservation officer)



4) Computer Data Management Program

This program will be the responsibility of the Modeling and Data Unit within the Special Analysis and Evaluation Cell. The unit will build a computerized data library and set up an information processing system. It will collect and systemize basic hydro-meteorological data from existing and new schemes, groundwater profiles, and agricultural land use patterns. A minor irrigation model will be developed and two existing schemes having good operational data will be selected from each region to test the model. The model will be used to design and analyze each pilot activity and, after being fully developed and tested, used on all schemes financed under the project. Micro computer hardware and software will be provided to each region and to the Special Analysis and Evaluation Cell.

c. Establishment of Hydrological Stations

In order to establish a more accurate and extensive hydrological data base for improved design of all types of irrigation projects, the GOM has proposed an instrumentation and data collection program to be financed under the project. Currently empirical formulas are used to determine water yields, rainfall/ runoff ratios, and other data crucial to irrigation planning. These formulas cannot match the accuracy of modern measurement devices in providing data required to estimate watershed yields, flood flows, and other information required to calculate design specifications for irrigation tanks. The GOM, with the assistance of various donors, intends to establish 275 additional hydrological stations throughout the major river basins of the State. The stations will be of different grades depending on the sophistication of the equipment provided. In addition, micro-computers will be established at the headquarters of the superintending engineer (Bombay) to facilitate analysis of the data for basin-wide studies as well as individual projects.

The Grade "A" station will incorporate instrumentation for measurements of evaporation and evapotranspiration, temperature, wind velocity and direction, sunshine hours, humidity, water quality and silt load. In addition to ordinary and automatic rain gauges, arrangements for discharge measurements with current meter (or floats in case of Grade B stations) will be included. Each type of station also includes the necessary infrastructure, such as buildings at the river gauging sites for operation and maintenance of the station.

Of the 275 stations, 52 will be financed under this Project, thirty Grade "A" and twenty two Grade "B" stations. Thirty Grade "A" stations are estimated to cost $1.35 million, including $30,000 in FX costs for imported equipment. Twenty-two Grade "B" stations are estimated to cost $650,000, for a total of $2 million.

These costs are broken down as follows: $840,000 for equipment to be financed under the project (including $30,000 grant financed and $810,000 loan financed); $1,070,000 for site preparation and buildings to be financed by the GOM; and $90,000 in annual establishment costs for operation and maintenance, also to be financed by the GOM.

3. Project Inputs

The project components will require inputs of technical assistance, training, construction, specialized equipment, and institutional support. The technical assistance team, known as the Liaison and Coordination Unit (LCU), will be grant financed for approximately three years full time and three years at one third time. It will consist of appropriate water management specialists and may inlclude an expatriate expert. (The expatriate expert may be required to be resident only for the first three years of the project.) Approximately thirty nine person months of short term technical assistance will be procured to supplement the services of the resident team. The LCU will be responsible for organizing training program in India and in the U.S.; assisting in the coordination, implementation, and analysis of the studies and pilot activities; monitoring the design and construction of irrigation schemes; and, assisting the GOM to establish the units introduced in the project description as vigorous and competent entities. GOI/GOM will be consulted for the activities described above.

Training and professional development will also be grant financed. In-country this includes procuring the services of instructors, and financing the purchase/lease of training aids and training sites. Out of country this includes international air fare, course tuition or fees, and a per diem allowance.

Two thirds of the eligible construction cost of each scheme will be loan financed by USAID with the remaining third financed by the Government of Maharashtra and in-kind contributions by farmers. Costs eligible for AID financing will include construction of headworks, control works, canals, distributaries, water courses, and field channels to carry the water to the farmgate. Also eligible are drainage works, roads, communication systems necessary for scheme construction and operation, civil works for resettlement of reservoir oustees, and other such physical works as may be required to ensure effective water storage and efficient conveyance of water to farm fields.

Except for some specialized imported equipment, such as water measuring devices, hydrological data gathering paraphernalia and various drip and sprinkler irrigation equipment, commodities will be loan financed.

In order to facilitate the early establishment of the institutional units and the early sanctioning of appropriate staff, staff assigned and working on the project in the SASC, the SAEC and the RMICs will be fully loan financed for the first three years of the project. Village extension workers and subject matter specialists will be fully loan financed for the first four years. Subsequently, the GOM will be fully responsible for all staff costs.

4. Project Outputs

The project will have both physical and non-physical outputs. The physical outputs will include 90 newly constructed irrigation schemes; 12 rehabilitated schemes, 1500 trained irrigation professionals; 1000 trained farmers; 6 completed studies; 12 completed diagnostic analyses; 30 completed pilot activities; 4 sets of baseline and follow-up surveys; and 52 hydrological stations.

The primary non-physical output will be the increased productivity of irrigation water. Contributing to the increased productivity will be well designed and constructed minor irrigation schemes; improved distribution, application, and utilization of water; improved communication and cooperation among irrigation and agricultural officials, agricultural universities, and farmers; improved information systems and capability to react to feedback; enhanced awareness of the factors contributing to inefficient use of water resources and an increased understanding of the technical, managerial, and sociological measures that can be taken to improve scheme performance; increased farmer participation in planning systems, determining how water is allocated, and maintaining watercourse channels; and increased understanding of water management principles among farmers.

Other project outputs include increased employment opportunities and higher incomes.

IV. Implementation Plan

A. GOI/GOM Implementation Arrangements

1. Planning and Budgeting

The Irrigation Department of the State of Maharashtra develops a five year plan for surface irrigation that is adjusted each budget year. The plan, which includes a minor irrigation component, is reviewed by the State Planning Department and concurred with by the GOI Planning Commission. Once GOI concurrence is received, the State Irrigation Department proceeds with detailed project development.

During the current five year plan (1980-85), the Irrigation Department is constructing 437 new minor irrigation schemes at a cost of Rs.2,622,000,000 (approximately $245 million). The Seventh Five Year Plan (1985-1990) calls for the construction of 843 new minor irrigation schemes at a cost of Rs.5,100,000,000 (approximately $476 million). Under this project approximately 90 minor irrigation schemes will be constructed at a cost of approximately $77.8 million. Of that total, A.I.D. will provide $42 million. The GOM Irrigation and Agriculture Departments will provide the remaining required funds which approximately total the equivalent of $35.8 million. In addition, the Agriculture Department will contribute $3.5 million for Part II works and ensure that these works are completed on project financed schemes.

The GOM will contribute $2.8 million and AID $4 million in loan funds for catchment treatment, hydrologic equipment and installations, and special staff. AID will provide $4 million in grant funds (see Financial Plan for details.)

2. Scheme Design and Appraisal

Scheme design will be the immediate responsibility of the executive engineer in the appropriate regional circle and will be completed only after extensive soil and topographical surveys have been prepared and discussions with farmers regarding channel layout have been held. Once a design has been completed and a scheme report prepared, an appraisal report will be prepared by the Special Appraisal and Supervision Cell. The appraisal report will be forwarded to the Minor Irrigation Committee which will review the report to ensure that the design is sound and that project criteria established in Volume II of this project paper have been met. Summaries of approved appraisal reports will be sent to USAID.

3. Scheme Implementation

The Irrigation Department will be responsible for construction of civil works down to the forty hectare block. Oversight of construction activities will be done by the supervising engineer and the executive engineer. A deputy engineer will be charged with implementing the construction activities. He will be assisted by five junior engineers. Contractors will be hired on a competitive basis to do the actual construction work. It is estimated that construction will be initiated on twenty schemes the first year of the project, forty schemes the second year of the project, and thirty schemes the third year of the project.

The Agricultural Department will be responsible for constructing all irrigation and drainage works from the forty hectare block to the farm gate (Part I works) and for individual on-farm development which includes land leveling and shaping (Part II works). A Sub-Divisional Soil Conservation Officer will supervise construction of the Part I and Part II works in each Sub-Division of a district. He will be assisted by five agriculture supervisors and 25 agriculture assistants. Actual construction work will be a accomplished by contractors hired on a competitive basis and farmers. An extension agent from the Agriculture Department will be assigned to each scheme, as appropriate, at least two years before the scheduled release of water to promote water user organizations and to familiarize farmers with irrigation technology.

4. Water Allocation and Management

On most canal irrigation systems, the distribution of water is permissive and offers enormous scope for improvement. Very often water is allowed to flow continuously without rotation. Headreachers then receive too much water and tailenders too little, if any at all. The essence of water allocation and management then is probably to be found in water distribution. General principles for allocating water amongst farmers are set forth in the Maharashtra Irrigation Act of 1976. These provide that irrigators desiring water service must make application in advance. The applications are approved on the basis of proposed crop mix and are subject to the availability of water. An even more ambitious scheme to get at the issue of water distribution is found in attempts to introduce water allocation systems which guarantee water in respect to a given volume to be supplied at a preestablished time. The rotational water system which minor irrigation systems financed under this project will follow is such a system. The process of introducing the rotational water system, including calculations of the rights of each farmer, the erection of a board at the outlet showing entitlements, and the installation at the outlet of a measuring device which farmers can monitor, will raise awareness and strengthen demands for water on the part of farmer groups; and this in turn is likely to encourage improved main system water distribution.

A program to accelerate groundwater use will be developed by the GOM.

5. Staffing Implications for GOM

Eight full time special units requiring the creation of 81 new positions will be established under this project to strengthen the minor irrigation program of the GOM. The Special Appraisal and Supervision Cell calls for eleven professionals, the Special Analysis and Evaluation Cell calls for sixteen professionals, and each of the six Regional Minor Irrigation Cells calls for nine professionals. The GOM actively participated in determining the staffing and responsibilities of these cells and fully concurs that they are necessary to the success of the project. The Agriculture Department will assign a village extension worker (VEW) to each A.I.D. financed scheme, as appropriate, and a Subject Matter Specialist (SMS) in Water Management to each district with an A.I.D. financed scheme.

The Irrigation Department organizes sub-divisions consisting of one deputy engineer, five junior engineers, clerks, and other staff for the construction of irrigation schemes. This project will require 327 sub-division years for construction and 23 sub-division years for planning and design to complete the project supported schemes. Ten new planning divisions and 101 new construction sub-divisions will be established.

The Agriculture Department organizes sub-divisions consisting of 1 sub-divisional soil conservation officer, 5 agricultural supervisors, and 25 agricultural assistants. The project will require about 41 sub-division years to complete Part I and Part II works assuming completion of 750 hectares per sub-division year. Thirteen new sub-divisions will be established. The Agriculture Department may, in some instances, contract with private firms to assist in the survey and/or construction process.

B. USAID Implementation Arrangements

1. Project Responsibilities

USAID/India has designated a Project Officer who will be responsible for the overall management and implementation of this project and the Maharashtra Irrigation Technology and Management project. He will ensure that activities under the two projects and the portion of the Irrigation Management and Training Project operating in Maharashtra are coordinated and, when possible, will maximize the resources under each project to benefit the others. He will be assisted by mission staff as required. The Project Committee with representatives of all relevant USAID offices, will assist, as appropriate, in implementing required USAID actions.

At the field level, a Liaison and Coordination Unit (LCU) will be created. This unit will be headed by an appropriate senior irrigation specialist. It will be responsible for consulting and working with the GOM in the implementation of all project activities at the field level. It will spend about half of its work time on technical assistance activities related to the various pilot investigations, studies, and training programs. The other half will be devoted to monitoring and assisting in the implementation of the planning, design, construction, operation, maintenance, and on-farm water and land management of the 90 AID supported irrigation schemes. The LCU will also assist the GOM, as required, in the implementation of the activities being carried out under the Maharashtra Irrigation Technology and Management Project. The unit will be required full time for the first three years of the project and one-third time during the last three years.

USAID will make the necessary grant funds available to the Water Management Synthesis 11 Project (WMSP) for the recruitment and support of the LCU. Requirements include 36 person months of resident expatriate assistance, 140 person months of long-term Indian assistance, and 39 person months of short term expatriate assistance (see Annex 2 for Scope of Work). For several reasons, USAID intends to tap WMSP to provide the technical assistance for all of its state specific irrigation projects.* First, USAID hopes to build a lasting relationship between the Indian irrigation establishment and the universities involved with WMSP. This relationship, which promises to benefit both parties, is still in an embryonic stage, and requires extensive and continuous contact in order to grow. Second, the use of one contractor eases what could prove to be a formidable coordination problem, given the size of USAID's irrigation portfolio. Under the WMSP scenario, consultants' time can be used more efficiently and can be more easily split between different projects. Plus the contractor can help USAID guard against collecting a group of individuals whose skills are redundant rather than complementary. Third, it is useful to have a core group of individuals become as familiar as possible with the irrigation sector in India, including its strengths, weakness, and key actors. This heightens their efficiency and increases the likelihood that the same lessons will not have to be learned over and over again. Finally, and probably most obviously, this saves the mission approximately 12 to 18 months in contracting lead time. With the WMSP, consultants can be brought out immediately to begin implementation and momentum gained during project design can be maintained.

2. Management of Irrigation Portfolio

By late FY 1984, USAID's Officer of Irrigation Management (IRR) will have under implementation, the Irrigation Management and Training Project and five state specific projects. To manage these projects and design future projects, IRR will have a staff of three U.S. direct hire, one Joint Career Corps appointee, two Indian direct

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*Technical and professional services for the Irrigation Management and Training Project will be acquired separately through the competitive procurement process.

hire, four full time Indian PSCs, and two part time Indian PSCs. Of the total planned staff of twelve professionals (one full time Indian PSC yet to be recruited), five will be project officers and seven will form a technical resource pool available to assist in the implementation and monitoring of all six projects. The Irrigation Management and Training Project will be managed by a U.S. direct hire with assistance from 3 individuals from the resource pool. Each of the state specific projects will be managed by an Indian employee. Training, special studies, and pilot activities are common to all the projects. To ensure maximum coordination, one FSN-PSC has been assigned responsibility for training under the Irrigation Management and Training Project and will coordinate those training activities with the training in the state specific projects. Similarly, an FSN-PSC has been assigned responsibility for action research and special studies under the Irrigation Management and Training project and will coordinate the similar activities under the state specific projects.

The Office of Irrigation Management has technical expertise in the areas of irrigation management, on-farm development, sociology, extension, training, irrigation engineering, and construction quality control. Expertise in economics, contracting, procurement, and voucher processing is available in other USAID offices.

C. Preliminary Calendar of Project Activities

1. Pre-Implementation Phase:

- Tentative selection of 90 possible minor irrigation schemes for support under the project and 12 existing minor irrigation schemes for basic data collection.
- Identification of individuals and creation of positions to serve on the MIC, SASC, SAEC AND RMICs.
- Create positions required by the Agriculture Department for topographical surveying and water distribution/drainage design units.
- Prepare project reports for first eight minor irrigation schemes.

2. Implementation Phase (if signing of Project Agreement is delayed project implementation schedule will slip accordingly.)

July 1984: GOI and USAID sign Project Agreement
WMS Project begins recruitment of liaison staff

August: USAID issues PIL No. 1
GOM identifies 12 on-going schemes, begins data collection

September:	SASC finalizes project reports for first ten MISs to serve as model General work plans are developed for the special studies, training activities, and pilots with TDY assistance
October:	Conditions Precedent to first disbursement met USAID and SASC review the first 10 model MISs and SASC finalize appraisal reports
November:	MIC approves first 10 MISs (10) SASC finalizes project reports for additional 10 MISs Liaison team leader arrives Initiate literature review on organizing farmers
December:	USAID and SASC review additional 10 MISs and SASC finalizes appraisal reports Begin development of detailed scope of work for each of the special studies, pilots and in-country training workshops Construction of first 10 MISs commences (10)
January 1985:	MIC approve additional 10 MISs (20) SASC finalizes project reports for another 10 MISs
February:	USAID and SASC review 10 MISs and SASC prepares appraisal summary reports Finalize scope of work for special studies Local training/workshop begins Construction on additional 10 MISs commences (20)
March:	MIC approves additional 10 MISs (30) SASC finalizes project reports for additional 10 MISs Begin design of pilot schemes
April:	USAID and SASC review 5 MISs and SASC prepares appraisal summary reports for additional 10 MISs AID commences detailed topographic surveys on 30 MISs and initiaties working with farmers to help them plan for water use and on-farm improvements VEW's posted to first 30 schemes (30) Construction on additional 10 MISs commences (30) Special studies commence

May: MIC approves additional 10 MISs (40)
SASC finalize project reports for next 10 MISs
Report on organizing irrigators complete

June: USAID and SASC review 2 MISs and SASC prepares appraisal summary reports for additional 10 MISs
Construction on additional 10 MISs commences (40)
Pilot project feasibility reports completed, reviewed and decision taken on the proposed pilot activities

July: MIC approves additional 10 MISs (50)
SASC finalizes project reports of next 10 MISs

August: Workshops on irrigator organization

Fall 1985: MIC approves appraisal reports on 20 MISs (70)
Construction commences on additional 20 MISs (60)
SASC completes project reports for next 20 MISs
First annual project implementation review
AD commences topographical surveys on next 30 MISs and initiates working with farmers to help them plan for water use
VEW's posted to next 30 schemes (60)

Winter 1985: SASC finalizes appraisal reports for last 20 MISs MIC approves last 20 MISs (90)

Summer 1986: Pilots on farmer participation in cropping pattern selection completed
Construction commences on final set of 30 MISs (90)
Distribution system planning completed on first 30 MISs (30)
GOM/AD commences topographical survey on last 30 MISs and initiates working with farmers to help them plan for water use and on-farm improvement
VEWs posted to last 30 schemes (90)

Fall 1986: Second annual project implementation review
Distribution system planning completed on next 30 MISs (60)

Spring 1987:	Results of special studies reviewed and incorporated into ongoing subproject designs Distribution system planning completed on last 30 MISs (90)
Fall 1987:	Third annual project implementation review first in-depth evaluation
Summer 1988:	Demonstration chaks started on first 20 MISs (20) Headworks, 75 percent distribution system completed (20)
Fall 1988:	First 30 MISs become operational (30) Outlet committees organized (20) Fourth annual project implementation review
Summer 1989:	Demonstration chaks started on next 40 MISs Headworks, 75 percent distribution system completed (60)
Fall 1989:	Next 40 MISs become operational (60) Outlet committees organized (60) Fifth annual project implementation review
Summer 1990:	Demonstration chaks started on last 30 MISs (90) Headworks, 75 percent distribution completed (90)
September 1990:	Final 30 MISs operational (90) Outlet committees organized (90)
Fall 1990:	EOP in-depth evaluation Liquidate final request for reimbursement
January 1991:	PACD

V. Cost Estimates and Financial Plan

A. Summary Cost Estimates

Total project costs are estimated at $92.6 million. The A.I.D. contribution includes $46 million in loan funds and $4 million in grant funds. The GOI/GOM will contribute the rupee equivalent of

$42.6 million. Project costs are summarized in Table 1. Projected GOM budget requirements and AID disbursements are shown by GOI and USG fiscal year in Table 2. Table 3 gives grant budget details by fiscal year.

1. Loan Budget

The construction of 90 minor irrigation schemes will require $77.8 million, of which AID will contribute $42 million and the GOI/GOM, the equivalent of $35.8 million. In addition, the GOI/GOM will budget the equivalent of $3.5 million for the construction of Part II works on farmer fields. Because the construction of Part II works is not initiated until other construction works are nearly complete, the GOI/GOM will not make final expenditure for Part II works until 1991, one year after the PACD. This final expenditure is expected to amount to the equivalent of $735,000.

In addition to construction, the AID loan will support catchment treatment pilots ($1.8 million), climatological and hydro-ogical equipment and its installation ($1.2 million), and GOM staff support ($1 million) for the special organizational units and other key staff inputs required under the project.

Contingency costs are incorporated in all loan financed items. Construction cost estimates have been increased for inflation at the rate of seven percent per year.

2. Grant Budget

Of the $4 million AID grant, $2.5 million will be for foreign exchange costs and $1.5 million for local currency costs. An estimated $750,000 of the foreign exchange is for the Liaison and Coordination Unit. An additional $845,000 of foreign exchange will be provided for pilot activities, special studies, and diagnostic analyses. The remaining foreign exchange will finance training estimated at $350,000, project evaluations estimated at $200,000, and commodities estimated at $215,000. Commodities include computer hardware and software, some hydrological equipment, and various drip nd sprinkler irrigation equipment.

Local currency costs consist of the rupee equivalent of $440,000 for demonstration chaks, diagnostic analyses, agricultural university contracts for the pilot activities, and special studies; $525,000 for in-country training; and $296,000 for the Liaison and Coordination Unit.

Grant contingency and inflation allowance for foreign exchange is $140,000 and for local currency, $239,000.

3. Explanation of Table 2

Table 2 provides estimates over the life of the project of GOM budgetary requirements and AID loan and grant disbursements. The data are separated into categories for the construction of 90 minor irrigation schemes, other loan financed activities, and grant funding.

Column (6) shows the total budgetary requirements by fiscal year for constructing the 90 minor irrigation schemes. Budgets will increase gradually to a peak in 1988 and 1989. Irrigation Department and Agriculture Department budgetary requirements are shown separately, including the Part II works which are not being financed under the AID loan. The Agriculture Department will budget $3.5 million for Part II works and assure that they are completed on each project financed scheme.

This estimate for Part II works assumes a unit cost of Rs.3,000/ha on about 40 percent of the total command area of 31,000 ha. Part II works are not started until the construction work is nearly complete and the availability of water is assured. For each tranche of schemes initiated -- 20 in year one, 40 in year two and 30 in year three, the initiation of Part II construction was lagged three years and assumed to be 20 percent completed in year three, 30 percent in year four, and 50 percent in year five. This will delay completion of the final tranche of Part II works into 1991, one year after the PACD. However, funds for 1991 Part II works are included in the totals in Table 1 and 2.

Normally, Part II works are financed by farmers with institutional credit. The bureaucratic and administrative difficulties in obtaining loans, plus the fact that a large proportion of farmers are expected to be ineligible for institutional credit, requires the adoption of different procedures by the GOM for financing Part II works. As in the case of the Maharashtra Irrigation Technology and Management Project, the funds will be budgeted and the work carried out by the GOM. Arrangements suitable to the GOM will be devised to recover these costs from farmers.

Column (7) gives AID loan disbursements for construction by fiscal year. Disbursements increase gradually to the fourth year and then level out at almost $10 million per year.

Column (8) is merely a residual (Column (6) minus Column (7)). The important column from the project point of view is Column (6), the GOM budgetary requirements.

The figures in Column (11) represent GOM costs for site preparation and buildings for the 52 hydrological stations to be established. Column (12) is the estimated AID cost for equipment for the 52 stations and for instrumentation on the minor schemes to be financed.

The fiscal year data in Column (13) do not include $40,000 required for VEW staff costs in 1991. However, the $40,000 is included in the total.

The fiscal year data in Columns (18) and (20) do not include GOM costs of $600,000 for Part II works, $360,000 for training and $40,000 each for VEWs and evaluations. These items are included in column totals.

Table 1: SUMMARY COST ESTIMATES

ITEM	A I D					G O M				GRAND TOTAL
	Loan	GRANT			Total	ID	AD	Part II Works	Total	
		FX	LC	Total						
1. Pilot Experiments and Demonstrations	1755	270	270	540	2295		745		745	3040
2. Studies and Diagnostic Analyses		575	170	745	745					745
3. Training		350	525	875	875	260	100		360	1235
4. Commodities	1200	215		215	1415	1160			1160	2575
5. GOM Special Staff Support						1110	890		2000	2000
6. Evaluation		200		200	200	20	20		40	240
7. Liaison and Coordination		750	296	1046	1046					1046
8. Construction										
MIS (Except Part II)	(43045)				(43045)	(29545)	(5210)		(34755)	(77800)
Part II Works								(3500)	(3500)	(3500)
Total Construction	43045				43045	29545	5210	3500	38255	81300
9. TOTAL	46000	2360	1261	3621	49621	32095	6965	3500	42560	92181
Inflation and Contingency		140	239	379	379					379
10. GRAND TOTAL	46000	2500	1500	4000	50000	32095	6965	3500	42560 1/	92560 1/

1/ Totals include $735,000 to be spent by the GOM in 1991.

Table 2: GOM BUDGETARY REQUIREMENTS BY GOI FISCAL YEAR AND AID DISBURSEMENTS BY U.S. FISCAL YEAR
(in Millions of Dollars)

Fiscal Year	MIS CONSTRUCTION							OTHER LOAN FINANCED								A.I.D. Grant Disburs.	GRAND TOTAL		
	ID Budget	AD Budget			Total GOM Budget	AID Loan Disburs.	GOM Share	Pilot Catchments		Hydrological Installation		Special Staff		TOTAL					
		MIS	Part II	Total				GOM	AID	GOM	AID	GOM	AID	GOM	AID		GOM	AID	TOTAL
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
1985	1.4	0.1	-	0.1	1.5	2.3	- 0.8	.10	.20	.40	.40	.22	-	.72	.60	1.25	-.08	4.15	4.07
1986	5.5	0.6	-	0.6	6.1	4.9	1.2	.14	.30	.50	.45	.32	-	.96	.75	.98	2.16	6.63	8.79
1987	13.3	1.9	0.2	2.1	15.4	5.8	9.6	.16	.40	.26	.35	.38	-	.80	.75	.61	10.40	7.16	17.56
1988	20.2	3.7	0.6	4.3	24.5	10.9	14.5	.14	.40	-	-	.38	-	.52	.40	.37	15.02	10.77	25.79
1989	18.3	3.9	1.1	5.0	23.3	10.0	13.1	.10	.30	-	-	.36	-	.46	.30	.37	13.56	10.67	24.43
1990	7.1	1.8	1.0	2.8	9.9	10.0	0.1	.10	.16	-	-	.30	-	.40	.16	.42	.50	10.58	10.88
TOTAL	65.8	12.0	3.5 1/	15.5 1/	81.3 1/	43.0	38.3 1/	.74	1.76	1.16 2/	1.20	2.00 3/	-	3.86	2.96	4.00	42.56 4/	50.00	92.56 4/

1/ Includes $600,000 for Part II works in 1991.

2/ Does not include $90,000/year for operations which will be absorbed by the GOM's on-going hydrologic data collection units.

3/ Includes $40,000 for VEW staff in 1991.

4/ Includes $600,000 for Part II works, $40,000 for VEW staff, $360,000 for training and $40,000 for evaluation.

Table 3: GRANT BUDGET DETAILS BY FISCAL YEAR
(in thousands of dollars)

	Total			FY 85			FY 86			FY 87			FY 88			FY 89			FY 90		
	FX	LC	Total	FX	LC	Total	FX	LC	Total	FX	LC	Total	FX	LC	Total	FX	LC	Total	FX	LC	Total
Pilot Experiments & Demonstrations	270	270	540	80	15	95	80	20	100	50	5	55	20	60	80	20	80	100	20	90	110
Studies and Analyses	575	170	745	290	75	365	180	5	185	35	5	40	35	30	65	35	20	55		35	35
Training	350	525	875	225	200	425	200	200	300	75	50	75		50	50		25	25			
Equipment																					
computers	135		135	135		135															
imports for MIS	50		50	50		50															
imports - state	30		30	30		30															
Sub-Total	(215)		(215)	(215)		(215)															
Liaison and Coordination	750	295	1046	150	45	250	200	50	250	200	50	250	67	50	117	67	50	117	66	50	116
Evaluations	200		200							100		100							100		100
Total	2360	1260	3626	860	536	1250	660	275	935	460	100	560	122	190	312	122	175	297	186	175	359
Inflation Factor				1.00	1.00		1.04	1.07		1.08	1.14		1.12	1.22		1.17	1.31		1.22	1.40	
T O T A L	2500	1500	4000	860	336	1250	686	294	980	497	114	611	137	232	369	143	229	372	227	245	472

B. Disbursement Procedures

1. Loan Funds for Minor Irrigation Scheme Construction

Traditionally, AID has used the fixed amount reimbursement mechanism or some modification thereof to disburse against completed construction targets in irrigation projects. If the primary objective of a project is to construct irrigation schemes this mechanism makes sense. The central objective of this project, however, is not construction but institutional development and improved irrigation performance below the outlet. Consequently, a performance-based disbursement mechanism that reflects the objectives and provides incentives for achievement of the objectives is proposed.

For each minor irrigation scheme, agreement will be reached between the GOM and USAID during the appraisal/approval process regarding costs allowable for (1) land acquisition, (2) headworks (3) irrigation distribution and drainage system up to the 40 hectare outlet, (4) Part I or community works (field channels, control structures, surface drainage network within the outlet command, and graded bunds for diverting excess runoff from within the outlet command to the natural/main drainage system), and (5) resettlement. These costs will be based on competitive bidding experience in Maharashtra and/or Irrigation Department scheduled rates. AID will reimburse at 67 percent of eligible costs. (Eligible costs do not include land acquisition costs and identifiable taxes.) It is expected that AID's portion of total scheme costs will run between 50 and 55 percent.

AID will reimburse its portion of the eligible costs for each of the approximately 90 irrigation schemes against the accomplishment of four pre-established performance benchmarks. The first benchmark is to improve the planning of irrigation schemes. Upon completion of the plan for an individual scheme, appraisal by the Special Appraisal and Supervision Cell, approval by the Minor Irrigation Committee, and acceptance by USAID, fifteen percent of the AID portion of eligible scheme costs will be disbursed.

Benchmark two addresses the issue of faulty construction of the irrigation distribution system due to inadequate design and the issue of farmer participation in channel layout. Specific and detailed criteria for the design of the distribution system have been agreed upon (see Annex 1). Upon completion of the planning of the distribution system and the Part I works for the entire command area according to the specified criteria and upon acceptance by the farmers of the distribution layout below the outlet, fifteen percent of the AID portion of eligible scheme costs will be disbursed.

The third benchmark will seek to correct the frequently encountered problem of headworks being completed but no, or very little of the distribution system being completed to get stored water to farmers. Upon completion of the irrigation and drainage system for 75 percent of the command area, completion of Part I works for at least 30 percent of the command area in composite blocks, completion of land acquisition for the distribution system, and completion of the headworks, 45 percent of the AID portion of eligible scheme costs will be disbursed.

The final benchmark is speedy completion of the entire scheme and the establishment of outlet committees to assure that the scheme is effectively utilized. Up to this point, the GOM will have been reimbursed 75 percent but will have incurred about 80 to 85 percent of scheme costs. This final disbursement is intended as an incentive for rapid completion of the schemes so that GOM can receive full reimbursement. Upon completion of the remaining 25 percent of the irrigation and drainage system, the remaining 70 percent of Part I works, the resettlement of any displaced land owners, and the organization of outlet committees in at least half of the command area, AID will disburse the final 25 percent of its portion of scheme costs.

Following is a summary of the proposed reimbursement procedure:

Benchmark	Percentage AID Contribution to be Disbursed	Verifiable Indicator
(1) Scheme planned by Regional Circle, appraised by Special Appraisal and Supervision Cell and approved by Minor Irrigation Committee	15	USAID participation in appraisal process on a selected basis USAID review of appraisal reports approved by MIC
(2) Design completed for distribution system and Part I works Farmers participate in determining layout of channels below the outlet	15	Detailed maps of command area and proposed distribution system Topographical and soil survey reports Document signed by village leader certifying farmer participation in process and acceptance of final plan

Benchmark	Percentage AID Contribution to be Disbursed	Verifiable Indicator
(3) Completion of headworks, 75 percent completion of irrigation and drainage system of the command area, 30 percent completion of Part I works of the command area, completion of land acquisition for distribution system	45	GOM Reports Random USAID spot checks
(4) Completion of remaining 25 percent of irrigation and drainage system, remaining 70 percent of Part I works, resettlement of displaced land owners and organization of outlet committees in at least half of command area	25	GOM Reports Random USAID spot checks

2. Staff Support

Implementation of the project according to agreed design and implementation criteria will require the GOM to create additional organizational units in the Irrigation Department and will require more intensive staffing of both the Irrigation and Agriculture Department than is normally the case.

For the Irrigation Department, the project proposes the creation of three new types of organization units -- the Special Appraisal and Supervision Cell, the Special Analysis and Evaluation Cell, and the six Regional Minor Irrigation Cells. It is critical to have all eight units in an operational capacity as soon as possible. The GOM would be fully responsible for these staff costs.

For the Agriculture Department, there are two staffing requirements that are essential to project success. One is the recruitment, training, and posting of Village Extension Workers (VEWs) in the command area of the schemes. The VEW will have an important role in transfering irrigation technology to farmers and in assisting with the organization of outlet committees.

The other important staffing action by the Agriculture Department is the recruitment, training at WALMI in water management, and posting of Subject Matter Specialists (SMSs) for water management in each District having project financed schemes. SMSs will provide training and technical backstopping to VEWs and other extension workers in the field. The expected cash flows are estimated below.

Table 4: Estimated Cash Flow ($000)

Units	Years							Total
	1	2	3	4	5	6	7	
RMICs	100	115	115	115	110	85	-	640
SAEC	45	55	55	55	50	40	-	300
SASC	25	30	30	30	30	25	-	170
Total ID	170	200	200	200	190	150	-	1,110
VEWs	25	25	25	25	25	-	-	125
	-	45	45	45	45	45	-	225
	-	-	35	35	35	35	35	175
SMSs	30	50	70	70	70	70	-	360
Total AD	55	120	175	175	175	150	35	885
Grand Total	225	320	375	375	365	300	35	1,995

3. Grant Funds

AID grant funds will be used for direct financing by AID for the foreign exchange costs and local currency costs of the Liaison and Coordination Unit, off-shore training, and expatriate short-term technical assistance. AID will also directly finance the special imported equipment.

In addition, AID grant funds will be used to finance the local currency costs of pilot activities, studies and analyses, and training. USAID will transfer at periodic intervals, the dollar equivalent of these costs into the New York account of the Reserve Bank of India, and will advise the Department of Economic Affairs (DEA) when this has been done. DEA will then arrange to have the rupee equivalent amount credited to the GOM current general budget.

An advance of one fourth the expected grant expenditures during any given year will be provided by USAID. The GOM will submit quarterly abstracts of expenditures, which will liquidate the advance and provide the basis for an advance of the next quarter's projected grant expenditures. Vouchers supporting the abstracts will be available in respective divisional GOM offices for verification if necessary.

Table 5: Disbursement Procedures*
($000)

Project Activity	Disbursement Method	A.I.D. Amount Loan	Grant
1. Construction	Reimbursement against performance benchmarks	43,000	
2. Catchment Treatment Pilots	Direct payment to GOI (3 month advances)	1,800	
3. Hydrological Equipment	Direct payment to supplier	1,200	
4. Technical Assistance	Direct payment to supplier		1,050
5. Pilot Activities, Special Studies Diagnostic Analyses	Direct payment to GOI (3 month advances)		1,285
6. Training	Direct reimbursement to GOI/Direct payment to supplier		875
7. Commodities	Direct payment to supplier		215
8. Evaluation	Direct payment to supplier		200
9. Inflation and Contingencies			375
	Total	46,000	4,000

*Prepared per the requirements of the Payment Verification Policy Statement.

VI. SUMMARIES OF ANALYSES

A. Technical Analysis

1. Agro-Climatic Conditions and the Implications for Irrigation

The Irrigation Department of Maharashtra recognizes six agroclimatic zones in the state. They are the coastal zone, the transition zone, the scarcity zone, the assured rainfall zone, the moderate rainfall zone, and the high rainfall zone.

a. Coastal Zone

The coastal zone, also known as the Konkan region, is a narrow stretch of land between the west coast and the crest of the Sahyadri Mountain Range. The region enjoys year round warm temperatures and an average annual rainfall of about 2,500 mm. Unfortunately, 94 percent of the annual rainfall occurs during the southwest monsoon season from June through September, and most of the rivers are almost dry several months later.

The ultimate irrigation potential of the region is 469,000 hectares or 55 percent of the total cultivated area. As of 1980, only 35,000 hectares of that potential had been created. The construction of storage tanks in the Konkan is much more expensive on a per unit of water stored basis than in other parts of the state. This is because the valleys of the region are narrow with steep slopes, and the height of dams must be higher than average. The soils have limited water holding capacity and drain rapidly. This, taken with the steeply sloping lands, means that a short, 5-7 day rotation period is required for lands under irrigation and that land shaping and leveling is critical.

The predominate crop is paddy, which is primarily rainfed. Low quality cereals such as jowar and millet are also grown. Irrigation would extend the growing season and increase the cultivation of fruits and vegetables.

b. Transition Zone

The transition zone is made up of three subzones: the high ridge line of the Sahyadri Mountain Range with high elevations, low maximum and minimum temperatures, and as much as 5000 mm of rainfall per year in some places; a narrow strip of land east of the ridge with lower elevations and an average annual rainfall of 1750 mm; and a wider strip of land with low elevation, high temperatures and an average annual rainfall of 700 mm of rainfall. In the ridge area, the soils are shallow, located on slopes, and capable of sustaining only inferior types of hill millets. In the adjoining strip of land on the eastern side, the conditions are suitable for paddy. It is the final strip of land where rainfall is low but soils fertile that holds the greatest potential for irrigation development. Currently, paddy, bajri, jowar and groundnut are the primary crops, but with irrigation, cash crops, such as cotton and sugar cane, could be promoted.

The transition zone has a total cropped area of 3.086 million hectares. An estimated 1.41 million hectares are irrigable. As of 1980, approximately 354,000 hectares of that potential had been created through surface irrigation schemes.

c. Scarcity Zone

The scarcity zone is in central Maharashtra where the rainfall ranges from 500 mm to 750 mm annually, the topography is comparatively flat, and the soils have a low water retentive capacity. Due to the agro-climatic conditions and the absence of an assured water supply, 65 percent of the cropped area is sown in drought-resistant, coarse grains. With irrigation development, the current cropping intensity of 111 percent could be increased to 140 percent and the gross cropped area could be increased from 5 million hectares to 6.28 million hectares. Maximum potential for irrigation development is estimated at 1.93 million hectares. Because of the flat topography, the primary constraint to developing the irrigation potential is identifying sites for storage tank construction.

d. Assured Rainfall Zone

The assured rainfall zone is to the immediate east of the scarcity zone. Rainfall ranges from 700-900 mm annually and as in the rest of the state, occurs primarily during the southwest monsoon season from June through September. The predominant soil type is black cotton soil with varying depths. Shallow soils with low water retention capacity are found on the high topographical areas, medium soils that are water retentive with good drainage are found in the intermediate areas and deep, finely textured soils are found in the low lying areas. The deep soils slow the transmission of soil moisture and being on flat topography suffer from improper drainage. With low rainfall, deep soils risk salinity and alkalinity whereas with assured rainfall waterlogging can be a problem. On the whole, conditions in the region are favorable to irrigation development provided proper soil conservation practices are adhered to. For this zone, the maximum irrigation potential is estimated to be 2.24 million hectares of the 6.91 million hectares of gross cropped area. By 1980, 401,000 hectares of irrigation potential had been created through surface irrigation schemes.

e. Moderate Rainfall Zone

The moderate rainfall zone in eastern Maharashtra receives between 900 and 1200 mm of rainfall annually. The soils are similar to those in the scarcity and assured rainfall zones. Also similar to the scarcity and assured rainfall zone is the flat topography and, hence, the problem of identifying suitable sites for storage tank construction. Under rainfed conditions, coarse grains and cotton are cultivated. Under irrigated conditions, paddy, wheat, fruits and vegetables become the principle crops. The maximum potential of surface and groundwater development is estimated at 1.499 million hectares against a cropped area of 2.71 million hectares. In 1980, the created surface potential stood at a little less than 228,000 hectares.

f. High Rainfall Zone

The high rainfall zone in eastern Maharashtra receives between 1250 and 1700 mm of rainfall annually, with 90 percent of the rainfall accurrring from June to September. The soils of the region are fertile and highly responsive to irrigation development. The main crop of the zone is paddy. The irrigation potential is 1.279 million hectares, which is equal to the total cropped area. The potential for surface water is assessed to be 1.022 million hectares. By 1980, the created surface irrigation potential was 189,500 hectares.

2. Minor Irrigation in Maharashtra

Minor irrigation schemes are those with a cultivable command area of less than 2000 hectares. The Maharashtra Irrigation Department recognizes seven classes of minor works: tanks; bandharas or direct flow diversion; tank and bandhara rehabilitation; land drainage; tubewells; lift irrigation schemes; and dugwells. This project will be concerned with the construction and rehabilitation of tank schemes. In addition, policies and practices that enhance the conjunctive use of surface and groundwater will be explored.

a. Tank Schemes

The minor irrigation tank is a small reservoir impounded by an earthen dam constructed across a small non-perennial waterway. An overflow spillway is constructed at one side of the dam to relieve flood flows. Water is released through a headregulator in the dam to an unlined canal distribution system branching away from the dam. The tanks can also be used as percolation structures to recharge the aquifer and improve the yields of nearby wells. In 1980, Maharashtra had 1091 irrigation department tanks in operation and 437 under construction. An additional 2000 sites had been identified for future construction.

The irrigation department employs qualified engineers and has many years of successful experience in the design and construction of dams and spillways. Until recently the state responsibility for construction ended with the provision of an outlet capable of providing 30-45 litres of water/second at the 40 hectare level (25-30 farmers). The GOM now provides funding to extend the channel down to the farm holding or to the two hectare level, whichever is larger.

b. Conjunctive Use

Groundwater is an important but vastly underutilized resource in Maharashtra. The Groundwater Survey and Development Agency estimates that 939,000 dug wells are annually supplying 7,471 MM^3 of water from a potential supply of 34,996 MM^3. Assuming average withdrawal rates, new well development potential is ap oximately 1.8 million wells. Groundwater is a readily availabl.. resource in those areas served by an irrigation tank. Aquifer recharging occurs as a result of conveyance seepage, deep percolation from tanks, and increased infiltration of water because of land development and sustained runoff conservation. Groundwater is not controlled by the irrigation department and consequently, affords the irrigator the flexibility to alter crop mix to meet market demands.

3. Agricultural Practices

a. Water Delivery

Water delivery is on a rotation basis called the Shejpali system. On or about October 1 of each year, the irrigation department assesses water availability and, based on that availability, sanctions the applications of farmers who apply for water for approved crops. Under the Shejpali system, turns are allocated among the irrigators beginning with those most distant from the tank. The system is extremely flexible because the time during which irrigators may take the water is not limited.

To overcome the problems with Shejpali, the Irrigation Department has devised an alternative system known as rotational water supply (RWS). The RWS is a rigid, time bound system whereas Shejpali, while basically incorporating the principle of RWS, keeps the scheduling in a rotation flexible. The RWS is not in general use in Maharashtra.

b. Cropping Patterns

The agricultural year in Maharashtra is divided into three cropping seasons, each from 120-123 days in length. The three seasons are kharif (mid-June to mid October), rabi (mid-October to mid-February), and hot weather (mid-February to mid June). Crops may be seasonal, i.e., sown and matured over a single season, like sorghum, pulses, and oilseeds; may require two seasons extending through all or part of kharif and rabi like chillies and some cotton; or perennial like sugar cane and some horticulture crops.

Traditional cropping patterns have evolved in such a way as to minimize risk and provide a self-sufficient, non-market oriented approach to farming. Where an assured water supply is not available, crops that are drought resistant and of relatively low economic value dominate the croplands. Irrigated cropping patterns vary from year to year depending on water supply. Government policy distributes water supply in such a way as to maximize the number of farmers receiving irrigation. Policy would have the farmers apply their water in such a way as to maximize crop output per unit of water applied and concentrate on food grains. Evidence indicates, however, that individual farmers are inclined to distribute their allotted water in such a way as to maximize returns from a system that includes food grains but also cash crops when possible.

c. Fertilizer and Pesticide Applications

It is generally recommended that animal manures be used to maintain soil fertility. However, the use of manures as fertilizer must compete with the use of manures as a household fuel. Consequently, major reliance must be placed on chemical fertilizers for soil fertility.

Maharashtra soils are lacking in nitrogen and phosphorous and occassionally, in zinc, boron and iron. Potassium content, on the other hand, is generally high. Research and extension agencies strongly recommend the use of complete or balanced nitrogen-phosphorous-potassium fertilizers. This practice is questionable because of the high soil reserves of potassium and because the residuary effect of phosphorous makes application necessary only every second or third year after the first application. The main concern in soil fertility for irrigated agriculture is the interaction between nitrogen and soil moisture. Too little nitrogen will sharply restrict soil moisture use efficiency whereas too much soil moisture will reduce nitrogen effectiveness.

Pesticides are used primarily on improved varieties and on cash crops such as cotton, sugar cane, and wheat.

d. On-Farm Development

Most agricultural lands have been developed to utilize the monsoon rainfall. Fields have been bunded and shaped to collect and distribute the rainfall as evenly as possible. To optimize the benefits of irrigation, fields need to be leveled and shaped.

4. Design Standards for A.I.D.-Financed Schemes

a. Water Supply:

The hydrology of the A.I.D. financed irrigation schemes will be planned in accord with the 1983 "Manual of Minor Irrigation Works in Maharashtra State" unless modified for selected pilot schemes. Reservoirs will be designed on the basis of 50 percent reliability unless modified by the special study to be undertaken on this subject.

b. Water Budget Analysis:

Currently, there are not enough stream gauges installed in the watersheds and potential yield (inflow) from the watersheds is being estimated using an empirical formula linking yield with precipitation and taking into consideration the topographical and vegetative characteristics of the watersheds. The accuracy of water supply estimates for future schemes will improve with the hydrological data bases set up under the project. A monthly or rotation water budget analysis will be made to determine the acreage to be commanded, canal and distributary capacities, and delivery rotation. Crop water requirements will be calculated according to the cropping patterns developed by the Agricultural Department and the climatological data from the area or nearby area using the modified Penman method.

c. Dams and Tanks:

The Maharashtra Irrigation Department has many years of successful design of tanks, dams, and spillways. Consequently, little assistance is required in this area. One area that requires study however, is the calculation of silt carried by the stream into the tank and the implications of silt load on the design of a tank. Designs would be according to existing standards unless modified by studies on silt load and associated design criteria. Evaporation losses from the reservoir will be estimated as for crop water requirements.

d. Distribution and Conveyance Network:

Conveyance design and layout will start with field channels and water courses and move toward the canal and dam. Only sandy or murrum substrata areas will be lined. Hydraulic conductivity tests will be made along canal alignments to identify potentially high loss areas.

e. Surveying and Mapping:

Detailed soil and topographic surveys will be completed prior to the design of each system.

f. Land Development:

Land leveling/grading will take place on a uniform field slope that minimizes the depth of soil disturbed.

g. Groundwater Development:

The state will evolve a suitable methodology for exploiting groundwater available in the command area and integrating it with the system of surface irrigation.

h. Water Allocation and Rotation

Water on all AID-financed schemes will be allocated under a rotational water system. Under the RWS the guarantee is in respect to a given volume of water to be supplied at a pre-established time. The farmer will be charged for water according to the crop area per present system of assessment approved by the GOM. The farmer can irrigate as much land as he chooses with crops having similar water requirements with his water/time allocation. If does not irrigate his farms within the specified time, his turn is missed until the next rotation.

i. Operation and Maintenance

The Irrigation Department will be responsible for O&M up to the outlet in the early years of a project. Field channels will be maintained by farmers. The Irrigation and Agriculture Department will organize farmers in outlet committees to eventually take over responsibility for O&M.

B. Social Soundness Analysis

1. Socio-Economic Setting

a. The People

Maharashtra is India's most industrialized and urbanized state. One-third of its population of 62.8 million lives in urban areas, with most of the industrial development concentrated in metropolitan Bombay and Pune. Two-thirds of the state's labor force remains in agriculture.

The distribution of population in the state is quite uneven. It ranks ninth among Indian states in terms of population density. Its average rate of 204 persons per square kilometer is roughly comparable to the national average of 221. Yet the range in density is enormous. There is an average of 13,644 persons per square kilometer in Bombay, which includes Asia's most populous slum, Dharavi, where 40,000 persons are squeezed into a few square kilometers. In some rural tracts, however, the landscape is desolate. The eastern district of Chandrapur, for example, contains only 79 persons per square kilometer.

Before 1971, Maharashtra's population growth rate exceeded the national average, but the latest census suggests the growth trend may have abated. The rate of increase between 1971 and 1981 was only 24.6 percent, which was precisely the same as the national figure.

Seven per cent of the state's population belong to the statutorily-designated "scheduled castes", representing traditionally disadvantaged socio-economic groups. They are dispersed throughout the state, but 68 per cent live in rural areas. Another 9 per cent of the population belongs to scheduled tribes, who are largely concentrated in the hill tracts of northwestern Maharashtra. The tribal peoples generally practice subsistence-level agriculture. They are among the poorest groups in Maharashtra.

b. Regional Variations and Development Strategy

The differences among the state's agroclimatic regions are reflected in the contrasting settlement patterns. Abundant rainfall in the coastal and eastern districts has promoted paddy cultivation and a patchwork of microscopic farms. The average farm size in the coastal region is 2.6 hectares, while the average number of persons per cultivated hectare is 4.86. In areas traditionally considered handicapped due to lack of rainfall, population density tends to be closer to the state average of 1.8 persons per cultivated hectare, and farm sizes are larger than the state average of 4.3 hec- tares.

