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PROPOSED WATER MANAGEMENT PROGRAM FOR MAJOR IRRIGATION SCHEMES IN SRI LANKA

PREPARED FOR

U.S. AGENCY FOR INTERNATIONAL DEVELOPMENT

FEBRUARY 1979

CH2M HILL

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CH2M HILL, Inc.

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The work of the team was made easier by the courteous and willing assistance which was given by a wide range of people at all levels of the Sri Lanka public service. Special thanks are due to the Director of Irrigation, Mr. Maheswaran; to our counterparts in the Water Management Branch, Messrs. Mapa and Rajalingam; to field staff working in the Uda Walawe, Gal Oya, Parakrama Samudra, Kaudulla, Morawewa, Mahakandarawa, Kalawewa, and Rajangane schemes; to Chuck Antholt of AID/Colombo; to Mrs. M. Chanmugam and Jenniffer Walpola whose able typing of sometimes illegible drafts made life so much easier; and to the IRRI Office in Colombo for kindly agreeing to reproduce the draft report.

USAID WATER MANAGEMENT TEAM

The team was assembled by CH2M HILL, consulting engineers, and consisted of the following members:

Mr. Edwin Lance, Civil/Agricultural Engineer, Team Leader, CH2M HILL

Dr. Roger Willsie, Agricultural Economist, CH2M HILL

Mr. Michael Moore, Sociologist-Anthropologist, Sussex University

Mr. Mel Hagood, Irrigation Specialist, Private Consultant

Dr. Doral Kemper, Soil Scientist, Colorado State University

PREFACE

This is a report on a subject of immense importance to the economic growth and welfare of Sri Lanka: management of water resources of major irrigation schemes in the dry zone. Water management is composed of a broad range of measures of physical operation, maintenance, rehabilitation, organization, training, and farm extension to make better use of existing water resources in irrigation schemes.

Available evidence suggests that a fraction of the potential irrigated acreage in dry zone schemes receives adequate and timely water issues. The result is much less food production, less farm income, and less farm employment than is possible from the land and water resources available. Poor water management practices exist at the level of the main systems and the individual farms. The systems deliver water in too large or too small quantities, and at the wrong times. Farmers do not plan well to receive water, or they take water when it should go to others. Facilities designed for irrigation are used inefficiently to provide domestic water.

Reasons for the present inadequacies in water management are many. In large part, inadequate system management can be attributed to inadequate water control and measurement facilities, lack of funding, lack of appropriate organizations and staffing, and lack of procedures for operation and maintenance. Farmers lack knowledge of system operations, proper cultural practices, and crop water requirements. There is a lack of rapport between system management and farmers.

This report suggests a program to begin the task of good water management on major irrigation schemes. Two schemes--under the program proposed here--would be reorganized, operated, and maintained according to effective water management principles. A comprehensive training and extension program in water management would be undertaken. The water management division at the Irrigation Department headquarters in Colombo would be strengthened to direct and support the program, and to coordinate the transfer of its successes to other irrigation schemes in Sri Lanka. The suggested programs are feasible and would aid the Government of Sri Lanka in its goal of becoming more self-sufficient in food production.

SUMMARY

The study reported here was made by the CH2M HILL consulting firm under contract to the United States Agency for International Development. The purpose of the study was to define the details of a program of assistance to the Government of Sri Lanka to improve water management on major irrigation schemes in the dry zone. During October and November 1978, a five-person team spent 7 weeks in Sri Lanka reviewing the literature, interviewing Government officials, visiting irrigation projects, analyzing problems, and drawing up details of a proposed water management program. During review and data gathering, the team found there was a broad consensus in diagnosing the problems. Because of the present low levels of water control on major irrigation schemes, the team concluded that the potential economic and social benefits to be reaped from improved water management are immense. If excessive use of water in some parts of irrigation systems, especially the head ends, can be reduced, then much larger acreages can be cultivated with a consequent increase in food production.

Many factors have led to the present situation, including the following:

- Scarce resources are directed to the completion of new construction projects rather than to operation and maintenance of existing schemes.
- Insufficient attention is given at the design stage to operational requirements.
- Budgets are inadequate for operation and maintenance.
- The professional staff of Government agencies managing irrigation schemes receive insufficient training in water management.
- Disproportionate attention is given to design and construction work because of the structure of professional rewards.
- Rewards for good performance in operation and maintenance of irrigation systems are inadequate.

- Cultivators help themselves to as much water as they think they need or are entitled to.

- Staff responsible for water management is not provided with authority and support needed to ration water. Relationships between farmers and Government agencies responsible for water issues are generally not good.

- Farmers' organizations are not playing constructive roles.

- Water is often used without restriction until supplies are exhausted.

- For many of the above reasons, there has been substantial deterioriation of physical structures on irrigation schemes, including disappearance of control gates, erosion of control and check structures, siltation, erosion of banks and bunds, and illegal takeout points. Laws regarding damage to Government facilities or misuse of water have not been enforced.

The following are the major needs for the improvement of water management on irrigation schemes:

- Substantial physical rehabilitation of systems

- Installation of control and measurement devices

- Increases in operation and maintenance budgets and reorganization of agencies responsible for management of the irrigation schemes

- Increased political and administrative support for water management

- Use of systems approach to operating projects--Improved training to provide greater expertise on the part of the present professional staff and increases in the numbers of persons trained in water management

- Increased funds and emphasis on training of extension personnel and farmer extension programs

- Research and experimentation on farm layouts, field channel designs, and cropping patterns aimed at water saving

A program of water management is proposed under which the Government of Sri Lanka, with AID assistance, would improve water management on major irrigation schemes. The proposed program would upgrade the Walawe and Gal Oya irrigation schemes, provide an improved training program, assist in improving the extension program, expand central support from the Irrigation Department, and fund a social research program. All six program elements would be coordinated and directed so as to provide direct and indirect benefits to the major irrigation schemes in the entire irrigation sector.

1. Program for Walawe

- Provide financial resources for staffing, equipping, and training the water management unit which would have authority for operation and maintenance of the developed system.

- Plan and implement a detailed water management program on one tract which presently uses excessive quantities of water. Elements of the program would include onfarm water management training, advice, equipment, and financial assistance for earthworks, maintenance and modification of structures, and provisions and facilities for water measurement and control. Daily delivery water schedules would be prepared, issues of water would be measured and recorded, and a field research program would be conducted to test feasibility of compacted earth linings or concrete linings of channels or buried concrete pipe systems. This would be done during the first 2 years of the 8-year program.

- Prepare and implement plans to extend the program on one tract to all tracts served by the right bank canal. This would be done during the last 6 years of the 8-year program.

- Conduct a drain and river flow measurement program. Prepare a master plan for reuse of water and an estimate of program costs for both the left and right bank systems.

- Prepare a plan to optimize the operation of the left and right bank main canal systems. Study the cost and benefits of adding regulators in the upper section of the main canal to bypass Shanderikawewa reservoir or regrading portions of the canal.

- Prepare a domestic water plan to meet requirements for domestic and animal use without wasting water or damaging structures.

- Provide technical assistance and equipment for experimental farm layouts in new lands on the left bank with the objective of saving water.

2. Program for Gal Oya

The following program was evolved in part based on discussions with the chief irrigation engineer and irrigation engineers:

- Remove silt and restore eroded banks on the main branch and distributary canals and the large field channels. Repair and replace gates and install measuring devices.

- Reshape and regrade field channels to provide flows required by delivery schedules. Also, install adequate farm takeouts and add regulators to long field channels to facilitate internal rotation of water.

- Establish organized staff; equip and train a water management section with operation and maintenance responsibility for the system.

- Prepare maps of irrigated service areas for canal systems. Prepare and implement delivery schedules for those field channels for which water delivery can be guaranteed.

- Prepare master plan for recapture and reuse of return flows on the left bank system and estimate costs and benefits of the program. Prepare a plan for the optimum operation of the main tank and canal system and evaluate benefits and costs.

- Prepare a plan to meet domestic and animal water requirements without wasting water or damaging facilities.

3. Proposed Training Program

The training program includes the following elements:

- Establishment of a permanent water management training school, preferably in the Farm Irrigation Department Training School at Galgamuwa--The school would run four courses:

  A 4-week course for staff irrigation engineers and senior technical assistants

  A 12-week course for staff technical assistants

  A 12-week apprenticeship course for newly trained and recruited technical assistants

  A 1-week course for students of the National Diploma and Technology (NDT) course to familiarize students with the use of laboratory and field equipment

- The provision of equipment and teaching staff to strengthen the NDT course in civil engineering at Katubedde and the Hardy Institute, Amparai--Apart from improving the teaching of irrigation engineering, the main purpose of the course program would be to improve the quality of the course as a whole, reduce current high failure rates, and increase the supply of qualified technical assistant trainees.

- Fund a special 3-month training course at the International Rice Research Institute, Philippines and in the United States, designed for instructors at the Galgamuwa Water Management School, staff of the Gal Oya and Walawe, and staff of the water management division of the Irrigation Department, Colombo.

4. Proposed Extension Program

There is an effective program of extension in the country; however, a need exists for additional work on water management at the farm level. The program suggests training two experienced agricultural instructors in soil-water-plant interrelationships plus work on use of visual equipment and other educational techniques. After completion of training, the extension instructors will be stationed at Walawe and Gal Oya. The program also includes production of a film on water management made in the first year of the program. The film would subsequently be used by the extension workers throughout Sri Lanka to train farmers in onfarm water management.

5. Improved Central Support by the Irrigation Department, Colombo

The program would support increased training and enlarge staff to administer the water management unit in the Irrigation Department at Colombo. The water management section would support, administer, and monitor effectiveness of the Gal Oya project. It would support the River Valleys Development Board with technical assistance for the Walawe project. The hydrology branch hydraulics laboratory and soil mechanics laboratory would be expanded and equipped as necessary to investigate canal losses, develop rating curves for measuring devices, and provide soils engineering assistance for compacted earth lining and pipeline installations.

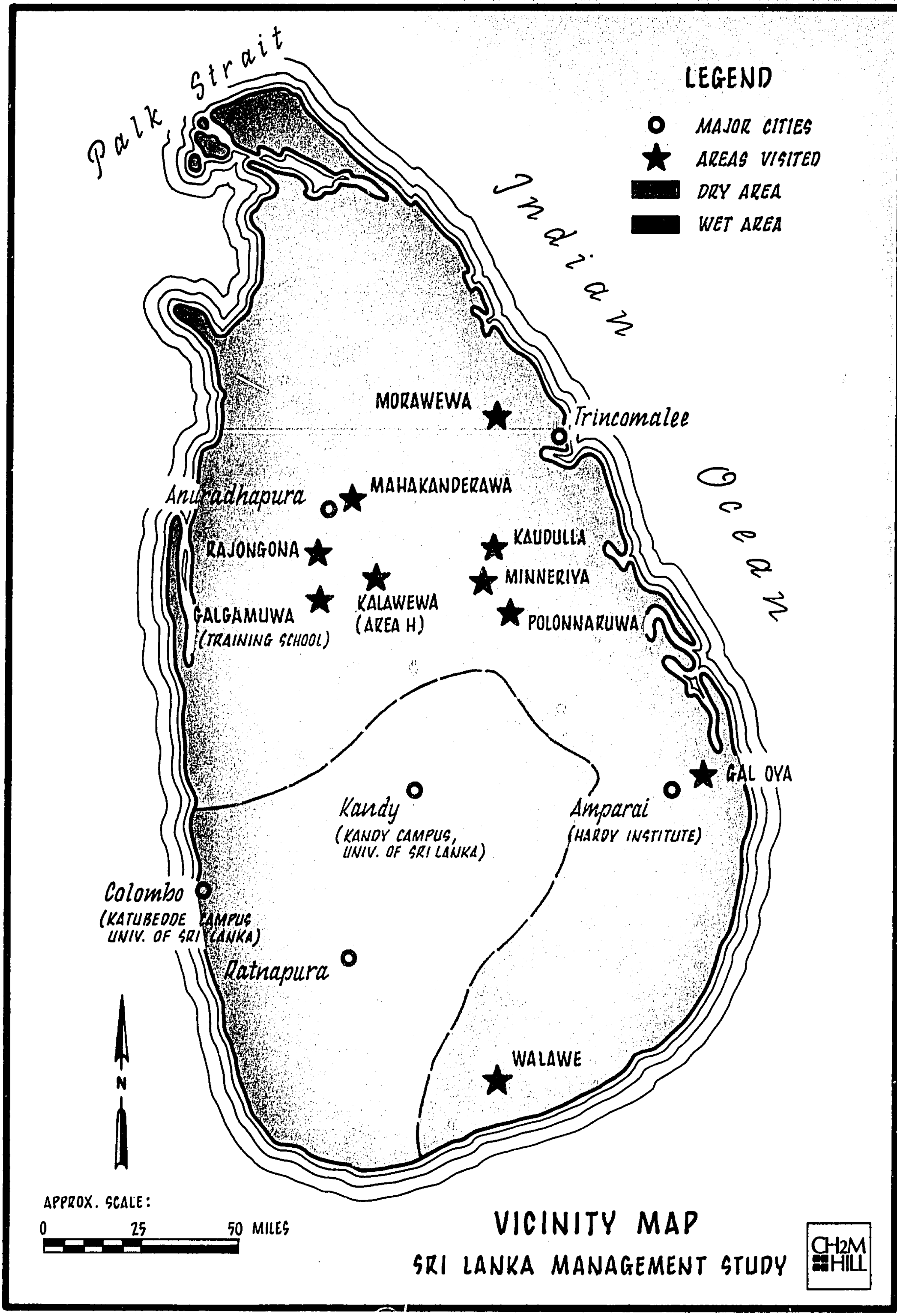
6. Proposed Social Research Program

A social research program is proposed to be launched in Walawe and Gal Oya to evaluate the consequences of the water management program for farmers and the effectiveness with which it is implemented.

The cost of the proposed program is $79.6 million including inflation and is scheduled over an 8-year period. Costs include contingencies, engineering, and escalation.

In order to make the USAID-financed water management program effective, certain changes will be desirable in the organization and procedures of agencies of the Government of Sri Lanka. A recommended organization plan for the program is shown in Figures 8-1 and 8-2, Chapter 8. The report suggests establishment of a time schedule for implementation of such changes with the Government of Sri Lanka. A few changes are considered necessary to enhance the chance of success of the water management program. It is suggested these changes be conditions precedent to agreement on the AID program. In addition, a time schedule of implementation activities is suggested. A recommended schedule is shown in Figure 8-3, Chapter 8.

The proposed program was evaluated according to technical, social, economic, administrative, and environmental standards. No significant limitations were discerned. The proposed program has an economic rate of return of 11.2 to 20.6 percent. A very favorable social impact is likely. The program is administratively feasible if adequate support is given; it has no adverse environmental impacts, with some small positive environmental consequences.



VICINITY MAP

SRI LANKA MANAGEMENT STUDY

Chapter 1
INTRODUCTION

Increased food production is a major economic development goal of the Sri Lanka Government. As an indication of its desirability, approximately one-third of the rice consumed in the country is currently imported. Significant quantities of other food products which could be grown in Sri Lanka are also imported. If more of the food imported were produced efficiently in Sri Lanka, the added cost for purchase of this food outside the country would be available for needed domestic investment or welfare purposes. In addition, the saved funds from production of food domestically could be used to purchase needed items outside the country which are not produced in Sri Lanka. Food requirements can be met in a number of ways. The water resources of the Mahaweli Ganga, when developed, will contribute to food requirements. In addition, several recent studies have indicated that a significant potential opportunity exists for increased production of food through improved management of irrigation water in the existing schemes. This study deals with those opportunities on existing major irrigation schemes in the dry zone.

There are essentially two means of increasing food production:

- Increase annual yield per acre
- Cultivate more acreage

Higher yields per acre may be achieved by a more favorable water distribution on cultivated acreage within the Maha and Yala seasons and by improving the distribution of water use between the Maha and Yala seasons. Improved water management can contribute to higher crop production through both of these means. Improved water management can also allow more acres to be cultivated annually by carrying more stored water into the Yala season and using water more efficiently in both Maha and Yala.