Since 46 per cent of Maharashtra's five million farms are below two hectares, the small owner-cultivator is an important figure in the state's agriculture. The state government has endeavored to reach this population through the provision of irrigation, so that the scarce water resource is not monopolized by large farmers with greater financial resources.

c. Employment and Migration Patterns

For decades, the only escape from rural desolation seemed to lie in migration to Bombay. It has attracted millions of job seekers from every corner of India, and displaced Calcutta as India's industrial giant.

There has been a long-established trend of migration from some parts of Maharastra where agriculture has remained particularly stagnant. Emigration has starved the countryside of its most productive labor force and thereby perpetuated its underdevelopment. It has also accelerated the proliferation of slums in Bombay, where the population soared by 44 per cent between 1961 and 1971.

The migrants are overwhelmingly male. In 1971, Bombay's population included about 3,478,000 men as compared to 2,500,000 women. Thus, while the agricultural areas can with irrigation development offer promising scope for agricultural development, particularly in important cash crops, the labor needed for such enterprises is conspicuously absent. In order to increase on-farm employment opportunities, and thus keep its male population on the land, the government has attached high priority to the provision of irrigation.

In other unirrigated parts of Maharashtra, where there is no established tradition of urban migration, a vast pool of surplus labor is dependent upon an agricultural sector characterized by low yields and slow growth. A series of devastating droughts during the early 1970s caused massive unemployment and hardship for this population.

In 1974, Maharashtra took the bold and pioneering step of promising work to the rural poor through a state-level program, the Employment Guarantee Scheme (EGS). The EGS aimed to provide employment in rural areas to all able-bodied adults who sought it. Legislation requires the state to provide jobs on demand to a group of at least 50 persons and the work must be carried out within 8 kilometers of the employment seekers' location. By 1977, EGS was estimated to have created full employment for up to 390,000 unskilled laborers. The EGS offers a rare example of an equal opportunity employer, for perhaps 65 per cent of its workers are women. Further, male and female EGS employees are paid equal wages for equal work. Statistics indicate that a considerable number of the workers belong to scheduled castes and tribes.

d. Landholding Structure and Tenancy

After independence, in a wave of land reforms ordered throughout India, Maharahstra's large estates were abolished, as were all intermediaries between the cultivator and landowner. In addition, laws were framed to give tenants security of tenure. However, tenancy is not characteristic of Maharashtra's agriculture, since 92 per cent of holdings are fully owned, 5 per cent partly owned and partly rented and 3 per cent wholly rented.

2. Socio-Cultural Feasibility

Minor irrigation has a long history in Maharashtra. For centuries, farmers in the northwest have operated an equitable system which distributes water from weirs. Tanks have dotted the landscapes of eastern Maharashtra's Bandhara and Chandrapur districts for at least 400 years, and they are familiar in the Vidarbha region also. Elsewhere in the state, farmers may be unaccustomed to irrigation and it may take time for them to adjust their cropping practices and organize equitable water distribution systems.

While cultivators invariably opt for private irrigation systems wherever possible in order to maximize control over the timing and delivery of water, rotational water distribution systems represent a major technical advance for application in Maharashtra. The field-to-field flood irrigation which is widely practiced does not permit the use of advanced agricultural technology. Since farmers cannot control the amount or timing of water received, the element of risk is very high. Rotational systems seek to provide a measure of predictability to water distribution, so that farmers can plan their crop patterns and invest in inputs whose efficient use requires irrigation water.

Even where farmers recognize the advantages of rotational distribution, it may prove difficult to adopt. Several prerequisites seem essential for its successful use: a scarce water situation, farmers cooperation, effective and fair administration by irrigation department officials, and favorable technical factors, such as distributary, field channel and land development, and a main system that can deliver the water.

3. Benefit Incidence

a. Impact on Incomes and Nutrition

The per hectare net income for the developed region in the late 1970s averaged Rs. 2399, as against Rs. 449.70 in the less irrigated and therefore underdeveloped region. The average annual income in the developed region (Rs. 11,600) was about one and a half times more than that of the underdeveloped region (Rs. 6900). Employment opportunities for agricultural laborers were also greater in the developed region, and the laborers' incomes were 1.4 times higher than in the underdeveloped one.

Irrigation development should also result in nutritional improvement in the project areas. Studies have shown clear associations between consumption patterns and income. In Maharashtra, increased income leads rural households to switch from coarse grains such as sorghum to wheat, and to decrease the overall proportion of cereals in their diets.

b. Spread Effects

In areas parched for centuries, the introduction of irrigation and irrigated agriculture may be watched somewhat cautiously by farmers not served by a given project. It may take time before non-beneficiary farmers demand their own project, but if the irrigated scheme has the desired impact, it is likely that others will want to follow. This process is illustrated by the construction of percolation tanks, which have been in great demand by local leaders and their constituents. Innovations are also spread widely through patterns of labor migration and marketing.

c. Employment Effects

Irrigation officials estimated that the implementation of 90 proposed minor irrigation projects commanding 31,000 ha would increase on-farm employment by up to 1.3 million person/days per year. It further estimated that project construction would create jobs totalling 52 million person/days over a six year period. Some minor projects are constructed under the Employment Guarantee Scheme, which requires that 60 per cent of expenditure be on unskilled labor.

The Irrigation Department projects a sizeable increase in the need for agricultural labor due to yield increases, crop pattern changes and the expansion of area under cultivation. A few statistics offer supporting evidence. For example, the main product of sorghum amounts to 1.4 tons per hectare under rainfed conditions, but the projected yield under irrigation is 3.5 tons per hectare. While the former requires 80 person days of labor per hectare, irrigated sorghum needs 110 person days. Wheat yields were expected to register a five-fold increase with irrigation, from .50 tons per hectare to 2.5, while the labor requirement would double, from 55 person/days to 110. Vegetable yields could increase from 12 tons per hectare to 20 tons, while the labor requirement would jump from 199 person days to 332. These figures do not take into account corresponding increases in labor involved in marketing and processing.

d. Effects on Women

The conventional notion of an Indian farmer centers on the man behind the plough,', a sturdy figure clad in a dust-colored loincloth. Yet in many parts of India, and particularly Maharashtra, the farmer wears a sari.

Statistics clearly show the pivotal role which Indian women play in agriculture. They sow the seeds, weed the fledgling plants and reap the harvest. In Maharashtra, there are 85 female landless laborers for every 100 males, compared with the national figure of 50 laborers per 100 males.

There are often wide disparities between the wages paid to men and women. This is true in agriculture, where custom often dictates the sexual division of labor and assigns different values to various agricultural operations. Ploughing is generally a male preserve, as are transportation by bullock carts and large scale marketing. As a result, these tasks are considered more prestigious than those associated with women, such as weeding. According to a national survey conducted in 1974/75, male agricultural laborers were paid Rs. 3.72 per day for sowing while women were paid Rs. 2.60. Women were paid Rs. 2.35 for ploughing while men received Rs. 1.00 more. Weeding paid Rs. 3.11 for men and Rs. 1.95 for women. Part of the problem may be that a work day is defined as a seven to nine hour shift, whereas many women must use a portion of that time in household pursuits. A large proportion of her wages may be deducted as a result.

The construction of a minor irrigation project represents important employment opportunities for women in a given community. A second benefit which becomes available immediately is water which may be used for domestic purposes. This can have a great impact on women's energy levels and the household's levels of sanitation and nutrition. This project will support one pilot activity whereby women become the primary target of the extension agent's attention to demonstrate the impact of increasing women's familiarity with water management principles.

C. Administrative Analysis

1. Administrative Set-up

a. 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 schemes.

The Irrigation Secretary is responsible for minor irrigation schemes and is assisted by a Chief Engineer with supporting staff at Mantralaya. The minor irrigation sector at the operational level is the responsibility of the six Regional Chief Engineers whose headquarters are at Bombay, Nasik, Pune, Aurangabad, Amravati, and Nagpur. The Regional Chief Engineers are responsible for the surveys, planning, design, implementation, monitoring, operation and maintenauce of minor irrigation schemes along with major and medium irrigation schemes under their charge. The surveying, planning, design, implementation, operation and maintainance are actually done at the divisional level by the executive engineer and his staff. Between the regional chief engineers and the executive engineers are superintending engineers. Under the executive engineers are deputy engineers and junior engineers.

The GOM/ID staff includes about 9000 engineers, 3000 of whom are graduate or post graduate engineers. The staff is highly competent in reinforced concrete and masonry design, hydraulics, hydrology, geology, and soil mechanics. Additional training in systems operation and water management is needed.

b. Soil Conservation Division, Agriculture Department

The responsibility for carrying out the Part I and Part II works rests with the Department of Agriculture, Soil Conservation Section (AD/SC). The AD/SC responsibility under this project includes all improvements from the ending point of the ID responsibility at the 40 hectare block to the individual farms in the command area, including improvement on the individual farmers' fields.

The AD/SC has 40 Soil Conservation Divisions and 200 Subdivisions under the supervision of the Deputy Director of Agriculture (DDA) for carrying out land development works. Of these, 8 Divisions and 40 Subdivisions are working on land development for minor and medium projects and soil conservation.

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 field technicians lack essential engineering technical background.

c. 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 groundwater 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 overexploitation is through credit control with GSDA certifying availability of groundwater in connection with loan applications.

2. Assessment of the Irrigation Establishment

The Irrigation Department is the lead agency in the construction of minor irrigation schemes, with an important supporting role played by the Agriculture Department. Other technical inputs are made by the Groundwater Survey and Development Agency, central government research and planning groups, and state university research and teaching institutions. Existing standards of practice have been gauged against five general criteria:

-- Is there a fundamental technical understanding of the irrigation system? Are the catchment, storage, distribution, application, drainage, and groundwater components each considered as a collective and integrated part of a whole hydrologic system?

-- Is there an appreciation of engineering interaction with agronomic, economic, social, and institutional factors necessary to make irrigated agriculture function profitably?

-- Is there a central strategy outlined for the processes of project conceptualization, planning, design, construction, operation, maintenance and rehabilitation which can be practiced?

-- Is there interaction among the research, executive, management, and user communities?

-- Is there a monitoring and evaluation process in place that is utilized for not only updating irrigation practices from conceptualization through implementation but also for manpower planning and inservice training?

Technically, the concepts of irrigated agriculture in the Maharashtra setting are well understood. The problems encountered in the field are discussed, a willingness to explore various solutions exists, and experiences outside of the state government agencies are studied. However, as is generally the case around the world, the technical personnel are primarily concerned with specific components of the irrigation system. In this instance, the components receiving the most attention are the tanks, dams, and the distributary canals. The attention accorded these components is evident in the high quality construction throughout the state. Water courses, field channels, and drainage structures and their relationship to the rest of the system receive less attention and the subtle interactions within a system are not always understood. Nevertheless, on the whole, the first criterion is met.

The technical expertise in Maharashtra is more stratified than is optimal. Institutions are not always cognizant of the capabilities and activities of other insitutions, although some efforts are being made to coordinate activities, exchange data, and plan collectively. A greater interdisciplinary effort will be necessary to realize more fully the benefits of irrigated agriculture.

Regarding the third criterion, central strategies are developed and standard procedures that support those strategies are published in widely distributed manuals.

Interaction among various concerned parties, criterion number four, is often a problem. Communication is largely from the top down, and gaps exist between the research and implementation. The problem is most severe at the on-farm level where useful interaction between farmers and irrigation professionals is rare and the available extension services are weak.

In regard to monitoring and evaluation, the fifth criterion, there is a remarkable statistical awareness of what is happening in Maharashtra irrigation. The Irrigation Department, the Agriculture Department, and the Groundwater Development Survey Agency all collect and publish substantial amounts of data. In several cases, the methods of calculating the data need to be revised and analytical skills need to be upgraded. The design of minor tanks depends on yield estimates developed nearly a century ago. Sediment yields from catchments are standardized estimates that have proven inaccurate. Seepage losses from the canal network should be known from monitoring and study of existing projects or estimated prior to construction in test pits. Finally, there is practically no feedback from observations of water applications on individual fields which would help to estimate water infiltration and thus the efficiency of water applications.

D. Economic Analysis

Economic viability of the project was examined using time-discounted cash flow analysis of a sample of four proposed subprojects. Description of the subprojects, methodology used for analysis, and the results of sensitivity tests for certain assumptions are summarized.

1. Methodology Used for AID analysis

Using World Bank (WB) projected 1990 world economic prices expressed in 1983/84 price level and "backed" to farm gate, this AID analysis developed individual crop budgets at economic prices. WB estimates of present rainfed yields and projections of "Without Project" (WOP) and "With Project" (W/P) yields for Maharashtra were used to determine the gross value of crops produced per hectare.

The WB's estimates of inputs per hectare were used. Labor was shadow priced at Rs.3 per day while the economic cost of draft animal labor per day was taken to be Rs.10. Fertilizer, in terms of N was priced at Rs.4/kg for the present case and Rs.4.8/kg for the WOP and W/P cases.

Costs in this analysis included (a) capital investment needed to achieve the projected income, such as reservoirs and associated works, the distribution system; (b) cost of land development at the rate of Rs.2220/ha of cultivable command area (CCA); and (c) operation and maintenance (O&M) costs.

Direct benefits in this analysis included incremental net farm income from crop production. Credit was taken for income from reservoir bed cultivation in the rabi season. Incremental net farm income was calculated as W/P net farm income minus WOP net farm income, excluding transfer payment.

Estimates of benefits took full account of transition periods involved in land and irrigation development and in the development of projected levels of agricultural productivity. These transitions were applied successively to each incremental area brought under irrigation. To reduce calculations, a combined transition obtained by multiplying area and productivity transition factor for each successive increment for each year was applied to W/P net return.

Subtracting annual costs from annual benefits the annual stream of incremental benefit (or cash flow) was derived for each scheme. The annual cash flow entries were then discounted by the Present Worth (PW) factors for various rates of interest. Following AID's traditional procedure, the base year's values were discounted by a factor of 1.0. The economic rate of return (ERR) was determined through an iterative procedure.

2. Description of Schemes

Kode: Located in western district of Kolhapur, the scheme consists of a 460 meter long earthen dam across Jambali Nalla, a 70 meter spillway and a lift network to irrigate 491 hectare out of a CCA of 589 hectares. Present cropping pattern includes inferior cereals, some paddy in kharif and sugarcane as a perennial crop. W/P cropping pattern is proposed to include irrigated rabi crops; high-yielding varieties (HYV) of wheat and maize and vegetables.

Gavase: This scheme is located in the same district of Kolhapur and consists of a 340 meter long earthen dam across a local Nalla, a spillway of 40 meters, lined main canal, field channels and drains. It is designed to irrigate 191 hectares out of a CCA of 239 hectares. Cultivation at present is rabi oriented (wheat, maize, gram and vegetables), though some paddy, sorghum and vegetables are grown in a small area in kharif. The proposed W/P cropping pattern does not introduce any new crops.

Waki: Located in the eastern district of Osmanabad, the scheme consists of an earthen dam 1620 meters long across the Waki Nalla. It is designed to irrigate 1150 hectares. Presently cultivation is restricted to kharif season, the principal crops being sorghum, pulses and groundnut. Projected cropping pattern W/P includes shifts to two seasonals and rabi crops like wheat, gram, HYV sorghum.

Dhule: this scheme in the northern district of Jalgaon consisits of a 1284 meter long earthen dam and canal network to irrigate 232 hectares in a CCA of 412 hectares. Present cropping pattern includes mostly kharif crops -- sorghum, cotton, pulses and groundnut. Irrigation will enable cultivation of rabi crops -- HYV wheat, sorghum, gram and vegetables.

3. Economic Rate of Return

Using methodology outlined previously, Economic Rates of Return (ERR) for the schemes were calculated.

Subproject	Capital Cost/ha with CCF (Rs.)	ERR %	CCA (ha)
Kode	9,640	16.03	589
Gavase	14,870	9.43	239
Waki	8,403	17.14	1150
Dhule	9,405	12.80	412

The estimated ERR varies a good deal from one scheme another. All schemes, except Gavase, yield an ERR greater than 12 percent, which is generally taken to be the opportunity cost of capital in the Indian economy. Two factors seem to have been responsible for the low ERR in the case of Gavase: (a) it is obviously a high cost scheme; and (b) W/P cropping pattern is almost the same as the WOP cropping pattern without any shift to high value crops. The Gavase scheme would not be financed under this project unless it changed its cropping pattern to increase the ERR.

4. Sensitivity Analysis

Sensitivity analysis was carried out in respect of construction period, initial period of release of water, shortfalls in area irrigated, and costs. First, completion of construction work was assumed to be delayed by one year with consequent delay in the start of the benefit stream. Second, water was assumed to be released one year ahead of schedule, other assumptions remaining the same as in the base case. Third, the scheme was assumed to have provided water to only 60 percent of the designated irrigated area. Finally, costs were assumed to be 10 percent (a) greater and (b) lower than the base case. The impact on the ERR of these variations in base case assumptions is shown in the following table.

Project	Kode	Gavase	Waki	Dhule
1. Completion delayed by one period	15.78	8.83	15.85	11.75
2. Benefits start one period ahead of schedule	19.52	10.51	19.47	14.47
3. Costs increase by 10 percent	16.21	8.69	16.13	11.92
4. Costs decrease by 10 percent	18.39	10.28	18.35	13.81
5. Irrigation provided to 60% of designated area	7.32	1.81	12.85	7.86
6. Base case	16.03	9.43	17.14	12.80

The results show that the rate of return is sensitive to an early release of water and advancing the benefit stream by one year ahead of the usual schedule. The physical construction schedule for minor irrigation schemes usually includes a four-year period of planning and construction and release of water in the fifth year, though it is frequently eight to ten years before water is available throughout the area that can be commanded. The design and construction schedules under the Project are intended to make water available, to at least part of the command, during year four.

However, the most important factor affecting scheme viability is the degree to which the system is operated to its design capacity. A review of the evidence regarding existing minor irrigation schemes shows that most schemes have been underutilized. An analysis by the ID of 49 schemes in Nasik, Dhule and Jalgaon Districts showed an average rabi utilization rate of about 40 percent over the life of the schemes. Variability from scheme to scheme was great, ranging from ten percent to 89 percent.

At rates of utilization currently prevailing on Maharashtra minor irrigation schemes they are clearly an uneconomic investment. Factors causing this underutilization are many and varied. Most frequently metnioned in the studies that have been done is the lack of reliability of the physical system to deliver water to farmers. This takes many forms -- from actual lack of a distribution system, through poor quality construction, to improper operation and maintenance. Design criteria and implementation procedures under this Project will eliminate, or at least minimize, these factors.

Another significant factor is the variability of rainfall. Dams and reservoirs will be designed at 50 percent reliability, which means that in only half the years during scheme life can full utilization of the system be expected. This is a deliberate policy choice by the GOM which is intended to provide water to a larger number of beneficiaries than if the system were design for more reliability. USAID has concurred in this design procedure with the proviso that GOM subject it to a thorough engineering, economic, and social analysis.

Some of the more intractable factors influencing underutilization are institutional. Water allocation laws in Maharashtra under the Shejpali system give farmers the choice at various times during the year of requesting water if it is needed; or not requesting water, and therefore not paying for it, if it is not believed by the farmer to be needed. Thus, in good rainfall years when a full irrigation water supply is likely, it is also likely that farmers will not request the full water supply. In this situation, water will likely remain in the reservoir at the end of the rabi season and could be released for hot season crops, even though hot season irrigation is not designed into minor irrigation schemes. The ID will analyze demand scheduling as an alternative to the shejpali system for water allocation. The GOM is also exploring the possibilities of a minimum charge for irrigation water availability so as to encourage farmers to take water. This charge has not yet been imposed.

Another institutional variable is the land ceiling law which imposed smaller ceilings on irrigated land. This has made farmers in some areas reluctant to utilize irrigation water that is available to them.

It has also been observed that farmers newly introduced to irrigation have not been given sufficient education in its use and are therefore reluctant to use it. Agricultural development demonstration chaks on each scheme financed under the project, trained VEWs and trained SMSs, and the organization of outlet committees will remove this institutional constraint.

This is not an exhaustive list of the factors affecting irrigation water utilization, nor of the measures under consideration by the GOM. It does, however, focus on those factors to be specifically addressed under the project.

5. Economic Criteria

Economic evaluation of schemes will use the discounted cash flow analysis.

A 12 percent ERR will be required for scheme approval, except in tribal, drought prone, Konkan or other areas where GOM policy provides concessions. In these areas schemes will qualify with a 10 percent ERR.

E. Financial Analysis

1. Financial Rate of Return

The Financial Rate of Return (FRR) was calculated for one project, Kode, by using market prices for outputs and inputs. Inputs, in this case, included interest on working capital, depreciation of machinery and implements, water charges, taxes and miscellaneous financial expenditure. Construction costs were not adjusted by the CCF. The estimated FRR for this project was 10.8 percent compared to an ERR of 16 percent.

2. Farm Income of the Average Farm

To ascertain the impact of irrigation on the net income of a two-hectare farm, a financial crop budget was developed. The present cropping pattern included the usual rainfed kharif crops with fallow land of 10 percent. With irrigation the cropping pattern was assumed to include rabi crops of wheat and maize. The results of this exercise are show in the following table.

Farm Income

Time	Total Net Income (Rs.)	Net Income Per ha (Rs.)
Present	1,071	535
Future Without Project	1,470	735
Future With Project	7,820	3,910

3. Cost Recovery

Current policy of the GOI and GOM is not to recover the capital costs of irrigation facilities. They do intend, however, to recover operation and maintenance costs through the imposition of water charges. The rates vary from crop to crop depending on crop value and its requirement for water. Current water rates are given in Table 6.

These rates are adequate to cover all O&M costs with a margin left to pay for collecting the charges and other administrative costs. In the case of the Kode Scheme, current water rates would yield over Rs.100,000 based on the proposed cropping pattern. O&M costs of Rs. 80/ha and the cost for a canal inspector total about Rs.60,000. Collections are more than adequate to cover recurrent costs.

Table 6: 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 Season	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

4. Recurrent Costs

Recurrent O&M costs are adequately covered as indicated above. Since it is planned to complete the 90 schemes financed under this project, the recurrent costs that have been a factor in some projects where AID is financing a time slice of a construction program will not be a factor in this project.

The SASC will likely be disbanded on completion of the schemes. If the SAEC and RMICs are found by the ID to be particularly effective, they may be retained for implementation of the GOM's irrigation programs. If so, costs for these units would be a part of their normal establishment costs and covered when projects are sanctioned for construction.

In the case of the AD, the VEWs will have essentially completed their work on project schemes by the PACD. They will be well trained and effective workers in irrigation water management and can be expected to remain a part of the regular staff of the AD. They will be transferred to other irrigation projects or to other activities of the AD. While this reflects a recurrent cost obligation, it is one that GOM can be expected to support. The same will be true of the SMSs. They will have been incorporated into the regular technical staff of the AD and can be expected to continue working in irrigated agriculture. Their role in this project was not a full time one in any case. They are expected to provide the technical backstopping and training for VEWs working on Project schemes but will have other duties in addition.

A significant number of construction subdivisions for both AD and ID will have been created to implement project schemes. Staff composition of these subdivisions will include both regular and temporary employees. If the GOM irrigation program expands as expected in the seventh and eighth plans these subdivisions will be reassigned to other new projects. If not, both the AD and ID have the administrative capacity for retrenchment in staff numbers. Therefore, it is not expected that the construction subdivisions will create a recurrent cost problem.

Overall, it is concluded that this project, while it may create some recurrent costs for the GOM beyond the PACD, these costs can be managed or avoided so as to eliminate any recurrent cost problems.

F. Environmental Analysis

1. Background

USAID/New Delhi submitted the Maharashtra Minor Irrigation PID to AID/Washington in Occtober 1982. In the PID, USAID maintained that an assessment of the environmental impact of irrigation development was unnecessary because the relevant issues had been identified and analyzed under the AID financed "Maharashtra Irrigation Management and Training Project" as well as other AID financed irrigation projects in areas with similar agro-climatic and topographical conditions. Moreover, USAID has been monitoring the environmental impact of its ongoing irrigation portfolio and has yet to detect any signs of significant environmental degradation caused by irrigation development. USAID did, however, plan to examine under this project the environmental impact of the construction of access roads to project sites. The APAC which met on October 29, 1983, had no issue with this approach.

The following is a scoping statement identifying the potentially negative effects of road construction on the environment. The scoping statement has been prepared in accordance with the procedures outlined in 22 CFR 216 and approved by the Asia Bureau Environmental Officer.

2. Adverse Impacts

a. Erosion

Some of the access roads for the construction of the dams and headworks will be in hilly areas. Road widths are narrow, designed primarily for one way traffic. The standard practice in constructing these roads is to cut a bench along the contour and push the spoil over the down slope side. Erosion can ensue if the earth is not properly shaped and compacted, embankments are not seeded, and drainage channels are not constructed to properly control the flow of runoff. Retaining walls with internal drainage must be built to stabilize those soils that have a low angle of repose. Most of the Maharashtra irrigation schemes will be in more level to rolling areas where erosion hazards are not serious.

b. Diversion of Natural Drainage Routes

Construction of access roads can block and thus force the diversion of natural drainage routes. Here, planners must not only consider the potential for erosion created by the new routes, but the environmental consequences of depriving the flora and fauna existing along the natural route of that particular source of water. Diversion can be averted by the construction of culverts and other cross drainage structures where appropriate. Current hydrologic procedures used in Maharashtra are satisfactory to determine the runoff potential for sizing the drainage structures.

c. Migration of Wildlife

While it is recognized that road construction is often responsible for the displacement of wildlife, it is doubtful that the construction of access roads will have any substantial effect on animal movement. This is primarily because of the existing presence of mankind in the areas identified for project activities, the relatively narrow width of the roads and the limited anticipated use.

3. Issues to be Eliminated from In-depth Analysis

The issues identified above were reviewed by the design team and Government of Maharashtra officials during the initial design stages of this project. It was determined that in-depth analyses would not be required during project design. The Government of Maharashtra is aware of the measures that must be taken to minimize the threat road construction poses to the environment and has incorporated them into their standard construction procedures. USAID will monitor construction at project sites to ensure that these procedures are followed.

VII. Monitoring and Evaluation

A. Monitoring

1. GOM Monitoring

Front line responsibility for monitoring project construction activities will rest with the respective Regional Minor Irrigation Cells. The RMICs will regularly forward comprehensive progress reports to the Monitoring, Evaluation and Survey Unit of the Special Analysis and Evaluation Cell. These reports will provide complete physical and financial details for each minor irrigation scheme under construction and will identify existing or forseen constraints to construction progress. The MESU will compile these reports on a semiannual basis and do an analysis of the strengths and weaknesses of the construction activities. The reports will be forwarded to USAID and senior officials of the Irrigation and Agriculture Departments for review and comments.

MESU will also monitor the progress of the studies and pilot activities being supported under the project. It will meet regularly with groups conducting the studies and pilot activities, undertake random spot checks of the pilots, and compile and scrutinize reports that groups conducting studies and pilot activities are required to submit.

To help it objectively measure the project achievements, MESU will contract agricultural universities to conduct benchmark and follow up surveys of socio-economic and technical conditions.

The Special Appraisal and Supervision Cell, drawing from information provided in the MESU reports and from its own site visits, will periodically review project progress. It will also be responsible for monitoring the training program.

2. USAID Monitoring

The Liaison and Coordination Unit contracted under the project will be responsible for the day-to-day monitoring of project activities. It will prepare quarterly reports on project progress, specifically discussing construction activities, studies and pilot activities, the professional development program, the institutional reorganization, the computer data management program, and the establishment of hydrological units.

USAID will monitor progress by reviewing the reports provided by the LCU and the reports provided by the GOM. In addition, the project officer will, on the average, make two trips per month to Maharashtra. One of the trips will be to monitor progress under the Maharashtra Irrigation Technology and Management Project and the other to monitor progress under this project. His particular emphasis will be on monitoring construction progress, although other project activities will also receive his attention. Over the six year life of the project, the project officer will travel to Maharashtra approximately 50 times in support of this project. He will visit each of the 90 schemes under construction at least once. Those schemes on which implementation constraints have been identified will be visited more than once. The percentage coverage will be higher in the initial years because fewer sites will be active. Fuller coverage is critical at the beginning however, to assure that new criteria are applied, new practices followed, and farmer participation taking place as planned. The PSC responsible for pilot activities in USAID's irrigation portfolio will also visit Maharashtra regularly. Training activities too will be monitored by mission staff, particularly those being introduced for the first time.

B. Evaluation

1. Annual Evaluations

The Government of India, the Government of Maharashtra, and USAID will conduct joint project evaluations on an annual basis to determine physical and financial progress of the project; extent of farmer participation; effect of demonstration chaks; impact of special studies, pilot activities and diagnostic analyses; and effectiveness of new organizational units. After identifying the constraints to project progress a plan of action will be developed by the joint evaluation team to improve project implementation.

2. In-depth Evaluation

An in-depth evaluation is scheduled for the end of the third year of the project. The evaluation team will look at, among other things, (a) construction progress, quality of construction, and acceptance of design and construction standards introduced under the project; (b) the extent of farmer participation compared to that on non-AID schemes and the differences increased farmer participation have made in operation of the schemes; (c) coordination between the various relevant departments; (d) the findings of the special studies pilot activities, and diagnostic analyses and how the findings are being applied; (e) the effectiveness of the training programs; and (f) the performance of the special institutional units. The evaluation team, after discussions with various USAID and GOM officials and farmer irrigators, will propose recommendations to increase the effectiveness of project activities.

At the end of the project, an evaluation will be conducted to assess the impact the project has had on the irrigation sector in Maharashtra and to consolidate the lessons learned.

Both evaluations will draw upon the information acquired during the project monitoring process. The baseline surveys and follow-up surveys conducted by the agricultural universities will be particularly useful.

Evaluation is a covenant to the Project.

VIII. Conditions and Covenants

A. Conditions Precedent to Disbursement

Prior to the first disbursement of loan funds the Cooperating Country will provide or cause to be provided evidence that the State of Maharashtra has established a Special Appraisal and Supervision Cell, a Special Analysis and Evaluation Cell, and six Regional Minor Irrigation Cells within its Department of Irrigation, and sanctioned adequate staff for the Special Appraisal and Supervision Cell; the Special Analysis and Evaluation Cell; and each of the six Minor Irrigation Cells.

B. Covenants

1. On Farm Part II Works. Except as the Parties may otherwise agree in writing, the Cooperating Country agrees to make all reasonable efforts to assure the availability of sufficient funds to the Agriculture Department to complete the On-Farm Part II works in accordance with the schedules to be established, by the GOI and USAID for that work.

2. GOI Project Staffing. Except as the Parties may otherwise agree in writing, the Cooperating Country agrees to establish an adequate number of positions, and post experienced qualified staff to these positions as necessary to effectively implement all Project

activities in accordance with Project schedules and budgets to be established, from time to time, by the GOI and USAID for the approved schemes.

3. Water Users' Organizations. Except as the parties may otherwise agree in writing, the Cooperating Country agrees that within two years from initiation of the Project, a plan shall be submitted, satisfactory to A.I.D. in form and substance, describing the organizations, authorities, and responsibilities of water users' committees at the outlet level, and a schedule for activation of such committees in those areas involved in the Project. A.I.D. reimbursement for costs connected with completion of irrigation schemes shall take into account activation of such committees in an appropriate number of project areas.

4. Project Evaluation. The Parties agree to establish an evaluation program as part of the Project. Except as the Parties otherwise agree in writing, the program will include, during the implementation of the Project and at one or more points thereafter: (a) evaluation of progress toward attainment of the objectives of the Project; (b) identification and evaluation of problem areas constraints which may inhibit such attainment; (c) assessment of how such information may be used to help overcome such problems; and (d) evaluation, to the degree feasible, of the overall development impact of the Project.

5. Post Training Employment. Except as the parties may otherwise agree in writing, the Cooperating Country agrees to require and enforce that all persons trained abroad under this Project be required, immediately upon completion of said training, to work in irrigation related activities for a minimum period of not less than two (2) times the length of the training abroad. AID reserves the right, in consultation with the GOI, to disallow costs for training abroad for those persons who without good cause do not work in irrigation related activities in accord with the terms of this Covenant.

ANNEX 1

MAHARASHTRA MINOR IRRIGATION LOGICAL FRAMEWORK

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumptions
Goal: To increase food production and rural employment	The index of the average value of output per ha will increase 2.5 times 6,500 person years of employment created annually	Baseline surveys completed under project Project evaluation Statistics compiled by Government of Maharashtra	Favorable weather conditions (i.e., no drought) Policies encouraging agricultural production in place Demand for more agricultural products exists
Project Purpose: To increase irrigation efficiency in Maharashtra by improving the management and physical infrastructure of irrigation systems and by improving the distribution, application of water below the public outlet.	90 well designed and constructed schemes that are set up for improved O&M Farmers participating in determining layout of channels and watercourses Farmers actively involved in operation and maintenance of irrigation systems Agriculture Department working with farmers to complete Part I and Part II works Hydrological data available resulting in better designed systems and better planned water budgets Greater communication between irrigation department, argicultural universities, and farmers More focus on quality control	Appraisal reports GOM records and reports USAID site visits project evaluations	Farmers are interested in increasing their participation GOM is committed to completing subprojects according to agreed project criteria GOM acts on recommendations of special studies and pilot activities Technical assistance provided is of high quality and training provided is relevant

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumptions
Outputs: Minor irrigation schemes constructed	90 schemes completed	GOM records and reports USAID site visits	Counterpart funds will be available
Existing minor irrigation schemes rehabilitated	12 schemes completed	GOM records and reports USAID site visits	Counterpart funds will be available
Hydrological stations established	52 stations established	GOM records and reports USAID site visits	Counterpart funds will be available
Staff capabilities improved	1805 staff trained Computer data management capability in place	Contractor records and reports	GOM staff available
Demonstration "chaks" disseminating tested technologies	2 demonstration chaks functioning per AID financed scheme	GOM records and reports USAID site visits	Agriculture department provides counterpart funds and staff
Problems identified and solutions tested	6 studies, 12 diagnostic analyses, and 4 sets of baseline surveys, 30 pilot activities completed	Copies of studies completed Reports on pilot activities	Qualified staff can be made available
Farmer participation increased	Farmers participating in determining layout of channels and assuming increased responsibility for operation and maintenance	USAID site visits	Farmer are interested in increasing their participation

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Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumptions
Inputs: Financial support for construction	$42 million disbursed Performance targets met	USAID field visits GOM reports	GOM counterpart funds available AID design criteria met
Technical assistance	40 person months of short term provided 108 person months of long term provided	TA contract	Qualified firm or institution identified
Training	1805 persons trained 160 workshops held	Trainers' reports	GOM staff available
Equipment	Procurement action of $1,415,000 completed	Shipping documentation	GOM can clear instrumentation through

RESPONSE TO APAC ISSUES

1. Local Participation: The APAC noted that small-scale nature of minor irrigation schemes presents an excellent opportunity for the project to increase local participation and suggested that the mission explore methods of involving farmers in the design of water courses, contractor selection and supervision, planning for water distribution, and identification of training needs. APAC also suggested that feasibility of farmer organizations controlling payments be explored.

Farmer participation will begin with the planning of the water distribution system. Irrigation and agriculture officials will discuss the proposed plan with the farmers and respond to farmer comments as to how it could be adjusted to best serve community interests. It is proposed that the village leader will sign a document that certifies that the discussions were held and that the design selected was acceptable to the majority of individuals affected. Approximately two years prior to the scheduled completion of the irrigation system, village extension workers (VEW) from the Agriculture Department will be assigned full-time to A.I.D. financed schemes. They will have been trained under the project and will be responsible for helping farmers organize outlet committees. The VEWs and the outlet committees will establish water allocation procedures and determine maintenance responsibilities. To learn more about farmer organizations and what makes them work, A.I.D. will finance a study on experience to date in organizing irrigators in India. The study will be completed in the second year of the project so that lessons learned can be applied. As explained in more detail in the project financial plan, farmer participation is part of a disbursement trigger for two separate performance benchmarks.

Ways to further increase farmer participation will be explored under two pilot activities financed under the project. One pilot will have farmers responsible for all earthwork construction below the outlet. The GOM will contribute technical assistance and assume responsibility for all structural construction. The other pilot will increase farmer participation in deteriming crop mix by increasing the variety of their crop choice. Current GOM policy restricts the cultivation of crops other than foodgrains on fields irrigated by surface water.

In addition to promoting increased farmer participation, the project will familiarize farmers with the principles of water management. Farmers need to understand the soil-plant-water relationship and must be taught to apply the proper amount of water at the proper time. The importance of on-farm land development must be emphasized to maximize irrigation efficiency. Direct responsibility for familiarizing farmers with water management principles will lie with the VEW. He will be assisted by the water management subject matter specialist which the Agriculture Department has agreed to appoint to each district with an A.I.D. financed scheme. To further enhance the farmers' understanding of irrigation technology and his grasp of the potential the technology creates, two demonstration chaks will be established in each scheme. Finally, special workshops, field days and short training sessions will be sponsored for farm families.

The design team considered APAC recommendations that farmers be involved in contractor selection, supervision, and payment, and in the identification of training needs and discussed these recommendations with the GOM. Both parties agreed that, at this point, neither AID nor the GOM had enough experience with farmer organizations in India to prepare farmers to undertake these types of tasks. It was agreed that rather than tempt failure by jumping too far too fast, the approach should be to tackle realistic targets, and increase farmer participation incrementally.

2. Evaluation and Monitoring: APAC called for a strong monitoring and evaluation component to formalize training process.

The project will create a Special Analysis and Evaluation Cell which will, among other things, monitor the progress of the special studies, pilot activities and diagnostic analysis; conduct benchmark and follow-up surveys; and monitor institutional and socio-economic variables. To facilitate the monitoring process, a computer data management capability will be established. To ensure that lessons learned are applied in the future, a link will be developed with the Technology Transfer Unit being supported under the Irrigation Management and Training Project. A Special Appraisal and Supervision Cell will monitor construction progress. A.I.D. monitoring requirements will be accomplished by the regularly scheduled visits of the project manager and by the reports of the technical assistance team.

3. Operation and Maintenance: APAC was interested in how operations would be financed and the role of beneficiaries in maintenance.

The GOM recovers operation and maintenance costs through the imposition of water charges. These rates are shown in Table 6 of the Project Paper. They are adequate to cover all O&M costs with a margin left to pay for collecting the charges and other administrative costs.

Beneficiaries will be responsible for maintenance of the watercourses below the 40 hectare outlet. The Argiculture Department will assist farmers to develop this maintenance capability and will monitor maintenance activities.

4. Infrastructure Support: APAC requested that the PP outline a mechanism which would ensure coordination for provision of infrastructure and other essential inputs.

A Minor Irrigation Committee, which includes representatives from all relevant government agencies, will be established under the Project. The MIC will meet regularly to ensure the coordination of inputs and provide overall operational guidance.

5. Attracting Contractor and Government Support: APAC noted remoteness and small size of minor schemes and asked whether adequate incentives existed to attract contractor and government support.

USAID does not foresee a problem in this regard. The GOM has an active policy of extending irrigation to areas most vulnerable to drought, often by-passing more accessible areas which offer a financially higher rate of return. Contractors also have not yet proved to be a problem. If, in certain instances, contractor services cannot be acquired, the GOM will construct the schemes by force ac- count.

6. Absorptive Capacity: Given two World Bank projects and with this project, the two A.I.D. projects, APAC questioned GOM absorptive capacity in terms of budget and manpower.

During the current five year plan (1980-85), the Irrigation Department is constructing 437 new minor irrigation schemes at a cost of approximately $245 million. The Seventh Five Year Plan (1985-1990) calls for the construction of 843 new minor irrigation schemes at a cost of $476 million. The World Bank projects, both of which were initiated before 1980, and the AID projects are all within the GOM's budgetary absorptive capacity.

The Irrigation Department manpower levels are increasing in accord with the budget increases. Training capacity has been substantially enhanced with the creation of WALMI. The Agriculture Department could face manpower constraints.

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7. Project Analyses: The APAC directed USAID to examine costs of minor irrigation schemes carefully and to examine land tenure issues.

The Project Paper estimate of the average cost of minor irrigation schemes is $2623 per hectare; it exceeds the earlier PID estimate by about $123 per hectare, or by about 5 percent. This estimate is based on the details of costs of recently approved schemes and seems reasonable.

Land tenure will not be an issue under this project. As indicated in the Social Soundness Analysis only 3 percent of Maharashtra's agricultural holdings are wholly rented.

8. Staffing: APAC directed that PP identify type of staff support project will require and discuss how support will be provided.

The Project Paper Implementation Plan thoroughly discusses USAID staffing arrangements.

Summary of Criteria and Conditions for Approval of Subprojects

Each individual Minor Irrigation Schemes (MIS) will be designed by the Executive Engineer of the respective regions, appraised by the Special Appraisal and Supervision Cell (SASC) and approved by the Minor Irrigation Committee (MIC) and will be based on the criteria described hereunder:

1. An Economic Rate of Return (ERR) of 12 percent or more, or 10 percent in tribal/drought prone areas.

2. All designs comply with the standard engineering design and cost estimation criteria established by GOM/ID and AD, and the Indian Standards Institute for various components of the scheme.

3. Dam and conveyance system of each MIS constructed within four years of initiation including the distribution network (Part I works) to individual farms or to the point that serves up to two ha block whichever is smaller.

4. Complete surface drainage system is designed and constructed in the entire CCA to remove rainfall intensities of a 5-year recurrence interval rapidly enough to avoid crop damage.

5. Crop water requirements calculated according to the cropping patterns developed by AD and using the climatological data from the area or nearby area. The conveyance system capacity to be based on maximum irrigation requirements of the system.

6. Estimates of monthly available water supply based on a 20 year reservoir operation study. The live storage capacity of the reservoir should be based on estimated 50 or 75 percent dependable flow as per "Manual of Minor Irrigation Works in Maharashtra State, 1983" till results of special studies and pilot projects become available.

7. The layout of the water conveyance and distribution system should be based on detailed soil and topographic surveys and finalized after reviewing the possible technical alternatives with farmers.

8. Sufficient hydraulic head to be provided to assure the designed flow between outlets and watercourses, watercourses and field channels, and a minimum of 15 cm. head between field channels and the highest point within the commanded fields.

9. Delivery system capable of delivering streams of 30 liters per second to gated outlets serving about 5-8 ha on a rotational basis.

10. Distribution system to be designed starting with farmer's field and moving upward through the system to the main canal outlet level.

11. Conveyance channels adequately designed and regulated with control structures to permit full delivery to each outlet even when main system is operating at 50 percent of design capacity.

12. Water measuring devices to be provided at the head of the main canal, at each offtaking distributary/minor and along the distribution system as required to delivery measu... flows among users.

13. Conveyance system adequately protected by cross-drainage structures and escapes as needed at the end and at various points along the canal alignment.

14. Conveyance/distribution system to be selectively lined based on detailed soil survey data and hydraulic conductivity-seepage loss correlation.

15. Water conveyance efficiency must be supported by seepage tests on the soils that canal passes through.

16. Water is allocated according to the rotational water system as detailed in project paper.

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ANNEX 4

SCOPE OF WORK

For Water Management Synthesis II Project

A. Objective

The contractor will recruit staff for, establish and backstop a Liaison and Coordination Unit (LCU) to be located in Maharashtra State. The Unit will be operated on a full-time basis for three years and on a part-time basis for the following three years.

B. Staff Recruitment

The contractor will recruit an expatriate team leader for the LCU who is an experienced and accomplished specialist in the field of irrigation and water management technology, and operationally knowledgeable regarding micro-computers and the software necessary for irrigation systems analysis. This individual should have at least ten years of experience; at least half of which is in developing countries. Preference will be given to individuals with South Asian experience in irrigation and water management.

In addition to the LCU team leader, contractor will recruit two senior Indian irrigation engineers or water management specialists to work under the supervision of the LCU team leader. Administrative assistants, typists, drivers and other support staff will be recruited as necessary to make the LCU function smoothly and efficiently.

C. Office Establishment

Contractor will set up the LCU office at a location in Maharashtra to be determined by the State and USAID. Contractor will lease space, furnish, and otherwise establish necessary office facilities.

D. Equipment

In addition to all normal office furnishings and equipment, contractor will purchase and set up in the offices of the LCU a micro-computer, or computers, compatible with the micro-computers to be acquired under the Project.

Contractor will also install a high-speed plain paper copier in the Special Analysis and Evaluation Cell to facilitate data dissemination throughout the State.

E. Technical Responsibilities of the Unit

The LCU will be responsible for coordinating and assisting in the implementation of all project activities.

1. The LCU will provide day-to-day counsel in water management and in the various aspects of the irrigation system planning, design, construction, operation and maintenance and management to the Irrigation and Agriculture Departments and other entities that are involved in the Project.

Specifically, the LCU will liaison closely with the Special Analysis and Evaluation Cell (SAEC) which is under the control of the Coordinating Regional Chief Engineer and the Special Appraisal and Supervision Cell (SASC) which is under the control of the Chief Engineer, Minor Irrigation, at the State level.

2. The LCU will assist the SASC in the manpower development activities proposed under the Project (see Attachment A). Working with the SASC, the LCU will prepare course outlines, sugge[illegible] additional training activities that may be needed, and conduc[illegible], or arrange for the conduct of the in-country short courses, workshops and seminars briefly outlined in Attachment A.

3. The LCU will prepare suitable itineraries and otherwise arrange for irrigation water management observation trips within India and to the U.S. and other countries for Irrigation and Agriculture Department senior, mid-level and junior officers. Such trips will be designed to broaden the experience and expose these officers to modern state-of-the-art irrigation management that may have some applicability in Maharashtra.

4. A number of data collection, special studies and pilot activities are proposed to be carried out under the Project (see Attachment B). The LCU will be responsible for, or arrange for the necessary technical assistance in the design and implementation of studies and pilot activities and in the overall data collection and processing effort. The LCU will work closely with the SAEC and the Regional Minor Irrigation Cells (RMIC) which have the implementation responsibility for these activities.

The LCU will prepare scopes of work for each of the above activities, arrange for, or help contract for the research talent required, assist in supervising the work, and assist the SAEC in incorporating useful results into scheme design criteria.

5. The LCU will give continuing assistance to the SAEC and the RMICs in the planning and design of about 90 MISs; to the SASC in the appraisal of the schemes and in monitoring their implementation; to the RMICs in the monitoring, coordination and evaluation of MISs financed under the Project; and to the Department of Agriculture in the implementation of demonstration chaks. It is expected that the LCU will spend about half of its available staff time on these monitoring and implementation activities.

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Attachment A

SUMMARY TRAINING PLAN

	Description of Training	Target Audience	Person Months of TA
a.	Short course on computer simulation modeling and information management (Three weeks)	Irrigation Department 5 (state) 10 (region) Agriculture Department - 5 Groundwater Survey and Development Agency - 5 University - 5	2
b.	Short course on operation of minor irrigation model (Four weeks)	Irrigation Department - 15 Agriculture Department - 5 Groundwater Survey and Development Agency - 5 University - 5	
c.	Short course on irrigation system management under demand scheduling (Two weeks)	Irrigation Department 10 (state) 30 (region)	1
d.	Short course on field irrigation practices like flow measurement, computing and measuring crop water requirements, and evaluation of on-farm water management practices (One week)	Irrigation Department - 50 Agriculture Department - 50 University - 10	1
e.	Workshop on irrigation methods (ID-1/pilot; AD-2/pilot; farmers-3/pilot) (One week)	Irrigation Department - 10 Agriculture Department - 20 Farmers - 30 University - 5	6
f.	Planning and layout of minors, water course and field channels (20-10 day workshops for 20 participants each)	Irrigation Department - 100 Agriculture Department -300	6

Description of Training	Target Audience	Person Months of TA
g. Short course on soil fertility and soil moisture interactions in crop yield; as well as diagnosis, prevention, reclamation, and management of soil salinity (2 subject matter specialists/ district = 60) (Two weeks)	Agriculture Department - 60 University - 10	
h. Train subject matter specialists (SMS) in on-farm water management Long-term course at WALMI	30	
i. Workshops on farmer organization	Irrigation Department - 50 Agriculture Department -10	2
j. Workshops for training trainers for agricultural development chaks (30 districts x 5 Agriculture Department and 1 Irrigation Department = 180 (Two weeks)	Irrigation Department - 30 Agriculture Department -150	-
k. Workshop for training farmers at each scheme (10 x 100 schemes) (One week)	Farmers - 1000	-
l. Train field level extension staff for water management (One week)	100	
m. Train field level extension staff capable of working with and assisting female farm operators. (10 participants - One week)	Agriculture Department - 10	
n. Train local contractor and Irrigation and Agriculture Departments supervisory staff	360	3

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Description of Training	Target Audience	Person Months of TA
in proper construction methods, quality control, and so forth, particulary in Part I and Part II works (3 regional level workshops = 18 workshops x 20 participants = 360 participants - One week)		
o. Observation tours for mid-level and senior officers in the U.S. and other countries to observe irrigation water management	Irrigation Department - 20 Agriculture Department - 5	-

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Attachment B

Data Collection, Studies and Pilot Activities

A. Data Collection and Studies

1. A computerized data collection and processing system will be developed to obtain and systematize basic hydro-meteorological data from existing and new schemes, including groundwater profiles and agricultural land use patterns.

2. Diagnostic analysis, patterned after the procedures developed in the Irrigation Management and Training Project, will be carried out on twelve existing schemes.

3. A minor irrigation systems computer model for analysis of MISs will be developed.

4. A comprehensive study of the inter-relationships between setting of sill levels, silt storage allowances, maximizing live storage, and other factors will be undertaken.

5. An analysis of the pros and cons of sizing reservoirs on a 50 percent dependability and command area on a 75 percent dependability will be undertaken.

6. Rotational water supply systems (RWS) will be analyzed and an RWS system for use on Project schemes will be devised.

7. An analysis will be made of the extent and nature of "participation" by irrigators on existing MISs, including study of the Phad system in the Nasik region, the Khajana well in Beed District and Malguzari tanks in Chandarpur and Bhandhara Districts.

8. Ongoing studies of how best to organize farmers to operate and maintain irrigation systems will be collected and analyzed and reported on by GOM at the end of the second year of project life.

9. On the piped distribution pilot schemes, the AD will contract with a university to analyze the costs of Part II works required under sprinkle irrigation and compare with costs of Part II works required for land shaping and levelling under surface irrigation.

10. An extensive set of baseline surveys will be undertaken which will cover a sample of Project financed schemes, the pilot schemes, and samples of both beneficiary and non-beneficiary farmers in Maharashtra. These same sample sets would be surveyed for evaluation purposes.

B. Pilot Investigations and Demonstrations

Pilot investigations/demonstrations are concentrated on key planning and technical design issues. A planning team or committee would be created for each of the pilot schemes and would be responsible for preparing a report with recommendations for the technical and organizational substance of the pilot activity which will guide the design and implementation of the pilot schemes.

1. Cropping pattern selection is a critical choice for irrigators, who currently have very little input into the selection. All ten pilot schemes will go through the analytical processes set up for involvement of irrigators and other institutions in cropping pattern selection.

2. Development of groundwater and conjunctive well/canal water utilization has been identified as a key issue in minor irrigation. Technical and institutional issues will be identified and analyzed in conjunction with the Maharashtra IT&M Project.

3. Financing groundwater development has been identified a critical variable in optimizing conjunctive use on existing schemes. An existing subproject under the Maharashtra IT&M Project will be analyzed for groundwater development potential. Local financial institutions will be involved in planning and offering a financial package for new wells and the repair and renovation of old wells.

4. New technological innovations will also be tested. Two or three new schemes in the Konkan region will be selected to experiment with a closed distribution system. Selected chaks in one or more of these schemes will experiment with gravity-fed sprinkler irrigation.

5. Demand scheduling of irrigation water deliveries appears to have advantages over the current Shejpali system. Demand scheduling provides a more reliable irrigation water supply but requires a user organization to make water scheduling decisions. One of the closed systems in the Konkan region and one other open system would be selected for experimentation with this new water scheduling system. The initial step will be an analysis and design by USAID provided technicians.

6. All schemes financed under the Project will be required to develop demonstration chaks which will show farmers the latest agricultural development technology, including optimum water utilization. All pilot schemes are included in this program.

7. The catchment of a minor irrigation tank is a critical element in the overall scheme. The yield of water for irrigation and the length of life of the reservoir due to siltation are critical variables determined by the nature and treatment of the catchment. Two existing schemes and three new schemes will have catchment treatment programs that may be financed under the Project. The instrumentation to be installed on each scheme will measure water inflow and other variables. The initial sediment content of the reservoir will be determined and annual sediment deposits estimated.

8. One new pilot scheme in the Aurangabad region will be selected to examine agricultural support programs for women agriculturalists that can be recommended, generally, for irrigated agriculture.

Section 611 (e) Certification
Maharashtra Minor Irrigation Project

This project will loan-finance 67 percent of eligible construction costs and grant-finance 100 percent of associated long and short-term technical assistance, training and research costs of approximately ninety minor irrigation schemes planned by the Government of Maharashtra to test and demonstrate ways to improve the efficiency of irrigation in Maharashtra.

I, Owen Cylke, 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 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.

Owen Cylke, Director
USAID/India

ANNEX 6

COUNTRY CHECKLIST

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

A. General Criteria for Country Eligibility

1. FAA Sec. 116. Can it be demonstrated that the 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.
2. 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.
3. 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.
4. 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.

5. 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 citizens or entities?	No.
6. 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 expected).	No.
	No.
Will assistance be provided to Afghanistan or Mozambique without a waiver?	No.
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?	Not applicable in this case.
7. 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.
8. 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.
9. 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.

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10. 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?

No.

11. 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.

12. 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:

The country has taken no such actions against U.S. fishing activities.

a. has any deduction required by the Fishermen's Protective Act been made?

b. has complete denial of assistance been considered by AID Administrator?

13. 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 counry in default exceeding one year on interest or principal on U.S. loan under program for which App. Act appropriates funds?

No.

14. 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 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).	Not applicable.
15. 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.
16. 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 with its un obligations.
17. FAA Sec. 620A; Continuing Resolution Sec. 521. Has the country granted sanctuary from prosecution to any individual group which has committed an act of international terrorism?	No.
18. 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.

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19. 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?

India has received no such equipment, materials or technology without specified safeguards. Based on information from the State Department the answer to the second question is also 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. India's Five Year Development Plan as revised (1980-85) is based on these criteria. The criteria are incorporated in the Country Development Strategy Statement.

b. FAA Sec. 104(d)(1). If appropriate, 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 an out of school, nutrition, disease control, maternal and child health services, agricultural production, rural development and assistance to urban poor?

Yes.

2. Economic Supportive Fund Country Criteria

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

C. 5C(2) - 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 that $1 million over that figure)?

(a) Formal Notification to Congressional Committees was given in AID's FY 84 Congressional Presentation. A Congressional Notification will be forwarded prior to the initial obligation of funds.

(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.

(b) Yes.

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.

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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 to effectively maintain and utilize the project?	Yes.
6. FAA Sec. 209. Is project susceptible to execution as part of regional or multilateral project? If so, why is project not executed? Information and conclusion whether assistance will encourage regional development programs.	No. Regional development programs are not pertinent to minor 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 loan 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 the letting of certain construction and technical assistance contracts. (c) Yes, especially rural credit institutions, and water user cooperatives. (d) Not applicable. (e) Yes, especially in regard to irrigation technology. (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; Indo-U.S. collaboration 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 Government of Maharashtra will finance between 45 and 50 percent of construction costs and is contributing sufficient amount of local currencies to meet the cost of contractual and other services.

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?

U.S. owned rupees are being used for various U.S. government agencies programs and administrative support.

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, 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?

(a) These represent the entire intent of the project.
(b) Water user organizations will be created on a prototype basis. Cooperative modes may be tried.
(c) This project entirely supports Indian self-help in agricultural development.
(d) A special pilot activity will encourage the increased participation of women.
(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 the agricultural productivity of small farmers.
c. [107] is appropriate effort placed on use of appropriate technology?	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, the recipient country will provide at least 25% of the costs of the program.
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; utilizes the country's intellectual resources to encourage institutional development; and supports civil education and training in skills required for effective participtіon 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.

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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.

This $46 million loan is well within India's capability to pay and given India's track record there is no reason to doubt that it will be paid.

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 Support Fund

This section not applicable.

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Guidance Cable

Department of State

Annex 7

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ORIGIN AID-00

INFO TELE-01 8-00 /001 A6

ORIGIN OFFICE ASPD-03
INFO AAAS-01 ASDP-02 PPCE-01 PDPR-01 PPPB-02 GC-01 GCAF-01
GCFL-01 STRD-01 ASTR-02 STAG-02 SAST-01 AGRI-01 STFA-01
RELO-01 MAST-01 ASBI-02 /025 A4 328

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TAGS:
SUBJECT: APAC GUIDANCE - INDIA MAHARASHTRA MINOR IRRIGATION PROJECT (336-0498)

1. APAC REVIEWED AND APPPOVED SUBJECT PP ON JUNE 6. FOLLOWING IS DISCUSSION OF ISSUES AND RECOMMENDATIONS.

2. FARMER PARTICIPATION: APAC WAS CONCERNED THAT PROJECT WAS NOT DOING ENOUGH TO INCREASE FARMER PARTICIPATION, ESPECIALLY GIVEN PROGRESSIVE ENVIRONMENT AND MATURITY OF INSTITUTIONS IN MAHARASHTRA. IT WAS SUGGESTED THAT SINCE THIS IS AN EXPERIMENTAL PROJECT, THE MISSION AND GOM SHOULD BE WILLING TO TAKE MORE RISKS. APAC WOULD HAVE LIKED PP TO INCLUDE GREATER FARMER PARTICIPATION IN CONSTRUCTION OF SCHEMES AND GREATER INVOLVEMENT OF PVOS IN THE FORMATION OF WATER USER ORGANIZATIONS. AID/W WOULD CONSIDER IT A SUBSTANTIAL ACHIEVEMENT IF ORGANIZATION OF OUTLET COMMITTEES TOOK PLACE IN AT LEAST HALF OF THE COMMAND AREA ON A.I.D. FINANCED SCHEMES. ALTHOUGH THIS IS IDENTIFIED AS PART OF THE FINAL DISBURSEMENT TRIGGER, THE PP DOES NOT ELABORATE ON HOW THE MISSION AND GOM WILL GO ABOUT ORGANIZING THE COMMITTEES; NOR DOES IT DEFINE THE COMMITTEES. APAC RECOMMENDED A COVENANT WHICH REQUIRES THAT THE GOI SUBMIT A PLAN WITHIN TWO YEARS OF THE INITIATION OF THE PROJECT THAT DESCRIBES THE ORGANIZATION, AUTHORITIES, AND RESPONSIBILITIES OF THE COMMITTEES AND PROVIDES A SCHEDULE FOR ACTIVATING THE COMMITTEES. THESE COMMITTEES SHOULD HAVE ASSURED FUNDING FOR OPERATIONS AND MAINTENANCE. IDEALLY, THEY SHOULD HAVE DIRECT ACCESS TO USER FEES.

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3. OPERATIONS AND MAINTENANCE: APAC FELT THAT PROJECT PAPER SHOULD HAVE DIRECTED MORE ATTENTION AND RESOURCES TO OPERATION AND MAINTENANCE OF IRRIGATION SCHEMES. IT WAS NOTED THAT IMPROVED DESIGN AND CONSTRUCTION STANDARDS PROMOTED UNDER PROJECT WILL DECREASE MAINTENANCE REQUIREMENTS. HOWEVER, TO FURTHER ENSURE SUCCESSFUL OPERATION AND ADEQUATE MAINTENANCE OF SCHEMES IT WAS RECOMMENDED THAT FARMERS BE INCLUDED EARLY ON IN DISCUSSIONS ON O AND M AND THAT APPRAISAL REPORTS BE REVIEWED FOR SUFFICIENT O AND M PLANS. IT IS ALSO URGED THAT THE MISSION EXPLORE THE POSSIBILITY OF EXTENDING A.I.D.'S INVOLVEMENT WITH A FEW OF THE EARLY COMPLETED SCHEMES TO EXPERIMENT WITH VARIOUS WAYS OF IMPROVING O AND M PROCEDURES WITH ACTUAL COMMUNITY MANAGEMENT SYSTEMS OPERATIONS, INCLUDING FUNDING SUPPORT IF NECESSARY.

4. POTENTIAL IMPLEMENTATION AND PIPELINE PROBLEMS: APAC QUESTIONED GOM ABSORPTIVE CAPACITY IN TERMS OF BUDGET SUPPORT AND TRAINED MANPOWER, PARTICULARLY IN VIEW OF MAHARASHTRA IRRIGATION TECHNOLOGY AND MANAGEMENT PROJECT (MITM) UNDER WHICH GOM HAS NOT YET PROVIDED SUFFICIENT STAFF AND ADEQUATE FUNDS. APAC WAS ALSO CONCERNED THAT, IN VIEW OF THE LARGE VOLUME OF DESIGN AND CONSTRUCTION IN THE MISSION'S PORTFOLIO, REQUIRING ENGINEERING EXPERTISE, THE MISSION DID NOT HAVE THE U.S. DIRECT HIRE ENGINEERING CAPABILITY TO MONITOR CONSTRUCTION OF 102 SEPARATE IRRIGATION PROJECTS. GIVEN THESE PERCEIVED CONSTRAINTS, APAC FELT THAT IMPLEMENTATION MIGHT MOVE TOO SLOWLY AND THAT PIPELINE PROBLEMS WOULD ENSUE. MISSION REPRESENTATIVE INDICATED MISSION SATISFACTION WITH PROGRESS UNDER THE MITM PROJECT NOTING THAT OVER 80 PERCENT OF GOM PROJECT STAFF WAS IN PLACE AND THAT PROJECT EXPENDITURE RATE WAS ACCEPTABLE. HE EXPRESSED CONFIDENCE THAT THE GOM WOULD PROVIDE SUFFICIENT FUNDS AND STAFF FOR THIS PROJECT. HE ALSO EXPLAINED HOW MISSION STAFF WAS ORGANIZED TO IMPLEMENT PROJECT AND ASSURED APAC OF MISSION'S ENGINEERING MONITORING CAPABILITY. APAC RECOMMENDED THAT IMPLEMENTATION AND MONITORING BURDEN BE TAKEN INTO CONSIDERATION IN DETERMINING SITES FOR USAID FINANCED SCHEMES.

5. DEGREE AND TYPE OF INSTITUTIONAL CHANGE: APAC FELT PP TO BE UNCLEAR AS TO DEGREE AND TYPE OF INSTITUTIONAL CHANGES THAT WOULD BE ACCOMPLISHED THROUGH THE PROJECT. PROPOSED ASSESSMENT OF IRRIGATION SECTOR SHOULD IDENTIFY MISSION'S ULTIMATE GOALS AND OBJECTIVES IN INDIA'S IRRIGATION SECTOR AND DISCUSS WHERE MISSION WILL BE IN REGARD TO THE ACHIEVEMENT OF THESE GOALS AND OBJECTIVES AS A RESULT OF THIS PROJECT.

6. TECHNICAL ASSISTANCE: APAC ENDORSED PP PROPOSAL TO TAP WATER MANAGEMENT SYNTHESIS PROJECT FOR TECHNICAL ASSISTANCE. IT WAS AGREED THAT THIS WOULD ACCELERATE PROJECT IMPLEMENTATION AND ENABLE THE MISSION TO COORDINATE TA FOR THIS PROJECT WITH TA BEING PROVIDED UNDER OTHER STATE SPECIFIC PROJECTS. TO COMPLEMENT ENGINEERING SKILLS OF OLSEN AND TO FACILITATE GREATER FARMER PARTICIPATION, APAC RECOMMENDING THAT LONG TERM EXPATRIATE FUNDED UNDER THIS PROJECT HAVE STRONG SOCIAL SCIENCE CREDENTIALS. HOWEVER, MISSION'S STATED INTENTION TO USE WMS II FOR TA TO SEVERAL STATE LEVEL PROJECTS RAISES SEVERAL IMPORTANT ISSUES FOR WMS II THAT MUST BE RESOLVED. THESE INCLUDE MANAGEMENT OF THE ACTIVITIES (GIVEN THREE MAJOR PARTICIPATING UNIVERSITIES IN THE PROJECT) AND THE LIKLIHOOD THAT THE PROJECT FUNDING CEILING WILL BE REACHED BY FY 86.

7. ECONOMIC VIABILITY: THE APAC NOTED THE PARTICULAR SENSITIVITY OF THE ERRS TO ASSUMPTIONS ABOUT THE PORTION OF THE DESIGNATED AREA TO WHICH IRRIGATION IS ACTUALLY PROVIDED, AS WELL AS THE UNCERTAINTY ABOUT UTILIZATION RATES BASED ON CURRENT PRACTICES. IN VIEW OF THIS SENSITIVITY, THE APAC RECOMMENDED THAT THE MISSION, IN EVALUATIONS, ENSURE THAT DATA ARE AVAILABLE THAT PERMIT RECALCULATION OF ERRS THAT REFLECT ACTUAL EXPERIENCE.

8. DISBURSEMENT PROCEDURES: FM CONCURRED WITH DISBURSEMENT PROCEDURES PROPOSED IN PP PROVIDED A CLEAR AUDIT TRAIL OF MISSION MONITORING AND DISBURSEMENT APPROVAL ACTIONS IS CREATED AND ANNUAL REVIEWS TAKE PLACE OF PROJECT RELATED FINANCIAL RECORDS MAINTAINED BY THE GOM. THESE REVIEWS CAN BE CONDUCTED BY GOVERNMENT AUDIT AGENCIES OR INDEPENDENT ACCOUNTING FIRMS PAID BY LOAN PROCEEDS.

9. PROJECT OUTPUT: APAC NOTED THAT THE PROJECT COSTS WERE BASED ON THE COST PER HECTARE OF IRRIGATION AND DRAINAGE SYSTEMS. AS SUCH THE APAC CONCLUDED THAT THE PROJECT PAPER SHOULD BE ADJUSTED SO THAT RATHER THAN NUMBERS OF SCHEMES, THE OUTPUT WILL BE 31,000 HECTARES BROUGHT UNDER IRRIGATION CONSISTING OF APPROXIMATELY 50 SCHEMES INCLUDING THE REHABILITATION OF APPROXIMATELY 12 EXISTING SCHEMES. SHULTZ

Annex 8

सत्यमेव जयते

D.O. No.F.2(16)AID/83

भारत सरकार

वित्त मंत्रालय

आर्थिक कार्य विभाग

Government of India (Bharat Sarkar)

Ministry of Finance (Vitta Mantralaya)

Department of Economic Affairs (Arthik Karya Vibhag)

H C PANT
DIRECTOR (AC)
TELE: 372020

नई दिल्ली/New Delhi, 31st July, 1984.

Dear Dr. Brown,

This has reference to our recent discussion on US AID assistance for Maharashtra Minor Irrigation Project. The total cost of this six-year project is estimated to be $ 92.56 million. During the discussions, you had indicated that AID would be in a position to provide assistance to the extent of $ 50 million consisting of $ 46 million in loan and $ 4 million in grant form.

2. Government of India hereby request that an amount of $ 25.9 million ($24.9 million in loan and $ 1 million in grant) may be provided for this project as the first instalment. Subsequent instalments may be provided towards AID's total contribution as and when you have received necessary authorisation.

3. The Indian contribution for this project is expected to be $ 42.6 million. As the first instalment, it is proposed to provide $ 21 million, the balance would be provided in subsequent instalments.

4. I shall be grateful if you could kindly give the earliest consideration to this request.

With kind regards,

Yours sincerely,

(H C Pant)

Dr. Richard M. Brown,
Acting Director,
US AID,
New Delhi.

Best Available Document

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UNCLASSIFIED

AGENCY FOR INTERNATIONAL DEVELOPMENT

WASHINGTON, D.C. 20523

PROJECT PAPER

INDIA

MAHARASHTRA MINOR IRRIGATION PROJECT

(386-0490)

VOLUME II

PROJECT ANALYSIS

USAID/NEW DELHI

APRIL 1984

UNCLASSIFIED

MAHARASHTRA MINOR IRRIGATION PROJECT

Chapter I - Introduction and Summary

II - Institutional Analysis - Irrigation Planning

III - Technical Analysis

IV - Agricultural Background and Support Services

V - Social Analysis

VI - Economic and Financial Analysis

VII - Administrative Analysis

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CHAPTER 1

INTRODUCTION AND SUMMARY

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A. Overview of Minor Irrigation

The State of Maharashtra has a total area of approximately 30.8 million hectares of which 22.7 million ha or about three-fourths are considered to be cultivatable. Of the 22.7 million ha culturable, some 18.5 million or 80 percent are in seasonal and perennial crops, the other 20 percent are in natural pasture and fallow.

Of the 22.7 million culturable ha, two million or about nine percent are currently irrigated. A government study in 1962 indicated that if all water resources were developed, it would be possible to irrigate seven million ha or about 30 percent of the arable land.

Of the two million ha currently irrigated, about 40 percent is from major, medium, and minor surface irrigation schemes and 60 percent from wells and lift schemes.

Minor irrigation is defined as projects commanding less than 2,000 ha. As a matter of procedural practice those projects in the 600-2,000 ha range are subjected to the same design standards as medium projects.

Minor surface irrigation is divided between two sets of public institutions, the Irrigation Department for projects from 100-2,000 ha and the local community Zilla Parishad and Panchayat organizations for the under 100 ha group. The 100-2,000 ha schemes planned, constructed, and managed by the Irrigation Department are known as "State Sector Minor Irrigation Schemes". The schemes under 100 ha. which are constructed and managed by the Zilla Parishads and Panchayats are known as "Local Sector Minor Irrigation Schemes".

As of 1980, State Sector minor irrigation schemes had created an irrigation potential of 382,000 ha. Projects presently under construction are expected to add another 160,000 ha by 1985, making a total potential of 542,000 ha. This Project would further add a potential of 31,000 ha through the construction of 90 MISs and modernization of 12 schemes.

Unfortunately potential does not represent actual area irrigated. Rates of utilization vary from project to project and from year to year but seldom reach the design potential. An Irrigation Department study of minor tanks in the Bombay Region 1/ showed an average utilization during the Rabi season of 40 percent and an overall utilization of 28 percent.

1/ "Minor Irrigation Works in Bombay Region, Report Summaries," Minor Irrigation Surface Water Unit, Nasik.

The reasons for underutilization are varied and complex [2/] and will be the focus of special studies and pilot schemes as well as the construction and other design criteria to be required under the Project. Ineffective utilization of irrigated potential results in high costs per ha irrigated. An additional cause for high cost/ha irrigated is that public systems are extensive systems purposely designed for a lower cropping intensity to maximize the number of beneficiaries under each scheme. While it is not expected that construction costs will be lowered under the project, it is expected that there will be major gains in water utilization resulting from increased efficieny of irrigation systems operation and thereby lowered costs per irrigated hectare (See Chapter VI, Economic Analysis).

State Sector minor irrigation involves all of the traditional irrigation institutions - ID, AD, GSDA, LBD's, Cooperatives and universities to some extent, and farmer irrigators. This project will focus on improving the capacities of these institutions to plan, design, construct, operate, maintain, and manage minor irrigation schemes.

B. Organization for Minor Irrigation

The organizational structure for executing the project will require the creation of several additional organizational units (See Chart I). The organizational units to be created, their primary function, and staff composition are as follows:

1. Minor Irrigation Committee (MIC)

The MIC will be composed of the representitives of each Department involved, i.e. Agriculture, Rural Development, Finance, Planning, etc. and chaired by the Secretary Irrigation. This committee would provide overall policy and opertional guidance and control and would be the final authority for approval of individual MI schemes under this Project. It would also recommend budget allocations among Departments and the staffing required. Departments will receive the budget required to carry out their part of the Project directly from the Finance Department.

2. Special Appraisal and Supervision Cell (SASC)

The SASC will be headed by a Superintending Engineer, assisted by two Executive Engineers, two Dy. Directors-Agriculture, four Assistant Engineers, one Economist, one Statistician and

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2/ See the Report Summaries, op cit, and the "Report of the High Power Committee", Irrigation Department, Government of Maharashtra, November, 1981.

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supporting staff and will work under the control of the Chief Engineer-Jt. Secretary dealing with MI works at Government level.

This cell would be responsible for:

a. Preparation of appraisal reports of individual MI schemes to obtain approval from MI Committee.
b. Coordination of planning and designing of MI schemes in accordance with the criteria agreed to in the Project Paper.
c. Supervision of the implementation of the Project and periodic program reviews including quality control.
d. Maintain liaison with the implementing agencies and the USAID and GOI.
e. Manpower training and development.
f. SE/SASC will serve as Member Secretary of the Minor Irrigation Committee.

This cell would have two separate units for scheme appraisal/approval, supervision, and implementation, and a unit for manpower training and development.

3. Special Analysis and Evaluation Cell (SAEC)

This cell will be headed by a Superintending Engineer, assisted by three Executive Engineers, two Economists, two Agronomists, two Statisticians, one Sociologist, five Deputy Engineers, and other supporting staff. The SAEC will work under the control of the Regional Chief Engineer who will be acting as Coordingating Chief Engineer for implementation of this Project. Three units would be created within this cell.

a. The Special Studies and Pilots Unit would be responsbile for: (1) special studies, (2) pilot schemes planning and design, including preparation of scheme report, and (3) diagnostic analysis.

b. The Modeling and Data Unit would be responsible for: (1) development of the minor irrigation system model, and (2) data collection and model application.

c. The Monitoring, Evaluation and Survey Unit would be responsible for: (1) benchmark and follow-up surveys through contracts to the agricultural universities, (2) compilation and scrutiny of reports on the studies, pilot activities, evaluation, etc. to be sent to GOM/USAID, (3) monitoring of institutional and socio-economic variables, and (4) preparation of claims for reimbursement.

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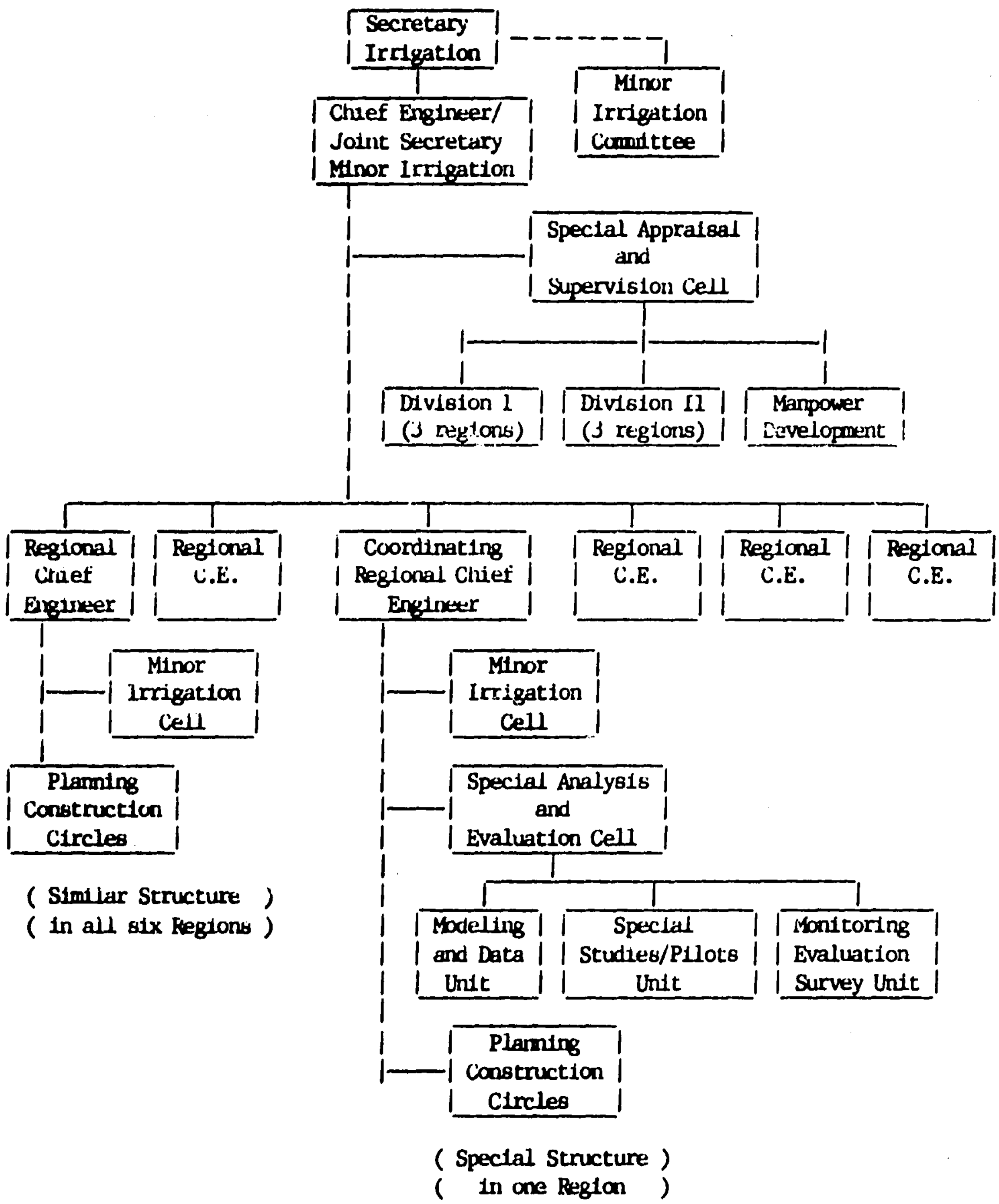
Chart I - IRRIGATION DEPARTMENT ORGANIZATION FOR MINOR IRRIGATION



4. Regional Minor Irrigation Cells (RMIC)

An RMIC would be created in each of the six ID administrative regions. These cells will be headed by an Executive Engineer, with two Deputy Engineers, two Sub-division Agricultural Officers, and four Junior Engineers, with allied supporting staff and will work under the control of the Regional Chief Engineer of each region.

The Cell would be responsible for:

a. Monitoring and assisting regular circles in preparation of project reports for MI schemes in the region according to the agreed design criteria.

b. Monitoring and coordination of the activities of soil and topographic surveys, distribution system planning, and land development work on the MI schemes in the region.

c. Data collection and minor irrigation model application for preparation of project reports.

d. Quality control on MI schemes.

e. Monitoring and evaluation of MI schemes in the region.

5. Regular Circles

The regular circles under the regional CE which are currently responsible for planning and construction would construct all of the MIS's. The planning and design of pilot schemes will be done by the SAEC assisted by the RMIC's. The regular circles will plan and design all non-pilot schemes, assisted by the RMIC's and the SAEC.

In order to facilitate the early establishment of these units and the early sanctioning of appropriate staff, the costs for these special units will be fully loan funded for the first three years of the Project. Thereafter, the GOM will be fully responsible for these staff costs.

C. Project Elements

The purpose of the project is an improved ability of institutions to plan, design, construct, operate and maintain, and manage minor irrigation systems efficiently and economically. As indicated above, the institutional focus will be on the ID and AD and other institutions involved in state sector minor irrigation.

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Current standards and practices for planning, design, construction, O&M and on-farm water management have been analyzed and the results of this analysis are presented in the remaining chapters of this Volume II.

The program elements evolved from this analysis that will achieve the project purpose of improved institutional capacity are (1) studies and pilot activities to explore new approaches to improving irrigation performance, including (a) improvements in basic data collection and analysis procedures to better understand how MIS systems work; (b) development and use of a minor irrigation model that will permit integrated consideration of the catchment, reservoir and the area under irrigated command; (c) diagnostic analysis and renovation on 12 existing minor schemes; and (d) about 30 pilot investigations that permit analysis and demonstration of new planning, design and management ideas in all regions of Maharashtra; (2) the creation of four new organizational entities to enhance the GOM's capability to manage its minor irrigation program; (3) the construction of 90 new MIS's using improved criteria for increasing irrigation water utilization and therefore efficienc . . economy; and (4) support for a state-wide hydrologic data base improvement program.

1. Studies and Pilot Activities

An extensive system of data collection, diagnostic analysis and demonstration of minor irrigation scheme improvement is proposed to be conducted in the six administrative regions of the ID. The background and rationale for the studies and pilot schemes is included in the Chapters which follow and will not be repeated here. A summary listing and short description is provided.

a. Data Collection and Analysis

(1) Data Collection and Processing: A computerized data library and information processing system will be developed to obtain and systematize basic hydro-meterological data from existing and new schemes. A special effort will be made to include the collection of groundwater profiles and agricultural land use patterns in the data base. A high speed plain paper copier will be installed in the SAEC to facilitate supply of appropriate data throughout the State. (III.C.1)

(2) MIS Instrumentation: New or augmented climatological stations will be established in the commands of each Project financed scheme. Appropriate hydrologic instrumentation will be installed, including a continuous stage recorder on the tank and one on a stream gauge installed below the command of each scheme financed under the Project. (III.C.1)

(3) Diagnostic Analysis: Twelve existing schemes identified as basic data sources for the minor irrigation systems model development will also be subjected to diagnostic analysis for problem identification and proposed solutions. (III.C.2)

(4) Minor Irrigation Model: Development of a computer model of minor irrigation systems and its testing will require extensive operating data from some existing schemes. For this purpose, two schemes having good operational data will be selected from each region. The data will be assembled by the Regional MI Cells and provided to the SAEC.

The SAEC will be responsible for development of the MIS model and will organize, with appropriate TA, training programs for Regional MI Cells, AD, GSDA, and University staff in the model's use. The model will be used to analyze and design each pilot experiment and, after being fully tested and developed, will be used on all schemes to be financed under the Project. Micro computer hardware and software will be provided at each region and at the SAEC. (III.C.3)

(5) Other Studies

(a) The setting of sill levels for tanks, the accommodation of the silt load to be deposited in the tank, and maximization of live storage at each site are interrelated factors not well understood presently. Comprehensive studies and analysis of these and other factors will result in recommendations for more efficient and economical dam and tank design. (III.B.2.b)

(b) The ID will analyze the pros and cons of sizing reservoirs on a 50% dependability (current practice) and the command area on a 75% dependability (not current practice) and propose design criteria for use on MIS's. (III.B.3.c.)

(c) The ID will investigate rotational water supply (RWS) systems and devise one for application on project supported MIS's. An operational study using the MIS systems computer model will analyze rotational water supply and demand delivery of water to water user associations to evolve the most effective operational strategy. (III.C.8)

(d) A survey and analysis will be made of "participation" on existing MIS's schemes. The purpose is to document the extent and nature of participation by irrigators in planning, design, construction, operation, maintenance, and on-farm water management; assess the adequacy of participation; and make recommendations for more effective participation, if this appears either desirable or necessary.

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There are a number of participatory processes that have been tried in Maharashtra including the Phad system in Dhule District, the Khajana well in Beed District and the Malguzari tanks in Bandhara and Chandrapur Districts. The AD will contract with an Agricultural University to conduct an in-depth interdisciplinary analysis of these for comparison with on-going schemes. (II.D.1)

(e) On-going studies of how best to organize farmers to operate and maintain irrigation systems will be collected and analyzed by a committee appointed by the GOM. This committee would report at the end of the second year of project life. (III.C.9)

(f) On the piped distribution pilot schemes, the AD will contract with a University to analyze the costs of Part II works required under sprinkle irrigation and compare with costs of Part II works required for land shaping and leveling under surface irrigation. (III.C.3.a.)

(g) An extensive set of baseline surveys are proposed which will cover a sample of Project financed schemes, the pilot schemes and samples of both beneficiary and non-beneficiary farmers in Maharashtra. These same sample sets would be surveyed for evaluation purposes. [II.B.3.b.(1)]

b. Pilot Investigations and Demonstrations

Pilot investigations/demonstrations are concentrated on key planning and technical design issues. A planning team or committee would be created for each of the pilot schemes and would be responsible for preparing a report with recommendations for the technical and organizational substance of the pilot activity which will guide the design and implementation of the pilot schemes.

Cropping pattern selection is a critical choice for irrigators, who currently have very little input into the selection. All ten pilot schemes will go through the analytical processes set up for involvement of irrigators and other institutions in cropping pattern selection. [II.B.3.a.(1)]

Development of groundwater and conjunctive well/canal water utilization has been identified as a key issue in minor irrigation. Technical and institutional issues will be identified and analyzed in conjunction with the MIT&M Project. (III.C.5.c.)

Financing groundwater development has been identified as a critical variable in optimizing conjunctive use on existing schemes. An existing sub-project under the MIT&M Project will be

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analyzed for groundwater development potential. Local financial institutions will be involved in planning and offering a financial package for new wells and the repair and renovation of old wells. [II.B.3.a.(2)]

New technolgical innovations will also be tested. Two or three new schemes in the Konkan region will be selected to experiment with a closed distribution system. Selected chaks in one or more of these schemes will experiment with gravity fed sprinkler irrigation. (III.C.5.a.)

Demand scheduling of irrigation water deliveries appears to have advantages over the current Shejpali system. Demand scheduling provides a more reliable irrigation water supply but requires a user organization to make water scheduling decisions. One of the closed systems in the Konkan Region and one other open system would be selected. Experimentation with this new water scheduling system will be initiated with an analysis and design by USAID provided technicians. (III.C.5.b.)

All schemes financed under the Project will be required to develop demonstration chaks which will show farmers the latest agricultural development technology, including optimum water utilization. All pilot schemes are included in this program. (IV.E.)

The catchment of a minor irrigation tank is a critical element in the overall scheme. The yield of water for irrigation and the length of life of the reservoir due to siltation are critical variables determined by the nature and treatment of the catchment. Two existing schemes and three new schemes may be selected to have catchment treatment programs that may be financed under the Project. The instrumentation to be installed on each scheme will measure water inflow and other variables. The initial sediment content of the reservoir will be determined and annual sediment deposits estimated. (IV.F.)

One new pilot scheme in the Aurangabad region will be selected to examine agricultural support programs for women agriculturalists that can be recommended, generally, for irrigated agriculture. (V.C.5)

Pilot scheme planning will be by teams created for each pilot. The analytical work and final designs report preparation will be the responsibility of the RMI Cell assisted by the SAEC. Leadership of the planning team for each pilot experiment will be with various institutions depending on the nature of the pilot.

Crop mix planning would be under the leadership of the AD which is responsible for sanctioning cropping patterns for MIS's. Conjunctive use analysis and development would be under the leadership of the GSDA. AD would handle the agricultural development chaks. The ID would take leadership on the remainder. Appropriate institutional representatives from the region including farmer irrigators in all cases, would be on the planning team for each pilot experiment. This integrated, multidisciplinary involvement will assist in achieving appropriately designed and implemented pilot experiments.

After each pilot scheme is designed, it will be implemented at field level, guided by the RMI Cell, and with participation of other institutions in their normal roles, ie, ID Circles for construction, AD for land development works and so on.

The various pilot investigations and demonstrations identified above will invove eight new schemes and two existing schemes. About 30 separate investigations will be conducted and reported on as part of the improvement program for building institutional capacity to plan, design, construct, operate, maintain, and manage minor irrigation schemes in Maharashtra.

The planning and design costs of each of the pilot experiments will be loan funded, as will construction and other non-planning and non-design costs. Data processing, technical assistance, and imported equipment will be grant funded.

2. Construction Program

Ninety new schemes will be constructed under the project. All will receive climatological and other instrumentation as part of an improved irrigation data base for Maharashtra. Twelve existing schemes that have a well documented hydrologic and irrigation history would be selected to provide the data base for the minor irrigation systems model. These schemes will be renovated as suggested by the diagnostic analysis.

3. Professional Development

The most important aspect of improving the capacity of irrigation institutions is the training of staff in the technical, analytical, and managerial skills required for irrigation development and management. The following listing identifies the training, the target audience and estimated TA requirements.

Description of Training	Target Audience	Person Months of TA
a. Short course on computer simulation modeling and information management (Three weeks)	ID-SAEC- 5 (State) - 10 (region) AD-5 GSDA-5 Univ.-5	2
b. Short course on operation of MIS model (Four weeks)	ID-15 AD- 5 GSDA-5 Univ.-5	
c. Short course on irrigation system management under demand scheduling (Two weeks)	ID-SAEC-5 (State) SASC - 5 (State) 30 (region)	1
d. Short course on field irrigation practices like flow measurement, computing and measuring crop water requirements, and evaluation of on-farm water management practices (One week)	ID-50 AD-50 Univ.-10	1
e. Workshop on irrigation methods (Id-1/pilot; AD-2/pilot; farmers-3/pilot) (One week)	ID-10 AD-20 Farmers-30 Univ.- 5	6
f. Planning and layout of minors, water course and field channels (20 - 10 day workshops for 20 participants each)	ID-100 AD-300	6
g. Short course on soil fertility and soil moisture interactions in crop yield, as well as diagnosis, prevention, reclamation, and management of soil salinity (2 subject matter specialists/district = 60) (Two weeks)	AD-60 Univ.-10	2

Description of Training	Target Audience	Person Months of TA
h. Train subject matter specialists (SMS) in on-farm water management Long-term course at WALMI	30	-
i. Workshops on farmer organization	AD-50 ID-10	2
j. Workshops for training trainers for agricultural development chaks (30 districts x 5 AD and 1 ID = 180 (Two weeks)	AD-150 ID- 30	-
k. Workshop for training farmers at each scheme (10 x 100 schemes) (One week)	Farmers-1000	-
l. Train field level extension staff for water management (One week)	100	-
m. Train field level extension staff capable of working with and assisting female farm operators. (10 participants - One week)	AD-10	-
n. Train local contractor and ID and AD supervisory staff in proper construction methods, quality control, and so forth, particulary in Part I and Part II works (3 regional level workshops = 18 workshops x 20 participants = 360 participants - One week)	360	3
o. Observation tours for mid-level and senior officers in the U.S. and other countries to observe irrigation water management	ID-20 AD- 5	-

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4. Technical Assistance

The technical expertise required for various aspects of the new technology being proposed are listed below. These requirements, plus TA required for training, total 79 person months of work on the job. It is proposed to provide this TA through a resident team located in Maharashtra, plus short-term expertise. A team, headed by an expatriate irrigation water management specialist and including two Indian irrigation specialists, would be required full time for at least the first three years of the Project and about one-third time during the last three years. As resident staff they would work half time to supply about 40 person months of the required TA listed below. The remaining 39 pm would be supplied by short-term experts. The resident team would spend the other half of its time on monitoring and implementation.

Description of Work	TA Disciplinaries	Requirement	Total Person Months
1. Development of a computerized data library and information processing centers	Irrigation engr. Computer prog. Social scientist	1 person month for each	3
2. Minor Irrigation System Model	Irrigation engr. Economist Irrigation agron.	2 person months per year for two year for each	12
3. Diagnostic Analysis	Irrigation engr. Irrigation agron. Economist Sociologist	1 person month each in year two and year four 1/2 person month each in year five	10
4. Water Measurement Manual	Irrigation engr.	2 person months	2
5. Irrigation Field Guide	Irrigation engr. Irrigation agron.	2 person months each	4
6. Gravity-fed Piped Distribution Network and Sprinkle Irrigation Systems under MIS Tanks	Irrigation engr.	3 person months	3
7. Demand Delivery Scheduling	Irrigation engr. Sociologist	1 person month per year for three years 1 person month	4
8. On-Farm Water Management	Irrigation agron.	1 person month per year for five years	5
9. Crop Mix Pilot	Irrigation agron. Economist	1 person month 1 person month	2
10. Conjunctive Groundwater Use Pilot	Hydrogeologist	1 person month	1
11. Monitoring/Evaluation/Baseline Surveys	Social scientist	2 person months	2
12. Women's Pilot	Sociologist	1 person months	1
13. Survey and Analysis of Farmer Participation	Social scientist	1 person month	1
14. Reservoir and Command Area Sizing Study	Irrigation engr.	2 person months	2
15. Analysis of Setting Sill Levels	Irrigation engr. Economist	1 person month 1 person month	2

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5. Improvements in Hydrological Data Base

In order to have a more accurate and extensive hydrological data base for improved project design of all types of irrigation projects, the GOM has proposed an instrumentation and data collection program to be financed under the Project. It is proposed to establish 275 additional hydrological stations which would be of different grades, depending on the sophistication of the equipment provided, and located throughout the major river basins of the State. In addition, micro-computers would be established at the headquarters of the Superintending Engineer (Bombay) supervising this work, to facilitate analysis of the data for basin-wide studies as well as individual projects. The computers would be grant financed under the Project.

The Grade "A" station would incorporate instrumentation for measurements of evaporation and evapotranspiration, temperature, wind velocity and direction, sunshine hours, humidity water quality and silt load. In addition to ordinary and automatic raingauges, arrangements for discharge measurements with current meter(or floats in case of Grade B stations) would be included.

Each type of station also includes the necessary infrastructure, such as buildings at the river gauging sites for operation and maintenance of the station.

Of the 275 stations, 52 would be financed under this Project. Financing the remaining stations will be arranged by the GOM. Thirty Grade "A" and 22 Grade "B" stations would be financed. Thirty Grade "A" stations are estimated to cost $1.35 million, including $30,000 in FX costs for imported equipment. Twenty-two Grade "B" stations are estimated to cost $650,000, for a total of $2 million.

These costs are broken down as follows: $840,000 for domestic equipment to be loan financed under the Project; $30,000 for imported equipment and $15,000 for computers to be grant financed; $1,070,000 for site preparation and buildings to be financed by the GOM; and $90,000 in annual establishment costs for operation and maintenance, also to be financed by the GOM.

D. Proposed Planning Design and Implementation Criteria

Following is a brief summary of proposed criteria and requirements for effective execution of the Project.

1. Technical Consideration

a. Water Supply: The hydrology of the proposed MIS's will be developed using the "Manual of Minor Irrigation Works in Maharashtra State; 1983", unless modified by the special studies and pilot projects. (III.D.1.)

b. Water Budget Analysis: A monthly or rotation water budgeting analysis will be made to determine acreage to be commanded, canal and distributary capacities, and delivery rotation. Details regarding calculating crop water requirements and conveyance and on-farm efficiencies are in Chapter III, Section D.2.

c. Dam and Reservoir Design: Design would be according to existing standards unless modified by studies on silt load and associated design criteria. Evaporation losses from the reservoir would be estimated as for crop water requirements. (III.D.3.)

d. Surveying and Mapping: Detailed soil and topographic surveys will be made. (III.D.4. and IV.G.9.)

e. Distribution and Conveyance Network: Conveyance design and layout would start with field channels and water courses and move toward the canal and dam. Only sandy or murrum substrata areas would be lined. Hydraulic conductivity tests will be made to identify potentially high loss areas. (III.D.5.)

f. Land Development: Land leveling/grading will be conducted on a uniform field slope that minimizes the depth of soil disturbed. (III.D.6.)

g. Groundwater Development: The State will evolve a suitable methodology for exploiting groundwater available in the command area and integrating it with the system of surface irrigation. (III.D.7.)

h. Water Allocation and Rotation: Water will be allocated under a modified Shejpali system that is strictly enforced. ID will study the applicability of RWS systems for Project supported MIS's. (III.D.8.)

i. Operation and Maintenance: ID will be responsible for O&M in the early years of a scheme. ID and AD will organize farmers in outlet committees to take over responsibility for O&M. (III.D.9. and II.D.3.)

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2. Other Considerations

a. A special effort to maintain quality of construction will be required, including quality control sub-units of the SASC located in the RMIC of each region. Involved contractors and AD and ID supervisory staff will receive training in construction quality control, particularly of Part I and Part II works. (VII.B.5.c.)

b. Substantial additional technical and professional staff will be required to effectively execute the Project.

(1) Irrigation Department

(a) The SASC and SAEC must be staffed at State and regional levels. (I.B.2. and 3.)

(b) The Regional Minor Irrigation Cells as new units will require additional staff. (I.B.4.)

(c) The regular Circles and Divisions will require additional staff for construction and for planning of non-pilot MIS's. (I.B.5.)

(2) Agriculture Department

(a) Subject Matter Specialists (SMS) in on-farm water management will be required at district level in all areas having Project financed MIS's (IV.G.2.);

(b) Field level extension staff for water management will be required for each Project financed MIS's (IV.G.2.);

(c) Field level extension staff capable of working with and assisting female farm operators will be required on one pilot (V.C.5.);

(d) The Soil Conservation Section will require additional staff to handle Part I and Part II works (VII.A.2.) and the pilot catchment treatment program (IV.F.).

(3) Other Departments

GSDA, Cooperatives, etc, may also require additional staffing. These needs will evolve as project implementation is planned in detail.

(4) Creation of new ID organization units (I.B.) and sanctioning of ID and AD staff required to carry out the Project will be a condition precedent to initial disbursement of loan funds. (VII.A.1. and 2.)

c. The GOM will arrange compensation for persons left with uneconomic sized units as a result of land acquisition for Project purposes by way of giving them priority rights for tank bed cultivation by way of giving priority for tank bed cultivation (V.C.4.).

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d. Budgets for schemes financed under this Project will be allocated directly at State level. (VII.B.2.)

e. The AD will initiate extension activities in schemes commands two years prior to availability of irrigation water. VEW's for each scheme will be trained and in place before initiation of extension activities. (VIII.B.5.b.)

f. The ID will provide at least one resident Canal Inspector for each scheme. (VIII.B.7a.)

g. The AD, CD, aud ID will organize outlet committees and water user cooperatives on each Project financed scheme. (II.D.3. and III.D.5. and 9.)

h. Economic evaluation using discounted cash flow analysis will be required. An ERR of 12 percent, with some exeptions at 10 percent, will be required. (VI.E.).

CHAPTER II

INSTITUTIONAL ANALYSIS

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A. Introduction and Methodology

Under this project it is intended to apply the methodology of "diagnostic analysis and search for solutions in live situations" to identify institutional models, structures, procedures and approaches which are actually working in the field. Once understood, these small or large successful experiments can be extended, expanded and replicated. Possibilities will also be identified where these successful institutional elements may even be grafted onto other institutional structures where they would appear to be useful.

It should be obvious that to be useful in suggesting expansions and transplants of successful institutional elements one must understand what is going on institutionally, be able to evaluate performance, and understand why certain things work and others do not. Though that is obviously an ambitious task, there does not appear to be an easier way to do the necessary analysis.

The Mission's overall irrigation strategy is centered on institutional improvement in six functional areas: planning, design, construction, operation, maintenance and on-farm water management. This chapter focuses on the institutional analysis of these functional areas.

B. Irrigation Planning

The next few paragraphs outline what planning means and how it differs from design.