PURPOSE OF STUDY

The purpose of the present study is to suggest changes in organizations and institutions as well as physical improvements on major irrigation schemes in the dry zone of Sri Lanka which will, if implemented, result in improved efficiency of use of irrigation water. Such improvements will result in increased production of food and a smaller gap in domestic sufficiency to provide food to the Sri Lankan population.

OBJECTIVES OF STUDY

As stated in the contract between CH2M HILL and USAID (AID/otr-C-1618, 20 September 1978), the objective of the present study was "to further identify and define the parameters of the USAID/Colombo fiscal year 1979 water management project." The operational objectives adopted by the study team to meet the overall objective of the study were as follows:

- Review and plan study--previous studies were reviewed, study plans were prepared, and an air reconnaissance was conducted in the study area.
- Define present conditions and problems--conditions were observed in the project areas. Government officials and farmers were interviewed.
- Analysis to determine possible solutions to observed problems
- Develop a specific water management program to assist in the solution of present problems
- Prepare a report of findings and recommendations for improvements

It is intended that the report prepared will constitute a draft of major portions of a project paper that will be used by USAID in its decision relative to funding the project.

SCOPE OF WORK

The scope of work is addressed in the contract between CH2M HILL and USAID. There it is stated that the project team will prepare:

- A detailed design of activities
- A list of anticipated physical and institutional outputs
- A list of inputs, with scheduling and suggested sources
- An analysis of the social, economic, financial, and environmental feasibility

In addition, the contract specifies that the project will address the problem of how to reduce the high quantities of water used in irrigation in Sri Lanka. The contract further discusses special considerations in conducting the analytical work, including institutional analysis, detailed definition of the components of the plan, and the role of complementary institutions in the water management program.

Certain limitations in the study are recognized. Sources of increased food production in Sri Lanka outside major irrigation schemes in the dry zone were not considered. Nor was increasing water supply through enlargement or improvement of impoundments considered. The extent of the study was limited by time available--8 weeks from initiation of the study to completion of the draft report.

ORGANIZATION FOR STUDY

The study was made under a contractual arrangement between CH2M HILL, a U.S.-based international consulting firm, and the U.S. Agency for International Development (USAID). The study is one phase in a process by USAID to develop a feasible project for assistance to Sri Lanka.

The team was composed of the following:

- Agricultural Economist
- Rural Sociologist
- Irrigation Specialist
- Agricultural Engineer
- Soil Scientist

The agricultural engineer served as study team leader. The team worked closely with irrigation engineers and the Director of the Irrigation Department of the Ministry of Irrigation and Lands of the Government of Sri Lanka. The office of the study team was at the Irrigation Department.

IRRIGATION SCHEMES VISITED BY TEAM

During the second and third weeks of the study the USAID team visited 10 major irrigation schemes in the dry zone of Sri Lanka. The places visited were suggested by the Irrigation Department, who arranged transportation and tours at each site. Members of the Irrigation Department accompanied the team. The schemes visited are indicated on Vicinity Map at the front of this report.

Chapter 2
PREVIOUS ANALYSES OF THE PROBLEM

This chapter reviews recent selected statements prepared on the subject of irrigation water management problems and ways in which these may be overcome. The statements illustrate that there is a considerable degree of consensus in defining the problems. The present study is built upon a great deal of previous work.

THE 1978 POLICY DIRECTIVE, MINISTRY OF IRRIGATION, POWER AND HIGHWAYS

In February 1978, the Minister of Irrigation, Power and Highways issued a policy directive entitled "Water Management in Irrigation Schemes." The directive cites experimental data from the Department of Agriculture indicating that successful cultivation is possible in the dry zone with a water duty of 3 acre-feet for Maha and 5 acre-feet for Yala. On the basis of a survey of 15 tank schemes in the dry zone, actual water duty is estimated to be 5 acre-feet for Maha and 7 acre-feet for the Yala season. The excessive use of water leads to problems including less than full extent of irrigation during Maha, water shortages at the end of Maha, and reduced availability of water during Yala, resulting in only parts of available acreage being irrigated. The potential effect of poor water management on the Mahaweli Scheme is discussed in the directive with the conclusion that, unless substantial economy in water use is achieved in the future, the scheme could run into difficulties. Some of the causes of excessive water use in existing schemes are described:

- The sowing season extends over a period of 2 or 3 months, with large water releases to puddle the soil. The sowing season need not extend beyond 1 month.
- Water is wasted by the farmer using flowing and standing water as substitutes for weedicides, transplanting, or manual weeding.
- Water is illicitly tapped.
- High percolation losses are incurred along canals.

- There are high losses of water due to badly maintained bunds on the farms.

- Cultivation of paddy is carried out on highly permeable soils.

- There is poor maintenance of the irrigation distribution system, faulty control, etc. Bad maintenance is said to be due mainly to shortage of funds and partly to inefficiencies in organization and implementation.

The following remedial measures are suggested:

- Ensure proper farmer participation and involvement in water management. Selection of group leaders for each field channel and representation of farmer group leaders on the tank management committee is proposed. The management committee would meet frequently and make all decisions in regard to water management, cropping patterns, etc.

- Survey encroachments in each scheme and provide regular water issues to such encroachments if water is available. Disallow water tapping by unregistered encroachers.

- Deal severely with any illicit tapping of water by encroachers.

- Set a cutoff date for the last water issue during sowing period.

- Allow extension of cutoff date only at heavy penalties.

- Adopt rotational issue of water as a matter of routine, down to the smallest field channels. To provide for maintenance of various control structures and pipe outlets, adequate funds should be made available to the Irrigation Department.

- Inform cultivators of permitted quantities of water, with quantities in excess subject to a penal rate.

- Carry out rapid soil surveys and change cropping patterns on soils where the percolation is high.

- Adjust prices for crops other than paddy to realistic levels.

IRRIGATION DEPARTMENT MEMORANDUM ON PROPOSED REVISION OF THE IRRIGATION ORDINANCE

To further the process of arriving at desirable organizational change through directive and legislation, the Irrigation Department forwarded a statement to the Ministry of Irrigation, Power and Highways on 28 September 1978 (Cultivation and Water Distribution in Irrigation Schemes). The statement was addressed to procedures to be adopted on irrigation schemes under the direction of the Irrigation Department and was offered "for further discussion." Five topics were addressed:

- Maintenance of Irrigation Systems
- Cultivation Meetings and Water Issue
- Distribution of Water
- Offenses by Cultivators
- Encroachments

The statement emphasizes the organizational arrangements necessary to rationalize operation of irrigation schemes. It suggests a "group representative" chosen by farmers on a field channel. They will function under the Cultivation Officer, Department of Agrarian Services. Irrigation and Agricultural Officers are to act as technical advisors to the Agrarian Services Committee. A Technical Assistant (TA) is assigned 5,000 acres and is responsible for water issue, operation, and maintenance. Under the TA are the Irrigation Overseer (2,500 acres) and the Irrigation Distributor (500 acres). The Distributor operates outlets and coordinates rotational water use with the Group Representative. The Distributor also looks after gauge posts, outlets, and bunds and closes sluices when rainfall is sufficient.

The statement also defines the roles of the Irrigation Department and farmer cultivators in maintenance of the system. All parts of the system are to be maintained by the Department, except for clearing and earthwork maintenance of field channels which are to be done by farmers. Farmers are to adhere to dates for beginning tillage and completing sowing; no extensions of water issue will be permitted. Failure to maintain a field channel would result in the Department doing the job with the costs collected from the farmers responsible. Damages to the system are to be repaired with cost assessed against those benefiting by the damage. Encroachments may be allowed or disallowed by the Engineer.

USAID-SPONSORED REPORTS

In April 1978 two separate reports were written on the subject of improving water management in Sri Lanka. These are: "Supplementary Report on Water Management" by Tom Wickham and "Apparent Investment Potentials for Increasing Food Production through Improved Water Management in Sri Lanka" by W. Dorel Kemper. The reports by Kemper and Wickham followed and enlarged on water management problems uncovered in a study entitled "Agricultural Sector Assessment for Sri Lanka" prepared by the Asia Bureau of USAID/Washington. In the "Agricultural Sector Assessment" it was indicated that only about one-quarter of the total land, or 16.2 million acres, in Sri Lanka is currently being used for agriculture, although the land and water resource base suggests 50 percent or more could be used for crops and forage. Research suggested to the authors of this report that production could be greatly increased by better management of presently available water. A large potential for expansion of the irrigation water supply was indicated. An opportunity existed for improved water delivery and management to reduce the waste and increase cropping intensity and per-acre yields from existing water. Water use was estimated to be 13 to 39 feet per acre compared with 6 to 7 feet needed for double cropping. The team recommended an improved water management program of 10 to 20 years duration to be supported by AID.

The report by Kemper is comprehensive and detailed. Only a brief summary will be provided here. Kemper indicates the gross underuse of available resources in the dry zone by indicating that most of the lands are not cultivated, although the total quantity of rainfall is adequate for most crops. Major constraints are seasonal rainfall distribution and limited water-holding capacity of soils. To increase crop cultivation a successful water management program will have to provide water when it is not available from rainfall. One means of providing for additional production in the dry areas is improved utilization of existing irrigation supplies. Kemper illustrates the high inefficiency of water use by examples of use of 12 to 39 acre-feet of water per year when in fact, 2.5 feet of water is adequate in 3 years out of 4 for double cropping of paddy and legumes in the Anuradhapura District. Considering loss through runoff or percolation of rainfall, Kemper concludes that 8 acre-feet of irrigation water per year is adequate. It is estimated that, on the average, 10 acre-feet per acre of irrigation water is released from impoundments, and about 80 percent is escaping from the project areas by surface or subsurface drainage. Much of the water loss is via leakage from canals and field channels, percolation past root zones, and drainage from the area. Kemper suggests means of saving water in water courses, including lining of canals and field channels, cleaning and maintenance of field channels, and compaction of soil in beds and banks of field channels. He also suggests that application efficiency could be greatly improved on upland crops and paddy. The following program of improvement is suggested:

- Education of farmers on water management principles and procedures
- Training of the water distributor in the techniques of and benefits to be derived from cleaning of field channels, in proper application of water, and in inducing positive cooperation from farmers
- Training of water management specialists
- Research on improved irrigation methods
- Evaluation of the role of upland crops to meet needs for domestic consumption or foreign exchange
- Improved maintenance of canals and their structures

Kemper also suggests training programs, including training of more civil engineers and providing incentives to keep them in Sri Lanka, better training of agricultural engineers, and training in water management at the University.

Wickham assisted USAID in developing a Project Identification Document (PID) for a proposed water management improvement project and prepared a supplementary report on water management. In Wickham's opinion the two most important problems of water use in Sri Lanka are disorganized cropping schedules, and overuse of water at head ends and corresponding water shortage at the tail ends.

He believes disorganized cropping schedules may be the result of constraints of labor and tractor availability, but admits to a need for more study of these subjects.

The problem of overirrigation along head ends and water shortage at the tail of schemes is said to be due primarily to the system inadequacies, rather than onfarm deficiencies. Farmers have little incentive to clean field channels if the water they are receiving from the system is three times that required, or a fraction of the requirement. Wickham suggests that the main function of institutions in water management is to relate the interests of farmers to those of the system. Institutions are required to bring the interests of the farmer and the system managers together. They should set and maintain dates of cropping by tract, and permit each party (farmer and system management) to go about its responsibilities unimpeded by the other.

Wickham suggests that the best strategy for system authorities is first to distribute water as carefully and as accurately as possible, and then start trying to curtail the activities of farmers who destroy structures or otherwise interfere with system management. Existing institutions should be built upon before making major institutional changes.

Field testing and research are recommended only in areas where lack of knowledge impedes implementation. Research is recommended on organizations, subsurface water flows, water reuse, rotational water issues, field channel maintenance, and proper size of areas to be served by field channels.

USAID proposed to assist the Government of Sri Lanka with grants and loans in a water management Project Identification Document (Project No. 383-0057 - 2 May 1978). The project would be addressed to the major problems suggested by Wickham; i.e.:

- Disorganized cropping schedules, and
- The tendency to overirrigate along the head-ends of canals, resulting in water shortages downstream.

The objectives of the program would be to increase cropping intensities, improve water efficiency, and increase per-acre yields on the lower half of irrigation schemes. Project features would include a field action program, field research, training, and extension of project experience to other areas.

WORLD BANK STUDIES

In discussing economic issues and production of food crops in Sri Lanka, the World Bank (SRI LANKA: Country Economic Memorandum - Report No. 1425 HCE - 28 February 1977) indicates that water management needs substantial improvement. The issue discussed in this report is the imposition of annual charges on irrigation schemes as provided under the Land Betterment Levy Act of 1976. The World Bank report indicates that the Government intends to increase charges gradually to recover operating and maintenance costs and an appropriate portion of construction outlay.

Another World Bank report (Development in Sri Lanka: Issues in Prospect - Report No. 1937-CD - 22 March 1978) discusses the problem of low cropping intensities. The cropping intensity on major irrigation schemes of 135 percent reflects a shortage of irrigation water, particularly for the Yala season. The irrigation water shortage is attributed to the issue of more water than is needed and is due to lack of incentives by the irrigation staff and farmers to save water. Unnecessary dependence on stored water in irrigation tanks during Maha results in inadequate water for Yala. The intensification of crop production would contribute greatly to Sri Lanka's goal of achieving self-sufficiency in rice. Water management is said to be the most challenging obstacle to output increases in agriculture. Physical rationing is recommended as the solution. The need is said to be for political commitment at the highest level to water discipline, backed up by strong support to field staff through protection against local pressures, rewards for success, and a strengthening of staff. Water user associations may help in providing water to farmers at the tailends of new systems. In comparing major projects to irrigate new acreage with more limited programs to improve efficiency of water use, it is stated that the success of each irrigation scheme is contingent on major improvements in water management, farm power availability, and cultural practices. For example, the Mahaweli master plan assumes an average water use of 6 acre-feet per acre for double cropped areas, perhaps one-half of present water use rates. If improvements in water management are not achieved, the Mahaweli scheme could meet with the same fate as other irrigation schemes in the dry zone, where there is hardly any cultivation in Yala. On the institutional side, the report recommends an adequate field level institutional infrastructure. The change in field level institutions made by the new government has resulted in an uncertainty that needs to be ended quickly. Farmer participation must be ensured.

One additional World Bank report is reviewed (Agricultural Sector Survey - Republic of Sri Lanka: Volume 2, Annex 2 - 8 February 1973. Report No. PA-134). Problems of irrigation systems are:

- Systems were designed for a different purpose than that which they are now expected to perform; i.e., supplementary irrigation of paddy in one season rather than almost continuous issues.

- The systems are so badly deteriorated that they are not able to meet the original design function satisfactorily.

Another problem is lack of subsidiary canal systems on the farm and lack of proper land forming, resulting in construction of an extensive bunding system and a complex water distribution system without a systematic drainage system. The lack of water control is probably a deterrent to use of improved cultural practices in many areas. Use of excess water by farmers is attributed in many cases to existing physical conditions. It is suggested that considerable improvement is needed in provision and maintenance of control structures on minor channels and of drainage. Administration of water distribution and maintenance of systems is a major problem. The principal reason for this problem is the failure of Government to allocate sufficient funds for personnel to maintain irrigation systems. The final recommendation is a major reorientation away from large capital-intensive irrigation and colonization schemes and in favor of rehabilitation of existing irrigation systems, combined with major efforts in crop diversification, extension, and water management.

THE UNDP/FAO REPORT ON GAL OYA

This report is entitled "Water Management for Irrigated Agriculture (Gal Oya Irrigation Scheme), Sri Lanka, Project Findings and Recommendations," UNDP/FAO, Rome, 1975. It is the result of about 5 man-years of investigation into the operation of the Gal Oya Scheme in the period 1972-74.