1. Planning as Distinct from Design

Planning is that process by which public and private entities develop a plan of action with reference to irrigation. It is the part of the cycle where general guidelines, policies and approaches are developed, where technological alternatives are identified, and where crop mix strategies and design standards are developed. As defined, planning is not project specific. It comes before site identifications and specific project designs are undertaken. Planning is however an ongoing process of updating strategies and standards based on experience with specific projects. By the above definition, research and development activities, pilot and experimental projects, studies and evaluations are all a part of planning. The boundary between Planning and Design is crossed when one begins to identify sites for specific projects and begins to apply the design standards at one of those sites.

2. Assessment of Current Planning Efforts

The distinction between planning and design explained above facilitates making a major point about irrigation instititions. The point is that in the Irrigation Department there is a lot of reasonably adequate design and construction up to the outlet, but little real planning as defined above. Below the outlet there has been almost no real planning, design, or construction by anyone but farmers. Farmer performance in planning for flow irrigation use is seriously hampered by inefficient distribution procedures and non-existent distribution facilities. The ID and AD are now committed on schemes initiated after 1980 to constructing distribution works to the farm gate. Most of the other public sector entities (GSDA, Universities, and financing institutions) are isolated from any planning role in surface irrigation which is dominated by the ID.

In groundwater and lift irrigation, the institutional entities are agroindustrial and marketing coops, individual farmers and public finance institutions whose planning processes are too little understood to reach any conclusions about their performance or how it could be improved. The prime beneficiaries (both direct surface users and indirect groundwater and lift users) are not involved in the planning of the public sector systems which are (by and large) the source of their water.

It is important to recognize that being involved in planning is not what is normally meant in the literature by participatory involvement in planning by small farmers through water users associations. Planning irrigation rotations and canal locations or participatory maintenance of tertiary distributaries are much smaller issues than the kind of participation under discussion. The kind of participation farmers want covers real system planning decisions such as what crops to grow with the water; and how to really get control over water use. This involves irrigation frequencies which go far beyond the capacity of traditional rotational turns (onions may take water each 8 days for example) and seasonal availabilities which go beyond what the government planning system is prepared to allow (perennials require year round irrigation). What is required is joint public and private planning of complex conjunctive use, intensive cropping patterns, flexible seasonal and on-demand supply systems.

The physical realities of water in Maharashtra demand a planning system which integrates groundwater, surface water, and private and public institutions. The monsoon, topography, soils, and illusive basalt fissures dictate the nature of the final solution.

In the public sector the lack of flexible, creative, and vigorous "planning" has resulted in design being frozen into "cookbook" solutions, in many cases resulting in extremely high costs and ineffective systems. Most often these solutions ignore the possiblities and problems unique to each site and miss important groundwater and below-the-outlet opportunities for more efficient water use. There is a lack of attention regarding the final impacts of the systems on basic production, small farmer income, employment and famine protection objectives.

Without clear and measurable final objectives, the public sector planning system does not allow consideration of the bigger and more complex picture of irrigation which is the true planning environment, rather than a heavy focus on building more dams.

This is not to say that dams and canals are not urgently needed. It is the very existence of the large number of dams which has created most of the really attractive opportunities for conjuctive use and more efficient on-farm technologies. Dams slow the monsoon water down and create both surface and highly productive groundwater potentials. To harvest these potentials will require a radically different level of creative evaluation of alternatives and aggressive planning, research, development and training.

3. Recommendations for Institutional Improvement in Irrigation Planning

The complexity of the water system and the alternative configurations of any truly efficient system to exploit its opportunities demand integrated planning with multiple objectives and multiple institutional involvement. Rather than propose a statewide rearrangement of the way planning takes place, a series of targeted pilot demonstration cum experiments are recommended to explore and perfect ways in which the various institutions can interact to bring about effective planning.

ID documents indicate that the current costs of their minor systems are uncomfortably high and that the utilization rates of the water are very low. These two are obviously interrelated and institutional efforts under the Project will be designed to increase utilization and therefore reduce unit costs. Accomplishing these two objectives will require involving farmers and other institutions in the planning process.

In the pilot schemes proposed below the involved institutions including the farmers should achieve three things: first, a better understanding of the complex water situation and the necessity for interacting in planning its use; second, institutional formats for interacting in integrated planning; and third, planned systems which actually increase the achievement of the stated final objectives.

a. Planning by Objective Pilot Schemes

As mentioned earlier the design of minor irrigation projects is guided by the specifications in applicable engineering and other manuals. Irrigation does have stated objectives clearly outlined in national and state planning documents. These objectives include famine protection, income distribution to weaker sectors and small farmers, and employment generation. These terms are often mentioned in discussions with irrigation staff but there is no mechanism for using them as planning tools. The ID has no way of knowing how projects impact on these objectives and no way to analyze different configurations of system elements for particular sites to increase the impact. This project will address this situation through the development of a minor irrigation systems model, supported by appropriate computer equipment and training, and a series of pilot investigations and studies directed at specific issues and problems which will utilize the model in analysis and design. The pilots and studies are described in this and following chapters.

Many of the factors which determine the impact of minor irrigation projects - cropping patterns, availability of groundwater, input and produce markets and developmental and operating finance - are not the direct responsibility of the ID, and it is this fragmentation of responsibility and lack of adequate attention from the institutions involved that is partly responsible for inadequate designs and inefficient water utilization.

The intent of the planning pilots is to explore ways of bringing the various institutions together to plan so that they will relate better during the operation phase. The planning pilots deal with essentially non-engineering institutional elements which appear to be hampering the effective functioning of minor irrigation tanks. Two planning pilots are proposed dealing with cropping pattern selection and conjunctive ground and surface water use planning and financing.

(1) Planning Crop Mix

Selecting the cropping pattern to be used is easily the most complex and important choice to be made in irrigation planning. From this choice flow almost all the design elements which will determine the magnitudes of impacts on final income, employment, nutrition and famine protection objectives. Crop mix determines the type of rotational system which will be adequate and hence the engineering design of distribution systems (size of canals or pipes) and many other considerations. Planning cropping patterns is the part of irrigation planning in which farmers express a strong interest in freedon of choice rather than living with government prescribed cropping patterns. In fact, evidence from Maharashtra* indicates that actual cropping patterns vary significantly from those proposed in project reports.

The objective of this pilot will be to explore and implement the institutional process of integrating the many entities which must be included if the cropping pattern choice is to be a rational one aimed at achieving final irrigation objectives of both farmers and the Government.

Two existing schemes and eight new schemes would be involved in this pil...

The institutions to be involved are:

1. The farmers in the command,
2. ID Project Design engineers,
3. Selected university crop production and marketing specialists,
4. AD Cropping Pattern specialists.
5. Cooperative Producers or Marketing associations including NAFED, and
6. Primary Credit Societies and Nationalized Banks.

The pilots would be organized and conducted by the AD. The AD would carry out a land use capability survey as soon as pilot sites are identified. Staff from the Agricultural University serving the pilot area, set up in teams of 2 to 4 depending on the agroclimatic type and situation of each site, would assist. There would be an initial survey by the university staff of cropping pattern possibilities from agronomic, economic and marketing points of view. These would include the necessary data regarding each crop

* Dhamdhere H.V. and Padhye, V.S. in "Scheduling of Irrigation", given at the National Workshop on Scheduling of Irrigation present evidence from the Mula project showing that actual cropping patterns reflect more sugarcane and hot weather groundnuts - high value crops - and less of Kharif seasonals and cotton than planned in the project report.

choice to permit computer analysis. These initial surveys would be the start of the process which would involve direct interaction of the various institutions named above.

The formats for that interaction would be evolved at each pilot and the experience of the various teams would be exchanged in seminars and be the final written outputs of the pilot. The mincr irrigation model to be developed under the Project (see Chapter III) would have a crop mix routine which would show quickly the annual, seasonal, and monthly income, employment, cash flows, credit needs, marketing flows, water requirements and other variables of different crop mixes. This would assist the various involved institutions in quickly seeing the implications of their choices. Each cropping pattern selection initial cycle would take not more than three months, at the end of which the University staff would submit a report on the process and substance of the pilot experience. The report on substance would be prepared by a university team member. The design of process, its evaluation and the final process report would be the responsibility of an extension specialist from the University Extension Department.

The AD, farmers, and other institutions would have responsibility for implementing the cropping mixes resulting from this planning process.

(2) Conjunctive Use Groundwater Planning and Finance

Conjunctive use planning and the involvement of different financial and executing institutions has been identified by both the Barve Commission* and the team as critical to efficient functioning of minor irrigation. The idea is to explore alternative institutional formats for financing full development of the groundwater resources on existing schemes.

The institutions involved would include:

1. The Groundwater Survey and Development Agency
2. The Farmers in the Command
3. ID Project design and operation engineers
4. The Land Development Bank
5. The Disrict Cooperative Banks & Primary Credit Soc.
6. The Local Lead Nationalized Bank

* Maharashtra State Irrigation Commission Report, 1962.

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The GSDA would provide the leadership for this pilot investigation. The investigation would be started by a detailed survey of the command groundwater system by the GSDA. The survey results would be integrated with the data to be gathered regarding system operation and be incorporated into the minor irrigation models.

The model can then provide rapid read outs of different well configuration, different monthly and daily well draw down and irrigation patterns, and the implications of different goundwater development and management patterns on final cropping patterns. The various participants can see how the groundwater could be used to provide more in income, employment and production terms.

The LDB's, cooperative banks and lead nationalized banks would develop a program for financing additional new wells required and rehabilitating existing wells as necessary for full groundwater development.

Conjunctive use analysis has been provided for in the Maharashtra Irrigation Technology and Management Project. This pilot investigation will be incorporated with the analysis done under that project.

b. Monitoring and Evaluation System

Perhaps the most important institutional mechanism for improving planning is the institutionalization of a systematic and effective process of monitoring and evaluation of ongoing projects. For a time (1976-1979) ID set up such a unit in Nasik for the Bombay Region with responsibility for evaluating on-going minor irrigation projects and making recommendations for improved design, organization and other matters that would increase utilization of irrigation water. This unit issued a summary report in 1979/80.*

Under this project a monitoring, evaluation and survey unit (MESU) will be set up in the SAEC. A sub-unit would be established in each Regional Minor Irrigation Cell. The MESU would have responsibility for initial benchmark surveys and for follow up surveys that assess the actual progress being made in the minor irrigation program, identifying the problems being encountered by farmers, and providing the basis for recommended improvements. This unit would contract with the Agricultural Universities for the survey and analytical work.

*"Minor Irrigation Works in Bombay Region, Report Summaries," Minor Irrigation Surface Water Unit, Nasik, 1979.

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The monitoring and evaluation system, the diagnostic analysis, and the whole pilot effort are seen as the principal mechanisms for bringing about improved integrated planning. The diagnostic analysis and pilot schemes are seen as producing viable working alternatives for continuing analysis and to prevent stagnation for lack of fresh ideas and functioning examples. This is the heart of the institutional improvement methodology which is borrowed from the Lowdermilk-Svendson approach called "searching for solutions in live systems." There will be some 20 or so live systems specifically used to search for solutions. Keeping everyone focused on ways to use minor irrigation to improve farmer income, increase employment, and grow more food and fiber is the essence of the system.

The monitoring and evaluation will require extensive benchmark and evaluation data. Data collection would be by sample surveys managed by one of the Universities. The capacity of the Universities is adequate to undertake this work. Where the Universities will need help is not in data collection but in simplifying the techniques for analysis. Analysis would focus on simple ratios and cross tabular comparisons. These can rapidly and simply achieve the desired results if they are carefully and creatively designed. Technical Assistance will be needed to help simplify the analytical procedures and focus data analysis and organization around final objectives and design alternatives.

(1) <u>Sample Design and Data Gathering Procedure</u>

Four separate survey populations would be sampled.

(a) <u>The AID financed new schemes</u>

The farms, landless worker households, and institutions (banks-traders-coops) in a sample of the 75 new AID financed commands would be sampled. Sample units of farms would be in two strata, large farms and small farms. Forty small and 40 large farms would be sampled, stratified by head and tail reaches. Forty landless worker households would be sampled from nearby villages, or if they are present in the commands then from those households as well. Key pieces of information about the activity level and institutional environment would be monitored with data from the related banks, traders, money-lenders, coops and panchayats.

These populations would receive a benchmark survey with necessary follow-up surveys for evaluation. The benchmark survey should be made as soon as the site is identified and before any works such a anticipatory well digging is commenced.

(b) The pilot demonstration schemes

Each of the pilot demonstration schemes (two existing schemes and eight separate pilots) would be sampled as described above.

(c) Control group of beneficiaries in existing minor schemes

Forty small and 40 large farms would be selected in each of the three major agroclimatic regions of the state (Konkan, transitions-scarcity, assured-high rainfall) at random from among all minor beneficiaries in existing minors. Forty landless laborere households would also be selected in villages near existing minors. Both of these samples would be "area frame" based so as to avoid large expense in sampling. The relative cost per interview will be high in these cases because of travel costs, but the value of a truly random sample far outweighs the additional costs of a dispersed sample population. This population would receive the benchmark and follow-up surveys.

(d) Control group of non-beneficiaries

Using area frame stratified sampling, a random sample of 40 small and 40 large farms would be selected in regions where minor irrigation projects are to be undertaken. In a similar fashion 40 landless worker households would be selected. This group would receive the benchmark and follow up surveys.

(2) Survey Instruments and Procedures

The Department of Agricultural Economics at Rahuri has already conducted a number of socio-economic surveys for the Irrigation Department and in the process has evolved a survey instrument which is an excellent one. It represents the state of the art in almost all respects including manageability in the field. Since this instrument has been field tested and its field practicability is known, it should be adopted with a few minor modifications as the basic instrument for the evaluation system. The modifications include an expansion of on-farm water management information, the addition of a 1:8000 ground water and similar scale land use classification map, a few additional sanitation-nutritional health measurements (antropometrics for example) and a much expanded section of farmer perspectives, ideas and suggestions for improving institutional performance.

(3) Streamlining and Accelerating Data Processing and Report Production

The Universities are generally efficient at undertaking surveys but hampered by lack of hardware and software in getting this data into useable form. The lead university would be provided with micro-processors which could handle both analytical work and word processing. Adequate software for these functions would also be provided.

4. State Sector Functions in Minor Irrigation Planning

a. Responsibility for Planning

(1) The role of the center

Irrigation, including minor irrigation, is a state responsibility in India, though it is in the Concurrent List of the Constitution implying that the Center also plays a role in the planning and development of irrigation. As far as major and medium irrigation projects are concerned, the Center takes an active part in the planning and approval of projects and the States are required to obtain technical and financial clearance for their projects from the Central Water Commission and the Planning Commission before taking them up for construction. In the case of Minor Irrigation projects, however, the Center plays an overall general review and policy role and does not reserve specific approval rights over financial or technical standards. They do review the Annual and Five Year state irrigation plans which are funded in addition to state sector resources, under the different channels such as the Drought Prone Area Program (DPAP), the Tribal Plan, and the Western Ghat Development Program.

The Drought Prone Area and Tribal Area Programs are fully financed by the Government of India. The Western Ghat Development Program is partially funded by the Center. The State Plan for irrigation, including minor irrigation, receives central assistance only by way of Block Assistance which is made available by the Center to the States according to a formula based on population, backwardness of certain areas, capability of revenue generation and other similar considerations.

(2) Annual plans for minor irrigation

The State Government sends proposals for minor irrigation to the Planning Commission by the month of November each year for the plan works to be undertaken during the comming year. The annual

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plans of the States are finalised by the State Governments in consultation with the Irrigation Ministry of the Government of India and the Planning Commission, normally in the last week of January of the following year.

(3) Organization at the center

Minor irrigation is directed at the Center by a Chief Engineer posted in the Irrigation Ministry under the Secretary, (Irrigation), Government of India. It is his responsibility to review the annual and five year plans sent in by the states with the intent of insuring only that the internal state distribution of projects is not overly weighted in favor of relatively well developed sections of the state and against what are known as the "weaker sectors". His office also reviews matters such as the attention given to drought prone areas, tribals, and remote hilly regions. The Chief Engineer (Minor Irrigation), is assisted in this task by a complement of technocrats who elaborate guidelines and general standards for minor irrigation design. These general frameworks, however, do not reach the detailed level necessary to actually constitute design standards.

This unit may also arrange for assistance to the states in preparing pre-feasibility reports for use with external donors such as AID or the Banks. This was the function of the Narmada Cell in the case of the minor irrigation tank proposal prepared for submission to the IBRD, and later to USAID.

b. Planning Organization at the State Level.

(1) Irrigation Secretary

At present, all the activities of the State Irrigation Department are looked after by two secretaries one for irrigation and one for CAD. The principal interaction of USAID is with the Irrigation Secretary. The Chief Engineer, Minor Irrigation, is charged with the planning and execution of minor irrigation projects.

(2) Regional offices

Projects are actually planned and implemented under the direction of the regional Chief Engineers whose central offices are located in the major regions of the state. There are six regions covering the major agroclimatic zones, though the regions do not exactly coincide with the climatic areas in the case of Nasik and Pune. These CE's are headquarted in Bombay for the coastal Konkan region, in Pune and Nasik for the transition and scarcity zone, in

Aurangabad for the assured rainfall zone, in Amravati for assured and moderate rainfall zone, and in Nagpur for the high rainfall zone. All of the functions related to minor irrigation depend directly on these regional Chief Engineers from planning through to operation and maintenance.

It is at this level that formal project planning is originated and then sent up to Mantralya where they are processed for official approval known as "Administrative sanction." The regional CE's provide the "technical sanction" for minor irrigation schemes.

The GOM will appoint one of the Regional Chief Engineers as the Coordinating Regional Chief Engineer for the Project. The SAEC and all of its pilot and study activities are under the control of this CE. He will be the primary liaison point for AID at the field level, including reimbursement claims preparation and coordination.

(3) Circle and district level

There is a great deal of variety and flexibility in the way minor irrigation functions are distributed between the Superintending Engineers. This flexibility should not be confused with disorder. The officials have very clear ideas of what they are in charge of and to whom they report. The regional Chief Engineer has considerable latitude in the manner in which he organizes the various minor, medium and major irrigation tasks in his region.

The planning design and implemention of the schemes at the District level is looked after by Divisions each headed by an Executive Engineer. Generally the jurisdiction of an Executive Engineer extends over one District, in some cases more than one such officer may be posted to deal only with Minor Irrigation in a District. The work of all the minor irrigation schemes is distributed among 40 Divisions assisted by 225 Sub Divisions. Sub-divisions are headed by Sub-Divisional Officers of the status of an Assistant Engineer. Of these 225 Sub-divisions 77 are charged with survey and preliminary design development and feasibility analysis. The others implement the schemes once they are "technically" and "administratively" approved.

c. Project Identification and Selection

Forward planning documents known as District Level Master Plans are elaborated in many areas each year. It is from these catalogues of possibilities that the District Planning and Development Council gives instructions to examine this MI scheme or that one in detail for formal clearances and funding.

When the ID group receives this list of priority projects from the DPDC, the Superintending Engineers from the Circle arranges a team to carry out the preliminary investigation and preparation of the formal engineering feasibility report. When the engineering plans are ready (based on an almost automatic crop mix selection process) they are sent for economic feasibility analysis.

Each survey sub-division is normally able to prepare detailed project reports for about four schemes every year. This list of planned projects is then finalized by the DPDC in consultation with State Government. This then becomes known as the District Sectoral Annual Plan which contains the MI scheme allocations for each district on a time and scheduled construction basis.

The Executive Engineer of the District, forwards at the time of preparing the Annual Plan, a list of on-going and administratively approve MI schemes to the DPDC for fund allocation. These funds may come from one of the four programes mentioned earlier, though most construction takes place with EGS budget complemented by District Plan monies.

To be fair to the planning process, it does, almost religiously attempt to implement intermediate objectives of spreading projects into disadvantaged areas and there is an eveness in understanding about this and the food grains policy. The problem with planning is that it is almost entirely blind to final impacts, costs and efficiency and almost prevents movement in those directions.

C. Institutional Aspects of Design and Construction of Minor Irrigation

1. Institutional Functions in the Design of Minor Irrigation

Minor irrigation systems may be usefully divided into four categories for the purpose of examining the institutional aspects of design. (1) State sector minor irrigation (the focus of this project), (2) local sector minor irrigation, (3) private sector wells and (4) lift cooperatives.

a. State Sector Minor Irrigation

The design of State sector minor irrigation projects is undertaken by the design cells in the Irrigation Department itself. The only other institution with a major involvement in this process is the Agriculture Department which is responsible for providing the design crop mix for the project. The design is conducted in rather strict accordance with the published minor project design manual as updated periodically by official communications.

Institutionally it is important to recognize that these designs are not subjected to scrutiny or review at the centre, thus differing from major and medium projects.

From an institutional point of view the design process with its internal review works smoothly and is perhaps the best organized of all of the phases of irrigation.

Weaknesses in the institutional setup arise from the fact that farmers are not involved in any kind of direct way in the process and have little input and control over its conduct. This problem has been examined in considerable detail in a following section on farmer participation and that discussion need not be repeated here except to say that one of the major pilot activities of this project experiments with institutional formats which involve farmers in the design and planning process.

b. <u>Local Sector Minor Irrigation Design</u>

Small tank schemes with commands under 100 hectares are jurisdiction of the Zilla Parishads and Panchayats with the important exception that design is normally undertaken by the Irrigation Department through a special local design cell. The same design standards contained in the minor design manual are in practice usually applied to the local sector works even though there is no strict requirement.

c. <u>Well Design</u>

Individual farmers, with occasional assistance from the Groundwater Survey and Development Authority, design their own wells. It is at the stage of energizing these wells that outside help may be given, particularly if institutional finance is involved.

d. <u>Lift Scheme Cooperatives</u>

A lift scheme cooperative is usually required, as a prerequisite for financing, to present an engineering design of the proposed system. Private engineering firms and individual consultants normally produce these designs. An important number of these systems have malfunctioned due to alleged design inadequacies reflecting a possible uneveness in design standards and the quality of engineering services in the private sector.

2. <u>Institutions Involved in Construction</u>

Three separate institutions are involved in the construction of minor irrigation schemes in Maharashtra. The Irrigation Department has Construction Divisions which supervise and in some cases undertake construction activities (most of the gorge closing operation). The Employment Guarantee Scheme is the second "institution" involved which organizes the unemployed for public works construction. However, most of the construction is contracted out to private firms. There is an obvious interaction between these three institutions, and in any particular case the mix and supervisory responsibility will vary.

Normally the construction of the main fill is done by local contractors. The distribution system may be constructed with EGS labor. At times this labor may be organized and supervised by ID officials, EGS officials or even in some cases by locally hired private sector "bosses".

Specialized equipment such as rollers may either be drawn from the ID's construction unit or contracted from private firms.

3. Contracting Procedures

Contracting procedures when private firms are involved follow established competitive norms for qualification and bidding, and established procedures for monitoring and payment. The Irrigation Department maintains blank forms with standard provisions for regulating the various steps of this process. On one existing minor project in the field the USAID design team reviewed some of the actual contracts and found that they had used the basic forms and procedures with the normally required contractor invoices and receipts attached. The procedure and controls met or exceeded USAID contracting requirements.

D. Farmer Participation in Operation-Maintainence of Minor Irrigation

This section examines the structure and role of local farmer institutions and how they interact in the planning, operation and maintainance of minor irrigation systems in Maharashtra.

The unique history and natural configuration of irrigation in Maharashtra have left it with a rather complex institutional framework. Three rather distinct systems are found in the state as a result of the shift in state boundaries and the incorporation of areas (Marathwada and Vidarbha) which had developed their own sets of irrigation institutions. To understand local farmer institutions it is necessary to understand at least in summary form the legal/regulatory framework in which these institutions have developed.

1. Summary of Irrigation Institutional Development: The Legal and Regulatory Framework

An institutional framework for irrigation began with public intervention after 1876 with the Famine Fund. Irrigation began not as a way of increasing production but as a way of stabilizing the production of food grains in unusual drought years. These beginnings have left their imprint on all institutional forms and regulatory structures which have developed since. This is known as "protective irrigation" and led the water institutions early into not just the control of water but into the control of the crops grown with the water.

When land reform legislation (Land Ceiling Acts) was added as an overlay onto the already complex regulatory situation it reduced even further the possibility that indigenous local farmer institutions would spontaneously appear and play an important role. The land reform and irrigation institutions are interrelated in that irrigated land is subject to lower land ceilings.

In the 1960s the decision was made to design systems at 50 percent reliability. This is an engineering concept that results in a canal system serving the area that can be irrigated in the median rainfall year. Less rainfall than the median means that water must be rationed. Each farmer is limited in the area he can irrigate by the available water. Crop mixes that are feasibile under this approach are essentially not in line with what many farmers see as their own best interest. In many cases farmers simply do not "come forward" to take the water thus causing a significant part of the underutilization problem.

The net result of all of this is that strong incentives were created encouraging farmers to develop wells to be able to have more control over their cropping patterns. Actual cropping patterns are closer to farmers wishes than cropping patterns proposed in project reports. Natural factors, particularly larger than average rainfall, provide an opportunity for the ID to accede to farmers wishes, but this is on an ad hoc basis.

When one talks to farmers in the field, it is clear that they want to be involved but they want that involvement in issues that matter. Farmers repeatedly told the design team that what they want is control over what is done with the water and that most often came back to control over what crops to grow.

Some observers have noted these problems and suggested simply that the crop and other restrictions simply be done away with and that farmer participation be organized along the lines in vogue elsewere. This ignores the deeply rooted legal and regulatory system in place and its almost inextricable links to "extensive" irrigation and land ceiling systems. If these roots could be waived by a single stroke, the positions taken by several official irrigation commissions would have accomplished the task.

The only reasonable explanations for the perpetuation of the present system in the face of repeated formal recommendations to change it lie in the fact that it does provide a practical way of rationing water from systems whose designs are "extensive." If the canal system has only half enough water to irrigate the land it could potentially serve then there must be a way to enforce spreading the water. The system which has grown up accomplishes that task. Local irrigation administrators, farmers and politicians have, over the century, worked out a way in which this works for them given their power relationships and personal objectives. It is likely that the farmer's general lack of vigorous involvement in this process has resulted from his lack of power and the fact that his interests were better served outside this system. Farmer participation must be analyzed inside this framework and not upon the erroneous assumption often made that present policies and procedures can be simply ignored or easily changed.

Abstracting from the general situation described above, there are a number of indigenous farmer group-managed irrigation systems in the state of Maharashtra. However, there are very little detailed data available on how these work. It seems very likely that important lessons could be learned from studying these self-managed systems which would be applicable on other schemes, especially MIS. In-depth interdisciplinary studies of a sample of these systems will focus on the underlying principles and procedures for management (e.g. decision-making, dispute settlement, water distribution, etc., all in the context of the existing social and economic structure), as well as the technical features of the systems. The major purpose of these studies will be to extract lessons or hypotheses which could be tested on other MIS.

Types of farmer group managed systems in Maharashtra include: a) Phad (or bandhare) systems (Dhule Dist.), b) Khajana well (Beed Dist.). This well is 300 to 400 years old, irrigates about 150 ha of land owned by a large number of small farmers, and is entirely farmer-managed (Farmers hire one person, paid in grain, to distribute the water). The government maintains the headworks, and does major canal repair. The farmers do regular maintenance, and distribute the water themselves. Two paddy crops are grown. These are older tanks, probably dating from British times.

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2. Farmer Participation: An Analysis of Existing Institional Structures and Activity

For discussion, the farmer participatory institutions may be grouped into four classes: (a) water user groups for flow irrigation, (b) water user cooperatives for well and lift irrigation, (c) private and voluntary organizations and (d) Zilla Parishads and Pahchayats.

a. Water User Groups and the Operation and Maintainence of Flow Irrigation Systems

Water user groups in the predominant Maharashtra system function at the "outlet" leve'. There are two forms of this institution, the first is called the "outlet committee" the second is called a "water users cooperative." The 1976 irrigation law provides for the creation of water users cooperatives. Yet, while the authority exists, the practice is rare. Outlet committees are more common and their functions are similar to those normally foun' in the literature for other countries in the operation and maintanance of flow systems.

This committee is to be made up of those farmers who have irrigation rights from a particular outlet which under the new policy is 8 hectares. Somewhere between five to ten farmers could therefore compose an outlet committee. These committees are to function in maintaining the channels and to meet with the canal officers to plan the rotational scheduling of the water.

In the design team's field visits it became obvious that this pattern varies widely and that its actual functioning depends more on local personalities and interests than on some overall legal or structural format. In some cases it appears that farmers take this seriously, meet frequently with the canal officer and maintain the channels with fidelity. In one case where it seemed to be functioning well (that is, channels were well maintained and farmers met with the canal officer regularly to plan rotations) the question was asked why farmers were not formally organized into either an Outlet Committee or a Users Cooperative. The question was met with a puzzled, "What for?"

b. Water Users Cooperatives in Development, Operation and Maintanence of Lift and Well Irrigation

Farmer participation in irrigation through cooperatives has been vigorous in Maharashtra and is the principal vehicle through which communities and small farmers have channeled irrigation action. These cooperatives have taken two basic forms, lift cooperatives and marketing-processing cooperatives.

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It is important to note that these cooperatives may in some cases be dominated in a management sense by larger and more well to do farmers, but the actual composition of the cooperatives and the benefits which have flowed from them are surprisingly well distributed to both the smallest farms and to the landless poor.

A field example will help to explain the unique and dynamic way the lift and marketing cooperatives have been used by small farmers to fuel irrigation development. A typical small farmer visited by the design team had wanted to finance the digging and energizing of a well. Without funds and without a mortgageable title he was unable to finance this activity through normal channels. His membership in a sugarcane cooperative provided him with an underwriting guarantee at the bank against which he obtained the funds. The marketing/processing cooperative provides the essential financial energy, harnessed through a variety of co-signature and less direct mechanisms, to start well and lift irrigation development. In the case of wells, since in Maharashtra they are predominantly a single farm venture, this farmer involvement is not institutionalized beyond his own farm. In the case of lift schemes many small farmers are involved, characteristically with a few larger ones, and a formal farmer water users cooperative is formed.

Water users groups in the form of Lift Cooperative Societies are growing at an annual rate of over 20 percent. This is evidence of the vigor of farmer participation in irrigation. One of the challenges which faces state sector minor irrigation is how to harness this local participatory energy inside the constraints of the flow irrigation regulatory structure.

c. <u>Private and Voluntary Organizations in the Operation and Maintanence of Irrigation</u>

While water users cooperatives are private and voluntary organizations in the best sense of the term, there is another type of indigenous organization which exists in Maharashtra and shows some vigor.

These are private and voluntary foundations and similar community groups which have grown up around the ideas of equitable water distribution. The Gram Gourav Pratisthan near Pune is one such organization and serves to illustrate the general characteristics of many of them. These groups are focused very much at the grass roots village level and have a hearty kind of participatory style which involves villagers on their own terms. They are deeply involved in ideas of basic social justice and equity and see water as a basic human right.

Given these origins it is understandable that some of them have also become personality focused and highly politicized. The individual personalities which originate and guide these organizations have a profound influence over the content and form of irrigation which is evolved, and their basic justice orientation has led to their political flavor.

Participation, while vigorous, appears to be taking place on fairly narrow terms proscribed by the personal and political nature with which issues are taken hold of and discussed. The rights to water are often to be allocated on a per-capita or per family basis and with deliberate disregard for soil types, topography, farm size, market availability and similar technical variables. Farmers who may feel these other issues are important are rather strictly encouraged to view all matters in what is cast as a "justice-equity" framework. For example, in one such grouping farmers who entered the system were asked "to stop dreaming of sugar cane" since that and other "cash crops" were predetermined in this structure to be anti-justice or anti-equity.

Hence many private voluntary organizations have been drawn into extensive spreading of water and small dose rationing with its consequent oppostion to higher value and intensive cropping systems.

After discussions with several PVO groups, including site visits and group discussions with participating farmers, the USAID Design Team concluded that the political orientation of these groups makes them unlikely prospects for AID financing through a project with the GOI. A mechanism for direct AID financing might be tried, but the requirement to be "non-political" (Handbook III, Appendix 4C) would exclude those visited by the Design Team.

There are therefore in these first four participatory organizational structures, two which are following the "extensive" or "protective" model (State and PVO's) and two streams (individual farm well systems, and lift cooperatives) following the "intensive" high value crop model.

d. Zilla Parishad and Panchayat Operation and Maintainence of Minor Irrigation Schemes

The final institution through which communities and small farmers participate in irrigation is through formal community and district political organizations, the village Panchayats and Zilla Parishads. Surface flow systems below 100 hectares are officially developed, operated and maintained by the Zilla Parishads and Panchayats. In practice, these systems are more politically controlled and can alter some of the constraints imposed on State sector irrigation.

Small farmers participate in the operation and maintainence of these systems much as in the case of the larger state sector schemes, and similarly, there is little formal structure to that participation. Farmers maintain and in some cases actually construct distributory channels and interact directly in rotational determinations.

3. Mechanisms for Increasing Farmer and Local Community Participation

Three approaches are woven into this project to increase farmer and community involvement in irrigation. All of these must be taken in the context of the foregoing discussion because these mechanisms are rather unique to the Maharashtra situation. The first is a strengthening of the existing framework of outlet committees and outlet water users cooperatives. The second is a pilot experiment with farmer involvement on those more important participatory issues of crop mix choice and conjunctive use. The third is an attempt to sensitize the Irrigation and Agriculture Departments to farmer perspectives by monitoring and evaluation of final income and employment impacts of minor schemes.

a. Farmer Outlet Committees and Water User Cooperatives

This project seeks to strengthen local water user organizations through the formation of the authorized outlet committees and water users cooperatives on Project financed schemes.

b. Pilot Involvements of Farmers in System Planning, Crop Mix Choice, Conjunctive Use and Women's Role

Three pilots are designed to get farmers and the Irrigation and Agriculture Department working together on the matters which farmers have expressed as their central concerns. The 1962 Irrigation Commission Report proposed farmer involvement in crop mix choice and system design. These three pilots institutionalize this involvement. It is recognized that this involvement is experimental and could not be implemented immediately on all MIS's, yet it is important to begin such farmer participation if only in pilot form. The pilot on women's role also experiments with improved participatory mechanisms.

c. Monitoring and Evaluating Final Farmer Impacts of Irrigation

Farmer involvement and perspectives can only be integrated into system design and operation if the GOM is aware of those perspectives and aware of how a particular project impacts on farmers objectives of income and employment. This project seeks to expand that awareness through a monitoring and evaluation system which quantifies the final farmer impacts of irrigation systems.

CHAPTER III

TECHNICAL ANALYSIS

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A. General Description Of Area

1. Topographic And Geologic Features

Maharashtra can be physically segregated into the coastal Konkan region and the Deccan Plateau. The Western Ghats, or Sahyadri range dividing the two regions, run parallel to the Arabian Sea coast across the length of the state. The topography of the region is highly undulating, ranging between barren hills and wastelands to valley regions formed by rivers and streams.

The major geological formations in terms of the geographical area, are distributed as follows:1/

Archaean and Dharwar metamorphic igneous	10.5%
Pre-Cambrian consolidated sedimentary	2.0%
Gondwana consolidated sedimentary	1.6%
Deccan Trap volcanic, multi-layered	81.2%
Alluvial unconsolidated sedimentary	4.7%

Soils in the state are derived from these primarily basaltic formations and are generally clay and clay loam in texture. In many areas, the soil overlays a region of fractured basaltic transition materials called murum.

2. Water Resources

There are five major drainage basins in the Deccan plateau: (1) Krishna; (2) Bhima Sub-Basin; (3) Godavari; (4) Wainganga Sub-Basin; and (5) Tapi.2/ About 80-85% of the annual rainfall occurs in the monsoon season (June to September) which flows from the catchments relatively soon after. Thus, with exception of the larger rivers, most waterways are non-perennial, requiring storage facilities to exploit the state's water resources.

1/ Government of Maharashtra, Directorate of Groundwater Surveys and Development Agency, 1983. "A Glimpse into Groundwater Resources of Maharashtra and Its Developmental Programmes." Pune, 41 pp. 9 plates.

2/ Government of Maharashtra, Irrigation Department, 1983. "Manual of Minor Irrigation Works in Maharashtra State," Government Press, Bombay. 279 pp. 31 plates.

Groundwater resources are currently used to irrigate 50-55% of the irrigated croplands in Maharashtra. Some aquifers are sufficient for tubewells in the northern districts, but generally the local groundwater basins are too shallow. Under these conditions, most well water for agriculture comes from "dug-wells," 5 to 6 meter vertical shafts extending up to 20 meters below the surface to intercept 1-2 meters of the water table. Groundwater is used principally for cash crops like sugarcane, grapes and fruits, groundnuts, and vegetables.

3. Climate

The climate of Maharashtra is tropical monsoon in which three primary seasons are encountered in the state; the monsoon and rabi seasons , and the hot weather season of March through mid June. The Deccan plateau is about 500 to 700 meters above sea level and is sheltered by the Western Ghats from maritime effects. Several climatic regions are delineated: (1) coastal zone; (2) transition zone; (3) scarcity zone, (4) assured rainfall zone; (5) moderate rainfall zone; and (6) the high rainfall zone.

4. Irrigated Agriculture

Because rainfall distributions are concentrated in the monsoon season, crop water requirements are not satisfied more than about 90 days (monsoon) per year without irrigation. Generally, the scarcity of water and the often shallow soil profile in the region limit rainfed cropping to the coarse grains. However, a wide range of crops can be profitably grown in the state if water resources are developed for irrigation. During the monsoon season, rice, cotton, Bajra, Jowar, maize, groundnuts, vegetables, sugarcane, and fruit can be grown. In the winter season, crops like wheat and gram can be added to the list. Hot weather crops include the high valued crops listed above (sugarcane, groundnuts, vegetables, fruits, etc.), but are generally not irrigated from small surface supply systems because of high evaporation losses.

Irrigation is required during the rabi and hot weather seasons. During the monsoon, dry periods may extend long enough to affect crop production and water may be utilized to irrigate. Between the monsoon and rabi seasons, irrigation may be needed to mature Kharif crops and pre-irrigate rabi fields to facilitate seed bed preparation. Maharashtra irrigation includes all of the gravity flow methods (basin, border and furrow) as well as experimental sprinkle and trickle schemes.

B. Irrigation

The basic requirments for effective and efficient irrigation are similar for any irrigated system. Water delivered to croplands must be reliably timed so that irrigators can minimize risks and properly plan other farming operations. The flow must be sufficient and the fields adequately graded to allow each watering to be applied uniformly. The rotation of irrigation water, or the frequency of waterings, must be sufficient to avoid prolonged periods of moisture stress in the crop environment.

Achieving optimal water utilization under irrigation implies good planning, design, operation, and maintenance procedures. During the life of a project, many agronomic, economic, and institutional factors are bound to change. The irrigation system must be flexible enough to remain effective. Unless the entire irrigation development process includes the inputs, cooperation, and enthusiatic support of farmers, production will not meet projected levels.

Irrigation in Maharashtra falls somewhat short of the criteria alluded to above. The small, uneven land holdings and scarce water supplies pose difficult irrigation problems which have yet to be solved. Equity between users relatively close to the source of supply and those further away is difficult to maintain. As a result, the operation of irrigation systems assume a rotational nature to ease management as opposed to supplying water according to the crop water requirements of specific fields. The cadre of professionals in Maharashtra developing water resources for irrigation are generally well-trained and supported by field research. However, one of the major problems is a critical lack of coordination and adequacy of an organizational set-up to provide linkage between on-farm water management and irrigation supply and distribution.

1. General Description of MIS

The term "minor" applies to small irrigation projects in which the cultural command area (CCA) is less than 2000 ha. The ID Lists seven classes of minor works: (1) tanks; (2) bandharas or direct flow diversions; (3) tank and bandhara rehabilitation; (4) land drainage; (5) tubewells; (6) lift irrigation schemes; and (7) construction of dug well facilities.3/ For service areas less than 100 ha, the primary responsibility for irrigation systems

3/ ibid

shifts from the ID to the local sector or Zilla Parishads. Irrigation Department MIS activities are planned and implemented at the regional level.4/

Other Maharashtra state agencies also play important roles in MIS's. The conjunctive use of surface and ground water involves the Groundwater Surveys and Development Agency (GSDA) in the Department of Rural Development. Special emphasis on the on-farm water management in USAID assisted irrigation projects gives the Agricultural Department (AD) and agricultural universities important responsibilities. The widely recognized need to improve water supply predictions by better understanding of the catchment hydrology, particularly with regard to runoff hydrographs and sediment yields (and the subsequent management) would include the Forestry Department (FD) as well as the AD. And, the focus on water user participation via either formal or informal user organizations should incorporate the experience of the Co-Operative Department (CD).

There are three types of minor irrigation that comprise the bulk of the area irrigated by minor schemes. These are: (1) tank schemes, (2) lift schemes, and (3) conjunctive groundwater development in the commands of both kinds of schemes.

a. Tank Schemes: The minor irrigation tank is a small reservior impounded by an earthen dam constructed across small non-perennial waterways. An overflow spillway is constructed at one side of the dam to relieve flood flows. Water is released through a head-regulater (outlet gate) in the dam to an essentially unlined canal distribution system branching away from the dam on one or both sides of the natural waterway (nalla). There were 1091 ID minor tank schemes at the operational stage by 1980, with 437 under construction and more than 2000 identified for future authorization in the state's 31 districts.5/ The minor tank scheme is rapidly implemented (usually 3 to 5 years), and also represents a mechanism to provide irrigation water to farmers over a wide geographical area. The tanks can also be utilized simply as percolation tanks to recharge the aquifer along the nalla and thereby improve the yield of local wells.

4/ The State is divided into six regions for irrigation administration (See Administrative Analysis).

Normally an open channel conveyance network is currently used on minor tank systems, with a few exceptions of piped networks where the topography makes them advantageous. The piped network would enjoy a number of significant advantages such as lower water losses, more flexible water delivery, saving of productive land area otherwise occupied by open channels and lower maintenance.

b. Lift Schemes: These involve pumping of water from perennial streams, canals, or tanks to upland cropped areas which cannot be otherwise commanded by gravity flow. A number of such configuration exist in Maharashtra. Minor lift schemes involve water lift up to 24 meters. A diesel or an electric pumping station is installed at a suitable location on the embankment of a tank, a canal, or a perenial stream for pumping water to a location from where the water can be distributed either using an open channel or a piped flow distribution system.

Prior to 1966, lift schemes were the responsibility of the local or private sector but that responsibility now rests with ID or the Zila Parishads (for schemes with service area less than 100 hectares). In 1983, the cooperative societies under the Cooperative Movement[6/] in Maharashtra were operating 1443 lift schemes in different ID divisions as detailed below:

ID Division	No. of Lift Schemes
Bombay	51
Nashik	216
Pune	1031
Aurangabad	62
Amravati	27
Nagpur	56

5/ Narmada Project Preparation Cell, Ministry of Irrigation, Government of India and Government of Maharashtra, 1981. "Maharashtra Minor Irrigation Tank Project." 208 pp.

6/ Government of Maharashtra, Commissioner of Co-operation and Registrar of Co-operative Societies, 1983. "Co-operative Movement at a Glance in Maharashtra State." Pune. 59 pp.

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c. Conjunctive Groundwater Use: The climate of Maharashtra and the relatively shallow soil-aquifer materials dictates that most water resources are produced and made available during the monsoon season, especially in the upland segments of the watershed where MIS's are generally located. Aquifer recharging will occur in the command area due to conveyance seepage, deep percolation from tanks, increased infiltration of water due to land development and sustained runoff conservation in addition to irrigation application and operational losses. These will enhance the potential of well water supplies. Harvesting these water resources by tubewells will be limited in Maharashtra, but the large diameter dugwells are quite effective.

Because of the cost involved and the dependability of well water, the pumped flows are generally applied to cash crops. Estimates currently indicate that more than 50 percent of the irrigated sector in the state is from groundwater. This percentage is expected to fall as the planned major, medium, and minor projects are completed. Even so, the importance of groundwater to agriculture will remain high through the stimulation of high valued crop production.

Farmers can be expected to utilize well water to improve their earnings and may generate conflicts among themselves if wells are not carefully located. The increased use of wells needs to be tied to the incremental gains in groundwater recharging due to the irrigation in the command area. Viewed individually, most wells serve only 1 to 2 ha, but considered as a community of withdrawals from a common source, they become a logical part of a MIS.

Groundwater development policies are sketched in a report "A Glimpse into Groundwater Resources of Maharashtra and its Development Programes" published by the GSDA[7/]. This report also outlines evaluation, monitoring and research programs underway.

2. Present Planning and Design Standards

a) Water Supply and Budgets

The annual inflow into the tanks varies widely depending on the climatic zone, topography, vegetative cover, type of soil, size, shape and the slope of the watershed. A realistic

7/ Op. cit,

approach for computing water supply would, therefore, be to gauge the stream flow at the proposed site for a number of years and derive therefrom expected flows into the tank reservoirs. However, there are not enough stream gauges installed in the watersheds of either the operational or proposed tank scheme sites. Therefore, the potential yield (inflow) from the watersheds on the minor irrigation tanks is currently being estimated using an empirical formula linking yield with precipitation and taking into consideration some of the topographical and vegetative characteristics of the watersheds. Precipitation data from the nearest rain gauge stations are commonly used. The ID has divided the State into three regions namely; Western Maharashtra, Marathwada and Vidarbha and through the issue of the Manual[8/] has recommended the use of Inglis formula for Ghat and non-ghat watersheds in Western Manarashtra; Strange's tables for Marathwada region categorising the individual watersheds as good, average or bad (taking the slope and vegetative cover in account) and Binnie's tables for the Vidarbha region. However, a comparison of the yields computed using different formulas described above, the World Bank[9/] and GOM agencies studies reveal that these formulas lead to conservative water supply storage designs. Normally, the design water supply is chosen as that which can be expected in 75 percent of the years (75 percent reliability) and modified usually to 50 percent, for the tanks located in scarcity area (precipitation below 750 mm).

Seasonal water requirements of crops at present are computed based on cropping patterns recommended by the AD. Commonly in Maharashtra, irrigation water requirements are computed using duty of water, which is defined as the number of acres/hectares which can be irrigated with one cusec/cumec of water delivered at the outlet.

The ID has issued guidelines with respect to assumption of duty of water depending on the region in which the project is located. Reservoir storage is provided for the designed rabi (3-4 waterings depending on rainfall conditions and soil type) and 20-50 percent of the Kharif requirements (20 percent for Western Maharashtra and Marathwada regions and 50 percent for the projects in Vidarbha region especially for the projects located in Akola, Buldana and Yeotmal Districts). No provisions are normally made for the hot weather crops.

8/ Op. cit.

9/ World Bank, 1979. "Staff Appraisal of the Maharashtra Irrigation II Project." Vol.1, Main Report, 95 pp; Vol.II, Sectoral Background, 115 pp. South Asia Projects Department, New Delhi.

In some of the recent project reports and the five model projects reviewed by the USAID design team, the crop water requirements have been computed using the modified Penman method. Similarly, the report entitled "Maharashtra Minor Irrigation Tank Project", prepared by the Narmada Project Preparation Cell[10/], uses the modified Penman method for computing water requirements for the propsed cropping pattern and uses monthly water budgets to allocate water supply after deducting estimated losses. This proposed procedure is a quantum jump from the "duty of crop" methodology, however, none of the operational or on-going MIS's have used this methodology. The guide lines and circulars compiled in the Manual do not specify the losses (conveyance, operational, evaporation, field application etc.) that should be assumed over and above the duty for determining the total storage capacity required, since the specified duty is supposed to include these losses.

b. Dams and Tanks

The ID possesses qualified and experienced construction engineers with many years of successful experience in the design and construction of dams and spillways. Review of the specifications and design standards currently in use and as recommended in the Minor Irrigation Manual reveals that these are comprehensive and do not need any special USAID design criteria.

The sill level in the tanks is governed by the topography of the proposed irrigation command and the allowance for the expected silt load carried by the stream into the tank. The current design procedures assume the life of the tank as well as the silt pocket ranging between 50 to 60 years and a design silt load of 166.7 cubic meter/sq. km./yr (35 acre/feet/sq. mile/year). The guide lines issued by the ID also recommend that the dead storage should not exceed five percent of the gross storage and can be as low as two percent depending on the site conditions. However, there is no basis enunciated for such recommendations. The proposed model projects have used triple the recommended silt load rates and half the design life based on a resurvey of selected tanks. However, this is an area which requires comprehensive study and analysis and formulation of recommendations resulting in improved and efficient design.

10/ Op. cit.

c. Water Distribution and Control

The conveyance and distribution of irrigation water from minor tanks (except percolation tanks) is accomplished with a branching network of open channels[11/]. The distribution network consists of a main canal off taking from the headworks (dam and appurtenances), a distributary off-taking from the main canal with a carrying capacity ranging between 0.7 to 2.8 m^3/sec (25 to 100 cusec), and minor canals limited to a carrying capacity of less than 0.7m^3/sec (25 cusec). There is no branch canal in the case of minor irrigation tanks since the capacity of the main canal is usually less than 2.8m^3/sec. Responsibility of the ID ends at the level of minor canals with a provision of outlets (capacity 30-45 litres/sec), suitably located to provide irrigation to 25-30 land owners (approx. 40 ha area). Until recently the construction of watercourses below the outlet and field channels to convey water to individual farm holdings was the farmers responsibility. GOM has now decided that it will extend the channels down to the farm holdings or the 2 ha outlet whichever is larger. Their repair and maintenance remains the responsibility of irrigators. Responsibility of systems operation and maintenance rests with the ID.