The team categorized the problems of the project into four main groups:

- Lack of accurate records
- Difficulties faced by farmers in adhering to agreed crop schedules
- Inadequacies in operation and maintenance, arising especially from low maintenance budgets, physical deterioration of conveyance and control structures, and encroachments
- The difficulties faced by the farmer, especially those arising from inadequate experience or training in irrigated agriculture

Analysis of past performance suggested low water use efficiencies of the order of 30 percent over a 4-year period. A substantial potential for increasing output by better water management existed. A small series of field trials covering 10 plots in two Yala seasons suggested that the excessive use of water at levels around the average for the scheme actually caused a loss of paddy production.

A long series of recommendations were made, including the appointment of a Water Manager; preparation of supply schedules; water measurement; investigation of operational problems; improved maintenance; separate supplies of domestic water; establishment of a communication system for project staff; research, trials, and demonstrations of improved cultivation practices; and stronger discipline.

The report on Gal Oya is reproduced in Appendix Four.

Chapter 3

CURRENT RESEARCH AND EXPERIMENTAL WATER MANAGEMENT PROGRAMS

This chapter describes some of the current research and water management experimental programs tried recently or going on currently in Sri Lanka. The review demonstrates the concern for improving water management and that much of the research necessary to develop standards for water management programs is proceeding.

A wide range of reseach and studies have taken place and papers have been written in Sri Lanka dealing with technical aspects of water requirements and water management, with other studies now underway.

These studies were useful in helping prepare suggested projects as they pinpointed specific problems in water requirements vs amount delivered, yield vs water applied, percolation rates of various soils and water-holding capacities, meteorological records, and data on effective rainfall.

The Food and Agriculture Organization of the United Nations study on Gal Oya was especially helpful in assessing the needs and possibilities for improvement of water management of that scheme. This report is included in Appendix Five.

H BLOCK

A research and demonstrational project has been initiated with H Block of the Mahaweli Development Scheme. This project is sponsored by the Mahaweli Development Board, with a Sri Lankan soil scientist from the Irrigation Department serving as project manager and an expatriate (U.S.) agricultural engineering advisor. The program is funded, in part, by USAID. The project site is in Block 305 of Stage II under the Kalawewa Left Bank Canal. The research area includes an experimental unit and a demonstrational unit of about 30 acres each. Each unit is one normal field channel system, with the research unit operated entirely by research personnel and the demonstrational unit farmed by 11 farmers.

Project objectives include:

1. Development of land preparation and farm irrigation techniques--These studies include analyses of various

types of terracing to improve water management and to permit growing upland crops under the same field channel as rice.

2. Development of techniques for scheduling and controlling water within the field channel system to ensure adequate and timely delivery of water to all farms within the system --Special attention is focused on farmer group participation in water use, methods of sharing the field channel discharge, and measurement and control of water.

3. Development of design criteria and operational procedures which will permit rice to be grown with upland crops on the same farm or under the same field channel system

4. Gaining a better understanding of the extension, institutional, and administrative requirements to extend the proven technologies to farmers throughout the irrigated areas of Sri Lanka

This 5-year project is only 6 months old; however, several individual research plots are in progress. Land basins, furrowed basins, sloping and level furrows have all been tested using upland crops, and rice is presently being grown under upland conditions.

Plans call for various terracing methods to be implemented by next Yala with proper earthmoving equipment, and some of the more promising techniques will be installed on the farmer-operated systems.

As a significant side benefit, the project will develop irrigation requirements for many species of upland crops to meet the needs of Objective 3 above.

<u>MAHA ILLUPPALLAMA</u>

The practice of growing rice in rotation with upland crops is also being studied at the Maha Illuppallama Research Station. The M-I station is also heavily involved with determining input requirements (fertilizer, pesticides, disease control, etc.) for these upland crops under irrigated conditions. Studies at Maha Illuppallama during 1977 included irrigation requirements of two varieties of paddy on three soil types as well as requirements of maize, soybean, groundnuts, and chillies. Water requirements using graded furrows were compared with requirements using liyaddes, with the finding that graded furrows required less water per irrigation. Graded furrows were also compared with broad based furrows and basins of various sizes. Ideal length of furrows was found to vary with crop, with 150-foot length being suitable for cowpeas but too long for paddy, even on poorly drained soils. Basins of 50 feet by 50 feet appear to be about the maximum size, with the 45 gpm flow rate used in this trial.

KAUDULLA

A water balance study sponsored by the United Kingdom is just underway at Kaudulla. The study includes systematic gauging of water flows, meteorological measurements with extra rain gauging stations, accounting for water in-water out by use of piezometers, and computing water use by crops.

UDA WALAWE

A small area in Tract 3 left bank is being tested for water reuse possibilities. Water is delivered in drainageways, then diverted at a check structure and contoured. Farms are developed below these diversions. The program is only partially complete with no data being taken to evaluate its performance.

RAJANGANE

The most widely quoted example of effective water management in Sri Lanka was the emergency program undertaken to save the 1976 Yala paddy crop under the Rajangane Tank. Despite the low level of water in the tank at the beginning of the Yala season, cultivators ignored advice to restrict acreage, and planted the whole tract. A Water Management Field Unit was established at the project in April 1976 when it became clear that the entire crop was threatened. No rains came, but almost the entire crop was successfully brought to harvest. This can be attributed to three factors: the high quality of the handful of staff in the Water Management Unit; the enormous effort put into collecting information to draw up a precise rotation schedule; and the political support given to the program. The degree of cooperation from farmers was not high. For example, late planting continued even after it was known that water was very scarce. Also, farmers refused to abandon late planted acreage.

Apart from the example and the lesson, the program has left no continuing legacy. The Water Management Unit in the area was dispersed as a side-effect of the communal disturbances of August 1977, and the tank has surplus water, even in the Yala season, now that it is in receipt of drainage waters from the H area of the Mahaweli Scheme. It is no longer necessary to save water, and, because of an excess of water in the upper channels, many control structures have been destroyed. Water management is impossible without substantial rehabilitation in the upper portion of the project.

PUBLISHED REPORTS

Some of the studies reviewed in the course of this study included:

1. *Land and Water Management Studies*, V. Rasiah and K. P. Alfred.

2. *Water Management Studies*, V. Rasiah and D. P. Alfred.

3. *Proceedings of the Cropping Systems Workshop*, Maha Illuppallama, April 20-21, 1976.

4. *Water Management in Major Schemes*, Vol. WM5/28 Irrigation Department 29-9-78.

5. *Water Management for Irrigated Agriculture (Gal Oya Scheme)*, UNDP FAO 1975. (A copy is found in Appendix Four of this report.)

6. *Report on Field Trip to Republic of Sri Lanka*, KEE SEUNG PARK, FAO, 1976.

7. *Some Aspects of Water Management in Dry Zone Areas in Sri Lanka*, Irrigation Department, Sri Lanka and Tropical Agriculture Research Centre, Ministry of Agriculture and Forestry, Japan, August 1977.

8. Water Management and Paddy Production in the Dry Zone of Sri Lanka. Occasional publication, ARTI, Robert Chambers, 1975.

9. *Water and Land Use Problems in Mahaweli Stage II Area*, S. Somasiri, Land and Water Use Division, Department of Agriculture 20-9-1978.

10. *Water Consumption Pattern of Crops in the Dry Zone Environment*, G. R. Panabokke, Land Use Division, Department of Agriculture, Sri Lanka.

Chapter 4
CURRENT PRACTICES AND PROBLEMS

THE ECONOMIC CONTEXT

Human, land, water, and other resources are underutilized in the dry zone. Much land, otherwise suitable for cultivation, is farmed occasionally or only during the Maha season, although sufficient rainfall exists for one or more crops per year. Water falling as precipitation is allowed to run off to the sea or evaporate when it could be stored for crop or domestic use. Facilities in existing irrigation schemes are being used inefficiently due to inadequate maintenance and operation and other factors.

At the level of the national economy, several problems could be lessened by greater development and more efficient use of agricultural resources in the dry zone. These problems include:

- A poor balance of trade, due in part to large imports of food--e.g., about one-third of the national consumption of rice has been imported in recent years.