The layout of the distribution system is based on the maps having a scale of 1:8000 where village maps are not available or using the village maps on a scale of 1:4000. Contour intervals of 30-60 cm. for flat country and 150 cm for steep country are normally used for planning the layout of the distribution system with an effort to align the system on ridges as far as possible in order to command areas on both sides of the system. The distribution system is normally not lined. The current practice for water control provides placing of standing wave flumes to measure discharge at the head of canal, distributaries and minors. The outlets are ungated. The circulars issued by the ID recommended that full supply level (FSL) should generally be 15-30 cm above the command area in order to ensure irrigation to the command immediately surrounding the system. No other structures for regulation and distribution of water in the system are provided.

Main canals under the minor projects are usually laid on a slope of 1:1500 to 1:2500 in relatively flat topography and 1:500 to 1:1000 in hilly terrain. A set of recommended velocity limits based on bed material - 0.3 m/sec in clay soil, 0.75

11/ See Annex III.3.

m/sec in murum, 1.2 m/sec soft rock and 2.75 m/sec in hard rock and lined channels is used. The conveyance system is designed using Manning's formulae which combines three parameters - slope, roughness coefficient and hydraulic radius. A free board ranging between 30cm to 60cm is provided depending on carrying capacity of the conveyance system.The distribution system is designed to meet the maximum demand considering that 30 liters/sec (one cusec) can irrigate only 2 ha (5 acres) in a day. Considering 12 days rotation, a 30 liter stream will irrigate 24 ha per rotation. The capacity is designed based upon the area to be irrigated. For annual irrigation, say of 240 ha, the canal size would be calculated as 240/24 x 30 = 300 liters/sec flow.

Water delivery is on a rotation basis, called the Shejpali system. On or about October 1 of each year, a preliminary irrigation program is prepared after the assessment of the water availability in the tank (excluding losses). The ID sanctions the applications of farmers who apply for water for various crops which is then utlized to estimate water requirements and to adjust as necessary to compensate for any shortage. The rotation schedule, or Shejpali, allocates turns among the irrigators beginning with those most distant from the tank. The Shejpali system is to be implemented on a 24 hour basis, however, none of the projects visited or evaluated by the USAID design team supply irrigation water at night. The ID provides for routine monitoring of minor tank systems. Canal Inspectors carry out monitoring and prepare a report which comprises: gauge and discharge readings thoughout the distribution system including reservoir levels and delivery to the farmers; distribution of water during a rotation period, a planned outlet delivery schedule, expected irrigated crop waterings and actual irrigation achieved; operational summary; and rainfall records. The ID has developed and prescribed a comprehensive set of data forms for recording the above information.

Maintenance of the distribution system primarily involves removing sediments and weeds and reconstruction of works that have failed.

d. <u>On-Farm Development</u>

Most agricultural lands under existing or anticipated MIS's have utilized the monsoon rainfall for generations. Fields have been bunded and shaped to some extent in order to collect and distribute the rainfall, but the fields are not sufficiently level for efficient surface irrigation. Delivering irrigation water to these systems will reduce the risk of crop failure by increasing the assured supply of water. If on the other hand, the irrigation system is poorly developed and managed, the farmer's perspective with regard to the reliability of supply will not change significantly from that under rainfed condition and thus he will not invest in more costly inputs and accrue the anticipated benefits.

The on-farm improvements needed to accommodate an irrigation water supply can be categorized into four types: (1) watercourses and field channels; (2) control structures; (3) on-farm channels and land grading; and (4) drainage. Irrigation greatly enhances the supply of water that will be available to the fields and must therefore be accompanied by a higher level of management.

As has been mentioned in the preceding text, construction of water courses and field channels, land development and drainage has been the responsibility of the irrigator and very little to no attention has been paid towards this critical activity by the GOM except on major projects where Command Area Development Authorities (CADA) have been formed. The Irrigation Department has recently published a manual entitled "Manual of Design for On-Farm Development Works"12/ to be used as a guide for the on-farm development activities being implemented by Soil Conservation/Land Development Divisions deputed from the AD to the CADA's on major projects.

e. Groundwater Development

The GSDA has surveyed the groundwater potential in 1,482 (200-300 km^2 size) catchments.13/ Current estimates indicate that about 939,000 wells are annually withdrawing 7,471 Mm^3 from a potential supply of 34,996 Mm^3. New well development potential assuming average withdrawal rates is about 1.8 million new wells. Based on the experience to date and the hydro-geological data being developed by GSDA, groundwater development guidelines have been formulated and published.

Groundwater is an important resource in Maharashtra even though in general the aquifers are not deep and well structures tend to be of the dug well type. Among the advantages foreseen relative to agriculture are the broad extent of the resource, the dependability and duration of the supply, the flexibility

12/ Government of Maharashtra, Irrigation Department, 1982 "Manual of Design for On-Farm Development Works". Government Central Press, Bombay. 76pp.

13/ Op. Cit.

wells afford the irrigator in altering cropping patterns to meet market demands and optimize the return from capital and labor inputs, the control of waterlogging and salinity, and the enhancement of irrigation projects through conjunctive use. The GSDA provides detailed hydro-geological maps (1:8000) for village level minor development schemes (this includes aquifer characteristics such as withdrawal and recharging rates, locaton of aquifer potential, and groundwater hydraulics).

It was noted previously that the ID lists groundwater development as a minor irrigation scheme. While some ID involvement in wells is legislatively possible most wells are privately financed by individuals through the private and public sector banking system. GSDA provides technical assistance to the individual as well as the lending agencies. An important area of interaction between GSDA and the ID could be the development of groundwaters resulting from irrigation return flows within the minor command area.

f. Lift Schemes

Lift schemes in Maharashtra are implemented either by Irrigation Development Corporation of Maharashtra (IDCOM) or by the Cooperative Societies. IDCOM takes up only such lift schemes which shall irrigate an area more than 100 hectares and shall have assured source of water supply certified by the concerned officials. The Corporation implements such schemes on behalf of the beneficiaries and obtains a loan for the land development. Since the Corporation has no staff of its own for implementation and maintenance of schemes, the job is assigned to ID on an agency basis. The cooperative societies take up implementation of lift schemes on the submission of application by the promoter of the society.

3. Assessment of Present Practices

In the previous section, a broad overview has been presented of the state sector minor irrigation scheme planning and design processes.

In this section, attention is focused first on the overall framework in place to plan and implement minor irrigation schemes. Second, an analysis is made of five model minor tank scheme proposals to determine whether or not the salient features of existing standards of practice are being followed. Third, a note discussing two existing schemes is presented and then a summary of technical weaknesses is presented along with suggested conceptual modifications which can be accomplished with special studies and pilot activities.

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a. Framework for Schemes Implementation

In Maharashtra minor irrigation schemes, technical practices are comprised mainly of civil engineering techniques. The Irrigation Department is the lead agency, but other technical inputs are made by the GSDA, the AD, Soil Conservation Section (AD/SC), Central Indian Government research and planning groups, and state university research and teaching institutions. Existing standards of practice should be gauged by a collective assessment of five general criteria:

(1) Is there a fundamental understanding at the conceptual as well as specific level of the nature of the irrigation system; i.e., are the catchment, storage, distribution, application, drainage, and groundwater components, each considered as a collective and integrated part of a whole hydrologic system?

(2) Is there an appreciation of engineering interaction with agronomic, economic, social, and institutional factors necessary to make irrigated agriculture function profitably?

(3) Is there a central strategy outlined for the processes of project conceptualization, planning, design, construction, operation, maintenance and rehabilitation which can be practiced?

(4) Is there technology transfer between the research, executing, management, and user communities, and is it a two way communication?, and

(5) Is there a monitoring and evaluation process in place which is utilized for not only updating irrigation practices from conceptualization through implementation but also for manpower planning and in-service training?

During the visit to Maharashtra and the preparation of this report, the technical capabilities of the groups involved in irrigation development noted above were considered. Conversations and interviews as well as observation of training circulars and written output were reviewed. Technically, the concepts of irrigated agriculture in the Maharashtra setting are understood. Most of the problems encountered in the field are discussed, alternative solutions are being proposed, and experience in outside areas is being sought. There is a remarkable statistical awareness of what is happening in Maharashtra agriculture, i.e. the yardsticks of irrigation development are being formulated and monitored. Like most, the technical personnel are primarily concerned with specific components of the irrigation system. Consequently, not all subtle interactions in the system are understood, but by and large, the first criterion is met.

The technical expertise in Maharashtra is more stratified than would be optimal, i.e. one institution is not always sufficiently cognizant of another's capability and importance. There are limited efforts being made to coordinate activities, exchange data, and plan collectively. The second criterion is considered in more detail in the previous chapter covering the institutional analysis. From a technical perspective a more interdisciplinary effort is needed.

Regarding the third criterion, the procedures for project development are published in manuals of practice, as reviewed in the previous section. The preparation of these materials reflects integrated strategies at the administrative levels within the respective agencies and departments. Strategies appear to be founded on basic experience.

Technology transfer is a major problem in developing areas and Maharashtra is no exception. The communication is largely top-down so that gaps exist between the research, implementation, and farmer groups. The problem appears to be particularly severe at the on-farm level. The operation of the water supply and distribution system should closely approximate the time and quantities of water needed by the crops. Rotational deliveries must be very flexible to meet the variations in these water requirements. In Maharashtra this is a problem which can only be alleviated by closer farmer contacts and better canal distributary management. Extension services are generally weak, further compounding the communication gaps. The fourth criterion is therefore not being fully met and this will be an important focus of USAID assistance.

The outlook on the fifth criterion is mixed. The ID and AD as well as the GSDA collect substantial amounts of data and do manage to publish summary statistics. However, there is generally a lack of information processing capability which would allow irrigation development to be improved project-by-project as well as with time under each project.

The design of minor tanks depends on yield estimations developed nearly a century ago. The records from some catchments have been evaluated in a limited way to see if better methods are available, but practically no reservoir inflow gauging is in place to refine these methods or choose others. Likewise, sediment yields from the catchments are standardized estimates which have been found to be inadequate. Seepage losses from the canal network should be known from monitoring and study of existing projects or estimated prior to construction from the alignment test pits (a simple procedure is given in Annex III-4). Finally, there is practically no feedback from observing water applications on individual fields for evaluating infiltration characteristics and thus, the application efficiencies that are actually occurring. As a substitute, application efficiencies are assumed along with conveyance efficiencies. The estimated efficiencies appear to be subtantially higher than real efficiencies, thereby causing significant shortfalls between the irrigated acreage anticipated and the acreage actually irrigated.

With the initiation of the Water and Land Management Institute (WALMI) at Aurangabad, the potential for manpower training for ID and AD, for example, is promising. Some of the problems occurring at the distribution systems/on-farm interface are the specific substance of WALMI programs. Its emphasis on field application of basic concepts, undertaken in relatively short but intensive sessions, should be particularly helpful to the field personnel.

b. Evaluation of Model Projects

Five proposed minor irrigation tank systems were evaluated by the USAID Design Team 14/. These proposals were intended to be models for the project preparation processes outlined in the new ID manual. While they were prepared by an independent cell (the Narmada Project Preparation Cell), they reflect planning practices within the ID. Annex III-5 summarizes the features of these schemes and notes some of the procedures that were followed. It is concluded that the basic planning and design procedures as laid out in the Manual have been followed closely for headwork and main canal design. Design of distributary and on-farm works are not included.

14/ a. Chorgewadi Minor Irrigation Tank Scheme Report.
b. Surabadi " " " " "
c. Ratnapur " " " " "
d. Utchil " " " " "
e. Dhule " " " " "

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Aside from a preliminary alignment of the distributary, nothing in the way of structures, watercourses, field channels, or drainage systems have been presented in the documents reviewed. Allowances for the costs of these items are based on assumed percentages of other scheme costs or the aggregate number of structures and channel lengths are estimated and then multiplied by estimated unit costs. Some improvements in the procedures have been made with respect to conveyance capacities. The Penman method of estimating potential evapotranspiration has been used and monthwise water budgets were generated to estimate delivery requirements.

c. Evaluation of Existing MIS

In addition to the minor schemes visited in the field, reports were obtained from a number of minor tanks which have been operating seven to ten years. Evaluation of other minor schemes are abstracted from the technical literature.

A summary of the features of two operating tank schemes is given in Annex III-6. The first tank is named Kothare in Dhule District, while the second is the Nisardi tank in Jalgaon District. Both projects are in the Nasik region. In examining these schemes, several points are apparent. First, the basic ID procedures have been followed in the planning and execution of the infrastructure. Again, the attention to the distributary and on-farm components does not appear in the scheme reports.

The second conclusion is that the development of irrigation water supply made the kharif water supply (monsoon rainfall plus supplemental irrigation from the tank) more reliable. Only 5-10 percent more land was cultivated during kharif but the nature of the crop mix shifted to higher value crops. The effect during the rabi season was much more apparent. Cultivated acreage under the Kothare command area, during rabi increased more than 350 percent. Of course, year-to-year variations are also substantial. Both schemes appear to have stimulated well construction, but interestingly, the lands served by wells did not show increases. In fact, the trend was opposite, suggesting that well waters are being concentrated to maximize production of high value crops.

A third observation is that the design command area is significantly larger than the actual acreage being irrigated. Under the Kothare minor, only 38 percent of the targeted acreage was irrigated during a full supply year. The use of the Nisardi project was 49 percent in 1980. While this is a higher value, it substantiates the conclusion that the target acreages are not being achieved. Some thought might be given to the issue of design dependability.

Data from these tanks do not differ appreciably from utilization under major and medium projects throughout Maharashtra. In a statement given to the team summarizing the 1978-1982 statistics on 27 major and medium projects in the six divisions of ID, the average utilization (actual area irrigated/area of potential created) averaged only 44 percent. GOM reports indicate that water in tanks and reservoirs are under-utilized due primarily to a lack of reliability or confidence at the farm level. It may be possible that utilizing a 50 percent probability to size the reservoir (which would make it bigger than a 75 percent probable design) and then a 75 percent dependability for the design of the command area (this would reduce the acreage served) would yield a more reliable water supply to farmers, but probably to fewer farmers. This aspect should be studied during the course of project implementation and recommendations utilized for project planning and design of schemes undertaken. Chapter V, "Social Analysis," emphasizes that the issue of reliability also extends to diversity in cropping patterns, i.e., ID sanctioning in blocks and allowing a wide crop mix would enhance utilization.

Finally, it is concluded that design cropping patterns as sanctioned by the AD are modified in favor of more diverse, cash producing patterns. An interesting question arises as to whether the current sanction of primarily food grains under state sector minor schemes is either desirable or necessary. It may be possible that areas of these crops remain high because they are the best risk strategy for kharif seasonal cropping, and thus specific government interventions to ensure their production may not be needed. These structured sanctions may not be desirable because they attempt to restrict the income generating capacities of the irrigators. It may be desirable to limit the acreages of perennials like sugarcane served by minor schemes, but probably not seasonal crops like oilseeds, groundnuts, cotton, etc.

This sample is far too small and concentrated to extrapolate state-wide implications. A sample of additional on-going schemes should be evaluated and recommended design criteria confirmed or revised during the project implementation period. Published reviews are available which support the general observations presented above.

C. Project Activities and Special Studies

Some weaknesses in present minor irrigation scheme planning and design practices have been referenced in the previous sections, and they are widely recognized. In order to develop improved criteria and strengthen the institutional capability for developing irrigation in the State, it is necessary to re-assess and supplement the technical state of the art in the Maharashtra setting. This should involve four programs which can be undertaken independently of new MIS construction, and immediately after execution of a project agreement. These programs are: (1) development of a baseline data inventory and processing capability; (2) diagnostic analysis and special studies to improve existing technologies and assess alternatives; (3) irrigation systems model; (4) updating of selected technical practices; and (5) pilot activities.

1. Data Collection and Processing

The collection of basic hydro-meteorological data in Maharashtra needs to be supplemented in several ways. It is, therefore suggested that at least 14 micro-computers be purchased and one or two installed in each of the six ID regional headquarters and the office of the coordinating Chief Engineer for specific MIS utilization. One or two would also be located in the headquarters of the Superintending Engineer (Bombay) responsible for overseeing the State-wide stream gauging and by hydrologic data collection program. Project related computer needs within the GSDA, AD, and Agricultural Universities will be identified and met to the extent that resources permit. Data from operating schemes which have been collected during the monitoring of minor schemes in the prescribed ID format should be coded. A similar effort should be made to create profiles of groundwater conditions, stream flows, climatic conditions, and agricultural land use patterns. A Special Analysis and Evaluation Cell will be set up under the Coordinating Chief Engineer to coordinate and monitor the data collection and analysis, supervise pilot activities, develop the MI systems model, and conduct and/or manage the special studies. Short-term technical assistance will be provided to assist in initiating this work. It is proposed that two officers from each of the five ID regions, five from the AD, five from GSDA, and five from the Agricultural Universities be assembled with the micro computers for a two-week in-country training course. Two months of technical assistance would be necessary to conduct the short-course on computer use and application in the MIS program. Procurement of the computers, training in their operation and the required technical assistance would be grant funded.

The GOM has proposed that the existing stream gauging and climatological network in Maharashtra be strengthened. Present data limitations restrict the use of more reliable procedures for estimating monsoon runoff as well as crop water requirements. The state has proposed expanding these two data collection activities to give more intensive coverage over the State. Some Project funds have been allocated to assist in this effort.

Two existing MIS in each of the six ID regions, will be identified which have a seven to ten years or more history of operation and which have relatively complete records of reservoir levels and canal flow distribution data. These 12 MIS's will then be utilized as the data sources for the short course outlined in the previous paragraph. A complete climatological station will be established in the command area of the 12 MIS's, including measurements of daily wind run, solar radiation, minimum and maximum daily temperatures, rainfall, relative humidity, and pan evaporation. In the event such measurements, or components thereof, are already being made, the project will support any necessary upgrading or replacement. A continuous stage recorder will be installed to record reservoir levels of minor tanks. A stream gauging station will be located immediately downstream of the command area for each of the MIS's comprising this project. Use and justification of these data will be described in a later section of this chapter.

The 90 or so new schemes that are constructed under the project, will have the same instrumentation as described above. Technical assistance for calibrating stream gauges will not be needed since this is a standard practice.

In the same 12 existing schemes areas and in all new schemes that are constructed, water levels and pumping records should be monitored monthly for a representative number of dug wells. The GSDA will be involved, particularly with regard to conducting tests of the aquifer characteristics in the command and the magnitude of local groundwater resources. The GSDA should begin a monitoring program for new projects before construction in order to assess the contributions of seepage losses and field irrigation to groundwater recharge.

Similarly, the area-capacity relations for the 12 existing tanks should be re-surveyed to quantify the reductions in reservoir storage capacities that have been caused by silt deposits. Historical land use patterns should be evaluated to determine how water availability affects crop mix and production.

These are not a comprehensive array of data that could be assembled and analyzed, but are noted to illustrate the fact that not all lessons have been learned from existing experience. In this regard, the SAEC will be responsible for integrating not only the existing information into a useable form, but also to standardize data acquisition efforts.

2. Diagnostic Analysis

Diagnostic analysis of minor irrigation systems will be undertaken by an interdisciplinary team of irrigation and agriculture professionals with farmer involvement to understand the system and identify those physical, biological and socio-economic components which are not functioning to meet the system goals. The problems of the system are identified and prioritized for developing solutions for improving the performance of the system.

The next step is a search for practical solutions by the same team, comprising an engineer, agronomist, economist and an extension professional. An in-depth investigation is carried out and the problems and solutions are worked out on-farm with farmers as cooperators. Those solutions which are cost effective, highly visible and acceptable to farmers are put in priority order.

The same team will asses each solutions package that has been worked out to ensure farmer acceptance and to identify what complementary inputs and services are required. Careful analysis of costs and benefits, externalities and institutional infrastructure needs will be conducted. The alternative packages evolved will be presented to the ID, AD, or other appropriate agency for policy decisions and for implmentation under the Project. Implementation consists of carrying out recommended improvements in the hardware or software in the system/sub-system under consideration. Such demonstrations developed and evaluated over one or more crop seasons will provide a visible demonstration of what water management really is.

The diagnostic analysis will be initiated on one scheme in late 1984 under the Water Management and Training (WM&T) Project. This will be a five year action research effort. During the first year a sufficient number of officers of ID, AD, GSDA, and the Universities will be trained so that they can staff the diagnostic analysis of five additional schemes in year two of Project life. Costs of the initial scheme analysis and training will be borne under the WM&T Project.

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Diagnostic analysis of the five schemes in year two will result in problem identification and proposed solutions. These solutions will be carried out on the five schemes and may include physical renovation as well as changes in water scheduling, other water management procedures, crop mix and crop production practices, agency organization, farmer organization, and so on. Successful and useful changes demonstrated in this process will be fed into the design of future minor schemes.

This process will be repeated on six additional schemes in year three and four of project life. In addition, in year five, two of the schemes diagnosed in year two would be reanalyzed for evaluation and proposed further changes.

The Design Teams analysis has presupposed some of the solutions/problems that will be identified in the diagnostic analysis and certain pilot demonstration/investigations and special studies have been proposed. It is expected that the diagnostic analysis will further refine these proposals and identify additional problems/solutions to be tested.

The diagnostic analysis will be grant financed under the Project. Any renovation required in the systems will be loan financed. No attempt has been made to estimate renovation costs. Necessary funds will come from that estimated for new schemes.

3. Minor Irrigation Systems Model

A series of modifications to the existing hydrologic data acquisition system are proposed that will include ten minor projects already functioning. The premise is that the best alternative for improving presently constituted standards of practice will be derived from information currently available or that will be collected. Careful data collection during each succeeding MIS can lead to further refinements which will inhance planning and execution of later schemes. In essence, it is important for the natural generation of field data to be continually evaluated with a view toward establishing an increasingly improved technical capability.

To make the best use of the existing data base and integrate each of the separate analyses that are possible, it is proposed that a computer model of minor tank systems be developed. The model should be a comprehensive simulation of the catchment, tank, canal and distributary conveyance network, chak and surface drainage system, and the goundwater basin. The coding should be modular so that alternative submodels of each component could be independently

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developed and tested, then inserted into the overall model without interupting the system level configuration. The model should be developed to operate in three modes, which can be defined as the simulation mode, the policy mode, and the operational mode.

In the simulation mode, the model should employ the characteristics of the physical system along with reasonable mathematical approximations of the hydrologic processes to duplicate as well as possible the actual system behavior. This mode is primarily a calibration and verification exercise. Historical data which are available through routine monitoring are used to adjust coefficients in the mathematical description (calibration) until system inputs like rainfall, climatic conditions, land use patterns, canal diversions, and groundwater withdrawals can be utilized to predict system behavior as reflected by catchment runoff, sediment loading, evaporation and conveyance losses, crop consumptive use, groundwater recharge, and surface and subsurface return flows to the stream or nalla. The simulation mode accomplishes two important objectives. First, updated computational procedures are introduced from the research and development groups, several of which will be described shortly. These procedures are then adjusted to the site specific application in Maharashtra and thereby become the basis for improved planning, design, and operational methodologies. For instance, more elaborate mathematical descriptions of the catchment hydrology which include such physical inputs as size, soil properties, topography, slope, vegetative cover, etc. should lead to more reliable estimates of yield, sediment loads, and peak flood flows needed to design dams and spillways. Secondly, the simulation mode provides the best framework for technology transfer and training. As new technological developments occur in understanding the nature of irrigation systems, they have a clearly identified location for testing and implementation. The simulation mode illustrates the essential continuity of the system and demonstrates the interactions between individual components, thereby broadening the perspective of personnel involved in irrigated agriculture at all levels.

The policy mode addresses "what if" issues. Instead of changing inputs to the model to see how the system will respond, the hydrologic conditions are fixed and the system characteristics are modified to determine if alternative planning, design, and operational practices would result in better irrigation systems. A number of questions can be addressed. A very short list might include:

(1) If grazing in the catchment was restricted and simple devices such as check dams or "nalla plugs" were installed, how would the life of the reservior be extended and would it be economically feasible?

(2) Would canal and distributary lining be justified by the additional water available for irrigation or would it be ultimately detrimental by reducing the use of groundwater?

(3) What structural and managerial changes would be necessary to change the existing rotational water supply policy to one of a demand nature?

(4) How do changes in the values of percent dependable rainfall affect a project's benefit/cost ratio through adjustments in the size of the structural elements and the command area?, and

(5) What is the optimal policy regarding relative levels of irrigation supply in kharif, rabi, and hot weather seasons?

The important objective accomplished by the policy mode is the capability to assess the feasibility of ideas put forward to improve the performance of minor tank irrigation. It is often costly to evaluate poor alternatives to existing methods by constructing the alternatives. Similarly, the risk of failure often prevents the execution of highly beneficial innovations.

Finally, the operational mode provides the real time data processing capability which allows better management. The system's physical characteristics are set and appropriate mathematical calibrations have been made. Historical data are used to compute the most likely conditions that will occur in the immediate future, but real time data are input to produce real time estimates and formulate plans for operations over the following one or two weeks. The operational mode is a tool for helping make day to day decisions with the corresponding projections of best outcomes. The objective of better managed systems depends heavily on better use of information.

The concept of modeling is not new, but it has not been widely applied. It is suggested that a team of U.S. and Indian technical specialists be put together to develop a minor irrigation system model for Maharashtra. This would involve sustantial synthesis from modeling efforts worldwide as well as close cooperation with the state's agricultural, groundwater, and irrigation agencies. The team should establish the boundary conditions for the model. It is proposed here, however, that the time steps used in the model be monthly or rotational increments where possible and that, with the exception of the catchment, transient hydraulic and short-term agronomic factors be ignored. Institutional and economic variables would be major inputs into the model. The technical assistance team will require 12 person months over a two year period. At the end of the development stage, a month long training course will be held to train ID, AD, GSDA, and University personnel associated with the data processing system described above.

4. Modifying Technical Standards

There are two areas where present technical concepts can be updated from developments outside Maharashtra. The first of these concerns flow measurement. Existing standards specify standing wave or Parshall flumes as the principal measurement structures used in minor systems. This array of structures is outdated. They require precision construction and maintenance which is nearly impossible in field conditions with unskilled labor. Furthermore, they are very costly. As a consequence, most operating projects do not have the measurement structures needed for effective water management, and even where present, the accuracy must be seriously questioned. It is proposed that two man-months of U.S. technical assistance be employed to write a water measurement manual for the Maharashtra ID. The new innovations would include the cutthroat flume developed at Utah State University and now widely used world-wide, and the broad-crested weir or long throated flume developed in Arizona by the U.S. Department of Agriculture. These devices are not only significantly cheaper and easier to build and maintain, but they are easily recalibrated if mistakes are made during field installation. The hydraulics of both structures can be easily coded in the micro-computer proposed for this project. Another innovation that is needed is to gauge the measurement structures with flow indicators rather than stage indicators. This will allow the irrigators as well as the ID operating personnel to know, just by observation, the distribution of flows in the system without the necessity to compute flow or look up the flow in tables.

A second contribution that could be made from U.S. technical assistance is the preparation of a field irrigation guide specifically aimed at computing crop water requirements and determining irrigation schedules. Similar guides are available in other areas in and out of India, including internationally recognized sources like the U.N. Food and Agriculture Organization. There are numerous micro-computer codes available. The principal problem in Maharashtra is that either a simple duty is used which ignores the important growth stage differences among crops or the "modified" Penman model is used. The Penman model is not the best tool for estimating crop water requirements on the bi-weekly or monthly time frame used for planning and design since the climatic data needed for effective use of the Penman method are not widely or accurately reported. Soil moisture accounting models are available to use with crop water requirement estimates to formulate on-farm irrigation schedules and/or target applications. The implementation of such a model at the appropriate level of sophistication along with a users guide may be a most helpful package to utilize in the micro-computer systems being proposed. The associated training in the use of irrigation scheduling models will be facilitated at the Water and Land Management Institute.

5. Pilot Schemes

Minor tank schemes are small enough to use as pilot scale tests of currently known irrigation technologies that are not presently used in Maharashtra. The three overall modeling studies described in the following sections will delineate a number of structural and operational options that can be tested on MIS. Experimental work on soils, soil fertility interactions, and watershed management introduce other opportunities for pilot level demonstration and analysis, as do various institutional aspects of minor irrigation.

a. Piped Distribution Systems

The first type of pilot tank scheme would be a gravity fed pipe network to replace canals, distributaries, and farm ditches. A 304 mm plastic pipe on a 1% slope would carry approximately 0.160 m^3/sec. Using a typical outlet flow of 0.03 m^3/sec, this capacity could supply five or six chaks ranging in size from 20 to 30 ha. The piped portion of the system will extend to the boundaries of each land holding rather than just to the eight ha outlet point. The piped distribution systems afford another option for applying water, namely sprinkle irrigation, without substantial additional costs above normal part I and II on-farm development works. The ID will select lands for pilot testing of sprinkle irrigation, enlist irrigator cooperation where possible, and implement two to four systems of different configurations suited to the various crops being cultivated. The AD will contract with one of the Agricultural Universities to analyze the costs and benefits of Part II works under sprinkle irrigaton as contrasted to land shaping and leveling under surface irrigation.

A detailed economic and operational analysis of the system will be undertaken over a three to five year period following construction. Such issues as cost, efficiency, maintenance, and use by irrigators will be evaluated together with the management implications to the ID. Technical assistance of about two person months will be made available to assess alternative sites and help prepare the designs. This pilot activity would be conducted on two or three schemes in the Konkan region.

b. Demand Scheduling

A second tank scheme using canal deliveries would be designed to operate on a "supply on demand" basis to test the hypothsis that completely flexible irrigation systems can be implemented in Maharashtra and that they will substantially improve agricultural output by improving farmer confidence in water deliveries. The delivery network would be somewhat larger in capacity than a rotational system and would require a higher level of management, alternatively it might be an opportunity for operation of all or part of the system by the users themselves. This would be an excellent opportunity to apply the MIS model in the operational mode. If the project was not successful, it could fall back on a rotational strategy quite easily.

A demand system would begin operation at the beginning of the rabi season by informing the irrigators of their proportionate share of water in the reservoir along with some technical assistance initially as to how much this amount could irrigate of various crops. The irrigator would also be instructed that he can utilize his proportionate share as desired, but he must also share proportionate evaporation and seepage losses. The usual land development componenets of an MIS would be supplied to assist him in using water efficiently. At the operational level, he could obtain water by giving a two day notice or order to the canal officer, indicating the duration he would like the stream.

Because demand systems are not routine in the State nor in India, the initial design would be developed by USAID supplied technicans and continuing assistance and training during conduct of the pilot experiment would be available under grant funding. One person month per year over a five year period by an irrigation engineer and one person month of a sociologist will be required.

This pilot activity would be conducted on one of the closed schemes proposed for the Konkan Region and on one open system to be selected.

c. Conjunctive Groundwater Use

The importance of groundwater to Maharashtra agriculture has been clearly stated. It has been previously recommended that in one or more of the existing or planned tank schemes, the GSDA conduct a detailed inventory of groundwater potential under the canal command. Then a groundwater development plan should be formulated to develop the unused supply through a system of dugwells. A well for each farmer would be impractical, exceed the capacity of the groundwater aquifer, and result in non-equitable withdrawal. Thus a lower number of wells which are shared by small groups would be required. Wells should be planned and located to assure that the withdrawals match the available recharge.

It is proposed that the above ideas and concepts be incorporated into the conjunctive use analyses to be carried out under the Maharashtra Irrigation Technology and Management Project and, if appropriate, designs be proposed for pilot testing in selected MIS's.

It is also proposed that an Agicultural University located in the region be given responsibility for developing a framework for evaluation of such pilots. The University would conduct a comprehensive economic, agronomic, engineering, and social analysis of such pilots to determine the interaction between the state sector MIS's and the private sector use of groundwater. One person month of technical assistance would be required to help design this study.

D. Proposed Planning and Design Criteria

1. Water Supply

During the initial stages of the Project, particularly while the minor system model is being developed, the hydrology of the proposed MIS's will be developed using current practices as per "Manual of Minor Irrigation Works in Maharashtra State, 1983."[15/]

Design of specific MIS components should be modified if necessary only after the results of the special studies and pilot projects become available.

2. Water Budget Analysis

A monthly or rotation water budgeting analysis should be made to determine acreage to be commanded, canal and distributary

15/ Op. cit.

capacities, and delivery rotations using the computer models mentioned earlier. The ID "model projects" reviewed illustrate the framework that should be used. A water budget for each proposed MIS should be prepared as follows:

a) Crop water requirements will be calculated according to the cropping patterns developed by the AD and the climatological data from the area or near-by areas using the modified Penman method. A monthly irrigation water requirement should be developed for the study period of 20 years using actual recorded rainfall in the project command area or adjusted from stations in nearby areas. The effective rainfall and soil moisture balance should be computed for the 75 percent probable rainfall for the month in the command and the net monthly water requirements should be worked out.

b) For planning purposes, the conveyance and on-farm application efficiencies should be assumed on the basis of unlined distribution systems as recommended in Maharashtra Irrigation Management and Training Project (Vol. II, p.4-15) as detailed below until additional substantiated results are available.

Item	Kharif Cropping (%)		Rabi Cropping (%)	
	Loss	Efficiency	Loss	Efficiency
1. Conveyance from dam to 8 ha government outlet	10	90	20	80
2. Operational losses	15	85	15	85
3. Field channel losses	20	80	20	80
4. Field application losses	20	80	25	75
Overall efficiency		49		41

Water requirements for land preparation and pre-sowing should be considered as follows:

Item	Water Requirements
1. Land preparation (paddy)	100 mm
2. Transplanting (paddy)	150 mm
3. Pre-sowing	100 mm

It is assumed, based on past studies, that supplemental kharif water supply, including a provision for pre-monsoon irrigation, would be tested in the reservoir operation study. The area to be sown in rabi would be determined by the storage available prior to the rabi planting season.

3. Dam and Reservoir Design

All minor project works associated with the dam, reservoir, spillway, and head regulator should be designed according to existing standards, until results of the proposed studies on silt load and associated design criteria as proposed in the Project become available.

Evaporation losses from the impoundments need to be estimated in the same manner utilized to determine crop water requirements above. If pan evaporation is recorded, average monthly reservoir evaporation should be 80% of the average pan evaporation. A monthly estimate should be prepared in conjunction with the budgeting procedure used to size the command area conveyance capacities.

4. Surveying and Mapping

The use of the Survey of India maps supplemented by strip surveys is acceptable for determining the dam location and possible location of the main canals. However, before the final location of the main canals are made, a detailed soil and topographic survey should be made, and the alignment rechecked.

The topographic map should be based on a close grid survey and should normally depict:

i) Ground elevations on 15m or 30m grid depending on the ground slope (30 m grid for slopes greater than one percent)
ii) Traverse line and grids as laid on the ground
iii) Location and value of bench marks within the area surveyed
iv) Cadestral boundaries
v) All permanent structurs in the area including Power Transmission
vi) Proposed alignment of main canal/distributory with FSL at apropriate places.

The topographic survey will be carried out first by the AD with a grid of 10 to 15 meters and a contour interval of 0.20m except in steeper areas where wider intervals may be used. The ID will use this base survey for design of the distribution system and

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for preparing appropriate scale maps as needed. The existing cadestral maps with appropriate enlargements may also be used as base map for traversing and subsequent surveying and mapping with the above criteria.

5. Distribution and Conveyance Network

Water is conveyed from the MIS impoundment to the individual fields through a network of canals, distributaries, watercourses, and field channels. It is proposed that MIS's developed under this project employ a "bottom-up" conveyance design and layout strategy. The bottom-up strategy begins with the field channels and watercourses and moves toward the canal and dam following these layout and design steps:

(1) Tentative layout of field channels and watercourses which can be served by approximately 5-8 ha outlets should be made. Likewise a surface drainage alignment should be identified. All field outlets should be at least 15 cm above field surfaces and the 5-8 ha outlet should be at least 15 cm above the maximum watercourse inverts. Prior to the finalization of these plans, the ID and AD personnel will meet with the farmers in each command and review with them the tentative plans and layouts of the watercourses, field channels and turnout locations. If required, possible technical alternatives for the alignment of the system will be presented to the farmers. Based on these discussions the final plans will be prepared for location and size of the system.

(2) Once the field distribution system has been planned and the 5-8 ha distributary outlets have been located, the alignment of the canals and distributaries can be finalized. Under this Project, the canals and distribution system should meet the following minimum design criteria: (a) The system should be designed to deliver at least 30 litres/sec. of water at the distributary outlet on a rotational basis. Outlets from the canal and distributary channels should be regulated with on-off gate structures; (b) Main and branch canals should be designed and constructed so that full irrigation deliveries at offtakes could be drawn when main and branch canals are flowing at 50 percent of their design capacity. They should therefore be provided with sufficient control structures to make the required diversions throughout the full operating range of the channel; (c) Measuring devices should be provided at the head of main supply channels and at each off taking distributary. Measurement structures should be located along the canals and distributaries as necessary to properly divide flows among users; (d) Escapes (wasteways) should be provided as needed at the end of canals and at various points along the canal alignment. Wherever

possible, wasteway gates should be combined with side channel overflow sections, specially towards the tail end, to provide both an automatic control feature and capacity to empty the canal; and (e) The conveyance capacity should be based on maximum irrigation requirements of the system.

Lining of canals, distributaries, and on-farm channels should only be considered where the alignment intercepts the sandy or murum substrata. No lining should be placed in sections aligned in the clay or clay loam soils. Hydraulic conductivity tests as outlined in Annex III-3 should be made at those stations which reflect a change in soil material to properly identify potential high loss regions. Existing lining standards adequately describe the procedures to be followed and materials to be used. A program to assist users in developing procedures and methods for continuing maintenance and reconstruction should be developed.

6. Land Development

Reasonable irrigation performance can only be expected if the fields are adequately prepared and sized to accomodate the flow rates diverted from the field channels. Under this project, the following general guideline should be adopted for land leveling or grading. A uniform field slope should be adopted which absolutely minimizes the depth of soil disturbed. This will dictate whether the application method should be basin (level in all directions), border (sloping in the direction of primary gradient but having zero cross-slopes), or furrow configurations (sloping conditions allowed in both field dimensions). Handbook information on land development appear to be available and training programs are being conducted under the MIT&M Project. Field personnel will be trained in identifying suitable methods of irrigation. Field bunding may already be in place as most lands served by MIS's will have had a history of rainfed agriculture. However, with the concurrence of the irrigators, additional bunds may be necessary to provide efficient irrigated and drained units.

7. Groundwater Development

Minor surface irrigtion schemes normally do not provide water for the more remunerative crops like hot weather groundnuts and sugarcane. Groundwater which can be used for cash crops or for premonsoon sowing provides a very valuable complement to a farm household economy. Conjunctive use of groundwater is thus a powerful factor in accelerating development in irrigation commands. Full well development within the command area to balance the natural and surface irrigation induced recharge will also essentially eliminate any potential waterlogging hazards. Analysis of various aspects of conjunctive use will be undertaken with the MIT&M Project.

As part of this Project, the State should evolve a suitable methodology of exploiting groundwater available in the command area and integraging it with the system of surface irrigation.

8. Water Allocation and Rotation

It is proposed to allocate water under this Project according to the Shejapali system of rotation, but with certain modifications. The water will be allocated to farmer proposed cropping patterns, first on an annual basis after deducting expected evaporation losses. The monthly water budgeting process conducted at the design stage will be repeated using average climatic conditions and operational efficiencies, but with a time interval equal to the cycle of the Shejpali rotation. Proportionate shares of the total resource will then be based on the proportionate annual demand. For example, a 1 ha field of rabi wheat requiring 600 mm of water to supply its consumptive use needs would be allocated (from the total tank supply at the beginning of the rabi season) one half of the water required for a sanctioned ha of a crop using 1200 mm during the season.

During each rotation period, the water will be divided on a volumetric basis to each participating field. The water budget for each rotation will identify the relative water requirements per ha of each crop. The water allocated to each field during the rotation will thus become the crop use multiplied by the area of the field divided by the total water requirement during the rotation. Because volumetric allocation is not easily accomplished directly, the rotational allocation will be divided by the discharge of the outlet to give the hours required to deliver the computed volumetric share.

The Shejpali system can be an efficient procedure if the ID implements the procedure correctly. If the schedules are not rigidly enforced, the rotation will quickly break down and begin to favor the users near the head of the conveyance system. A pilot test under the Girna Canal System [16/] has demonstrated the utility of a more rigid, crop independent, rotational scheme labeled RWS (rotational water supply). This system tends to ease the management of the tank and reservoir system by allowing a significantly

16/ Lele, S.M., R.K. Patil, and D.N. Kulkarni, 1979. "Rotational Water Supply on Girna Canal System." Study by the Project Formulation Cell, Planning Department and Command Area Development Authority, Irrigation Department, Government of Maharashtra. Bombay, 22 pp. 5 plates.

tighter, less flexible rotational schedule, and it tends to increase the reliability of service from the irrigator's view point. The ID should investigate this alternative further for MIS applications. Some form of RWS or strictly enforced Shijapali will be required on AID-financed MIS's.

Under this Project an operational study is proposed using a minor irrigation system computer model applied to 12 existing MIS's for testing and verification. Rotational water supply would also be studied along with demand delivery of water by the ID to water user associations. In addition, similar studies are to be carried out on the USAID assisted medium irrigation projects in Maharashtra. The results of both of these studies will be available prior to the completion of many of the MIS's and can be used to develop a policy on the best system of allocation to be applied.

9. Operation and Maintenance

During the initial years of operation of each individual MIS, the ID will be responsible for the operation and maintenance of the system. The ID in collaboration with the AD will organize farmers in outlet committees to take over the operation and maintenance of the system, starting at the chak level. Once the farmers have been organized and are able to operate successfully and maintain the system from the head of a distributary, they may then be organized on a distributary basis and perhaps eventually on a main canal basis. Much is to be learned in organizing farmers from various social and economic regions of the country. Many studies are under process in India to attempt to answer the question of how best to organize farmers to operate and maintain these small irrigation systems. Studies are underway by the Indian Institute of Management in Bangalore, various studies are being supported by the Ford Foundation, studies are proposed to be carried out on the USAID supported Maharashtra IT&M project and studies are being carried out under World Bank projects.

Under this project, workshops will be held by the AD to assimilate the information being gathered from the various studies. To accomplish this, the AD will appoint a committee to identify and analyze the studies that would provide useful information for the organization of farmers under the MIS. A report should be prepared by the end of the second year of this project to be used as a guide in carrying out workshops of the ID and AD personnel responsible for organizing farmers in each of the MIS's.