- Unemployment estimated at about 20 percent, with significant numbers of new job-seekers entering the labor market each year--New jobs in farming and agricultural business could be provided by increased irrigation development.

- Unused industrial capacity--At least the part used for agricultural service and food processing could be more fully used with increased agricultural development in the dry zone.

- Low per capita incomes and the related problem of low savings to provide investment capital--Larger, more efficient agricultural production in the dry zone could increase farmers' incomes and savings.

Viewed from the cultivator level, production per farm is presently at an amount only large enough for subsistence of the family. It was estimated recently (*The Small Farmer in Sri Lanka*, T. Yogaratnam, Conference on Agriculture in the

Economic Development of Sri Lanka, Ceylon Studies Seminar, Peradeniya, 1974) that a farm family of seven required Rs.3,000 for their needs. Assuming gross income of Rs.4,000 is needed to net Rs.3,000, 69 percent of the families in Hambantota and 59 percent of the families in Anuradhapura do not meet this standard (*The Agrarian Situation Relating to Paddy Cultivation in Five Selected Districts of Sri Lanka, Part 6, Comparative Analysis*, Agrarian Research and Training Institute, December 1975). Average family incomes were Rs.3,565 for Hambantota and Rs.4,768 for Anuradhapura, and the families were dependent to the extent of 85 percent and 65 percent, respectively, on paddy for their income. Higher incomes from improved yields and greater farming intensity could increase the welfare of these families.

Project operation and maintenance is carried out largely under an anarchic rules procedure. The rules are determined largely by the government operators of the irrigation scheme, with little participation by the farmer cultivators. Farmers pay slight attention to suggested planting, irrigation, and harvesting dates, and alter irrigation facilities to suit their independent desires. One factor affecting the farmers' actions is lack of economic incentive to act otherwise. By and large, farmers consider land and water resources in the irrigation scheme a gift from the Government since no charge is levied for use of the resources. An administrative decree has been issued to all large irrigation schemes managed by the Irrigation Department specifying a flat annual charge per acre for irrigation services starting 1 January 1979. Since farmers have a poor record of payments to the Government for land taxes and loans in the past, the collection of the irrigation service fee will likely be difficult.

LAND USE AND SETTLEMENT

The policy of resettling rural families on new irrigation schemes in the dry zone dates back to the 1930's. The dominant purpose of the early settlement schemes was to alleviate the population pressure on land in the densely populated areas of the wet zone. It has long been realized that most of these schemes have yielded low returns for the capital invested. In the last two decades more emphasis has been placed on increasing production in the schemes, increasing the economic returns, and making them contribute to national economic goals, especially self-sufficiency in rice.

Most of the command areas of the new schemes were previously Crown land. That is to say, they were either unoccupied or occupied by people with no valid legal title to the land. Land was alienated to the settlers on permanent lease under the Land Development Ordinance. Those formerly occupying the land were formally given title. The practice of alienating Crown land only on lease and not in full private ownership is almost universal in Sri Lanka. The main purpose is to make it legally possible for the Crown to easily resume rights over such pieces of land as may be required for public purposes, such as rights-of-way, Government offices, etc. In the irrigation colonies there was an additional reason to keep land in Crown hands. In the early stages of settlement there was a general belief that the fragmentation of allotments led to small-scale and inefficient farming. It was made a condition of receipt of land that each allotment could only be used by the legal owner and handed intact to a sole heir. It was possible to enforce this only if the land remained in the hands of the Crown.

In practice, the legal restrictions on the disposal of allotments have been widely flouted. Single allotments are subdivided among family members or given out on sharecropping tenure. Some persons, typically wealthy traders and tractor-owners, have, by calling in (illegal) mortgages, gained effective rights to use a number of allotments. These arrangements are usually known to and tolerated by the staff of the Land Commissioners Office and other Government agencies concerned.

A major reason for de facto subdivision of allotments on the older schemes was that they were larger than one family could easily manage, 5 acres of paddy and 3 acres of highland. In response to both this problem and to the increasing scarcity of land, the size of new allotments has decreased over the years. The current allocation is 2 acres of paddy and 1 acre of highland. It is likely, although no evidence exists on this, that the extent of subdivision is less on newer schemes.

Over the 4 decades during which the irrigation colonies have been settled, land allocations have become relatively more valued by the rural population. Reasons are (1) land has become more scarce as population has grown; (2) with the control of malaria and improvements in public transport, health, and education facilities, the dry zone has become a more hospitable habitat for human beings; and (3) with the relative increase in food prices, dry zone cultivation has become economically more attractive. In the early stages of settlement it was often difficult to find people willing to go to the dry zone as settlers or, once there, to remain. The current situation is very different. Areas scheduled for irrigation development are encroached upon by squatters who expect that this will entitle them to land allocations in the development scheme. They are usually given land.

There are two other types of land encroachment widely associated with irrigation settlements. First, the Crown land reservations along roads and channels have mostly been converted into paddy fields by adjacent farmers, normally even to the extent of cutting into and weakening bunds along channels. Secondly, other areas originally scheduled for other purposes--highland, waste, etc.--have been converted into paddy fields, and access to irrigation water has been obtained by various means. The result is often that the actual irrigated areas are substantially larger than the scheduled areas. The extent of unscheduled irrigation is very uncertain. We were often quoted figures of around 20 percent of the scheduled area, but estimates varied widely for the same schemes.

The settlers in the irrigation schemes were initially provided with almost every facility, including prepared lands, houses, and supplies of drinking water. The extent of provision has been scaled down over the years to cut the high costs of settlement and as a reaction against the high dependence on Government assistance among settlers. The latter phenomenon, however, still persists. Settlers often appear to believe that they have a natural right to irrigation water and cultivable land, with no corresponding obligation on their part to pay for these facilities or take responsibility for the maintenance of physical structures like irrigation channels.

Effective management of settlers and schemes, including water management, has become difficult for three reasons:

1. The settlers have unreasonably high expectations about the extent of Government provision of assistance and services. It is difficult to kindle self-help movements.

2. Because of the prevalence of illegal land tenure practices--leasing, mortgaging, subdivision, absentee ownership, encroachments--many farmers are wary of approaching Government officers on agricultural or land matters. This leads to lack of trust and cooperation.

3. No single Government agency has close contact with the settlers over a wide sphere of activities and can therefore act in some way as their main contact and spokesman. Such agencies existed in the early stages of settlement, when almost all the Government officials were under the effective control of one settlement officer--the Colonization Officer on most schemes, the Project Officer on Uda Walawe, etc. However, when construction and early problems are settled, there is a

strong tendency for this one officer to lose, formally or informally, his control over other Government officers in the area. The settlement becomes much like any other rural area, where a range of Government officers work without much contact or coordination with one another. The question of water issues concerns the irrigation officers, agricultural officers, and, in relation to domestic water supplies, the colonization officers. They do not always work closely.

There has been some discussion recently of the possibility of converting the Crown leases on land allotments to ownership holdings. No policy decision appears to have been taken on this.

There is a substantial margin of error in the information available on land use and land tenure in the irrigation schemes, especially the older ones.

THE PHYSICAL STRUCTURES

Basic Components and Designated Responsibilities

The systems usually consist of the following:

- A tank (reservoir), which often receives supplemental water as direct supply or drainage from other irrigation systems in addition to runoff from its own catchment area--This portion of the system is operated entirely by the Irrigation Department[1] except that farmers have a voice in the decision of when irrigation issues should be started and stopped for each crop season.

- Canals, which deliver water to the areas to be irrigated--These are operated and maintained by the Irrigation Department.[1]

- Distributaries, issuing through control gates from the main canals, are generally operated and maintained by the Irrigation Department,[1] but when maintenance budgets are reduced to levels which do not allow cleaning of all the channels, farmers are occasionally called upon to clean the distributary channels in "Shramadanas," which are cooperative voluntary work programs.

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(1) In new developing systems, the River Valleys Development Board or the Mahaweli Development Board will be the operators until the system is completely developed and turned over to the Irrigation Department.