ANNEX III-1

MAHARASHTRA RAINFALL PATTERNS

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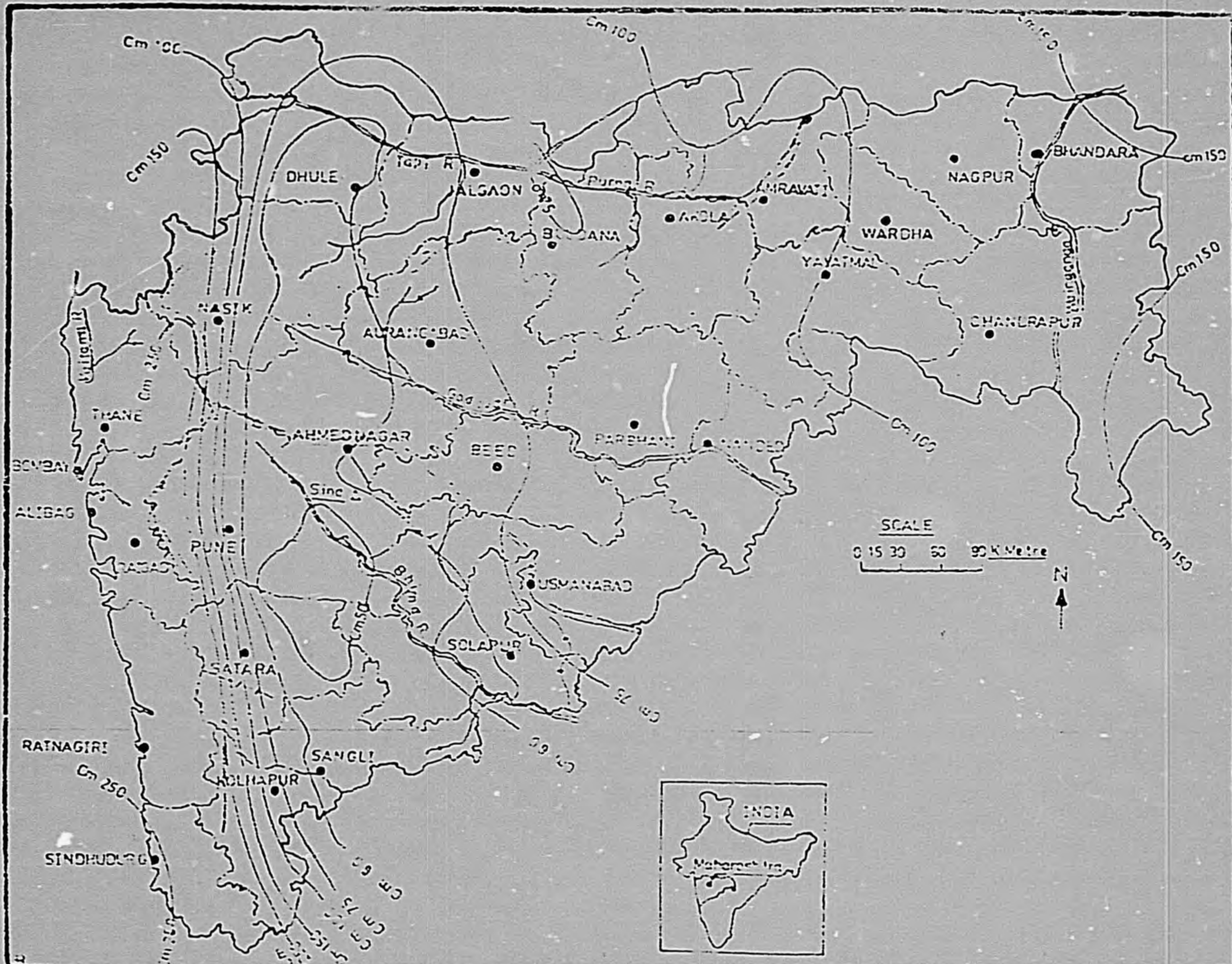
DHULE
NASIK
AURANGABAD
THANE
BOMBAY
ALIBAG
RAIGAD
PUNE
AHMEDNAGAR
BEED
PARBHANI
NANDED
USMANABAD
SOLAPUR
SATARA
SANGLI
KOLHAPUR
RATNAGIRI
SINDHUDURG
NAGPUR
BHANDARA
WARDHA
YAVATMAL
CHANDRAPUR
AKOLA
Tapi R
Purna R
Sina R
Bhima R
Cm 100
Cm 150
Cm 250
Cm 75
Cm 60
Cm 50
SCALE
0 15 30 60 90 K.Metre
N
INDIA
Maharashtra

ANNEX III-2

MAHARASHTRA AGRO-CLIMATIC ZONES

Government of Maharshtra

Irrigation Department

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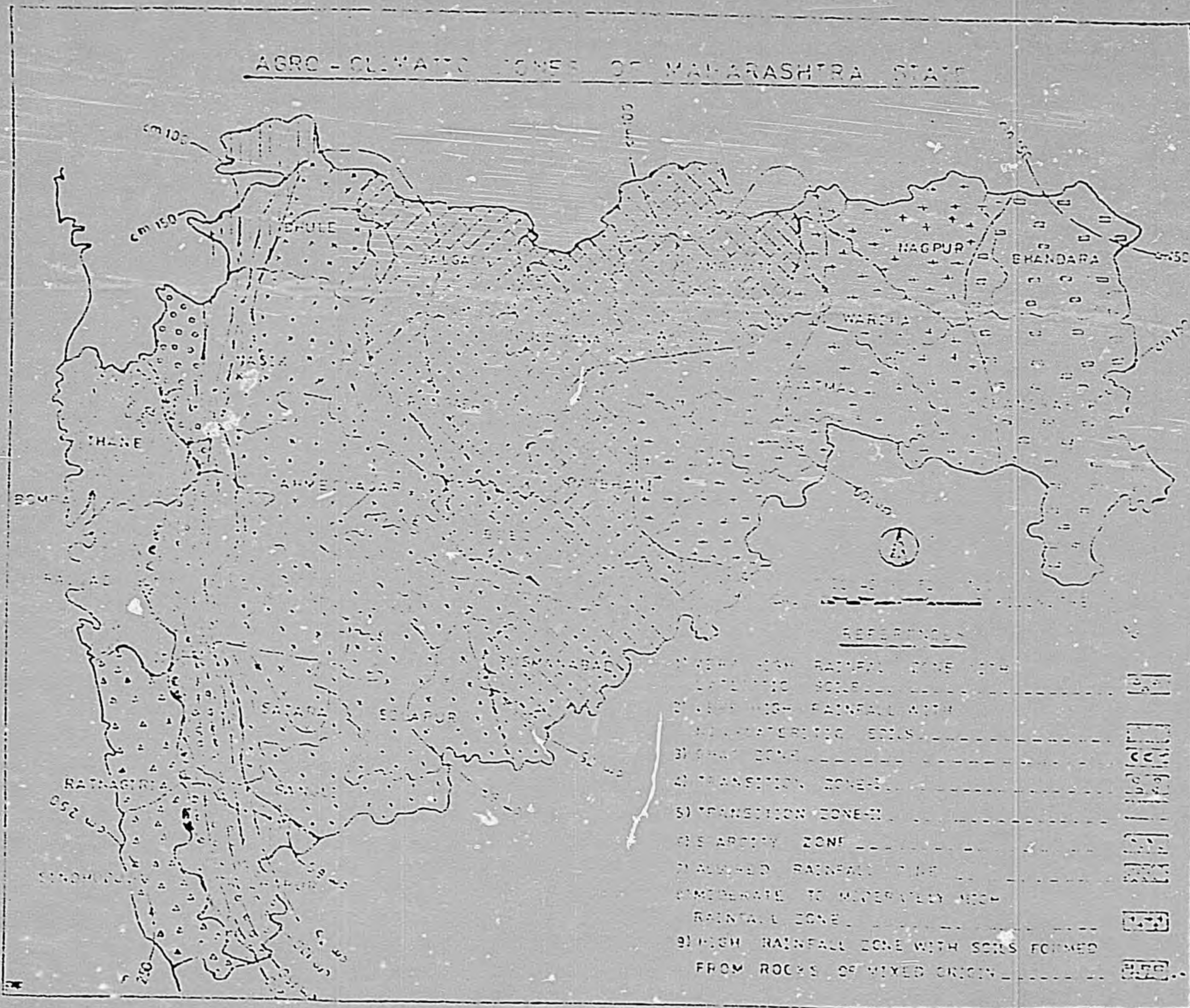

AGRO-CLIMATIC ZONES OF MAHARASHTRA STATE
cm 100
cm 150
DHULE
JALGAON
NAGPUR
BHANDARA
WARDHA
THANE
AHMEDNAGAR
PARBHANI
SATARA
SOLAPUR
RATNAGIRI
REFERENCES
5) TRANSITION ZONE-II
9) HIGH RAINFALL ZONE WITH SOILS FORMED
FROM ROCKS OF MIXED ORIGIN

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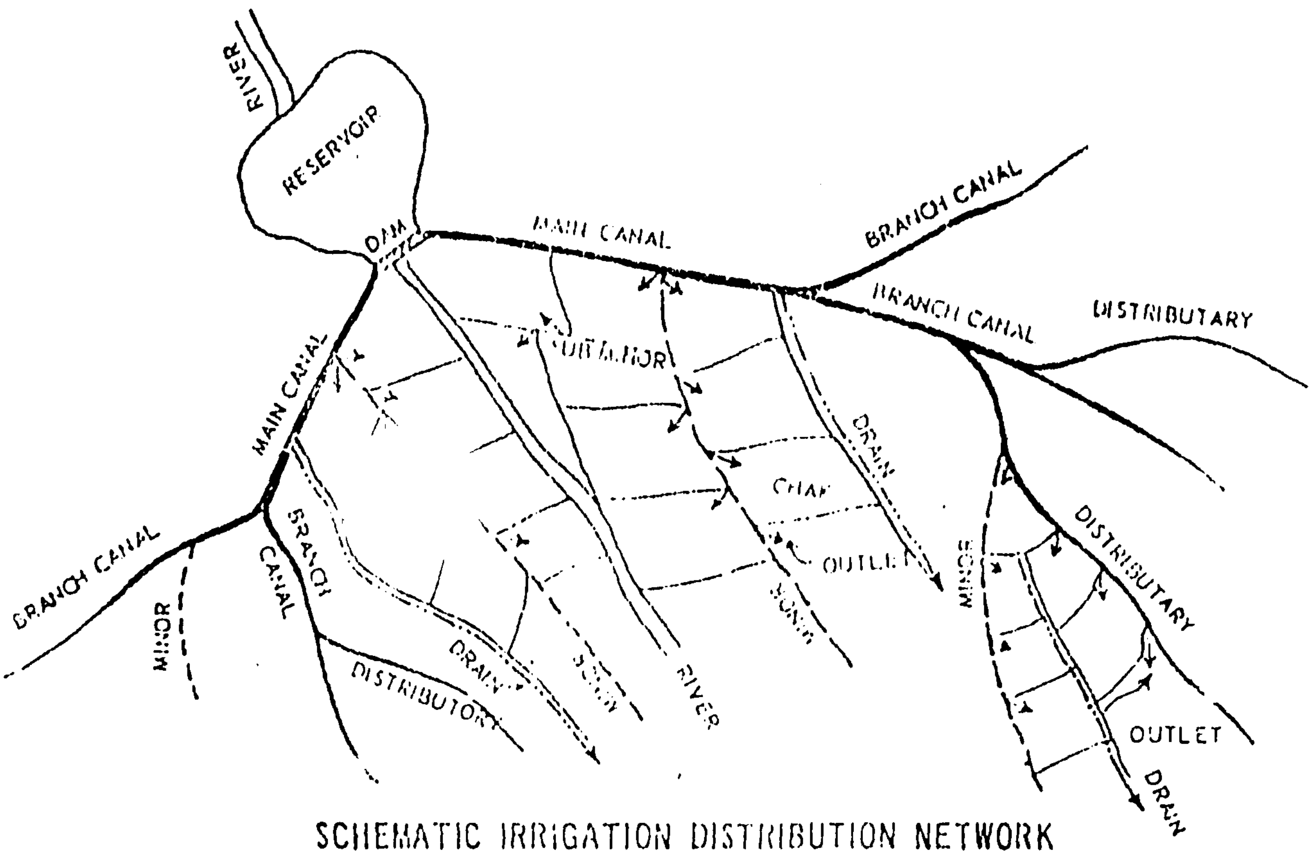
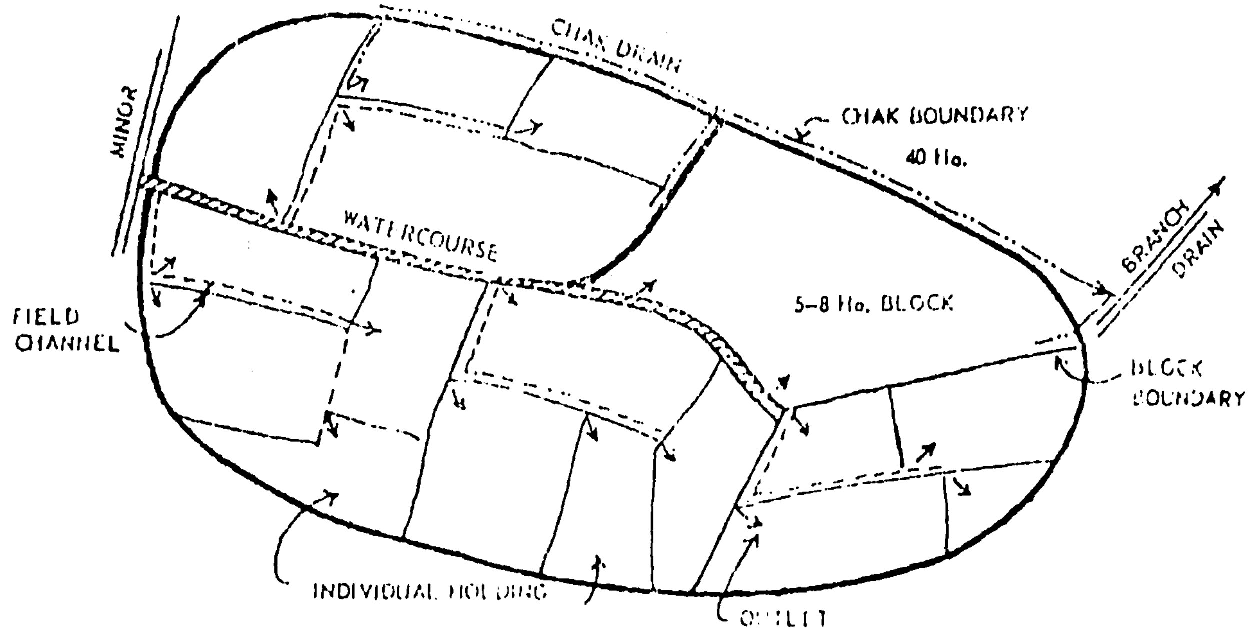
ANNEX III-3

TYPICAL COMMAND AREA, WATER DELIVERY AND DISTRIBUTION LAYOUT



SCHEMATIC IRRIGATION DISTRIBUTION NETWORK



WATER DISTRIBUTION WITHIN A CHAK

ANNEX III-4

TEST PIT METHOD OF EVALUATION; THE CONDUCTIVITY OF SOIL MATERIALS ALONG CANAL ALIGNMENTS

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 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. Larger sizes can be used, but the larger the pit, the more water required.

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 by-pass hoses and a large carbeurator for the finer regulation to keep the water depth reasonably constant. The carbeurator can be installed by placing it in a perforated tincan 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 carbeurator 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:

$$K = \frac{1{,}440Q}{CaD}$$

Where:

K = hydraulic conductivity (feet per day)

a = diameter of a circular pit, the side dimension of a square pit, or the 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 tes pit (feet)

C = conductivity coefficient from the following tabulation

D/a	Circular test pit of diameter a	Square test pit of dimensions a by a	Rectangular test pit of dimensions a by 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 attached. Sufficient time must elapse after filling the test pit and before taking measurements to permit establishment of a relatively steady state of flow. A comparison of values of C obtained by an electric analog study with K values determined analytically showed the anolog values to be about 30 percent lower at a ratio of D/a = 3 and about 10 percent ratio of D/a = 10 than the analytical study. Whenever possible, the test pit method should be checked against some other method of determining hydraulic conductivity.

Location ______________________________

Observers ________________ Date __________

Texture of test zone ______________________

Structure of test zone _____________________

Type of pit: circular with diameter a

D = 2 feet
a = 1 foot
D/a = 2 feet
C = 6.92

---- Time ----		Time	Tank Reading ---- ft3 -----		- Hydraulic Q - conductivity, K	
Initial	Final	Min	Initial	Final	ft3/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: $K = \frac{1440Q}{CaD}$

$$K = \frac{1440Q}{(6.92)(1)(2)} = 104.05\ Q$$

From Drainage Manual, U.S. Bureau of Reclamation, 1978.

ANNEX III-5

DESCRIPTION OF MODEL PROPOSED TANK PROJECTS EVALUATED

MINOR PROJECT EVALUATION

Name of Project:	Chorgewadi
District:	Sindudurg
Proposed or Existing:	Proposed model

Salient Features:

1.	Catchment	
	Area (km^2)	1.53
	50% Dependable Rainfall (mm)	3656.7
	Yield (Mm^3)	4.356[1/]
	Silt Load (Mm^3/km^2)	.092[2/]
	Design Flood (m^3/sec)	55.59[3/]
2.	Tank, Bandhara, or Lift	Tank
	Construction Type	Zoned Earth
	Live Storage (Mm^3)	3.214
	Dead Storage (Mm^3)	0.014
	Spillway Type	Clear Overfall
3.	Water Allocation	
	Irrigation demand including losses (Mm^3)	2.57[4/]
	Evaporation (Mm^3)	0.63
	Public Drinking Supply (Mm^3)	-
4.	Cropping Pattern	
	Kharif (%)	-
	Rabi (%)	
	70% Paddy	
	10% Two Season Rice	175 ha
	20% Vegetables	

Water Requirements modified Penman with monthly water budgeting

5.	Distribution System (main) Type	right and left bank[5/]	
	Capacity (m^3/sec)	0.2	0.10
	Length (m)	8000	3000
	Controls Measurement	listed but not shown on maps	
6.	Distribution System (Distributary and Farm)		
	Surveyed	Only distributary located,	
	Controls & measurement	but not designed[6/]	

MINOR PROJECT. EVALUATION

Name of Project: Surabardi

District: Nagpur

Proposed or Existing: Proposed Model

Salient Features:

1.	Catchment	
	Area (km^2)	7.122
	50% Dependable Rainfall (mm)	1105.25
	Yield (Mm^3)	2.533[7]
	Silt Load (Mm^3/km^2)	0.666
	Design Flood (m^3/sec)	140[8]
2.	Tank, Bundhura, or Lift	Tank
	Construction Type	Zoned Earth
	Live Storage (Mm^3)	1.789
	Dead Storage (Mm^3)	.08[3]
	Spillway Type	Submerged Overflow[9]
3.	Water Allocation	
	Irrigation demand including losses (Mm^3)	1.803[4]
	Evaporation (Mm^3)	0.73
	Public Drinking Supply (Mm^3)	-
4.	Cropping Pattern	
	Kharif (%)	-
	30% Jowar	
	5% Vegetables	)
		) 451 ha
	Rabi (%)	)
	70% Wheat	
	2% Pulses	
	3% Vegetables	
	10% Cotton	

Water Requirement modified Penman with monthly water budgeting

5.	Distribution System (main) Type	left bank[5]
	Capacity (m^3/sec)	.451
	Length (m)	7020
	Controls Measurement	10/
6.	Distribution System (Distributary and Farm)	
	Surveyed	11/
	Controls & measurement	

MINOR PROJECT EVALUATION

Name of Project:	Ratnapur
District:	Ahmednagar
Proposed or Existing:	Proposed Model

Salient Features:

1.	Catchment	
	Area (km^2)	65.35[12]
	50% Dependable Rainfall (mm)	619.25
	Yield (Mm^3)	6.371
	Silt Load (Mm^3/km^2)	.073[3]
	Design Flood (m^3/sec)	1583[8]
2.	Tank, Bundhura, or Lift	Tank
	Construction Type	Zoned Earth
	Live Storage (Mm^3)	1.66
	Dead Storage (Mm^3)	.708[13]
	Spillway Type	Clear Overfall
3.	Water Allocation	
	Irrigation demand including losses (Mm^3)	1.733[4]
	Evaporation (Mm^3)	.646
	Public Drinking Supply (Mm^3)	-
4.	Cropping Pattern	
	Knarif (%)	-
	8.27% Jowar	
	6.02% Bajari	
	4.51% Ground Nut	)
	2.25% Vegetable	)
		) 288 ha
	Rabi (%)	)
	69.17% Wheat	)
	69.17% Jowar	
	17.29% Grain	
	17.29% Vegetable	

Water Requirement modified Penman with monthly water budgeting

5. Distribution System (main)	left bank5/
Type	
Capacity (m^3/sec)	.288
Length (m)	6000
Controls Measurement	10/
6. Distribution System (Distributary and Farm)	
Surveyed	11/
Controls & measurement	

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MINOR PROJECT EVALUATION

Name of Project: Utchir

District: Pune

Proposed or Existing: Proposed Model

Salient Features:

1.	Catchment	
	Area (km^2)	10.4
	50% Dependable Rainfall (mm)	1841.60
	Yield (Mm^3)	13.05[14]
	Silt Load (Mm^3/km^2)	0.092[13]
	Design Flood (m^3/sec)	201[15]
2.	Tank, Bundhura, or Lift	Tank
	Construction Type	Zoned Earth
	Live Storage (Mm^3)	2.94
	Dead Storage (Mm^3)	.12
	Spillway Type	Clear Overfall
3.	Water Allocation	
	Irrigation demand including losses (Mm^3)	3.06[4]
	Evaporation (Mm^3)	.33
	Public Drinking Supply (Mm^3)	-
4.	Cropping Pattern	
	Kharif (%)	-

30% Paddy
3% Ground Nut
3% Vegetable
15% Jowar
15% Rainfed Bajra)
4% Pulses)
) 680 ha
Rabi (%))
25% Wheat)
15% Jowar
13% Jowar (local)
5% Vegetables
18% Pulses

Water Requirements modified Penman with monthly water budgets

5.	Distribution System (main)	left bank[5]
	Type	
	Capacity (m^3/sec)	.885
	Length (m)	13000
	Controls Measurement	10/
6.	Distribution System (Distributary and Farm)	
	Surveyed	11/
	Controls & measurement	

MINOR PROJECT EVALUATION

Name of Project: Dhule

District: Jalgaon

Proposed or Existing: Proposed Model

Salient Features:

1. Catchment

Area (km^2)	13.856
50% Dependable Rainfall (mm)	651.75
Yield (Mm^3)	2.008
Silt Load (Mm^3/km^2)	0.011

2. Tank, Bundhura, or Lift

Tank, Bundhura, or Lift	Tank
Construction Type	Zoned Earth
Live Storage (Mm^3)	1.687
Dead Storage (Mm^3)	.15
Spillway Type	

3. Water Allocation

Irrigation demand including losses (Mm^3)	1.636[4/]
Evaporation (Mm^3)	.213
Public Drinking Supply (Mm^3)	-

4. Cropping Pattern

Kharif (%) -

	Irrigated	Rainfall
Jawar	17	21
Paddy	10	-
Cotton	5	18
Veg.	2	-
Pulses	-	42
Gr. Nuts	-	19

412 ha

Rabi (%)
- 40% Wheat
- 10% Grain
- 15% Jowar (local)
- 10% Vegetables

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Water Requirements modified Penman with monthly water budgets

5. Distribution System (main)	left bank 5/
Type	
Capacity (m^3/sec)	.03
Length (m)	4500
Controls Measurement	10/
6. Distribution System (Distribution Farm)	
Surveyed	11/
Controls & measurement	

NOTES

1/ Computed with Inglis Formula for Ghat Catchments $R = 0.85 \times (P-304.8) \times A$ where P is 50% dependable rainfall in mm, A is in square kilometers, and R is in Mm^3. Note that actual yield should be 3.705 Mm^3.

2/ Usually based on .0671 Mm^3 km^2 over 60 year period, this has been found to be to conservative. In this project, the sediment yeild is based on 0.092 Mm^3/km^2 over a 30 year life.

3/ Based on Inglis Formula

$$Q = CA/\sqrt{A+4}$$

Where Q is in ft^3/sec, A is in square miles, and C=7000. However it should be noted that for catchment areas of less than 20 square miles (52 square km), the C value should range from 4000 to 7000.

4/ Conveyance efficiency as assumed to be 85%
Application efficiency to paddy8 as assumed to be 90%
Application efficiency for other crops is assumed to be 70%
Demand satisfied by rainfall has been deducted.

5/ Lined with prefabricated concrete slabs. Survey included detailed longtudinal section.

6/ For economic feasibility study, the number of flow measurement and control structures were estimated and multiplied by average unit costs. Locations of watercourse and field channels were not mapped.

7/ Estimated by Strange's table.

8/ Based on metric form of Inglis Formula, $Q = C'A^{.5}$, C'=52.488 which corresponds to C=4671 in note 3 above.

9/ Design discharge of 112.87 m^3/sec.

10/ See notes 5 and 6 for Chorgewadi.

11/ See Chorgewadi evaluation.

12/ Located in a catchment of 174.94 km^2 in which three other minor tanks are already located.

13/ At the published siltation rates, this is insufficient dead storage for 30 year life.

14/ Only a fraction of the estimated yield is to be collected in the tank in order to avoid submerging a local village.

15/ Method utilized the Inglis Formula, C = 5000.

ANNEX III-6

DESCRIPTION OF EXISTING MINOR TANK PROJECTS EVALUATED

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MINOR PROJECT EVALUATION

Name:	Kothare Tank
District:	Dhule
Date of Project Start:	June 1972
Date of Completion:	June 1974

Features at Design Stage:

Catchment Area (KM^2)	58.88
Expected Yield (Mm^3)	5.19 1/
Design Live Storage (Mm^3)	4.22
Design Dead Storage (Mm^3)	.45 2/
Expected Irrigated Area (ha)	648

Sanctioned Cropping Pattern:

	Water Use (Mm^3)	Area (ha)
Kharif		
Jawar & Bajari	.62	81
Cotton		121.5
Rabi		
Wheat & Jawar	3.22	558.70

Pre-Project Cropping Pattern:

Kharif	Area (ha)	Rabi	Area (ha)
Bajari	247	Bajari	39
Jawar	209	Wheat	10
Cotton	78	Ground Nut	16
Ground Nut	152		
Total	686		65

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Features at Operational Stage:

Reservoir History [3]

Year	Live Storage for Rabi (Mm^3)	-- Use (Mm^3)[5] -- Kharif	Rabi	-- Non-Use (Mm^3) -- Feb. 28	June 30	Net Additional[6] Inflows (Mm^3)
1974	.42	-	.62	-	-	.20
1975	1.04	.14	.84	-	-	.03
1976	3.55[4]	.82	2.54	.19	4.22	3.36
1977	2.30	.64	.92	.18	.30	- .44
1978	1.87	.92	.90	1.02	1.07	1.02
1979	4.22	1.12	1.20	.93	.16	-1.74
1980	4.22	1.71	1.94	1.15	1.70	1.13

Groundwater Development:

Year	Number of Wells	Area Irrigated (ha)
1974	74	69
1975	74	48
1976	75	45
1977	87	46
1978	89	42
1979	95	44
1980	96	58

1980 Command Area Cropping Pattern (7 year average in brackets):

Crop	Irrigated by Project (ha)	Irrigated by Other Source (well)(ha)	Rainfed Area (ha)
Kharif			
Onion	20 (5)	-	-
Bajari	29 (12)	-	202
Jawar	25 (10)	-	149
Cotton	9 (8)	-	46
Ground Nut	46 (17)	-	139
Sali	3 (10)	-	5
Other[7]	-	-	74
Total	132 (62)	-	615

Crop	Irrigated by Project (ha)	Irrigated by Other Source (well)(ha)	Rainfed Area (ha)
Rabi			
Onion	5 (2)	5	-
Jawar	9 (2)	28	-
Gram	- (4)	15	-
Dudar	2 (2)	-	-
Ground Nut	114 (29)	10	-
Wheat	117 (162)	-	-
Bajari	-	-	-
Total	247 (201)	58	-

1/ from Strange's Table, 50% Dependable Yield
2/ assuming "35 acre-feet/100 mi^2 for 65 yards
3/ filled 3 of 7 years
4/ actually filled at beginning of Kharif season, calculated value presented
5/ includes net losses from evaporation
6/ October - June mass balance
7/ gram, mug., kulith

MINOR PROJECT EVALUATION

Name: Nisardi

District: Jalgaon

Date of Project Start: 1966

Date of Completion: 1970

Features at Design Stage:

Catchment Area (KM^2)	29.53
Expected Yield (Mm^3)	2.29 1/
Design Live Storage (Mm^3)	2.07
Design Dead Storage (Mm^3)	.25 2/
Expected Irrigated Area (Ha)	334

Sanctioned Cropping Pattern:

	Water use (Mm^3)	Area (ha)
Kharif		
Jawar & Bajari Cotton Groundnut	.11	71
Rabi		
Cotton	.55	263
"Seasonal"	1.47	
Total	2.13	334

Pre-Project Cropping Pattern

Kharif	1961-62 Area (ha)	1972 (ha)	Rabi	1961-62 Area (ha)	1972 (ha)
Jowar	89	106	Jowar	67	146
Bajari	77	118	Wheat	46	81
Pulses	104	-	Gram	6	131 G.Nut
Ground Nut	207	161			
Cotton	167	412			
Oil Seeds	1	25 Paddy			
Total	645	822	Total	119	358

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Crops Irrigated by Wells:

Crop	(1961-62) Area (ha)	1972 Assessement Report Area (ha)
Chillies	32	36
Vegetables	3	10
Rice	1	)
"Plant"	1	) 1
Sugar Cane	13	)
Total	50	47

Features at Operational Stage:
Reservoir History 3/

Year	Live Storage for Rabi (Mm^3)	-- Use (Mm^3)4/ -- Kharif	Rabi	-- Non-Use (Mm^3) -- Feb. 28	June 30	Net Additional5/ Inflows (Mm^3)
1971-72	2.07	-	1.79	.28	.23	-.05
1972-73	-	-	-	-	-	-
1973-74	2.07	-	1.67	.34	.22	-.18
1974-75	2.07	-	1.92	.28	.41	.26
1975-76	2.07	-	1.55	.81	.69	.17
1976-77	2.07	-	1.28	.74	.74	-.05
1987-78	1.45	-	1.27	.15	.43	.25
1978-79	.08	-	-	.32	.06	-.02
1979-80	.53	-	.37	1.32	.39	.23
1980-81	2.07	-	1.80	.27	.27	0

Groundwater Development:

Year	Number of Wells	Area Irrigated (ha)
1971-72	4	61
1972-73	6	45
1973-74	6	44
1974-75	2	35
1975-76	1	19
1976-77	3	13
1987-78	5	27
1978-79	4	31
1979-80	7	19
1980-81	3	19

1980-81 Command Area Cropping Pattern:

Crop	Irrigated by Project (ha)	Irrigated by Other (ha)	Rainfed Area (ha)
Kharif			
Jawar	26	.8	72
Bajari	-	-	24
Pulses	.7	-	19
Ground Nut	8	3	43
Cotton	4	5	47
Oil Seed	-	-	.5
Paddy	-	.4	2
Rabi			
Wheat	114	1	-
Gram	9	.2	-
Vegetables	-	-	-
Mug.	-	-	4
Total	162.6	19.4	211.5

1/ From Stange's Table, 60% Dependable Yield
2/ Assuming "30 acre-feet/100 Me·^{2} for 60 years".
Reduced siltation capacity was surveyed in May 1978. The deposition was 0.059 Mm^3 in 7 years. At this rate, the dead's forage woule be utilized in just under 30 years.
3/ Reservoir filled 6 of 10 years, exactly what it was designed for.
4/ Includes evaporation losses.
5/ Net inflow required to man balance October - June water in reservoir.

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CHAPTER IV

AGRICULTURAL BACKGROUND AND SUPPORT SERVICES

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A. Physiography and Climate

The physiography and climatic information for the State is provided in Chapters III and V of this Volume.

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.

Eighty-four percent of Maharashtra soils are derived from the basaltic Deccan Trap rock. Accordingly, these soils are the target of most of the planned irrigation expansion in the state. Characteristically, Deccan basalt gives rise to soils that are dark colored and fine textured with the clay fraction dominated by montmorillonite. These soils are commonly referred to as black cotton soils but technically they are vertisols, which term signifies self mixing or churning. Mixing occurs because the soil shrinks on drying,forming deep cracks into which surface soil falls during the dry cycle. Upon rewetting the soil swells causing internal pressures and upward heaving. Thus, vertisols tend to be more or less homogenous vertically with no well defined B horizon (zone of illuviation).

Vertisols have a high action exchange capacity and are base saturated. These soils are usually calcareous (i.e. contain free calcium carbonate), the pH typically ranging between 7.2 and 8.5. Maharashtra vertisols are high in plant available potassium, low in available phosphorus and nitrogen, and low in organic matter. Some plant deficiencies of zinc, iron and boron have been reported in crops growing on these soils. In low lying areas these soils tend to be waterlogged when irrigated and thus are prone to become saline and/or sodic. Soil fertility is readily managed if irrigation is controlled so as to avoid losses of soil nitrogen by leaching and/or denitrification.

Vertisols formed on residuum in the higher parts of the watersheds are shallow to medium depth and are underlain by partially weathered basalt rock, a material referred to locally as "murum." The texture of murum is coarse sand or gravel so these soils are normally well drained. Vertisols formed on river floodplains are moderate to very deep, and sometimes are poorly drained.

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Vertisols absorb water readily when dry but when wet infiltration is very slow. Vertisol subsoil has very low hydraulic conductivity and the surface soil may temporarily saturate during rain or irrigation. Vertisols have a blocky structure in the surface layer but in some the subsoil is structureless or massive. There are few if any plant roots in this massive subsoil. Thus, soils which appear to be quite deep may actually be quite shallow, from the point of view of irrigation and soil moisture management.

Because of their high clay content, vertisols are difficult to manage when wet. For this reason, farmers tend to fallow the land during kharif and utilize the residual moisture supply during rabi. Without vegetation during the rainy season, vertisols are subject to considerable loss of soil by sheet erosion.

In relation to irrigation construction projects, technical engineering problems associated with vertisols are: (1) 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; (2) expansion upon wetting causes displacement of structures, particularly those resting on the soil surface such as precast concrete tiles.

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.

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 portion of the state (Chandrapur and parts of Bhandara 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 predominantly 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 minor irrigation projects are implemented. 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

In 1980 about 60 percent of the land in Maharashtra was under cultivation including about six percent under irrigation, 18 percent was under forest and 22 percent was listed under miscellaneous land use. The irrigated land use pattern is changing rapidly during the decade of the 80's because of the heavy emphasis given to irrigation resource development by the state and national governments. Irrigated cropping patterns vary from year to year depending on water supply. The water supply also affects the mix of irrigated and non-irrigated crops on the same farm from year to year.

Government policy distributes water supplies in such a way as to maximize the number of farmers receiving irrigation. Policy would have the farmers apply their water in such a way as to maximize crop output per unit of water applied and concentrate on food grains. The evidence indicates, however, that individual farmers are inclined to distribute their alloted water in such a way as to maximize returns from a system that includes food grains but also cash crops when these are possible. In effect, the amount of irrigated land on a given farm expands and contracts with changes in annual water allocations, relative prices, and other technical and economic variables.

Traditional agricultural practices thus 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 in such a way as to minimize risk and provide a self sufficient, non-market oriented approach to farming. A number of relatively low economic value crops comprise a majority of these systems. Initiation of irrigation can lead to radical departures from traditional agriculture.

In recent years pressure has been increasing for more land for production. Cultivation is being extended into marginal areas resulting in deforestation and increased hazards of soil erosion. To meet the increasing demand for food, 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.

On many of the vertisols where rainfall ranges from 800-1500mm, cropland is commonly fallowed during the monsoon. Data collected at ICRISAT 1/ indicates that about 30 percent of the vertisol land area of India remains fallow during Kharif. Reasons for this include (1) the extreme difficulty of planting crops and managing these soils when wet, (2) reduced yields from flooding during heavy rains, and (3) decreased residual soil moisture for the rabi crop. To the contrary, studies by ICRISAT show that cropping during Kharif has very little effect on residual soil moisture because so much of the rainfall is lost as surface runoff when the soil is fallow. With the crop in place, more total rainfall enters the soil replacing moisture lost by transpiration. If improved soil management practices are adopted, growing crops during Kharif can be both moisture and soil conserving (because of reduced soil erosion). It is a question of being able to manipulate the soil before or at the onset of Kharif to get crops established. Constraints to kharif cropping appear primarily related to points (1) and (2) above.

Crop yields under traditional management fall far short of yields that have been attained with improved managment. Kanwar 2/ indicated that, commonly, yields of grain range between 300 and 800 kg/ha/yr. Research reported by both ICAR and ICRISAT show that the potential grain yield ranges between 2500 and 3500 kg/ha/yr,

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1/ Problems and Potentials of the Black Soils of India: Some Suggestions for an Action Plan. J.S. Kanwar, International Crops Research Institute for the Semi-arid Tropics. Seminar on Management of Deep Black Soils, New Delhi, May 1981.

2/ Op cit.

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depending on rainfall. These estimates are without irrigation. With irrigation, as supplementary moisture during Kharif and with fulltime irrigation during rabi and possibly hot weather, the annual crop yield potential expands to very high levels.

The important factor in adopting new technology, especially irrigation, is that single factor inputs such as improved seed variety or improved soil moisture control, has limited effect on yields. However, if a combination of practices is used yields can increase several fold. An appropriate combination of high yielding varieties, land and crop management, and fertilization is necessary to achieve the potential that can be reached with irrigation.

In areas where rainfall is low (less than 500mm), and shallow to medium vertisols predominate, cropping only during the rainy season is traditionally 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 makes possible sequencial planting of two or three crops on the same land each year.

The availability of improved crop hybrids has helped increase 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 adapted to dryland agriculture. Nevertheless, HYV's sorghum are increasingly being grown under irrigation. Other crops such as millet, cotton and ground nuts 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 or other cash crops. With limited irrigation, 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. The crop mix pilot investigations are intended to serve this need.

D. Fertilizer Practices

It is generally recommended that animal manures collected on farms represent a very effective way of maintaining soil fertility. However, fertilizer use of manures must compete with use of manures as household fuel. Therefore, major reliance must be placed on chemical fertilizers for soil fertility management.

It has already been pointed out that Maharashtra soils are lacking in nitrogen (N) and phosphorus (P). Occasionally zinc, boron and iron deficies are reported. By contrast soil potassium (K) reserves are high in Vertisols. It has been observed that complete or "balanced" N-P-K fertilizers are being strongly recommended by research and extension agencies. The use of K fertilizer is highly questioned because of the high reserves in vertisols. The recommendation that P fertilizer be applied as a matter of routine is questionable because the residual effects of P fertilizer persist for several years and small maintenance doses applied every second or third year is all that is required once the fertility has been built up to non-limiting levels.

The main concerns in soil fertility management in irrigated agriculture revolves around nitrogen; how much is applied, and the method and frequency of application. Interactions between soil moisture and soil nitrogen as expressed in crop yield are most profound. Too little nitrogen will sharply restrict soil moisture use efficiency. On the other hand, too much soil moisture will reduce N-use efficiency by leaching and/or denitrification.

E. On-Farm Water Management

Under this Project, operational demonstration chaks will be established on each new minor irrigation scheme and on existing schemes. The demonstrations will be developed and conducted jointly by the AD and ID. The AD will be responsible for on-farm technical and developmental work. During the final design stages of each scheme, the Irrigation Department in collaboration with the Agriculture Department, will select two representative minor canals within each scheme, one located near the head reach and one near the tail of the system. Each representative minor will be selected on the basis of the topography and soils representative of that part of the scheme. Within each minor selected, the AD and ID, working with the farmers of the area, will select one eight ha chak for demonstration purposes. During the final design stages of the irrigation schemes, the AD and ID personnel will begin work with the farmers of the selected aks to obtain their acceptance and confidence.

Farmers will be provided detailed information related to irrigated agriculture and efficient water management. This information will be assembled and adapted for use in the area by the AD, assisted by the Agricultural University serving the area in which the scheme is located.

The demonstration chaks will provide a mechanism for showing farmers within the command of the MISs and in the surrounding areas, the latest irrigated agriculture development technology for increasing crop production. The demonstration chaks will show:

(1) the impact of land development in improving irrigation water utilization;

(2) optimal cropping patterns consistent with the seasonal availability of water;

(3) suitable irrigation methods commensurate with the stream size, soil type and crops to be grown;

(4) efficient water distribution control techniques at the field level;

(5) rotational water supply for equitable water distribution;

(6) farmers' involvement in sharing water and maintenance of watercourses; and

(7) optimal agronomic and cultural practices emphasizing the importance of timely sowing and use of hybrid seeds, fertilizers and pesticides.

The AD and ID personnel will work with the farmers in the area, assisting in arrangement of credit and encouraging on-farm development in the form of field channels, land leveling and surface drainage. In the selected chaks, land development will be provided on areas not to exceed 1/2 ha per farm at Project grant cost for demonstration purposes.

For the first two years in which water is available, the AD and ID personnel will work with the farmers in the two selected chaks recommending the types of seeds, seeding rates, fertilizer requirements, pesticide requirements and timings of application. On demonstration chaks all the inputs for up to 1/2 ha will be provided at Project Grant cost to the participating farmers.

The AD will set up Special Demonstration Committees to coordinate the activities related to the demonstration chaks. Each Committee will consist of a District Agricultural Officer/Subject Matter Specialist (district level), a Subdivisional Officer (Agriculture), a Senior Extension Officer (block level) and the associated Agriculutural Extension Officers and VAEOs positioned in the area where the demonstration chak is located. As indicated in Section G.2., at least one trained VEW will be assigned to each scheme.

The Committee will be responsible for organizing inputs and other logistical matters.

The demonstration chaks will also serve as a training location for farmers, AD and ID personnel. The Committee will organize tours, prepare publications, and generally be responsible for spreading the demonstration results to farmers fields within the command and surrounding areas. It would also arrange for visits by farmers of other areas at the critical stages of crop growth and when important activities are planned.

F. Catchment Treatment

The catchment area above a dam site is an integral part of an irrigation project. The size and nature of the catchment determine water yield to be used for irrigation. Land cover, soils, and other characteristics of the catchments determine the rapidity of runoff, the degree of soil erosion, and the resulting sediment load to be stored in the reservoir.

The AD/Soil Conservation Section has developed a number of engineering and biological treatment measures to control soil erosion in catchment areas. These include contour and graded bunding, nalla plugs or check dams, and planting of grasses and tree crops (horticultural, fodder, and fuel trees). The Forestry Department is involved in extensive reforestation efforts in tank catchments.

The AD/SC, and/or the Forestry Department, will design and implement an appropriate treatment program for the catchments of up to two existing and three new minor irrigation schemes which are included in the pilot program. Costs of catchment treatment can be reimbursed under the loan.

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G. Agricultural Services

1. Functions and Organization of Agriculture Department (AD)

Services provided by the AD include: (1) technical extension, (2) planning/monitoring of input requirements and distribution, and (3) soil conservation/land development works. In addition, a number of state sector schemes such as horticulture, livestock, cash crops, etc. are the responsibility of 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.

The AD consists of seven regional divisions covering extension and input planning. 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, responsibilties 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 Agricultural 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.

The Soil Conservation Section of the Agriculture Department (AD/SC) has 40 soil conservation divisions and 200 sub-divisions for attending to all matters relating to soil conservation, land reclamation, and land development in the commands of irrigation projects. AD/SC involvement in land development on project financed schemes is described in Chapter VII.

2. Technical Extension

Beginning in 1981, the Maharashtra's agricultural extension services have been intensified and reorganized through a World Bank (WB) assisted project. The methodology follows the Training and Visit System which has already been adopted in several other Indian states over the last several years. The WB project emphasizes

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increased staffing with Subject Matter Specialists (SMS) and Village Extension Workers (VEW), systematic farmer contacts and linkage with research institutions for training and improved technology transfer.

Implementation of the T&V system is planned for completion by the end of 1984 and will cover all districts. Nearly all of the additional manpower is allocated to SMS and VEW which deal exclusively with technical matters and farmer contacts. VEW's are added as Agricultural Assistants, Agricultural Supervisors and Agricultural Extension Officers. New positions are added at the JDA level and the Assistant Subdivisional Agricultural Officers level to supervise VEW's. The primary emphasis in the T&V system is placed on food grains and pulses with relatively little effort put into cash crops.

The lack of adequate technical support for farmer irrigators has been identified as a major constraint in efficient water utilization. In order to help remove this constraint, the AD will recruit, train, and post Subject Matter Specialists (SMS) in irrigation water management in each District where Project finan... schemes are located. These specialists will be responsible for on-farm water management training of VEWs assigned to areas having Project financed schemes. At least one trained VEW will be assigned to each 400 beneficiaries under the Project with a minimum of one VEW per scheme. VEW's assigned to Project financed schemes and the SMS's will be loan financed fully for the first four years of the Project and fully financed by GOM thereafter.

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 operate through the Zilla Parashad (district council) and Panchayat Samiti (block council). 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 Government. The CEO administers 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 who operate outside the responsibility of the block council. In addition, the CEO in conjunction with the district and

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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 who receives guidance from the Agricultural Extension Worker.

Estimates of imput requirements (fertilizers, seed and pesticides) are prepared by special committees at the district, block and village level. Membership in these committees is shown in Table 1.

Table 1: COMPOSITION OF DISTRICT, BLOCK AND VILLAGE COMMITTEES

District Level Committees

1. President, Zilla Parishad (ZP) or 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 representative of District Sales and Purchase Organization	Member
7. Executive Engineer, Irrigation Department	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

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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 Registrar 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 on 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 increased availability of certified seed. 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 determined 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 SDAO. Surplus seed is sold in the open market.

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 Maharashtra Agricultural Industry Development Corporation (MAIDC) and Vidarbha Cooperative 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 the 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 Planning - Maharashtra State:

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, prepares annual Agricultural Production Strategy Programs for each of the growing seasons (hot weather, kharif and rabi season). The program for each season is developed based on the experience, success and constraints encountered during the preceeding years, and normally covers the following:

a. Projections of the area coverage for different crops under hybrid or high yielding varieties (HYV's). 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 officials involved with the program. Officials from the AD, district level administration and agricultural extension are required to undertake training on specialized topics which have direct bearing on increasing crop production during that season.

e. Decisions are also made on assigning responsibilities to agricultural universities and colleges for the districts they serve.

f. Requirement of crop demonstrations, their number and area under demonstration.

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g. Responsibility of agricultural extension for stressing increased production through improved soil cultivation, optimum dates of sowing, use of plant protection measures, seed rates, and suitability of varieties.

5. Adaptive Research, Farm Trials and Recommendations:

The T&V extension focuses on developing recommendations for specific agroclimatic zones. The recommendations take into account cropping patterns, soil moisture management, farmers skills, and available resources. Whereas the universities and other research institutes are responsible for basic and applied research, extension emphasizes on-site verification trials which lead to specific recommendations. Under the T&V system, the farm trials program is planned at district monthly workshops and subsequently executed by SMS and Agricultural Assistant/Agricultural Supervisor (AA/AS) on farmers fields. Results of the farm trials are analyzed at a monthly workshop and formulated into recommendations. Participating farmers are asked to bear the cost of trials unless input costs are greater than his present practice in which case the extra costs will be borne by the AD.

6. Linkage of Extension to Research:

Linkage between research and extension has not been well coordinated in the past. This linkage is being strengthened under the T&V approach. Monthly district workshops are utilized for systematic training of AA/AS as well as for formulating the farm trials program. The Principal Agricultural Officer (PAO) and University extension agronomist are responsible for organizing workshops. Workshops include the participation of district/subdivisional SMS and university research staff.

In addition to monthly workshops, seasonal zonal workshops are 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 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, selected 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. Historically, universities have not had a mandate to extend their research results to the level of production agriculture. Recently, the universities have begun to focus more attention on problems of on-farm irrigated crop production. Currently a range of studies is directed toward specific aspects of irrigated agriculture such as crop water requirements, methods of irrigation, drainage, etc.

It appears, however, that several important facets have been overlooked for lack of resources or other reasons. Some of these topics are:

1. The vertisols subsoils: the massive structure where it exists and general subsoil physical properties; cause and effect relationship on subsoil moisture relations, aeration and plant root activity, mineralogy, chemistry.

2. Soil organic matter and crop residue management: improving soil physical and chemical properties, and irrigation and fertility management; costs of crop residue management as affected by power requirements for incorporation in the soil and alternative uses as fodder or fuel.

3. Economic viability of newly developed irrigated crop production management practices based on markets and input-output prices.

4. Watershed management by controlled grazing, introduced drought-resistant, improved forage grasses; culturing fruit trees (e.g. mangoes) and fuel trees or shrubs; contour bunding; bunding of nallas; decreased soil erosion and sedimentation of water storage reservoirs; increase groundwater storage in the watershed and extend water yield period.

5. Soil fertility and irrigation water management.

The universities maintain a network of about 20 main research stations and 30 substations. Here, most research is currently oriented toward crop improvement schemes such as wheat, sugarcane, oilseed, sorghum, pearl millet, cotton and pulses. The opportunity exists for developing the adaptive research focus at the station and substation level because resource constraints can be more clearly defined.

The four universities and six additional agricultural colleges graduate about 1,000 students each year with B.Sc. degrees. Nearly 300 receive M.Sc. degrees. Presently, Agricultural Assistants obtain two years of training at one of 25 agricultural schools. Gram Sevaks get six months training at five special training centers.

8. Credit/Marketing:

Short, medium and long term loans are made available to farmers through coopertive 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 a 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 Credity Societies (PACS) at 8 percent. These primary societies are the main sources of credit for short and medium term loans to farmers. Farmer membership in 1983 was over five million.

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 2.

Table 2: CREDIT LIMITS FOR DIFFERENT CROPS

Name of Crop	Credit in kind (Rs/ha) Seed	Ferti-lizer	Insect-icides	Credit in Cash	Total
High yielding paddy	75	700	225	-	1000
Hybrid sorghum	60	640	100	-	800
High yielding sorghum	25	450	125	-	600
Hybrid pearl millet	25	425	50	-	500
Hybrid maize	70	600	130	-	800
Pigeon Pea	60	75	75	-	210
Moong	60	75	75	-	210
Blackgram (pulse)	60	75	75	-	210
Ground Nut	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 amount of lending for irrigated crops is about two to three times higher than for non-irrigated. As shown in Table 2 for example, a farmer can obtain about 1500 Rs/ha for non-irrigated cotton and 2700 Rs/ha for irrigated cotton. The additional amount loaned for crops under irrigation results from higher input 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 through the Land Development Bank, and more recently, some Cooperative Banks. 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.

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 arise. 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, 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 areas as demand arises.

9. <u>Soil Surveys</u>:

The Division of Irrigation Research and Development (DIRD) of the Maharashtra Irrigation Department conducts detailed soil surveys (series level) in all major and medium irrigatin project command areas. This service is not routinely provided to minor irrigation schemes. However, under this Project, DIRD will provide detailed soil surveys. DIRD will need to expand its staff to service MIS.

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.

CHAPTER V

SOCIAL ANALYSIS

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A. Socio-Economic Setting

1. Land and People

Maharashtra's development is characterized by striking contrasts. On the one hand, it is India's most industrialized state and its level of urbanization is also highest. One-third of its population of 62.8 million live in urban areas. Yet most of the industrial development is concentrated in a region including metropolitan Bombay and Pune, and two-thirds of the state's labor force remains in agriculture. The productivity of agriculture is also uneven. While yields for foodgrains staples such as sorghum are low, sugarcane yields are high.

It is important to understand how islands of development within agriculture and industry interact with surrounding areas of slow growth. This relationship has shaped employment and migration patterns and thereby accentuated the imbalanced development which has occurred. In recent years, however, the Maharashtra government has taken significant steps to modify the growth patterns which have created disparities between city and village, and between rainfed and irrigated agriculture. First, it has accelerated the development of irrigation, in order to extend this scarce resource of water to as many farm families as possible. It has also invested in the technology needed to enhance agricultural productivity and thereby expand employment opportunities in production and marketing. Secondly, it has launched an ambitious scheme to provide employment in rural areas, and thereby stem the drift of migration to the cities. These measures will be briefly discussed following a description of the state's social landscape.

The distribution of population is quite uneven in Maharashtra. It ranks ninth among Indian states in terms of population density. Its average rate of 204 persons per square kilometer is roughly comparable to the national average of 221. Yet the range in density within Maharashtra is enormous. There are an average of 13,644 persons per square kilometer in Bombay, which includes Asia's most populous slum, Dharavi, where 40,000 persons are squeezed into a few square kilometers. In some rural tracts, the landscape looks almost desolate. The eastern district of Chandrapur, for example, contains only 79 persons per square kilometer.(1)

Between 1941 and 1971, Maharashtra's population growth rate exceeded the national average, but the latest census suggests the growth trend may have abated. The rate of increase between 1971 and 1981 was only 24.6 per cent, which was precisely the same as the national figure.

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Seven per cent of the state's population belong to the statutorily-designated "scheduled castes", representing traditionally disadvantaged socio-economic groups. They are dispersed throughout the state, but 68 per cent live in rural areas. Another 9 per cent of the total belongs to scheduled tribes, who are largely concentrated in the hill tracts of northwestern Maharashtra. The tribal peoples generally practice subsistence-level agriculture. They are among the poorest groups in Maharashtra.

As in other states, the number of females per 1,000 males has been declining in Maharashtra since the beginning of the 20th century. In 1901, the sex ratio was 978, but it was only 938 in 1981, slightly higher than the national figure of 935. In terms of literacy, however, Maharashtra diverges sharply from the national pattern. Forty-seven per cent of its population was literate in 1981, as against 36 per cent in the nation as a whole.

2. Regional Variations and Development Strategy

The dramatic differences among the state's agroclimatic regions are associated with contrasting settlement patterns and levels of development. Abundant rainfall in the coastal and eastern districts have promoted paddy cultivation and a patchwork of microscopic farms. As shown in Table 1, the average farm size in the coastal region is 2.6 ha, while the average number of persons per cultivated hectare is 4.86. In areas traditionally considered handicapped due to lack of rainfall, population density tends to be closer to the state average of 1.8 persons per cultivated hectare, with farm sizes larger than the state average of 4.3 hectares. Table 1 shows that farm sizes in the scarcity region are nearly twice as large as those in the coastal area but population densities are less than half as high. This suggests the precarious nature of existence in both zones, for very different reasons.

Since 46 per cent of Maharashtra's five million farms are below two hectares, the small owner-cultivator is the predominant figure in the state's agriculture. Consequently, agricultural development requires the participation of this category of cultivators, who may need much assistance in order to exploit new opportunities. The state government has endeavored to reach this population through the provision of irrigation, so that the scarce water resource is not monopolized by large farmers with greater financial resources.

In addition to minimizing disparities between rich and poor farmers, the Maharashtra government has also sought to help the dry areas compensate for the poor hand dealt by nature. It has invested approximately $1.3 billion in major and medium surface irrigation systems, which has added over one million hectares to the state's irrigation potential. The extension of irrigation to dry areas, through both public and private facilities, has led to dramatic increases in agricultural productivity in those regions, particularly with regard to cash crops such as sugarcane, fruits and vegetables. Those crops accounted for more than 50 per cent of the output increase between 1960/61 and 1977/78.