- Field Channels carry water from the distributaries to outlets that serve individual farmer's tracts, which are generally uniform in size in a given system. Most field channels in the newer systems are designed to serve about 50 acres and vary in length from one-quarter to one-half mile long. However, in the older systems there are field channels more than a mile in length. These field channels including their control structures are generally designed and constructed by the Irrigation Department. Responsibility for cleaning these field channels is delegated to the farmers, and the Irrigation Department can withhold water from these channels before each season if they are not properly cleaned by the farmers. Responsibility for the maintenance and repair of structures on the field channels belongs to the Irrigation Department.

- Field ditches carrying water from the farmers' outlets on the field channel to his fields, and the layout and leveling of his fields have, on some projects, been totally the responsibility of the farmer. However, on some of the newer projects, fiscal provision has been made for the Mahaweli or River Valleys Development Board to design and develop an effective ditch and field layout.

- Drainage channels, in most cases, are the natural drainage channels. The additional load of water from the irrigation tail water has caused many of these channels to erode to a lower level. The Irrigation Department does provide drainage under or through supply channels which would otherwise block the natural drainage.

- Facilities for reuse of drainage water, usually through anicuts, to bring drainage water out of the drains to irrigate additional lands or supplement the water supplies to tail-end sections of existing systems is common, particularly in the older systems. Many of these anicuts began as "stick dams" built by private farmers to supply water to supplement their supply on the tail-ends of irrigation systems and to irrigate additional acreage. In many cases, the Irrigation Department has recognized the need for and utility of these structures, helping design channels and eventually building concrete structures in which planks are used to check the drain water up to the desired level.

Problems in the Sections Maintained by Government Agencies

Lack of Measurement and Control. None of the major bifurcations of the canals are being operated as calibrated measurement structures. None of the older systems have measurement structures at outlets from the canals to the distributaries nor at outlets from the distributaries to the field channels. There are control structures at the major bifurcations, and gates with closures have been installed at outlets to most distributaries and, in some cases, at outlets from distributaries into field channels. However, a major portion (30 to 50 percent) of the gates from distributaries to field channels have been broken by farmers who wanted water when it was not their turn. A substantial portion of the gates from the canals to the distributaries have been broken for the same reason. Most of the gate breakage occurs in the upper reaches of schemes where water is plentiful.

Lack of measurement leaves the issue of how much water is the fair share for a channel to the subjective judgment of the Irrigation Department employee. Farmers often disagree with such judgments and consequently feel morally justified in breaking the gates to take what they believe is rightfully theirs.

When the gates are broken, the water supply to the distributary or field channel is generally greater than delivered to other channels where the gates are intact. This "moral justification" coupled with small chance of being caught and successfully prosecuted appear to be major factors in the high incidence of damage to the gates. Lack of budget to replace these gates compounds the problem.

The resulting lack of measurement and control leads to more water than is needed in some channels and less in others. This lack of control also prevents operation of the systems on a rotational basis, which appears to have been the operational plan the designers had in mind when they built these large field channels and their associated structures.

Losses of Water From the Delivery System. Many of the soils in Sri Lanka have high permeability when they are not compacted. Many of the bunds on the field channels and distributaries had not been properly compacted. The result is excessive settlement and substantial erosion of these loose banks and an open invitation to crabs and other burrowing creatures which riddle the banks with holes. Practically all field channels where the water surface is appreciably above the level of the surrounding land are leaking profusely.

The rights-of-way provided for maintenance of the earthen channels have been taken up for cultivation by the farmers. This results in two major degrading factors. Farmers in many cases have narrowed the banks of the channels to give themselves extra land to cultivate; this increases the probability that the crab holes, etc., will go completely through the banks. An even more damageing aspect of this encroachment on the right-of-way is the proprietary attitude which the farmers have developed regarding this right-of-way. When the banks of the channel wash out and there is a crop in the right-of-way, the farmers commonly "will not allow borrowing of soil from the right-of-way to repair the bank." Repair often requires hauling soil hundreds of yards and requires much time and equipment. This encroachment on the right-of-way by the farmers is a major factor in the cost of maintenance and the high water losses from the channels. In most cases, adequate roads and extended takeouts were never constructed to utilize the reserved right-of-way.

Rapid Degradation of the Distribution System. In addition to the factors just discussed, the following are contributing to the rapid degradation of the systems:

- Livestock are allowed to enter distributaries to drink and bathe, and their hooves cut holes through the banks.
- Erosion of the uncompacted canal and distributary banks has been appreciable in many canals, and the sediment has accumulated in their lower reaches, reducing their depth and leaving them with wide shallow cross sections which increase the head losses in the channels and decrease their carrying capacity.
- A large number of the engineers formerly in management level positions have left the country for higher salaries, leaving vacancies and inadequate staff to orient new personnel to operation and maintenance jobs.

Inadequate Water to Lower Ends of the System. Most of the factors discussed previously cause more utilization or wastage of water at the top of the system, resulting in less than the desired amount of water reaching the tail end. Social inertia appears to be a major factor in allowing this inequitable situation to persist. The top ends of the system are settled first when there is adequate water for all concerned at that time. Farmers at the top end use all the water they want, develop wasteful habits, and develop paddys on all their land including the highly permeable, coarser textured soils. Part of the reason for this action is that they are new farmers, short of labor, and paddy rice is considered the least labor-intensive crop.

By the time the tail end of the system is settled, the water supply available there is considerably less than designed. The farmers at the tail end of the system never experience the luxury of adequate water supply, and they learn to subsist on what they have. Top-end farmers tend to become wealthy and influential and strongly resist moves to equalize the water distribution. Tail-end farmers do not prosper and often cannot resist the influence of the top-end farmers. The result is continuing inequity of distributions. The Irrigation Department proposes utilization of drain water to supplement the supply of the farmers at the tail end rather than redistribution of unneeded supply from the farmers at the top end. Utilization of drain water is more politically feasible.

Problems in the Sections Maintained by Farmers (Field Ditches and Outlets)

Lack of Measurement and Control. In some of the channels observed, gauges had been driven into the bed of the channel. Some of these had been "calibrated" by estimating the flow with a current meter, cross-section procedure when the water was at a specific height on the gauge. However, sufficient equipment and personnel have not been available to calibrate these gauges through a range of water levels. Several of the gauges observed were in sections where variable downstream conditions of the channel (i.e., recent cleaning of channel would affect the level of water at the gauge post). Department personnel in areas where gauging had begun indicated that a large portion of the gauges installed had been vandalized. Gauging had not begun in most of the field channels observed.

Most of the Technical Assistants contacted reported that farmers were constantly asking them for more water. They stated that they decided on whether more water should be issued on the basis of observation of the area for which the water was requested. If the farmers could show a need and water was available, more was issued. They felt that these subjective actions at the head ends were reducing water available at the tail ends of the systems.

Most of the field channels were provided with 3-inch outlets and masonry or concrete check structures with grooves to receive check boards. The size of the structures and channels indicates that they were designed to carry more water than they are now carrying (probably allowing for the possibility of rotational issues of water). However, the channels observed were flowing continuously with a small head of water in the channel. Head loss across the 3-inch-diameter pipes was commonly only about .1 foot, and raising the water at the check structure by another .1 foot with rocks or weeds was increasing the water supply to a few greedy farmers to 40 percent more than their neighbors.

In many cases, illegal cuts were made in the bank where water had been taken out of the channel to the adjacent fields. This was done to divert more water from the field channel to the farmer than what the 3-inch farm outlet could deliver. The results of this action are (1) loss of the water due to overirrigation in the field bypassing the 3-inch outlet, (2) loss of adequate flow to lower farms served by the field channel, (3) loss of access down the field channel, and a disruption of normal operation and maintenance of the field channel.

At present, there are no elected farmer representatives who have the responsibility and authority to control misbehavior of individuals who take more than their share of the water from the field channels. Irrigation Department technical assistants and overseers with authority are not adequate in number, and they do not have time to patrol the ditches to detect such breakage of the law. Moreover, when a miscreant is caught in the act and a case drawn up against him, it will often take 2 or 3 years and many days of the irrigation employee's time to carry the case through the overloaded district courts.