The extension of area under such crops has created an island of development within agriculture, and an important focus of rural employment. At sowing and harvest time, long caravans of families in bullock carts crisscross rural Maharashtra seeking work. This migration pattern is only seasonal, for they return to their villages after the work is done. This pattern is particularly striking in sugarcane areas, where millowners tap a seemingly inexhaustible supply of workers from unirrigated areas where sugarcane cannot be grown.

TABLE 1 -- FARM CHARACTERISTICS, BY REGION (1971)

Region	Persons per Cultivated Hectare	------Farm Size------ Average	Median
		----------ha----------	
Coastal	4.86	2.6	1.0
Gr. Bombay	-	-	-
Kolaba	4.91	2.1	0.9
Thana	5.29	2.8	1.2
Transition	2.23	3.9	1.8
Nasik	1.76	4.7	3.2
Pune	1.86	4.0	2.3
Satara	2.53	2.7	1.4
Kolhapur	3.68	2.0	1.0
Scarcity	1.55	4.4	2.5
Dhule	1.99	4.9	3.7
Sangli	1.88	3.4	1.7
Bhir	1.23	6.1	4.2
Sholapur	1.32	5.9	4.0
Ahmedanagar	1.60	5.2	3.3
Assured Rainfall	1.42	5.2	3.5
Jalgaon	1.97	3.7	2.4
Aurangabad	1.24	6.0	4.3
Parbhani	1.22	6.4	4.7
Osmanabad	1.37	6.7	4.9
Buldhana	1.45	4.9	3.9
Akola	1.37	5.1	3.0
Amarvati	1.54	4.2	2.4
Moderate Rainfall	1.46	5.7	3.9
Nanded	1.49	4.9	3.7
Yeotmal	1.43	7.1	4.7
Wardha	1.34	5.7	3.8
Nagpur	1.53	5.1	3.5
High Rainfall	2.63	2.9	1.7
Bhandara	3.51	2.2	1.2
Chandrapur	2.12	3.7	2.4
TOTAL MAHARASHTRA	1.82	4.3	2.5

Source: World Bank, staff appraisal report, India, Maharashtra Irrigation II Project, Volume II - Sectoral Background, September 13, 1979, p.62.

3. Agricultural Trends and Rural Income

The impact of cropping patterns upon income levels is also dramatic. Table 2 shows the wide variation in the gross value of agricultural production per rural inhabitant and per agricultural worker in Maharashtra's regions. The tremendous gap between the value of production in the coastal zone and zones characterized as 'transition,' 'scarcity' and 'assured rainfall' reflects the greater importance of high-value crops in the latter regions, including sugarcane, horticultural crops and vegetables. Where foodgrains predominate, productivity and incomes remain low. Although the state accounted for 11 per cent of India's area under foodgrains and 34 per cent of its cotton area in 1981-82, foodgrains production was only 8 per cent of the Indian total, and cotton only 19 per cent.

The extent of the state's vulnerability became painfully obvious during the early 1970s, amidst the devastation caused by a crippling series of droughts. The government thereafter launched programs on two fronts to alleviate rural poverty. First, it sought to expand irrigation and new agricultural technology. Second, it provided work to rural people, including small cultivators and landless laborers, through an Employment Guarantee Scheme (EGS). The results were encouraging. Agricultural output grew at a compound rate of about 9 per cent between 1973/74 and 1977/78. In addition, the EGS seems to have arrested the growth of rural poverty by providing employment to the landless, which increased their incomes by about 10 per cent.(2)

TABLE 2: GROSS VALUE OF AGRICULTURAL PRODUCTION BY REGION

Region	Per Hectare	Per Head of Rural Population	Per Worker in agriculture
	1983/74-74/75		
	Rs.		
Coastal	1,470	291	953
Transition	1,679	707	2,321
Scarcity	1,200	726	2,369
Assured Rainfall	1,138	753	2,115
Moderate Rainfall	1,063	684	1,867
High Rainfall	1,160	412	1,138
TOTAL MAHARASHTRA	1,243	645	1,949

Source: World Bank, staff appraisal report, India, Maharashtra Irrigation II Project, Volume II - Sectoral Background, September 13, 1979, p.61.

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Nevertheless, agricultural incomes have declined in recent years. The state's per capita income of about $100 is substantially higher than the national average of $70. Yet 50 per cent of Maharashtra's rural population have incomes below the poverty line of $75, even during a normal agricultural year. This impoverishment appears to be spread fairly evenly throughout the countryside, reflecting relatively equitable patterns of landownership. The Gini coefficient* for rural consumption has averaged about 0.28 since 1960/61. (3)

4. Employment and Migration Patterns

For decades, the only escape from rural desolation seemed to lie in migration to Bombay. The city's ability to provide work has given it an aura of hope and success. Thus it has attracted millions of job seekers from every corner of India, and displaced Calcutta as India's industrial giant.

There has been a long-established trend of migration from some parts of Maharastra where agriculture has remained particularly stagnant. Emigration has starved the countryside of its most productive labor force and thereby perpetuated its underdevelopment. It has also accelerated the proliferation of slums in Bombay, whose population soared by 44 per cent between 1961 and 1971.

This pattern of interaction occurs in its most extreme form between Bombay and one of its hinterlands, the coastal region of Konkan. Konkan boasts an abundance of natural resources, but these remain largely untapped. The region's population density on the land is the highest in the state, while its per capita income from agriculture is the lowest. This region thus depends not upon productive agriculture and industry but on the export of its people. In exchange, the migrants send small monthly money orders, to pay for the food and essential commodities for the migrants' family members who remain behind.

The largest proportion of migrants are from Konkan's Ratnagiri district. While the state's population increased by 27 per cent between 1961 and 1971, Ratnagiri recorded a population growth rate of only 9 per cent between 1961 and 1971, which suggests the extent of the exodus to Bombay.

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* The Gini coefficient ranges from 0 to 1, the closer it is to zero the more equitable is the distribution.

Unlike the seasonal migration to secure agricultural employment, the migration to Bombay is generally permanent. The new urbanite may return home only once a year, for a major religious festival. Otherwise contact with his family is maintained only through moneyorders which represent a slice from his monthly paycheck.

The moneyorders cannot inject much capital into the rural economy to enhance productive capacity. The average earnings of Bombay migrants are only about $32 per month, which is below the city's poverty line. In addition, job prospects are not assured. There is a high level of unemployment in the Bombay slums, and the average migrant may have to wait up to six months to find work.(4)

The migrants are overwhelmingly male. In 1971, Bombay's population included about 3,478,000 men as compared to 2,500,000 women. Women greatly outnumber men in Ratnagiri district, since they constitute 1,103,600 of the district's population and males only 887,000. Thus, while the Konkan region offers promising scope for agricultural development, particularly in important cash crops such as cashew, mango and coconut, the labor needed for such enterprises is conspicuously absent. Farming is generally conducted by women, who, for reasons which will be explored, cannot make full use of the land. In order to expand the area's productivity, in hopes of keeping its male population on the land, the government has attached high priority to the provision of irrigation. The lack of irrigation is considered an important constraint on development.

In other unirrigated parts of Maharashtra, where there is no established tradition of urban migration, a vast pool of surplus labor is perched precariously upon an agriculture characterized by low yields and slow growth. A series of devastating droughts during the early 1970s caused massive unemployment and hardship for this population, and the central government quickly devised several schemes designed to aid the rural poor, such as the Crash Programme for Rural Employment.

In 1974, Maharashtra took the bold and pioneering step of promising work to the rural poor through a state-level program, the Employment Guarantee Scheme (EGS). The EGS aimed to provide employment in rural areas to all able-bodied adults who sought it. Legislation requires the state to provide jobs on demand to a group of at least 50 persons and the work must be carried out within 8 kilometers of the employment seekers' location.

Initially, it was thought that the lack of vigorous local institutions in much of the Indian countryside would constrain the development of rural employment generation schemes, and make their administration enormously difficult. These fears proved unfounded in parts of the Maharashtra, for some local leaders quickly appreciated the value of EGS for their constituents' welfare and as a device for mobilizing political support for themselves.

Yet there is some variation in the ability of local communities, and thus of regions, to take advantage of this new resource. As Dandekar noted, "The relatively advanced (organizationally and politically as also economically) districts of Western Maharashtra had the larger proportion of the EGS funds"(5) although districts with the greatest proportion of landless laborers were supposed to benefit most. In addition, districts which were underdeveloped due to concentrations of tribal populations and to stretches of drought-prone area also tended to receive less EGS expenditure, largely because their representatives were less active and influential within the wider political circles.(6)

Since the generation of projects is often associated with local politics, their productivity may sometimes be questionable. Projects may not always be located where the need is greatest, or where technical considerations are most favorable. In some areas, there is an excess of particular types of projects, such as percolation tanks used for minor irrigation, and these projects may sometimes threaten the environment through waterlogging.(7)

Yet as Dandekar emphasizes, these critcisms are minor in view of the EGS's very substantial achievements. The program cannot simply be judged by strict economic ratios. In social terms, it must be considered a success. By 1977, EGS was estimated to have created full employment (for 300 days in a year) for up to 390,000 illiterate and unskilled persons, who comprise 8 per cent of the state's rural labor force. (8) These persons are at the base of India's socio-economic pyramid, for they include the landless, women and disadvantaged castes and tribes. The facilities constructed include minor irrigation tanks which may yield important benefits for the workers and their communities as the rural people are familiarized with the soil conservation construction practices.

The EGS offers a rare example of an equal opportunity employer, for perhaps 65 per cent of its workers are women. Further, while women are paid less than men for agricultural operations,(9) male and female EGS employees are paid equal wages for equal work. While even the EGS may tend to award more remunerative tasks to men, confining women mostly to rock-breaking and carrying loads of earth, it does appear that EGS represents a major opportunity for rural women to augment their familes' income, on terms equal to those awarded to men.(10)

Statistics indicate that nearly half of the workers may belong to scheduled castes and tribes, but the proportion of such workers varies considerably. In Kohalpur, a relatively prosperous district, EGS schemes are not a major source of employment, and only 8 per cent of EGS workers are backward class members. In coastal Thane, on the other hand, 94 per cent of EGS workers belong to traditionally disadvantaged groups, while 100 per cent of Amravati's EGS workers fall in that category.(10)

The wages paid are low, and it is estimated that a couple working full time throughout the year could support only 1.5 dependent adults on their wages. Yet a survey found that two-thirds of the workers' income came from EGS, which illustrates the critical need for rural employment.(11) Another study found that landless EGS workers in an arid region had incomes slightly above those of marginal farmers .(12) Further illustration of the scheme's importance is offered by a study of the effects of Maharashtra's blistering drought of 1972-73, which found that landless families employed on temporary rural works programs were better off than during a normal year.(13) These studies attest to the urgency of measures to aid a countryside which had stagnated for years while urban areas consumed a disproportionate share of resources.

5. Landholding Structure and Tenancy

After independence, in a wave of land reforms ordered throughout India, Maharahstra's large estates were abolished, as were all intermediaries between the cultivator and landowner. In addition, laws were framed to give tenants security of tenure. Tenancy is not characteristic of Maharashtra's agriculture, since 92 per cent of holdings are fully owned, 5 per cent partly owned and partly rented and 3 per cent wholly rented.(14)

It has nevertheless proved difficult to enforce legislation designed to protect tenants and sharecroppers. Land owners have denied tenants the right to cultivate their lands from year to year for fear they might claim the lands they till. It is also difficult for tenants to establish legal rights to the land. Village land records may not recognize the tenants' legal rights, and subordinate Revenue Department officials often side with the powerful landlord, who can mobilize resources to contest the tenant's claim. (15)

Availability of water is the determinant of land ceilings in the State. The permissible holding size is indicated below:

Table 3: LAND CEILINGS IN MAHARASHTRA

Type of Land	Land Ceiling (hectares)
Perenially irrigated land	7.2
Assured seasonally irrigated land	10.8
Unassured seasonally irrigated land	14.4
Assured rainfall land	14.4
Other rainfed land	21.6

The ceilings apply to a family of husband, wife and minor children. For each member in excess of five, the ceiling is increased by 20 per cent up to a maximum of 100 per cent in families of 10 or more members. The implementation of ceiling reforms has been slow, as is generally the case in India. Only about 175,000 hectares had been distributed to landless households in Maharashtra by 1977/78. That imbalances persist is suggested by Table 4.

Table 4: LANDHOLDINGS IN MAHARASHTRA

Size (hectares)	Percentage of Holdings	Percentage of 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
Total	100.0	100.0

Source: U.S AID, Maharashtra Medium Irrigation Project, Vol. II.

Thus, while the average farm size is 4.3 hectares, 46 per cent of farms are less than two hectares. They include 11 per cent of the total farm land, while 7 per cent of the farms exceed 10 hectares and occupy 31 per cent of the farm land. It is clear that the small farmers operating less than two hectares must be considered the target of the minor irrigation project. Another major target group is the vast pool of landless laborers in the state. They numbered 6.5 million in the 1981 census, and 52 per cent of them are women. The previous section indicated the importance of rural works programs for this sector of the population. Since that employment is not stable, or materially or spiritually rewarding, it is hoped that the minor irrigation project will provide better opportunities within agriculture, as more land comes under the cultivation of labor-intensive crops.

Evidence regarding the beneficiaries of existing minor irrigation projects is extremely limited. The size groups of farmers was not always indicated in project reports, and there was no information about the impact on landless laborers. It was not possible to determine the extent to which beneficiaries belong to backward classes, or even determine the proportion of female cultivators who benefited. Such information will be obtained and analyzed in socio-economic benchmark and follow-up surveys conducted under the project.

It does appear that small farmers are generally the principal beneficiaries of the few projects for which information is provided. Statistics on a minor irrigation tank in Jalgaon district, called the Nisardi project, indicates that the average holding size was 2.5 hectares. The largest landholder in the command area of 561 hectares was a farmer with 8.7 hectares, while the smallest owned .3 hectares. The average holding size of a sample of farmers served by the Galan tank in Jalgaon district was even smaller -- 1.75 hectares. The largest farmer in the sample had 5.5 hectares and the smallest, half a hectare.

A report on the Pabhare minor irrigation tank in coastal Raigad district showed that 64 per cent of the landowners held less than one hectare while 28 per cent held between one to two hectares.(16) These figures are encouraging, for they suggest that the benefits of irrigation can be extended to the less-privileged farmer instead of being monopolized by those with resources and status.

While the Irrigation Department does not identify beneficiaries by caste or ethnic group, the Pabhare study, which is one of the pioneering attempts to assess the impact of minor irrigation upon a community, shows that tribal people were heavily represented in the command area, with nearly 28 per cent of the population. The scheduled caste population was only 2.5 per cent, however.

B. Socio-Cultural Feasibility

1. Socio-Cultural Aspects of Minor Irrigation

Minor irrigation has a long history in Maharashtra. For centuries, farmers in the northwest have operated an equitable system called phad, which distributes water from weirs. Tanks have dotted the landscapes of eastern Maharashtra's Bandhara and Chandrapur districts for at least 400 years, and they are familiar in the Vidarbha region also.

Elsewhere in the state, farmers may be unaccustomed to irrigation and it may take time for them to adjust their cropping practices. This has proved true in Konkan, for example, where irrigation seemed an impossible dream even 20 years ago due to the region's rugged terrain and small holdings. These factors rule out the possibility of large and medium scale irrigation works, which sets the stage for the development of minor irrigation.

Because water is such a scarce resource, the low level of utilization of irrigation water in some parts of Maharashtra has caused consternation in some official circles. Studies suggest that the problem is not that the state's farmers are unwilling to risk innovation. Instead, cultivators in a minor irrigation project area in the agriculturally backward Konkan region were described as "progressive and eager to take up horticulture and new crops"(17). Their heroic attempts to modernize their farms were described in some detail. Initially, farmers were enthusiastic about the potential afforded by irrigation, but technical difficulties prevented its utilization. They abandoned efforts to cultivate new crops and fell back on traditional subsistence agriculture.

Their problems centered upon deficient distribution systems and a lack of land development, which made it impossible to receive water on a predictable basis. Such factors have contributed to shortfalls in irrigation utilization throughout India (18) and within Maharashtra as well. Thus, although farmers in Vidarbha may be accustomed to tank irrigation and be as eager to exploit it as the would-be irrigators on the coast, the frustrations of manipulating water supplies have deterred many. (19). The present project is designed to see that these deficiencies are corrected. In addition, the Project will provide farmers with the extension advice they require in order to use the irrigation water to the best advantage. Lack of knowledge regarding irrigated agriculture, or the inputs needed by newly-adopted crops, was identified as a constraint in studies and field interviews. (20)

Minor irrigation projects offer important advantages over large-scale works. First, they do not greatly disrupt the environment, and the social landscape is relatively undisturbed. Secondly, the benefits of irrigation may be realized within a short period. A generation of farmers may pass from the scene in the time elapsed between the preparation of a blueprint for a major dam and the first release of water. For minor projects, the gestation period is only three to five years.

Minor projects offer vast scope for innovative means of providing local communities with a scarce resource, and fostering cooperation in its distribution. While the canals associated with major projects traverse many communities, inhabited by villagers who do not know or trust one another, the scale of minor projects is so small that participants may have long-established patterns of interaction with one another. It is easier for farmers to deny water to downstream strangers than it is to the neighbors he has known for decades. Still, patterns of cooperation may involve time and effort, due to socio-economic as well as technical hurdles.

It is concluded that with dependable water supplies, timely land development works, and appropriate technical assistance as will be provided under the Project, the proposed minor irrigation schemes will be socially and culturally feasible, even eagerly sought after.

2. Rotational Water Supply Systems: Problems and Prospects

Rotational distribution systems represent a form of organized cooperation among farmers designed to apportion water sequentially throughout a canal system. Rotational systems are not widely practiced in the state. In North India, by contrast, farmers have utilized irrigation according to prescribed rotational forms since the latter part of the 19th century.

While cultivators invariably opt for private irrigation systems wherever possible, in order to maximize control over the timing and delivery of water, rotational systems represent a major technical advance for application in Maharashtra. The field-to-field flood irrigation which is widely practiced does not permit the use of advanced agricultural technology. Since farmers cannot control the amount or timing of water received, the element of risk is very high. Rotational systems seek to provide a measure of predictability to water distribution, so that farmers can plan their crop patterns and invest in inputs whose efficient use requires irrigation water.

Even where farmers recognize the advantages of rotational distribution, it may prove difficult to adopt. Several prerequisites seem essential for its successful use: a scarce water situation, farmers cooperation, effective and fair administration by irrigation department officials, and favorable technical factors, such as distributary, field channel and land development, and a main system that can deliver the water in a reliable and timely manner. Deficiencies in these areas can make rotational systems ineffective or impossible, and deter many farmers from utilizing canal water.

The technical section of this report has discussed problems of land and field channel development, and has shown why immediate attention is required. This section will focus upon socio-economic aspects of rotational distribution, and then discuss systems practiced in Maharashtra. The most prevalent form is the Shejpali system, under which irrigators are given water for the crops which are officially sanctioned for cultivation. Water is provided sequentially to irrigators along a watercourse, starting with the farmer located at the tail of the distributary. The Irrigation Department is committed to supply water to each farmer once during a rotational period, which usually covers a 21-day period during the winter season.

The system is extremely flexible, because the time during which irrigators may take water is not limited. In addition, provision is made for last-minute changes in cropping plans. As a result, the Shejpali plan which was carefully calculated at the beginning of the season may not bear much resemblance to actual practice, which defeats the purpose of the elaborate planning exercise and may result in inequitable water distribution.

To overcome these problems, the Irrigation Department has devised a system known as rotational water supply (RWS). Unlike the Shejpali system, RWS is very rigid, and the time period during which water is made available is carefully specified. The RWS has not been widely applied in Maharashtra, and only limited information is available about its performance. Yet some preliminary assessments about its prospects may be made on the basis of the literature on irrigation systems and socio-economic conditions in South Asia.

In many parts of South Asia, canals are associated with an inequitable distribution of water, for two reasons. The first has to do with the technology of canal irrigation, which tends to distribute more water to those at the head of the system than to those located at the tail, where the water ends its journey. The second concerns socio-economic factors, which determine the pattern of resource and benefit distribution.

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The extent of India's 'tail problem' is not known, but it is estimated that perhaps 10 million hectares of tailend area are denied their fair share of water due to their location at the lower reaches of canals.(20) This is partly because farmers located at the head take more water than they should, and partly because canal seepage prevents appropriate quantities of water from reaching the tail.

In addition, since field channels may be in poor condition, and land development work may be required, water cannot be evenly distributed to all farms served by a given canal. The Shejpali system has addressed this problem by allocating supplies first to tail enders, but the evidence suggests that imbalances persist, and tail irrigators generally do not receive their fair share. Deficiencies in field channel and land development work bear a large share of the blame.(22)

A recent study of major canal irrigation system's tail problem noted dramatic consquences for regional development. (23) Agricultural development and related services tended to cluster at canal head reaches, as did towns and industry. Toward the tail, agriculture languished and populations were demonstrably poorer. (24)

The socio-economic inequalities which are rooted in an inegalitarian landholding structure cause additional distortions in canal water allocation. While studies in Maharashtra show that all size classes of farmers suffer when they are located at the tail of a canal,(25) a large body of evidence suggests that large and powerful farmers get more water than small farmers.

As Daniel Thorner noted, there is a tendency for two classes of service to prevail in South Asia's canal systems. The first is a superior level of service, which goes to the 'strong'--those who are powerful as a result of their lands, wealth and contacts. Such farmers get water on a priority basis, and they often receive as much as they wish, technology permitting. The second class service goes to the weak, who lack wealth and influence. In general, they get insufficient supplies and irregular delivery.(26) Such patterns have been observed along canals in Maharashtra. Mitra, for example, found that small farmers were much less likely than large and medium cultivators to get sufficient water and to get water on time. (27). As a result, the weak cannot be sure that their crops will survive, so they do not invest in inputs which require precise applications of irrigation water. Thus their cropping intensities, productivity and incomes are lower than those of the strong.

While this scenario has been repeated throughout South Asia one region in Maharashtra offers an interesting variation on th theme. In the eastern area of Vidarbha, some large landlords do no use canal water for fear of losing land under the stricter ceilin laws applied to irrigated area. Thus, instead of competing wit small farmers for scarce resources, large farmers opt out of th game (28) and, by thus opting out, have brought about substantia under-utilization of available irrigation water.

In other regions, it seems large farmers are activ competitors who can supplement canal supplies through privat facilities, particularly wells.(29) They can also flount official rotation schedules in order to ensure first class service for their own lands. The two-tiered system of service may be reinforced by institutions. Wade's study of the pressures impinging on irrigation officials in a state bordering Maharashtra suggests reasons why functionaries accede to farmers' demands. Because powerful cultivators often have contacts beyond the village, they can wield important powers over irrigation functionaries. For example, they might arrange for the functionaries' transfer to undesirable posts by appealing to politicians or to higher Irrigation Department officials. (30)

The power of state and national level institutions frequently does not extend to local bodies, whose workings may instead be determined in large part by forces within the community. The functionaries who staff subordinate levels of administrative organizations are typically paid very low wages but given large jurisdictions. With weak incentives for good performance, plus inadequate supervision, subordinate personnel generally try to make their work and life easier by appeasing those who can cause problems for them. Thus they may accomodate influential farmers and thereby deny service to the poor and powerless. The financial rewards can supplement meagre incomes and perhaps also enhance the living standards of higher officers.(31)

Canal officials may defend their malfeasance on grounds of physical intimidation by large landlords, also. The influential members of a community can often mobilize dependents to carry out their wishes, and in many parts of South Asia, irrigation water has provoked bloody battles. Transfer might not be the worst fate to befall an unmalleable canal insnector.

Yet while the cana ter or other minor Irrigation Department employees are indeed bject to pressure and violence, they can hold tremendous power i ommunities dependent upon canal water supplies. This derives from their command of discretion, which enables them to specify the terms on which water is made available.(32) They can thereby increase or dispel the risks involved in agriculture for their clients. From Kerala to Karachi, there are proverbs about the power of lowly officials employed by the Irrigation and Revenue departments. Where such an official has the power to ration scarce water supplies, farmers must bargain with him even to get the services to which they are entitled. Thus to understand how canal water is allocated, it is essential to collect field-level data about the pattern of interaction between farmers and subordinate officials. While a field trip did find evidence that some canal masters in Maharashtra could dispense water from minor tanks as they pleased, disregarding official Shejpali schedules, there is a critical lack of information on this issue. This project will fill in those gaps by closely evaluating and monitoring the operation of minor irrigation schemes.

The need for "water reform" (33) has been recognized by irrigation officials as well as scholars and disadvantaged farmers. Prevailing systems could be characterized by an excess of flexibility, which foster the development of a two-tier system of delivery. It is not as if farmers with superior service make more efficient use of water supplies. Studies show that they tend to over-irrigate their crops, thereby wasting water, denying it to others and aggravating the threat of waterlogging and salinity.(34)

In order to remedy these difficulties, the Irrigation Department devised the rotational water supply system (RWS), which minimizes flexibility in prevailing allocation systems by authorizing water releases appropriate for a given crop, in a constant 1.0 cusec discharge throughout the rotation. The RWS schedule is to be strictly observed by both canal authorities and irrigators.

Evidence on its workings is limited to an official study (35) and an academic paper by A. Mitra. (36). While the former reports encouraging results, Mitra concluded that the system's success is conditional upon factors which are often absent. They include well-designed and maintained main distribution systems; steady and predictable discharge; and the prevention of unauthorized irrigation by influential farmers. (37).

Mitra found that since the Mula project site was in an area whose climate and soils favored sugarcane cultivation, the temptation to do so proved irresistible for cultivators with access to water supplies, although GOM policy did not permit the use of canal water for this purpose. Irrigation officials found it impossible to deny canal water to farmers who said they were using

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water from their own wells rather than public supplies. In fact, officials reported: "if they were to implement the present rules very strictly, then, probably, canal water would have to be denied to the majority of the irrigators under pilot-project, thus, virtually abandoning the project itself." (38).

Farmers' reaction to RWS appeared qualified. While the idea of fair, measured distribution has wide appeal, farmers resented the system's crop restrictions. (39) Some irrigators in the Mula project threatened to discontinue their dealings with the Irrigation Department if regulations were strictly enforced. Farmers' opposition to strictly-enforced crop restrictions, which have been associated with RWS, has impeded officials' ability to popularize the system.(40) A second factor limiting the spread of RWS concerns technical prerequisites. Officials doubted whether these conditions--namely, precise discharge and land and field channel development--could be widely met in the near future.

The difference in irrigators' cropping pattern objectives, practices and capabilities makes it difficult to establish a uniform pattern of rules for a given watercourse, which can be strictly enforced. Pilot projects will be able to address this problem during the planning stages, by seeking to ascertain farmers' objectives regarding irrigation as well as their requirements. The pilots will also address questions of optimum conjunctive use of ground and surface water supplies and cooperative exploitation of these resources by communities and irrigation officials.

A second issue which requires attention in irrigation systems throughout South Asia concerns the administration of canals. It is clear that both incentives and supervision of subordinate irrigation personnel require enhancement if performance is to be improved. Systems such as RWS may threaten to close off some present income sources, and this may prove so unpalatable to officials that they choose to re-establish personal control. It does not appear that administrators have been provided the means or incentives to withstand these pressures.

Approaches to the problem are suggested in the literature on irrigators' organizations in Sri Lanka and the Philippines.(41) In conjunction with efforts to organize farmers, there were attempts at "bureaucratic reorientation" in order to elicit better performance from subordinate irrigation personnel. Through their contacts with organized farmers' groups, officials and farmers gained a better appreciation of one another' perspective and established grounds on which to build more cooperative relationships. Previously, relations between irrigators and officials had been generally hostile, and the exchange of rewards and sanctions had been conducted almost exclusively upon an individual basis.

While irrigation officials endorse the concept of farmers' organizations, little is done to facilitate them. Other agencies such as the Agriculture and Cooperative Departments, which have organizational capacities could assist in this effort but their assistance has not been effectively mobilized. The involvement of these agencies in the pilot projects on planning may evolve a format for effecting viable farmer organizations. Persons trained in social work and community organization were effective in facilitating both farmers' organization and communication between irrigators and officials, as was the case in Sri Lanka (42). A longer range solution now under consideration in India would be the creation of water distribution cadre in Irrigation Departments.

The organizational process must be location-specific, since no blueprint has been found that is applicable to the variable conditions obtaining in South Asia. It does appear that conditions in Maharashtra offer some grounds for optimism, however, since rural socio-economic structure is not characterized by sharp inequalities. Experience suggests that organizational initiatives have a better chance of survival where small farmers predominate.

To address the problem discussed above, Project design criteria will require analysis and adoption of some form of rotational water supply or strict enforcement of the Shejpali system. Organization of farmer/irrigators will be experimented with on selected pilot schemes, as will the adoption of cropping patterns suitable to farmers' needs as well as those of the Government.

C. Benefit Incidence

1. Impact on Incomes and Nutrition

The direct benefits of irrigation projects may be considered in terms of enhanced incomes, nutrition and employment. This section will briefly review the evidence on income and dietary changes before turning to the question of employment.

Changes in income may result from increased yields, increased cropping intensities and changes in the crop mix. Of these three factors, changes in cropping pattern may have the most dramatic impact upon agriculturalists' income levels. Specifically, it is the switch to high-value crops, which are often perennials, which is most likely to provide more cash to farmers and more jobs, and therefore more income, to agricultural laborers.

Table 2 noted the very large gaps in the gross value of agricultural production in Maharashtra's various regions. It showed

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that in Konkan, agricultural incomes are lowest in the state, although there is much scope for the cultivation of valuable crops such as mangoes, bananas and cashews. Because irrigation is limited in that region, few perennials are cultivated. Even vegetables are imported from Bombay in some parts of Konkan, although the relationship should be exactly the reverse. A major objective of the minor irrigation scheme in this area is to facilitate the production of high-value produce, for which there is a ready market.(43) This change in crop pattern would undoubtedly expand lagging income and employment opportunities in the region.

A case study showed farmers in Konkan to be well aware of market prices for horticultural crops, and eager to cultivate them. But irrigation was so problematic that even during the winter season, only 10 per cent of the village land was cultivated.(44) Farmers with irrigation facilities were able to grow crops such as coconut and betelnut, but the majority could cultivate only paddy. They could not earn cash which would allow them to invest in the opportunities which were so apparent, but still beyond their reach.(45)

A recent study of developed and underdeveloped parts of three districts (Satara, Sangli and Kolhapur) found important differences in yields, cropping intensities and incomes as a result of irrigation. In the developed region, the average farmer irrigated a much larger proportion of his holding than in the underdeveloped region and grew a higher percentage of intensive crops. The percentages of food grain crops and cash crops were 45 and 46 respectively, while foodgrains occupied 92 per cent of the cropped area in the underdeveloped region, and cash crops only 8 per cent.(46) In both regions, the proportion under foodgrains declined with increased farm size.

Farmers in the developed region used larger quantities of inputs, and thus their per farm costs and costs per cropped hectare were higher than in the underdeveloped region. The per hectare net income for the developed region was Rs. 2400, as against Rs. 450 in the less-irrigated and therefore underdeveloped region.(47) The average annual income in the developed region (Rs. 11,600) was about one and a half times more than that of the underdeveloped region (Rs. 6900). Employment opportunities for agricultural laborers were also greater in the developed region, and the laborers' incomes were 1.4 times higher than in the underdeveloped one.(48) In the underdeveloped region, laborers needed to supplement their earnings through participation in non-farm activities such as the Employment Guarantee Scheme.(49)

Further evidence is offered by a study of beneficiaries of the Ghod irrigation project in Ahmednagar district, and their non-beneficiary neighbors.(50) The gross income from crop production of benficiaries was found to be about four times that of the gross income of non-beneficiaries. Fifty-one per cent of the beneficiaries' gross income came from sugarcane, while 91 per cent of the non-beneficiaries' income came from sorghum. As a result of the irrigation project, the gross income of the selected villages increased by Rs. 154,000, which represents a 171 per cent increase. Without irrigation, important cash crops could not be cultivated, and this variable accounted for significant differences in cropping pattern and income between beneficiaries and less fortunate farmers.

The authors also found significant differences in foodgrains yields as a result of irrigation. Beneficiaries of the Ghod project reaped 7.2 quintals of jowar per hectare, while nonbeneficiaries harvested only 4.8 quintals of that important foodgrains staple. Only 1.7 quintals of hybrid bajra per acre were harvested by nonbeneficiaries while beneficiaries reaped an astounding 10.7 quintals.(51)

Farmers interviewed at a minor irrigation project site in Pune district reported a 50 per cent increase in their sorghum and millet yields since their lands came under tank irrigation. Yet they said they would prefer to grow cash crops such as groundnut and cotton, which were more profitable than foodgrains but were not sanctioned for cultivation.

As a result of the project, however, they were able to increase the area under cultivation, which meant more work for family and non-family labor. The Kohalpur study also noted differences in the amount of land under cultivation in developed and underdeveloped regions. In the former, the net cropped area was 87 per cent, as against 61 per cent in the lagging area.(52) The gross sown area of villages in the Ghod survey increased by 800 hectares, or 4.3 per cent as a result of the project. The increase in area under irrigated crops had a substantial impact on the beneficiaries' incomes.(53).

Minor irrigation schemes may also serve to increase cropped area, incomes and yields in an indirect way. Groundwater supplies may be augmented by tanks, allowing farmers to supplement public water supplies through wells. Although precise estimates of this benefit are not available, its importance is considerable and will be the subject of some of the pilot schemes.

It is hoped that agricultural development will also result in nutritional improvement in the project areas. Farm families whose caloric and nutritional intake are inadequate cannot perform at maximum productivity, or maintain good health and longevity. Studies have shown clear associations between consumption patterns and income. In Maharashtra, increased income leads rural households to switch from coarse grains such as sorghum to wheat, and to decrease the overall proportion of cereals in their diets.

Khare's study of expenditure patterns in Ahmednagar shows a clear decline in foodgrains and pulses with increased income, and a rise in expenditure on foods such as milk, meat, fish and oils.(54) The increased income was made possible by the extension of area under irrigation. The studies show that the poor seek to diversify their diets whenever possible, and agricultural development allows them to make better choices about their food.

Another study sugggested that landless persons' diets may often be deficient in calories, according to Indian Council of Medical Research standards. This is a particularly serious problem for women. Since cultural traditions demand that they be served last, they generally do not get as much food as men, even though they may work harder due to their dual roles as homemakers and agriculturalists.(55) Their insufficient diet leads to higher mortality rates and difficulties in accomplishing their heavy responsibilities.

2. Spread Effects

Regional development is an important issue in Maharashtra, where rural hinterlands have recently made claims on the state's limited supply of resources earmarked for developmental purposes. Perhaps all rural Maharashtrians are aware of the importance of irrigation in a water-short economy. Agricultural development is necessarily associated with the provision of irrigation water, for both crops and domestic purposes.

It is always hazardous to concentrate resources in one small point on the map, because the impact on surrounding communities cannot be predicted. In areas parched for centuries, the introduction of irrigation and irrigated agriculture may be watched somewhat cautiously by farmers not served by a given project. It may take time before non-beneficiary farmers demand their own project, but if the trail blazer has the desired impact, it is likely that others will follow. This process is illustrated by the construction of percolation tanks, which have been in great demand by local leaders and their constituents.

The technology of irrigated agriculture may be spread in diffuse ways, perhaps more through farmers' direct observation of one another's fields than through extension agents' "lectures". Innovations are also spread widely through patterns of labor migration and marketing, in processes not generally chronicled in studies of the diffusion of new ideas and practices. This does not diminish the need for special extension efforts in areas new to irrigation, however.

The development of canal irrigation in India has been followed by the growth of towns, markets and transport, which have changed barren landscapes forever. On a small scale, the minor irrigation project seeks to effect such a transformation in Maharashtra. To do this, two areas will receive particular attention. First, irrigation supplies will be made as reliable as possible, through distributary and field channel development and land development. Secondly, institutional help in extension, inputs and marketing will be provided, to meet farmers' changing needs.

3. Employment Effects

Irrigation officials estimated that the implementation of 90 proposed minor irrigation projects commanding 31,000 ha would increase on-farm employment by up to 1.3 million person/days per year. It further estimated that project construction would create jobs totalling about 52 million person/days over a six year period.(56)

Some minor projects are constructed under the Employment Guarantee Scheme, which requires that 60 per cent of expenditure be on unskilled labor. This guarantees that jobs will be made available to the poor in project areas. When EGS labor is used, irrigation engineers are required to supervise their work and handle their weekly payments. This is a source of annoyance to officials, who contend their work is slowed as a result. While this is likely, important advantages of the EGS were noted in Section A. It is clear that the EGS, and the work it provides, make a vital contribution to many rural households in Maharashtra.

The Planning Commission holds that agricultural development must be stepped up in order to provide for expanded employment in related fields.

"This means increasing the productivity of available land through irrigation, multiple cropping and improved technology. The main thrust of the planning strategy, therefore, would be to expand the area under irrigation as rapidly as possible, and to develop cropping patterns and agricultural practices which optimize the use of land and water resources."(57).

The Irrigation Department projects a sizeable increase in the need for agricultural labor due to yield increases, crop pattern changes and the expansion of area under cultivation. A few statistics offer powerful supporting evidence. For example, the main product of sorghum amounts to 1.4 tons per hectare under rainfed conditions, but the projected yield under irrigation is 3.5 tons per hectare. While the former requires 80 person days of labor per hectare, irrigated sorghum needs 110 person days. Wheat yields were expected to register a five-fold increase with irrigation, from .50 tons per hectare to 2.5, while the labor requirement would double, from 55 person/days to 110.

Vegetable yields could increase from 12 tons per hectare to 20 tons, while the labor requirement would jump from 199 person days to 332.(58) These figures do not take into account corresponding increases in labor involved in marketing and processing. Some of those jobs will also go to the poor, and particularly to the marginal farmers and landless laborers who are important target groups for the minor irrigation project.

A study of beneficiaries of the Ghod irrigation project found that they used much more labor than their neighbors who were not served by the canal. The irrigators were able to grow intensive crops which used more labor than traditional rainfed foodgrains, but their labor requirements increased even for those crops.(59) Similarly, a study of the Kolhapur region found far greater scope for agricultural labor in irrigated areas than in dry ones, where the poor were forced to seek other sources of income.(60).

4. Reservoir Displacement and Land Acquisition

Thousands of persons have derived inestimable benefits from the development of major and medium-scale irrigation works in Maharashtra. But their construction has meant hardship and even ruin for others. Villages have been submerged to create reservoirs for major projects, forcing the relocation of thousands of persons. Until 1976, the displaced persons were given cash compensation but were not provided with alternative means of livelihood.. The bitterness increased as irrigation developed, and governmental attention was drawn to their plight. A series of public meetings were held throughout the state, which offered those who would be hurt by irrigation projects a chance to air their grievances. Displaced farmers and artisans urged policymakers to induce beneficiaries to give up some of their land for resettlement purposes. This proposal was subsequently adopted by policymakers.

A comprehensive program to assist displaced persons was adopted under the Maharashtra Resettlement of Project Displaced Persons Act of 1976, which assigns the government responsibility for resettlement. This legislation has not been applied to minor projects. Villages are not submerged by minor schemes. Land acquired for reservoirs and the canal system can be no more than 25 per cent of the proposed command area. Still, house sites and farm land must be purchased by the government, and the process is no less painful to the individuals concerned than it is to those displaced by larger developmental initiatives.

The Land Acquisition Act of 1976 gives the state the authority to identify and purchase land required by a proposed minor irrigation project. The Act is complicated, with many facets, and the land acquisition processs may be drawn out over many months. A minimum of 44 weeks is required by various procedures included in the Act; in addition, there may be further delays if the property owner contests the acquisition in court.

The Irrigation Department works in conjunction with the Revenue Department to identify the land to be acquired and process the paperwork. The latter decides upon the rate of compensation to be paid, and this is published in official documents. The compensation paid depends upon land sales transactions of nearby property. Still, the amount may not be sufficient to allow the displaced person to purchase additional land, and this is why farmers dislocated by larger projects prefer compensatory land to cash.

Cultivators and landless laborers displaced by minor projects often migrate to urban areas, where their compensation money is used in the search for employment. Their situation is therefore precarious. While the migrant who willingly left the countryside has powerful incentive to adapt to his new milieu, the project-displaced person may not be as willing or able to adjust. The Resettlement of Project Displaced Persons Act also provides for resettlement of landless laborers whose jobs are lost due to acquisition of project lands.

A study of persons displaced by a major irrigation project in Pune District found a sharp decline in the socio-economic position of farm families and laborers.(61) Land holding sizes declined and many families had to sell part of their capital assets and livestock in order to make ends meet. The provisions made under the rehabilitation program could not compensate for the losses incurred. While the dislocated could obtain some income from the

EGS and scarcity works, the authors suggested that additional help be given in the form of land, financial assistances and employment activities.

Land is not generally given to persons displaced by minor projects but they are given priority in leasing "tank beds", or land which is submerged when the tank is full but left exposed when it is not.

Over the long term, it is expected that the development of irrigation will create additional employment in agriculture, which may absorb some of those whose lands and houses were submerged. In the meantime, there is scope to develop agro-related industries in the project area, which could offer opportunities to those who would otherwise feel impelled to migrate. Such industries may include fisheries development, rope-making and food processing such as mango pulp manufacturing. These enterprises would also provide work to unemployed or underemployed members of farm and agricultural labor households.

In order to provide equitable treatment to all persons affected by the Project, the GOM will arrange the resettlement of persons left with uneconomic sized units as a result of land acquisition for Project purposes.

5. Effects on Women

The conventional notion of an Indian farmer centers on 'the man behind the plough,', a sturdy figure clad in a dust-colored loincloth. Yet in many parts of India, and particularly Maharashtra, the farmer wears a sari.

Statistics clearly show the pivotal role which Indian women play in agriculture. They sow the seeds, weed the fledgling plants and reap the harvest. In Maharashtra, there are 85 female landless laborers for every 100 males, compared with the national figure of 50 laborers per 100 males. (62) There are also many more female cultivators in Maharashtra than in India as a whole: in Maharashtra, there are 33 women farmers for every 100 males, while the national figure for women is only 13. (63)

Despite their prominence, there is little official recognition of women's role in agriculture or knowledge of their objectives and difficulties. Official and scholarly sources still focus their attention upon the man behind the plough, rather than the woman who shares his burdens in the field or cultivates alone.

As a result, in this and other spheres, the Planning Commission observes that non-recognition of women's role "has led to complete neglect of their needs." (64)

Some of the difficulties faced by women are related to problems encountered by other disadvantaged groups, as a commision on the status of Indian women noted in 1974:

"Sexual inequality cannot in reality be differentiated from the variety of social, economic and cultural inequalities in Indian society. The inequalities inherent in our traditional social structure, based on caste, community and class, have a very significant influence on the status of women in different spheres." (65)

The status of women varies regionally, and among different social and economic groups. It also depends upon their position within the family and the wider social system. These factors may change dramatically over time, but some broad generalizations can be made. First, Indian society assigns distinctive roles to its male and female populations, relegating the latter to the home. Women are supposed to cook, serve and process food, while men seek a living from the world beyond their doors. A woman's further contribution to productive activities or family income varies mainly with the family's socio-economic status. When that status is low, she may seek employment in manual labor; thus there is often an association between membership in a statutorily designated backward class and this type of labor force participation. As a result, the female manual worker will face problems similar to those of scheduled caste men.

Regional patterns of female labor force participation are striking. In parts of North India, for example, a family's social status has traditionally depended upon the seclusion of women within the home. In Punjab, for example, only families in dire economic circumstances allow women to work in the fields, but in neighboring Haryana, such participation is more socially acceptable. In Maharashtra, also, women have a long tradition of working outside the home.

For women and traditionally disadvantaged groups, expanded opportunities which will allow the worker control over economic resources seems to offer the best hope of elevating his or her social status as well. As Barve observed:

"For the welfare of women and in order that they may be enabled to develop their personalities fully and partake of their duties and responsibilities as full-blooded members of the citizen-body, the most important factor is economic self-reliance; that is to say, employment opportunities." (66)

It would be useful to sketch the opportunities available to women and the conditions under which they work. First, women's association with the home means that she cannot shed domestic responsibilities even if she puts in a full day's labor in paid employment. Not only do they bear and rear children, they must perform all household chores, including cooking and washing. Thus a female farmer cannot simply go to the fields at dawn as her husband would do, she must first cook and feed the family. On her return at dusk, she must again tend to the family's needs. This puts severe limitations on her performance as either a farmer or a mother.

Employment opportunities for women are limited. Ninety per cent of Indian women workers are employed in the unorganized sector, where the state cannot enforce job conditions and pay scales. Wages tend to be short and hours long, conditions perpetuated by the great surplus of available labor. Jobs in the organized sector tend to be located in urban areas, and assigned to men. There is little scope for women's employment in manufacturing, mining, transport and services. . Thus "in villages there is work for women, but in cities, there is not." (67) While educated urban women can find employment in fields traditionally open to them, such as teaching, most Indian women find employment in agriculture.

As a result, employment tends to be seasonal in nature and of short duration. Where the local economy depends upon a single crop, income-earning opportunities are scarce throughout the year. The number of women forced to depend upon this erratic and limited employment has increased in recent years. Throughout India, the number of agricultural laborers registered a sharp increase between 1961 and 1971. In Maharashtra, the number of male agricultural laborers rose from 24.5 per cent of the total male work force to 31 per cent; while the figures for women were 34.5 and 55.3, respectively.(68) These figures suggest deteriorating employment and income levels for both men and women.

There are often wide disparities between the wages paid to men and women. This is true in agriculture, where custom often dictates the sexual division of labor and assigns different values to various agricultural operations. Ploughing is generally a male preserve, as are transportation by bullock carts and large scale marketing.(69) As a result, these tasks are considered more prestigious than those associated with women, such as weeding. According to a national survey conducted in 1974/75, male

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agricultural laborers were paid Rs. 3.72 per day for sowing while women were paid Rs. 2.60. Women were paid Rs. 2.35 for ploughing while men received Rs. 1.00 more. Weeding paid Rs. 3.11 for men and Rs. 1.95 for women.(70) Part of the problem may be that a work day is defined as a seven to nine hour shift, whereas many women must use a portion of that time in household pursuits. A large proportion of her wages may be deducted as a result.(71)

The position of women in Konkan illustrates the problem of women agriculturalists in extreme form. Women are the dominant members of the cultivating class due to the mass exodus of able-bodied men to cities. The circumstances for agricultural development appear unfavorable. Holdings are small and the terrain is often hilly, which complicates the application of advanced agricultural technology. In any event, the most important prerequisite for its use, irrigation, is generally absent. Agriculture is thus pitched at the subsistence level, yielding perhaps one modest foodgrains crop per year. That crop may afford a slim existence to the family, which may be supplemented by a small check from the male household head employed in the city.

The money order is sent to the eldest male in the house rather than to the migrant's wife, who is the principal agricultural decision maker. (72) It is used to purchase essential items which are not produced locally, such as utensils and cooking oil. There is no spare cash available for investment in improved agricultural inputs, such as seeds, fertilizer and equipment.(73)

Incentives for improvement cannot easily be developed under present conditions. First, there are limitations of time and energy due to the women's dual roles as agriculturalists and providers within the home. Both jobs involve a great deal of drudgery, which may sap strength already drained by malnutrition and poor health (74). In addition, a woman may be forced to spend a sizeable chunk of her day fetching water, for domestic and irrigation purposes. Barve found it "monstrous and insufferable" that "so many millions of women in our country should have to waste away large portions of their daily working lives in the mere act of drawing up and supplying water for the daily requirements of their families. The provision of these and other elementary and basic labour-saving devices is now an indispensable pre-requisite of civilized existence and the need for extending such amenities, at the highest possible speed, hardly needs to be emphasized." (75)

Incentive is also frustrated by a general lack of institutional support. As in more developed countries, Indian women are less likely to receive credit from banks or cooperatives--even less likely than the average small farmer who is a male. In any event, women agriculturalists rarely venture to approach a male-dominated credit institution on their own, because they fear the complicated procedures which deter many males from seeking credit. Thus there may be more limits on a woman's ability to risk investments in her farm, even if circumstances improve through the construction of an irrigation project.

Institutional help from male dominated and oriented extension services may not be available to her. Extension agents often tend to neglect poor farmers who cannot afford to risk innovation, as well as those who do not complain about deficiencies in extension performance. Agriculture Department officials conceded that their field staff does not try to reach women, who are short of capital and overburdened by both household and farm work. The agents' neglect also conforms with cultural taboos on the interaction of unrelated males and females.

The experience of the Employment Guarantee Scheme suggests that where on-farm family labor is sufficient, there is considerable scope for expanding off-farm employment among women. Initially, it was believed that women would not seek emplyment on public works schemes built under the EGS, but women sought such jobs as soon as they became available. Landless families sent equal numbers of men and women to EGS sites; while cultivating families of small holders might send only women household members for EGS employment.

The construction of a minor irrigation project may thus represent important employment opportunities for women in a given community. A second benefit which becomes available immediately is water which may be used for domestic purposes. This can have a great impact on women's energy levels and the household's levels of sanitation and nutrition. Ideally, the introduction of irrigation should trigger agricultural growth, thereby expanding both employment and income opportunities. This occurred in one coastal area served by a minor irrigation project (76) but important constraints made it difficult for the women farmers to push agriculture to a higher stage.

First, there was a labor shortage, due to the male population's permanent relocation in Bombay. Second, institutional support in the form of credit and information on cropping practices and markets was not provided. There was also a lack of help from official agencies in developing the project's field channels to distribute the water, and the lands which were to receive it. In order to maximize use of such facilities by women agriculturalists, then, such problems must be addressed. It would seem useful to foster the development of cooperative societies which could help women find both credit and markets. In some areas, where high-value crops may be grown with irrigation, the prospects for employment generation and income enhancement are substantial.

Women clearly benefit from the provision of irrigation water to rural communities due to employment generation and relief from needless drudgery. Yet it is also clear that women will need additional institutional assistance in the initial stages of development in order to enable them to create a better life for themselves and their families.

A pilot scheme focusing attention on women farmers is recommended. Although women comprise a substantial proportion of Maharashtra's agricultural labor force, they seem virtually "invisible" to official agencies. The pilot would be located in the area served by Mahatma Phule Agricultural University (MPAU) since its Transfer Technology Center has experience in training farm women (1400 in 1980-81). The scheme selected would have a relatively large proportion of women agriculturalists.

The MPAU would survey the pilot scheme; design training and other programs to benefit women; train local extension staff in program implementation; and, after sufficient experience, develop recommendations for women's programs having general applicability in irrigated areas.

6. Impact on Tribes

About 7 per cent of Maharashtra's population belongs to the traditionally-disadvantaged scheduled castes, who have been officially designated as those at the bottom of India's social hierachy, and an additional 9 per cent belong to scheduled tribes.(77)

Traditionally, scheduled caste members were physically isolated by their higher-caste neighbors, and in many rural areas, they continue to live on the outskirts of villages. Tribal populations faced even greater isolation, for they tended to live in remote areas not easily reached by communications networks. Although socio-economic change has broken down the old isolation of tribal cultures and forced their assimilation into the wider Indian society of cities and settled agriculture, tribes remain heavily concentrated in hilly sections of northwestern and eastern Maharashtra. Due to the limited spread of institutional resources and facilities, those areas lag behind other regions according to developmental indices.

Since it is assumed that tribal societies cannot long exist in isolation, the problem facing planners has been to ease the transition into new social and economic orders and to minimize the inevitable dislocation involved. The central government has long favored protective discrimination to raise the social and economic status of disadvantaged castes and tribes, through reservations in educational institutions and employment.

In 1975, the Indian government inititated a special program to promote tribal groups' economic welfare, which was followed in 1976 by the enactment of a similar program in Maharashtra. Most of the state plans were designed to further agricultural development, because 80 per cent of the population depends upon farming.(78)

Tribal agriculture is typically characterized by small holdings, the use of traditional techniques, meager capital and inadequate inputs. Access to institutional support from credit agencies and cooperatives is also limited. As a result, agricultural yields and income are low. One case study estimated per capita income of tribal persons at less than $50.(79) Because agriculture is not productive, and tied to uncertain rains, the population may depend upon only one crop per year. This means limited employment opportunities, and frequently, malnutrition due to an inadequate diet.(80)

The topography of the lands inhabited by tribal communities often rules out the possibility of exploitation of water resources through large-scale irrigation projects. Deep water tables may make it virtually impossible for poor farmers to dig a well. Lift irrigation and land development may be prohibitively expensive. There is considerable scope for the development of minor irrigation in such areas.

Minor irrigation offers important advantages. First, the schemes do not disrupt the landscape very much. Tribes' relationship to their environments is delicate and complex, and change may easily have adverse consequences. For example, the exploitation of natural resources through mining or forestry may threaten tribal populations' livelihood where food and income is derived from forest products. In addition, soil erosion has been aggravated by resource depletion in tribal parts of Konkan.

Second, small minor irrigation schemes can be run by communities, and adapted to their particular requirements. In addition, routine maintenance does not pose problems which would be exacerbated by limited communications and repair facilities.

In some areas, tribes and backward caste members have a traditional association with minor irrigation. Tanks have long been used in the eastern districts of Chandrapur and Bandhara, where there are large concentrations of tribal people. In such areas, local populations may be quick to take advantage of new water resources, especially if given supplementary assistance in areas such as credit and extension.

Where tribal communities are isolated in underdeveloped areas, they face particularly severe problems of communication, markets and institutional and social services. Small and scattered settlements are not readily served by extension agents, who have only bicycle transportation, or by credit institititions. Populations become dependent upon the local traders for supplies, which often results in indebtedness for tribesmembers and a shortage of cash which could be used to improve agriculture.(81)

As Brahme emphasizes, a development program to aid scheduled castes and tribes must begin by ensuring that such farmers have productive resources which will allow them to meet their basic needs. Programs must also take into consideration the critical deficiencies in infrastructure, skills and education in the beneficiaries' communities.(82) Training programs in irrigated agriculture will be essential.

The minor irrigation project may be seen as a direct effort to improve the beneficiaries' production capacities, and thereby expand employment opportunities. The construction of such facilities has provided jobs to tribal populations under the EGS, and it has helped them break out of vicious circles of indebtedness.(83) Yet because the areas where such disadvantaged groups are concentrated are not represented by influential political leaders, they may have difficulty securing such projects. It is certain, however, that tribal persons will receive greatest benefit where minor irrigation programs are fully or partly funded by the government's tribal sub-plan.(84)

For the period 1978-82, the funds allocated to minor irrigation in tribal areas represented 16 percent of the total. This represents a deliberate effort by the GOM at benefitting tribal populations who represent only nine percent of Maharashtra's population. Such preferential treatment is expected to continue under this Project.

To fully utilize irrigation resources, the benficiaries must be assured access to credit, inputs and information. They should be given extension advice for agriculture, including tree planting and conservation techniques. Irrigation is likely to allow for production of new crops, which could represent important additions to local diets as well as to income. Such crops include tubers, yams, casava and other deep-rooted plants.(85) Work in reforestation and cultivation of deforested common lands would enhance employment during lean periods of the agricultural year. In all these areas, special extension attention and training may be required.

To the extent possible, local men and women should be trained to assume leadership positions. The tendency for non-tribal extension agents to ignore women has had an adverse impact upon tribal economies, and in particular, upon tribal women. Whereas in the past, tribal women played an important role in cultivation, which was mostly carried out on a shifting basis, extension agents have taught new technology only to men.(86) The objective of irrigation and associated development projects is to ensure that tribal and lower caste beneficiaries obtain the resources and skills to take advantage of new opportunities. To this end, extension, credit and input supply will be included in Project financed schemes.

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CHAPTER VI

ECONOMIC ANALYSIS

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A. Introduction

Economic viability of the project was examined using time-discounted cash flow analysis of a sample of four proposed schemes. Description of the schemes, methodology used for analysis and the results of sensitivity tests for certain assumptions and estimates are summarized.

1. Present Appraisal Procedure

Estimates of benefits and costs are currently developed and benefit/cost ratios are calculated for minor irrigation projects in Maharashtra by the ID. Using market prices and crop yields supplied by the the AD, gross value of total production from part of the CCA (which would be provided with irrigation) "before" and "after" project is calculated. From this gross value deductions are made, using certain rules of thumb for farm inputs; labor cost for instance, is taken to be 20 percent of the gross value per ha of the crop. Net value of production is derived after deducting costs of fertilizer, chemicals, seeds, labor, depreciation (10 percent of gross value) and interest on production credit (5 percent). In the calculations of the net value of production "after" irrigation, credit is taken for tank bed cultivation to the extent of 50 percent of the submerged area, and for the rainfed area. Net incremental direct benefit due to the scheme is derived by subtracting net value of production "before" project from that "after" project. A three-year transition is assumed for rainfed land to shift to irrigated cultivation. No transitions are considered for agricultural productivity.

Costs include construction costs of dams, canals, field channels, outlets, land acquisition, and physical contingencies -- all valued at current financial prices. Operation and maintenance costs (O&M) are taken at Rs 80/ha of CCA. Annual net benefit and cost streams are then discounted at 12 percent over 30 years and summed to determine the net present worth (NPW) of investments and benefits. Finally, the benefit/cost ratio is derived by dividing the NPW of benefits by the NPW of costs.

2. Methodology Used for AID Analysis

The AID analysis developed individual crop budgets using World Bank (WB) projected 1990 world economic prices expressed in 1983/84 price level and "backed" to the farm gate. WB estimates of present rainfed yields and projections of "Without Project" (WOP) and "With Project" (W/P) yields for Maharashtra were utilized to determine the gross value of crops produced per hectare. For some

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non-traded commodities, financial prices were projected to 1990 and adjusted for inflation, these were then further adjusted for projected changes in demand and supply, including an appropriate conversion factor. After the recent sharp downward revision of WB agricultural price forecasts, the world market prices of most traded commodities have come close to parity with the Indian market prices; in fact the market prices received by Indian farmers for some commodities are now higher than world market prices. Consequently, a conversion factor of 1.0 was used in the case of some non-traded commodities.

WB's estimates of inputs per hectare were utilized. Labor was shadow priced at Rs 3 per day while the economic cost of draft animal labor per day was taken to be Rs 10. Fertilizer, in terms of N was priced at Rs 4/kg for the Present case and Rs 4.8/kg for the WOP and W/P cases. Table 1 summarizes the economic crop budgets for principal crops.

Costs in this analysis included (a) capital investment needed to achieve the projected income, such as reservoirs and associated works and the distribution system; (b) cost of land development at the rate of Rs 2220/ha of CCA; and (c) operation and maintenance (O&M) costs. Financial cost of construction was converted to economic costs by the use of a construction cost factor (CCF) of 0.75. CCF was applied also to cost of land development. O&M cost was taken to be Rs 80/ha of CCA and the standard conversion factor (SCF) of 0.8 was used. Construction cost estimates related to 1981. These were brought up to date and were expressed in 1983/84, that is, the base year's prices, by using a combined wholesale commodity and an agricultural labor consumer price index. All costs and benefits were expressed in terms of 1983/84 purchasing power. Price escalation was ignored. Construction cost did not include the cost of land acquisition. However, the income from submerged agricultural land was deducted from the projected W/P net benefits.

Direct benefits in this analysis included incremental net farm income from crop production. Credit was taken for income from reservoir bed cultivation in the rabi season. Incremental net farm income was calculated as W/P net farm income minus WOP net farm income, excluding transfer payments.

Estimates of benefits took full account of transition periods involved in land and irrigation development and in the development of projected levels of agricultural productivity. For the WOP case, an eight year linear transition was assumed for net returns from the Present case. Transitions in cropping patterns were expected to be short and were taken to be subsumed in the land transition. For the W/P case a four-year linear transition period for irrigated area expansion was assumed, while an eight-year linear transition period was considered for agricultural productivity beginning at the 0.5 level, i.e., assuming that one half the irrigated yield potential is achieved during the first year of irrigation. This transition was applied successively to each incremental area brought under irrigation. To reduce calculations, a combined transition obtained by multiplying area and productivity transition factors for each successive incremental area and summing for each year was applied to W/P net return.1/

Subtracting annual costs from annual benefits, the annual stream of incremental benefit (or cash flow) was derived for each scheme. The annual cash flow entries were then discounted by the Present Worth (PW) factor derived from the expression PW = $(1+R)^{-n}$, where R is the interest equal to the opportunity cost of capital and n is the number of years after the base year. Following AID's traditional procedure, the base year's values were discounted by a factor of 1.0. The Economic Rate of Return (ERR) was determined through an iterative procedure. Annex tables illustrate the step-by-step procedure and the determination of the ERR in the case of the Kode Scheme.

B. Analysis of Proposed Schemes

1. Description of Schemes

Kode: Located in the western district of Kolhapur, the scheme consists of a 460 meter long earthen dam across Jambali Nalla, a 70 meter spillway and a lift network to irrigate 491 ha out of a CCA of 589 hectares. Present cropping pattern includes inferior cereals some paddy in kharif and sugarcane as a perennial crop. The W/P cropping pattern is proposed to include irrigated rabi crops -- high-yielding varieties (HYV) of wheat and maize and vegetables.

1/ The W/P irrigated net farm income ought to have been adjusted by an average water supply factor. However, in the absence of reservoir operations studies, the average water supply factor could not be estimated. Therefore, benefits are somewhat over-estimated. It is recommended that (a) such studies be undertaken as part of the preliminary project report for schemes forwarded for AID funding; (b) average water supply factor be calculated from these studies and used for adjusting W/P irrigated net farm income.

Gavase: This scheme is located in the same district of Kolhapur and consists of a 340 meter long earthen dam across a local Nalla, a spillway of 40 meters, lined main canal, field channels and drains. It is designed to irrigate 191 hectares out of a CCA of 239 hectares. Cultivation at present is rabi oriented (wheat, maize, gram and vegetables), though some paddy, sorghum and vegetables are grown in a small area in kharif. The proposed W/P cropping pattern does not introduce any new crops.

Waki: Located in the eastern district of Osmanabad, the scheme consists of an earthen dam 1620 meters long across the Waki Nalla. It is designed to irrigate 1150 hectares. Presently cultivation is restricted to kharif season, the principal crops being sorghum, pulses and groundnut. The projected cropping pattern W/P includes shifts to two seasonals and rabi crops like wheat, gram, and HYV sorghum.

Dhule: This scheme in the northern district of Jalgaon consists of a 1284 meter long earthen dam and a canal network to irrigate 232 hectares in a CCA of 412 hectares. Present cropping pattern includes mostly kharif crops -- sorghum, cotton, pulses and groundnut. Irrigation will enable cultivation of rabi crops -- HYV wheat, sorghum and gram, and vegetables.

2. Economic Rate of Return

Using methodology outlined in Section A.2 Economic Rates of Return (ERR) for the schemes were calculated.

Subproject	Capital Cost/ha with CCF (Rs)	EER %	CCA (ha)
Kode	9,640	16.03	589
Gavase	14,870	9.43	239
Waki	8,403	17.14	1150
Dhule	9,405	12.80	412

The estimated ERR varies a good deal from one scheme to another. All schemes, except Gavase, yield an ERR greater than 12 percent, which is generally taken to be the opportunity cost of capital in the Indian economy. Two factors seem to have been responsible for the low ERR in the case of Gavase: (a) it is

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obviously a high cost scheme; and (b) W/P cropping pattern is almost the same as the WOP cropping pattern without any shift to high value crops. The W/P rainfed cropping pattern includes only low value inferior cereals and grass.

3. Sensitivity Analysis

Sensitivity analysis was carried out in respect of construction period, initial period of release of water, shortfalls in area irrigated, and costs. First, completion of construction work was assumed to be delayed by one year with consequent delay in the start of the benefit stream. Second, water was assumed to be released one year ahead of schedule, other assumptions remaining the same as in the base case. Third, the scheme was assumed to have provided water to only 60 percent of the designed irrigated area. Finally, costs were assumed to be 10 percent (a) greater and (b) lower than the base case. The impact on the ERR of these variations in base case assumptions is shown in the following table.

Project	Kode	Gavase	Waki	Dhule
1. Completion delayed by one period	15.78	8.83	15.85	11.75
2. Benefits start one period ahead of schedule	19.52	10.51	19.47	14.47
3. Costs increase by 10 percent	16.21	8.69	16.13	11.92
4. Costs decrease by 10 percent	18.39	10.28	18.35	13.81
5. Irrigation provided to 60% of designated area	7.32	1.81	12.85	7.86
6. Base case	16.03	9.43	17.14	12.80

The results show that the rate of return is sensitive to an early release of water and advancing the benefit stream by one year ahead of the usual schedule. The physical construction schedule for minor irrigation schemes usually includes a four-year period of planning and construction and release of water in the fifth year, though it is frequently eight to 10 years before water is available throughout the area that can be commanded. The design and construction schedules under the Project are intended to make water available, to at least part of the command, during year four.

If land development and work on the distribution system are undertaken early, it would be possible to release water in the fourth year and derive a greater return on the investment. Considering the small size of most of the proposed schemes, it seems feasible to complete the construction work in three instead of four or more years.

However, the most important factor affecting scheme viability is the degree to which the system is operated to its design capacity. A review of the evidence regarding existing minor irrigation schemes shows that most schemes have been underutilized. An analysis 2/ by the ID of 49 schemes in Naisk, Dhule and Jalgaon Districts showed an average rabi utilization rate of about 40 percent over the life of the schemes. Variability from scheme to scheme was great, ranging from ten percent to 89 percent.

At rates of utilization currently prevailing on Maharashtra minor irrigation schemes, they are clearly an uneconomic investment. Factors causing this underutilization are many and varied. Most frequently mentioned in the studies that have been made is the lack of reliability of the physical system to deliver water to farmers. This takes many forms -- from actual lack of a distrubution system, through poor quality construction, to improper operation and maintenance. Design criteria and implementation procedures under this Project will eliminate, or at least minimize, these factors.

Another significant factor is the variability of rainfall. Dams and reservoirs will be designed at 50 percent reliability, which means that in only half the years during scheme life can full utilization of the system be expected. This is a deliberate policy choice by the GOM which is intended to provide water to a larger number of beneficiaries than if the system were designed for more reliability. USAID has concurred in this design procedure with the proviso that GOM subject it to a thorough engineering, economic, and social analysis.

Some of the more intractable factors influencing underutilization are institutional. Water allocation laws in

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2/ "Minor Irrigation Works in the Bombay Region, Report Summaries," Minor Irrigation Surface Water Unit, Nasik, 1979/80.

Maharashtra under the Shejpali system give farmers the choice at various times during the year of requesting water if it is needed; or not requesting water, and therefore not paying for it, if it is not believed by the farmer to be needed. Thus, in good rainfall years when a full irrigation water supply is likely, it is also likely that farmers will not request the full water supply. In this situation, water will likely remain in the reservoir at the end of the rabi season and could be released for hot season crops, even though hot season irrigation is not designed into minor irrigation schemes. The ID will analyze demand scheduling as an alternative to the Shejpali system for water allocation. The GOM is also exploring the possibilities of a minimum charge for irrigation water availability so as to encourage farmers to take water. This charge has not yet been imposed.

Another institutional variable is the land ceiling law which imposes smaller ceilings on irrigated land. This has made farmers in some areas reluctant to utilize irrigation water that is available to them.

It has also been observed that farmers newly introduced to irrigation have not been given sufficient education in its use and are therefore reluctant to use it. Agricultural development demonstration chaks on each scheme financed under the Project, plus one trained resident VEW and one trained Canal Inspector on each scheme, plus the organization of outlet committees will remove this institutional constraint.

This is not an exhaustive list of the factors affecting irrigation water utilization, nor of the measures under consideration by the GOM.[3/] It does, however, focus on those factors to be specifically addressed under the project.

C. Financial Analysis

1. Financial Rate of Return

The Financial Rate of Return (FRR) was calculated for one project, Kode, by using market prices for outputs and inputs. Inputs, in this case, included interest on working capital, depreciation of machinery and implements, water charges, taxes and miscellaneous financial expenditure. Construction costs were not

3/ See the "Report of the High Power committee," Government of Maharashtra, November 1981, for a detailed analysis of underutilization throughout the State and recommendations for improvement.

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adjusted by the CCF. The estimated FRR for this project was 10.8 percent compared to an ERR of 16 percent. This result seems to suggest that without shadow pricing of inputs and outputs and without appropriate adjustment of the construction costs for the low productivity labor component, some of the minor irrigation projects may not be economically viable.

2. Farm Income of the Average Farm

To ascertain the impact of irrigation on the net income of a two-hectare farm, a financial crop budget was developed. The present cropping pattern included the usual rainfed kharif crops with fallow land of 10 percent. With irrigation the cropping pattern was assumed to include rabi crops of wheat and maize. The results of this exercise are shown below.

Farm Income for a Two Hectare Farm:

Time	Total Net Farm Income (Rs)	Net Income Per ha (Rs)
Present	1,071	535
Future Without Project	1,470	735
Future With Project	7,820	3,910

D. Analysis of An Existing Scheme

1. Description of the Scheme

The performance of the Kothare scheme in Dhule district was reveiwed. Construction was started in 1972 and completed in 1974. However, no expenditure on land development was incurred. By today's standards, construction costs were low -- about Rs 2702/ha of CCA. The scheme was designed to irrigate 761 hectares out of a CCA of 810 hectares, with emphasis on rabi season crops. The projected irrigated crop pattern included about 73 percent rabi crops (mainly wheat and grain sorghum) and about 16 percent two-seasonals (cotton).

Available records show that the maximum area that has been irrigated by the project was about 59 percent of the designed irrigated area, and that this area was reached only in one year out of seven years of operation. Surface irrigated area fluctuated widely from year to year. Records also show that the reservoir did not fill in four out of seven years.

2. Economic Evaluation

AID analysis assumed four scenarios. In the first scenario, it was assumed that ultimately the project would irrigate about three-fourths of the designed irrigated area and that his area would be reached by the eleventh year of operation. In the second one, the assumption was that by the eleventh year the full designed irrigated area would be reached. The assumption in the third scenario was that the project would not be able to provide water to more than 59 percent of the design irrigated area, which is the maximum area irrigated through 1980/81. The fourth scenario used an average utilization rate of 46 percent which reflects Kothare's actual history during 1974 to 1981.

Costs and benefits were evaluated at 1975 constant prices. Costs (excluding those for land acquisition) incurred before 1975 were adjusted for price rise and brought up to the 1975 base year level by using a factor weighted by the wholesale and agricultural labor price indices; these were adjusted by the CCF, and the O&M costs were adjusted by the SCF. Output prices were derived from 1975 world prices and were "backed" to the farmgate. On the basis of the 1980/81 cropping pattern, annual rainfed area from 1974 onwards was estimated. Composite net returns per hectare were estimated from the 1980/81 cropping pattern for canal and well irrigated areas and for rainfed area. W/O project net returns were estimated from "before" project cropping patterns, and deducted from with project net returns; the incremental net benefit was adjusted for agricultural productivity transition by applying appropriate factors to incremental area under different types of farming (surface, wells, and rainfed) each year. Finally, net annual incremental benefits were reduced by the WOP estimated income from submerged area to reflect its opportunity cost.

In addition to the ERR under the various scenarios, the net present value of scheme benefits at 12 percent interest was calculated. The results of the analysis are tabulated below.

Percent of Designed Area Irrigated	ERR	NPV at 12 percent (Rs 000)
100	15.7	1,243
75	13.1	300
59	11.3	166
46	6.3	-1,057

The ERR varies, of course, with the degree of utilization of the system. A rough interpolation of these data suggests that somewhere around 66 to 68 percent utilization would achieve the cutoff 12 percent rate of return. Actual experence to date has been much less than this.

The NPV data show the economic worth of the scheme to the Maharashtra economy at 12 percent interest. If utilization rates remain at the 46 percent level reflected in Kothare's history throughout the life of the scheme, the opportunity loss to the economy of Maharashtra for investing in Kothare rather than a scheme that did yield a 12 percent return would be over one million Rupees. Serious efforts are warranted for increasing utilization rates on Kothare and other lagging schemes. Project activities discussed earlier in Section B.3. are expected to help.

E. Economic Criteria

Economic evaluation of schemes will use the discounted cash flo analysis described in Section A.2.

A 12 percent ERR will be required for scheme approval, except in tribal, drought prone, or other areas where GOM policy provides concessions. In these areas, schemes will qualify with a 10 percent ERR.

Table 1: ECONOMIC CROP BUDGETS FOR PRINCIPAL CROPS

	Yield (Q/ha)	Price (Rs/Q)	Gross Value* (Rs/ha)	Labor (Rs/ha)	Total Inputs (Rs/ha)	Net Val (Rs/ha
Present: Rainfed						
Paddy	15	130	2,150	270	840	1,310
Sorghum	6	90	720	180	480	240
Pearl Millet	3.5	150	669	120	270	399
Maize	10	104	1,160	216	546	614
Nachani	4.6	82	417	120	175	242
Grass	9	20	180	36	36	144
Cotton	3	380	1,140	225	420	720
Groundnut	7	320	2,907	285	1,010	1,897
Pulses	3	240	740	120	270	470
Wheat	5	140	800	270	670	130
Gram	4	290	1,220	135	335	885
WOP						
Paddy	17	150	2,770	282	980	1,790
Sorghum	7	110	980	189	501	479
Pearl Millet	4	170	848	126	286	562
Maize	12	126	1,652	228	622	1,030
Nachani	4.6	116	574	120	175	399
Grass	9	29	261	36	36	225
Cotton	4	390	1,560	240	495	1,065
Groundnut	8	490	4,220	315	1,071	3,149
Pulses	4	330	1,345	132	282	1,063
Wheat	6	170	1,116	285	727	389
Gram	5	330	1,720	147	463	1,257
W/P: Irrigated						
Paddy	25	150	4,000	324	1,434	2,566
Sorghum	30	110	4,050	255	1,125	2,925
Pearl Millet	20	170	3,688	255	969	2,719
Maize	30	126	4,180	342	1,412	2,768
Cotton	18	390	7,020	630	2,690	4,330
Groundnut	15	490	7,975	450	1,880	6,095
Wheat	25	170	4,570	330	1,536	3,034
Gram	12	330	4,140	216	1,140	3,000
Sugarcane	870	24	20,880	675	4,515	16,365
Vegetables	200	80	16,000	996	5,816	10,184

* Value of Biproducts Included

Table 2: WHOLESALE PRICE INDEX AND CONSUMER PRICE INDEX FOR AGRICULTURAL LABOR

	Wholesale Price Index Base 1970-71 = 100	CPI for Ag. Labor Base 1960-61 = 100
1971	105.2	200
1972	113.0	225
1973	131.6	283
1974	169.2	368
1975	175.8	317
1976	172.4	302
1977	185.4	323
1978	185.0	317
1979	206.5	360
1980	248.1	409
1981	278.1	448
1982	285.1	441*
1983	290.9*	460*

* Estimated from linear trend equation

Table 3: COSTS, KODE MINOR

Estimated construction cost 1981:	Rs 7.078 million
less price escalation	- .512
	Rs 6.566
less land acquisition	- .137
	Rs 6.429 million

Wh price index 1983-84/1980-81 290.9/248.1 = 1.172
A index 1983-84/1980-81 460/409 = 1.125
We construction cost index (.4)(1.125) + (.6)(1.172) = 1.153
Base year (1983-84) construction cost (6429)(1.153) = Rs 7.413 million
Apply CCF: (.75)(7413) = Rs 5.559 million

Land development cost at Rs 2220/ha: Rs 1.308 million
Apply CCF: Rs 0.987 million

O&M costs at Rs 80/ha: Rs 0.047 million
Apply SCF: Rs 0.038 million

Period	Major Works	Land Development	O&M Costs	Total
0	667			667
1	1557			1557
2	2057			2057
3	1278	118		1396
4		275	10	285
5		363	19	382
6		225	29	254
7			38	38
.			..	..
.			..	..
24			38	38
25	-2779*	-981**		-3760

* Salvage value 50 percent
** Salvage value 100 percent

Table 4: CROPPING PATTERNS AND ULTIMATE NET RETURNS: KODE

	Area (ha)	Net Value (Rs/ha)	Total (Rs)
Present: Rainfed			
1. Nachani	128	242	30,976
2. Paddy	83	1,310	108,730
3. Grass	202	144	29,088
4. Sugarcane	78	5,400	421,000
			589,994
WOP: Rainfed			
1. Nachani	128	399	51,072
2. Paddy	83	1,790	148,570
3. Grass	202	225	45,450
4. Sugarcane	78	5,940	463,320
			708,412
W/P: Irr.			
1. Wheat	265	3,034	804,010
2. Maize	113	2,768	312,784
3. Vegetables	30	10,184	305,520
4. Sugarcane	83	16,365	1,358,295
			2,780,609
W/P: Rainfed			
1. Nachani	128	399	51,072
2. Paddy	83	1,790	148,570
3. Grass	196	225	44,100
			243,742

W/P:	Irr.	2,780,609	
	RF	243,742	
	Total	3,024,351	
WOP:			708,412
Present:			589,994

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Table 5: LAND AND PRODUCTIVITY TRANSITIONS

Year	Area	Technology	Composite
1	0.25	0.5625	0.1406
2	0.50	0.6250	0.2968
3	0.75	0.6875	0.4687
4	1.00	0.7500	0.6562
5		0.8125	0.7187
6		0.8750	0.7813
7		0.9375	0.8483
8		1.0000	0.9063
9			0.9532
10			0.9844
11			1.0000

Table 6: **ANNUAL CROP NET RETURNS: KODE**
(Net Returns Rs 000)

Year	Transitions: Composite	Transitions: Old Area*	W/P: Newly Irr. Area	W/P: Present Area	W/P: Total	WOP	Net Total
3				590	590	590	0
4	.14	.75	423	454	877	605	272
5	.30	.50	907	310	1217	620	597
6	.47	.25	1421	159	1580	635	945
7	.66	0	1996			650	1346
8	.72		2177			665	1512
9	.78		2359			680	1679
10	.84		2540			695	1845
11	.91		2752			708	2044
12	.95		2873			708	2165
13	.98		2964			708	2256
14	1.00		3024			708	2316

* Area not yet receiving irrigation

Table 7: INVESTMENT, INCOME AND INCREMENTAL BENEFITS: KODE

Period	Major Works	Land Dev.	O&M Cost	Total Cost	Farm Income	Incremental Benefit
0	667			667		- 667
1	1557			1557		-1557
2	2057			2057		-2057
3	1278	118		1278		-1396
4		275	10	285	272	- 13
5		363	19	382	597	215
6		225	29	254	945	691
7			38	38	1346	1308
8			.	.	1512	1474
9			.	.	1679	1641
10			.	.	1845	1807
11			.	.	2044	2006
12			.	.	2165	2127
13			.	.	2256	2218
14			.	.	2316	2278
15			.	.	.	2278
16			.	.	.	2278
17			.	.	.	2278
18			.	.	.	2278
19			.	.	.	2278
20			.	.	.	2278
21			.	.	.	2278
22			.	.	.	2278
23			.	.	.	2278
24			38	38	2316	2278
25	-2779	-981				3760

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CHAPTER VII

ADMINISTRATIVE ANALYSIS

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A. Capacities of Implementing Organizations to Undertake the Project

1. 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 Irrigation Secretary looks after the minor irrigation schemes and he is assisted by a Chief Engineer with supporting staff at the Mantralaya (location of ID office in Bombay). The minor irrigation sector at the operational level is looked after by six Regional Chief Engineers whose headquarters are at Bombay, Nasik, Pune, Aurangabad, Amravati, and Nagpur. The Regional Chief Engineers are responsible for the surveys, planning, design, implementation, monitoring, operation and maintenance of minor irrigation schemes along with major and medium irrigation schemes under their charge. The regional Chief Engineers give technical sanction for the schemes, while the administrative approval for the schemes is accorded by Government.

The six Regional Chief Engineers are assisted by 13 Superintending Engineers who in addition to minor irrigation works, are also responsible for some of the medium irrigaton works within their jurisdiction. The planning, design, construction, management, monitoring and maintenance of the schemes at the Divisional level are looked after by Divisions each headed by an Executive Engineer. The construction of all the minor irrigation schemes is distributed among the 40 Divisions assisted by 148 Sub-Divisions each headed by a Sub-Divisional Officer.

In order to carry out surveys, plans and estimates of each minor irrigation scheme, separate sub-divisions are earmarked by each regional Chief Engineer. There are 77 such sub-divisions which survey, plan and prepare estimates for irrigation projects assigned to them, including minor irrigation schemes.

The jurisdiction of the Executive Engineer, normally extends to one District but in Districts where the work load is heavy, more than one Executive Engineer is posted in charge of minor irrigation schemes in the District. The Executive Engineers hold all the powers of canal officers under the Irrigation Act and are therefore primarily responsible as "Executive Officers" for efficient management of and control over the irrigation works in their charge.

The table below gives the names of the regions and the numbers of circles, divisions and sub-divisions under which the minor irrigation works are distributed for planning, design, construction, implementation and operation.

Irrigation Department Organization

Name of Region	Circle	Division	Sub-Division Survey	Sub-Division Construction	Sub-Division Total
Bombay	2	8	16	21	37
Nasik	2	7	15	28	43
Pune	3	8	12	30	42
Aurangabad	2	9	20	36	56
Nagpur	1	2	6	9	15
Amravati	3	6	8	24	32
TOTAL	13	40	77	148	225

The ID figures its work-load in financial terms. A sub-division will accomplish work costing from Rs. 1.5 million to Rs. 2.5 million depending on whether the work is on the distribution system or the dam and headworks. An average of Rs. 2 million per sub-division year seems reasonable. On this basis 430 sub-division years will be required for construction and, at four per year, 25 sub-division years for planning and design. This effort will not be expended evenly over the six year Project life. The following is a rough approximation of costs by year, the corresponding sub-division years required, and the new subdivisions that must be established by year.

Year	Project Expenditure ($ million)	Required Subdivision Years			Additional Sub-divisions Required		
		Planning	Construc-tion	Total	Planning	Construc-tion	Total
1	1.34	5	7	7	5	7	12
2	5.44	10	27	37	5	20	28
3	13.22	8	66	74		39	46
4	20.16		101	101		35	44
5	18.19		91	91		-	-
6	7.07		35	35		-	-
Total	65.42	23	327	350	10	101	111

The additional 111 subdivisions required to carry out ID responsibilities for scheme planning and construction will be supplied by transfer from other projects or the recruitment of new staff, or both. The GOM will sanction the required additional staff prior to initial disbursement of loan funds.

The ID staff includes about 9,000 engineers, about 3,000 of whom are graduate or post-graduate and the remaining 6,000 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. Additional training/competence is required in distribution system planning, systems operation and water management, and land development procedures.

The ID has established a Division of Irrigation Research and Development (DIRD) which has the assigned responsibility and sufficient staff for making detailed soils surveys on medium and major irrigation projects and for designing sub-surface drainage schemes on major and medium irrigation command areas. MIS's will also be required to have detailed soil surveys and additional DIRD staff and strengthening of Soil Survey Units will be required for this purpose.

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 not only for the Irrigation Department, but also for the 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 the ID with assistance from 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 ID and AD responsible for improving land and water management. Curricula include agronomic and social science, as well as engineering courses applied to actual field problems. The capacity and capability of WALMI to train officials in all areas of irrigated agriculture is to be improved under the USAID Irrigation Management and Training Project. This expansion will have a direct positive effect on this Project.

To implement this Project the GOM will establish (1) a Minor Irrigation Committee, chaired by the Secretary, Irrigation; (2) a special Appraisal and Supervision Cell at State level in the office of the Chief Engineer, Minor Irrigation; (3) a Special Analysis and Evaluation Cell in the office of the Coordinating Regional Chief Engineer; and (4) a special Minor Irrigation Cell in the office of each regional Chief Engineer. The functions of these organizational entities are described in Chapter I.

During the 30 years prior to the 6th Five Year Plan, the ID has planned, designed, constructed, managed, and operated major, medium and minor irrigation works serving 1.45 million ha and costing Rs. 11.5 billion ($1.15 billion).[1/] The investment in state sector minor irrigation for this same period was Rs. 1.55 billion. Budgets for the ID in recent years of the 6th Plan have been about Rs. 3 billion ($300 million) per year.

In summary, the ID will be well staffed and organized to plan, design, and construct the dams and canals proposed to be financed under this project. There are suggested technical, training, and investigative activities to improve planning, design, and construction processes; but even more attention will be given to management, operations, and maintenance.

2. Agriculture Department, Soil Conservation Division

The responsibility for carrying out the distributary and land development works (Part I and II works) below the 40 ha outlet rests with the Department of Agriculture, Soil Conservation Section (AD/SC). The Part I and II works include all improvements from the ending point of the ID responsibility at the 40 ha chak, including

1/ At Rs. 10/$ -- Total not corrected for inflation. Source is "Maharashtra Minor Irrigation Tank Project," September, 1981.

improvement on the individual farmers' fields. Part I works will be financed under the Project. Part II works will be budgeted separately by the AD.

The AD/SC has 40 Soil Conservation Divisions and 200 Subdivisions under the supervision of the Deputy Director of Agriculture (DDA) for carrying out land development works. Of these, 15 Divisions and 75 Subdivisions are engaged in CADA work on major irrigation projects. The remaining 25 Divisions and 125 Subdivisions are working on rainfed land development or on minor and medium projects.

The GOM recently reviewed the work norms of the Subdivisions and has decided that each Subdivision must complete Part I and Part II 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 be reasonable. Since it is proposed to create 31,000 ha of additional irrigated area under this project, about 20 subdivision years will be required for Part I distributary works and Part II on-farm land development works. The phasing of construction is such that six sub-divisions will be required during year four and five. The estimated requirements are given below.

Year	Area (ha)	Sub-division Required	New Sub-division
1	204	-	-
2	1,564	1	1
3	5,350	3.5	2.5
4	9,962	6	2.5
5	9,680	6	-
6	4,240	3	-
Total	31,000	19.5	6

2/ Previous norms being 2,400 ha per year.

At 37 technical personnel per Subdivision, about 222 personnel will be required during years four and five for Part I and Part II works. The AD/SC is not presently staffed to handle this additional workload. GOM and USAID will assess staffing availability against projected requirements and GOM will arrange to sanction and recruit adequate AD/SC staff.

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 field technicians lack essential engineering technical background. The AD/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 started a training program at Sholapur for training relating to field and drainage channels (Part I) and individual land development (Part II) techniques in 1981 and opened another center at Aurangabad in 1982. Training will be provided to Sub-divisional 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.

3. <u>Groundwater Survey and Development Agency</u>

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 groundwater development in the State's 1,481 watersheds. Surveys on about one-third of these have been completed and completion of the remainder is scheduled within five years. Well develoment is financed individually, usually through institutional credit, principally with the Land Development Bank (LDB). Control of over-exploitation is only through credit control with the GSDA certifying availability of groundwater in connection with loan applications. Groundwater exploitation as conjunctive use with surface water will be explored under this Project — starting with pilot schemes and evolving a program to apply to all schemes financed.

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

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4. Forestry, Panchayat and Revenue Departments

Forestry, Panchayat, or Revenue Departments may become involved in the catchment treatment pilots if the catchments chosen involve lands under control of these Departments. In this case the GOM will arrange for appropriate participation by these Departments.

5. Credit Institution

The role of credit institutions in minor irrigation varies with the different categories of minor irrigation. In the case of the state sector, the role of credit is limited but critical. Present policy provides for Government financing, as a project cost, for the entire system down to the farm gate. The critical role of financial institutions is in loans for on-farm development works, including the field channels and appurtenant structures, land leveling or shaping, and dugwells and power sources (See Chapter IV.G.8.).

6. The Agriculture Universities

(See Chapter IV.G.7.)

7. Construction Contractors

(See Chapter II.C.2. and 3. and VII.B.5a)

B. Procedures for Implementating the Project

1. MIS Identification and Approval for Survey under Current Practice

As distinct from State level major and medium schemes, the minor irrigation schemes are called District level schemes and are included in the development plan for the District which becomes a part of the State Annual Plan. The State Plan is finalized after taking into account the district-wise requirements based on economic parameters like population and economic backwardness. The total outlay for all development schemes in the District is finalized by the Government in consultation with the District Planning Development Committee (DPDC) headed by the Minister-designate for the District. The District Planning Council under the Chairmanship of Minister designate, in consultation with the Regional and District level officers of the District concerned, decide the broad outlines of intrasectoral allocations and send their proposed plans to the Planning Department of the State Government for approval. After consultation with GOI, approval of the final Annual Plan is given by the State Government with necessary modifications which then forms the District level Annual Plan. In order to facilitate and hasten the planning process, a Master Plan for minor irrigation schemes for each District in the State has been prepared based on preliminary studies using topographic maps. The project authorities (ID, AD, et al) identify a list of MIS's, generally from among those included in the Master Plan, and send them to the District Planning and Development Committee for allocating priorities for scheme design. The final prioritized list is sent to the Irrigation Department by the DPDC.

Detailed design and preparation of project reports are conducted by the respective survey sub-division on instructions from the Superintending Engineer and Executive Engineers. The plans and estimates are routed by the sub-divisions through the Executive Engineer and Superintending Engineer to the Regional Chief Engineer who is the final authority for according technical sanction to MIS's. For purpose of administrative approval, the Regional Chief Engineer sends a proforma of salient features of the feasible minor irrigation schemes to the State Government.

2. Funding Arrangements under Current Practice

The Executive Engineer of the District forwards a list of administratively approved schemes to the District Planning and Development Committee for allocating funds for implementation of the schemes. The funds for these schemes, within the allocated priorities by the District Planning and Development Committee, are finalized under four programs; (1) State Plan, (2) Integrated Development of Western Ghat region, (3) Drought Prone Area Program, and (4) Tribal Sub-Plan. The Drought Prone area program and the tribal sub-plans are funded fully by the Government of India. The funds for operation and maintenance come from non-plan grants provided by the State every year.

The inter-regional allocation of funds under the four different programs are closely watched by the State. With a view to monitor orderly development of all the areas by laying special emphasis on the development of areas which are backward due to socio-economic and agroclimatic reasons, such areas are given a higher weightage in allocation of funds. The economic yardsticks for judging the economic viability of the schemes to be taken up for implementation in these areas are also modified to bring larger and larger areas under irrigation. The allocation of funds under each of the four programs by the State during the last five years is given below.

Funds Allocation to State Sector Minor Irrigation

Million Rs.

Year	Allocation under State Plan (normal)	Allocation Under DPAP	Allocation under Tribal Program	Allocation under Western Ghats Program	Total allocation
1977-78	111.5	23.2	28.3	9.5	172.5
1978-79	127	33.5	28.3	9.5	198.3
1979-80	103.7	30..8	25.0	--	159.5
1980-81	107.2	16.4	25.7	3	152.3
1981-82	120.0	18.5	30.0	6.5	175.0
	569.4	122.4	137.3	28.5	857.6
% to Total	66.4	14.3	16	3.3	100

Completion of minor irrigation schemes has tended to be slow because of the large number of schemes under construction and tendency of the District Councils to spread available budget resources too thinly over this large number of schemes. Budgets for MI schemes financed under this Project will be allocated directly at State level rather than through the District Councils in order to assure timely, or even accelerated completion of the schemes.

3. Design Procedures under the Project

Schemes will be jointly designed by the GOM Departments of Irrigation, Agriculture and other involved institutions according to the norms and criteria laid down by the State and additional criteria included in the Project Paper. The SAEC will be responsible for all special studies, the pilot analysis and demonstration program, MI Systems model development, and data collection and coordination efforts. It will assist the Minor Irrigation Cell to be established under this Project in each region, in the planning and design of pilot schemes and also assist the regular Circles and Divisions in planning and design of the non-pilot schemes. The SAEC will coordinate the extensive inputs from pilot planning activities into the design process.

4. Appraisal and Approval Procedure under the Project

The SASC will be responsible for preparing an appraisal report on each AID-funded MIS. The appraisal report will be prepared on the basis of guidelines and criteria as detailed in the Project Paper. The appraisal, generally, will involve the following concerns.

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

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

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

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

e. staffing of Irrigation Departments at the construction and supervision level to assure that sufficient staff is available to supervise construction adequately (this is likewise an AID requirement);

f. Staffing of AD in both Technical Extension and SC land development Subdivisions to assure that Part I and II works are installed by the time water is available and to assure technical support for water management;

g. General plan of the ID and AD in workig with the farmers in the layout of the system and plans for establishing formal or informal farmer groups for the O&M.

h. economic rate of return for the project: AID and the Project Preparation Cell, Pune, have been working together on improved procedures for calculating rate of return and this improved procedure will be used for all MIS's under this Project;

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

The Minor Irrigation Committee (MIC) will then review each appraisal report and certify the scheme is eligible for AID financing. USAID would participate in MIC deliberations on a selective basis.

After approval of the scheme by the Committee, the eligible expenditures accrued after the date of signing of the agreement will become eligible for reimbursement under the loan.

5. Implementation

The SASC will have full time responsibility for assisting Regional CE's in MIS development. The SASC will oversee implementation of this project, and maintain liaison with GOM Departments of Irrigation, Agriculture, and other involved agencies, for coordinating project preparation, construction and other activities.

a. Construction of Dam and Canal System

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

Two different procurement procedures are used for constuction -- competitive bidding and force account by the ID. For implementation of dam and appurtenant works, model draft tenders have been prepared by the State Government for guidance of the officers. These items are generally let out to classified registered contractors, after inviting tenders publicly. The irrigation distribution system is generally executed through small piece-work or under the Employment Guarantee Scheme (EGS) to provide assured employment to local labourers. Works are also given on contract to registered labour cooperative societies for implementation at estimated rates.[3]

The canal system will be constructed through local contractors, piece-work by inviting quotations publicly for fixing unit rates for each item of the work, under the Employment Guarantee Scheme, or in a few cases with the registered cooperative societies. However, the dam and appurtenant works will be constructed by local contractors using competitive bidding to assure that the works are implemented efficiently and economically.

In order to assure orderly completion of scheme construction and timely delivery of water to farmers, the ID will fill the dam gorge only after 75 percent of the distribution network has been constructed. This will assure water availability to farmers as soon as construction is completed and will improve water utilization.

Contractor's certification of qualification is etablished 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 scheme is close to the unit rates established by ID, the contract is awarded, provided other legal requirements are met. Where bids are too high or no responsive bidder can be found through the competitive bidding procedure, ID may do the work departmentally using their own machinery and a set labor rate.

MIS's funded under the Project will be relatively small and frequently located in isolated areas so that there may be difficulty in obtaining qualified contractors. In such cases, the ID will do the work under force account.

b. Distributaries and Land Development Works

GOM Department of Agriculture (Soil Conservation Section) is responsible for field and drainage channels and other distributaries

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3/ There are 2,847 such registered labour co-operative societies in the State classified under "A," "B," "C," and "D" category depending upon their assessed capacity vis-a-vis others. The society registered under "A" is assessed to execute works costing not more than Rs. 100,000, while the lowest category of the co-operative society classified as "D" can be entrusted with the works costing less than Rs. 25,000.

from the 40 ha chak to the farmer field, as well as for land development. The AD/SC will start implementing land development works in each outlet command as soon as field channels have been constructed up to the farm gate. Field channel and drainage works are usually constructed under the EGS.

Other activities like agricultural extension (T&V System) will commence two years prior to the expected delivery of water. The VEW required to be provided for each scheme will be trained and in place to help initiate extension activities.

c. Quality Control

The ID has a quality control system that works satisfactorily for controlling quality on major engineering works, particularly for earthwork and concrete masonry which constitute most of the major works. Maintaining quality on minor items, some canal structures, particularly lining and small structures has been a problem in Maharashtra. 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 medium projects in Maharashtra indicates that short-term training for supervisors and contractors will be helpful.

The SASC will make a review of quality control and construction supervision on one or more on-going MIS's in each Region as soon as possible following Project approval to determine what ID or AD action, including training, if any, needs to be taken to insure quality control at all level of construction. The SASC will place a quality control unit in each of the five regions.

6. Monitoring and Evaluation

After the approval of each subproject by the MIC, the SASC will begin the process of in-depth on-site periodic progress reviews and annual implementation reviews. During these reviews physical progress, adequacy of staff and budgets for timely completion of the project will be reviewed. The Regional CE will be regularly advised on the inadequacies noted during the conduct of reviews so appropriate action can be taken. GOM Departments of Irrigation and Agriculture, and USAID will be kept advised on the project status through the review reports of the SASC. Regular quarterly and annual reviews will occur throughout the construction period of the MIS, and will be followed up thereafter until the project becomes fully operational. Review of a sample of completed projects by SASC will continue for an additional few years (about five) to evaluate operational effectiveness of the project and utitlization of irrigation potential created.

For monitoring and evaluation at the regional level the SASC will place a unit in each Regional Minor Irrigation Cell. In addition to this systems monitoring and evaluation, the Monitoring, Evaluation, and Survey Unit of the SAEC will conduct benchmark surveys, monitor and report to GOM and USAID on the evaluation work at the regional level, and conduct follow-up impact surveys and analyses of Project programs. The MESU will be partially staffed by the Agricultural Universities. (See Chapter I‾.B.3.b.)

7. Operation and Maintenance of the Canal System

After construction is completed the scheme will be placed under the jurisdiction of the appropriate operation and maintenance division in the region.

a. Operation

Irrigation water is supplied to the farmers in the rabi season after collecting their applications for a supply of irrigation water to meet their requirements for the full crop period. These demands are met by the ID to the extent of the availability of water. During the kharif season protective irrigation is given on application without resorting to formal practice of collecting demands from the farmers.

On each minor irrigation scheme financed under the Project, at least one canal inspector will be in charge of operation and maintenance of the irrigation system.

b. Maintenance

The maintenance of the minor irrigation distributation system down to the 40 ha outlet will be the responsibility of the ID. Field channels and other Part I works constructed by the Government, however, will be maintained by the farmers. In case of failure on their part, the Government reserves the right to deny irrigation water. Even though the AD will be responsible for constructing Part I works, maintenance by farmers will be monitored by the ID.

To enable the maintenance staff to maintain the irrigation works in a satisfactory manner, Government has increased the maintenance grant from Rs. 40 per hectare to Rs. 80 per hectare since 1981. This cost includes the expenditure on work-charged establishment but not the temporary and permanent establishment of the Government. Normally, the grant is found to be adequate to maintain the irrigation system in a satisfactory condition. But, in the coastal region due to frequent breaches of the irrigation system during rains and heavy cost of desiltation and de-weeding, a high maintenance cost, nearly four times the above figure is required. The State Government provides such grants as a departure from normal practice.