Lack of Equitable Distribution. Stealing of water at the top end of the field channel, lack of scheduling and issuing and measuring procedures, inadequate cleaning of the field channels, and small continuous flows are the primary causes of decreased water supply at the tail end of field channels. Cleaning of the channels is particularly important because increasing grass and sediment in the channel causes higher levels of the water in the head reaches of the channel. This pushes more water into the outlets near the head of the watercourse and more water out through the crab holes. This results in decreased supply or no water at all in the tail reaches.

Rapid Disintegration of the Field Channels and Associated Structures. Animals and equipment crossing the channel, buffaloes wallowing in the field channels, and farmers cutting the bank to take out the water all contribute to the disintegration of the channels. However, the most costly degradation noted was associated with erosion around the masonry check and drop structures. Cleaning and maintenance of the field channels is delegated to the farmers, but they do not take the responsibility of plugging the small leaks that commonly develop around such structures. These holes result from inadequate compaction of fill dirt around the structure, crab and rodent activity, etc. When detected and closed in their early stages, a few shovels full of soil and a few minutes of attention will stop these leaks. However, many field channels had been leaking for months or years and several cubic yards of soil had eroded away. In some cases, the structures had cracked or fallen because their support had been eroded away.

Farmers cropping the maintenance rights-of-way and denying earth removal when their crop is growing confound this problem of maintaining the field channels.

Lack of Authority for Water Distribution and Organizing Cleaning and Maintenance. In the past, the Vel Vidane and other officers or farmers' representatives have had such authority, but in recent years, organization and discipline have disappeared. Recent encouragement by top Government leaders, Agrarian Services and Irrigation Department personnel, and in some cases religious leaders have motivated farmers in a few areas to cooperatively clean their field channels. In some cases, they have also cleaned the distributaries where departmental maintenance budgets were not adequate to get this cleaning done.

ONFARM WATER USE

Water Efficiency

Most schemes have estimates of the duty of water and usually some idea what it should be with reasonable efficiency. Many variables affect onfarm efficiency, including soil type, topography and leveling, farm size and shape, farm distribution systems, crops and cropping systems, and management. Plant needs can be estimated from meteorological data with known procedures. Most of this information is available. Irrigation requirements can only be estimated as the amount and intensity of rainfall varies from year to year. Taking into account effective rainfall, month by month and scheme by scheme, full-season full-canopied crops will require from around 2.5 to 3.5 feet of water. In most of the country, water use is around 3 to 5 feet in the Maha season and from 5 to 8 feet in the Yala season, an annual range of 8 to 13 feet. The duties at Walawe project are much higher, with rates in excess of 8 and 15 feet, respectively, for Maha and

Yala. With this wide range of variables and estimated duties, computations of water use efficiencies can only be approximate. The only firm conclusion possible is that use efficiencies are low.

Soils

Infiltration and percolation rates are high on much of the upland soils now being developed, with some specific studies showing rates of over .25 inch per day. There are three major soils in many of the schemes, usually designated as well drained, intermediately drained, and poorly drained, indicating their suitability for irrigation of different crops. Water-holding capacities appear to be approximately the same for all three soils.

Crops

Crop water requirements are highest for paddy rice with evapotranspiration rates approximating evaporation rates as the soil is either saturated or flooded throughout the life of the plant. There are many paddy varieties with varying life periods, but the usual length of plant growth is around 3 to 4 months. Water use can be regulated by variety selection. The methods of seeding (i.e., wet seeding, dry seeding, or transplanting) also affects water requirements. Transplanting reduces length of growing period and water needed for weed control. In practice, very little transplanting is done at Gal Oya or Walawe, and continuous flow applications are often extended for 6 to 8 weeks. It is estimated that 40 percent of the duty is used during this period. Dry seeding saves on water currently used for tillage and puddling. The scheduling of planting dates and land preparation can affect water requirements as much as 30 percent according to some Irrigation Department officers' statements. Planting of the entire scheme at about the same time simplifies water delivery and thus is encouraged as a major water saving technique.

Subsidiary crops (cotton, chillies, green grams, beans, cow pea, vegetables) grown under less than field capacity water requirements can utilize soil moisture and rainfall more effectively, thus reducing irrigation requirements. Reasons for not growing more of these crops are more social and economic at the farm level as there is no charge for water and thus few reasons for saving water by crop selection. Subsidiary crops are grown where water is limited.

Land Preparation

In newly developed areas where land must be leveled by hand, many years are required before the land is level and smooth within the small liyadde. Unevenness requires extra water depth to ensure complete water coverage at minimum depths. This is especially wasteful during land preparation for seeding. Much of the paddy is grown on slightly rolling terrain so that land is terraced, with water flowing from one liyadde to another and wasted to the drains as surface runoff. Terracing to fit the land contour, with larger liyaddes and slightly graded to facilitate crops with a return flow ditch which will return the waste to the field channel would increase both farm and overall efficiency of the system. Very few, if any, examples of using these techniques were found in the schedules. Water is impounded on the land for long periods of time during land preparations for various reasons, including weed control and during the cultivation period when bullocks or mamoties are used.

Weed Control

Water is used in large quantities in preparing the land for seeding, in large part to control weeds. Later, water depth is regulated to suppress weed growth. Up to 30 percent savings of water could be made if weeds could be controlled with herbicides.

Water Changing

Some growers feel water must be drained and replaced occasionally in the liyaddes as the water becomes warm. This practice wastes water and has questionable benefits.

Water Distribution

The usual practice is to irrigate all crops by flooding the small basins with water flowing from one to the other down slope. Water stands on the upper part of the farm for a long period of time which causes deep percolation losses. Better farm distribution system along with leveling could reduce these losses.

REUSE OF RETURN FLOWS

Return flows originating from surface drainage from field drains and leaks, deep percolation, and canal losses are estimated to amount to approximately two-thirds of the diversions in the many project areas. At Gal Oya a considerable amount of reuse is occurring in the river diversion area, and, to a lesser extent, on the right bank system. Very little reuse occurs on the left bank, except for some encroachers cultivating near the drainage channels who are tapping drain water. At Uda Walawe there is no recapture or reuse of drainage water.

There is significant potential for increasing water use efficiencies in both Uda Walawe and Gal Oya because drainage water is presently wasted directly into the ocean. Much the same potential exists in most of the schemes we observed.

DOMESTIC WATER SUPPLIES

Apparently, it is the practice on all major irrigation schemes to issue some water into the canals for "domestic" use--washing, drinking, and for buffaloes--during the inter-crop period when the canals would otherwise be closed. A common schedule of release is a 3-day issue every 10 days. There are several disadvantages to such a practice:

1. It wastes large quantities of water. It is difficult to obtain figures on quantities released from the tanks for domestic issues. With the possible exception of Uda Walawe, we found no case where this reached as much as 10 percent of total annual issues, and in most cases it is far less. The magnitudes of waste for domestic purposes are small compared to the amounts wasted by overissue of irrigation water. However, the rate of wastage of domestic water issues is very high. It is almost always issued into dry channels, and thus a great deal is lost by wetting of canal perimeters and by percolation. Domestic water issues seldom reach the tail ends of systems.

2. The major cost of domestic issues is that the channels are never dry for more than a few days at a time, and thus it is difficult to schedule regular maintenance. The maintenance period between paddy seasons is normally no more than a month.

3. In order to gain access to water, people and animals damage the banks of channels and exacerbate siltation problems. This is because of the lack on all but a few systems of access steps and for special buffalo-wallows separate from 'e channels.

4. Farmers who have not adhered to agreed crop schedules can use an alleged need for domestic water as a pretext to obtain more water for their crops, thus relaxing further discipline.

5. The use of surface water for human consumption is more unhealthy than the use of well water.

In the face of all these objections, the practice of making domestic issues continues for two related reasons. One is that settlers have come to expect it and feel a strong moral entitlement. The other is that settlers sometimes actually need it as they have no alternative source of supply. The two factors interact: because cultivators feel entitled to canal water for domestic purposes, they do not make the same efforts that are made by rural people in other areas to construct their own wells. There are some community wells constructed at the time of settlement in some areas, but these were often poorly sited and are ineffective.

The severity of drinking water problems usually corresponds to the degree of scarcity of irrigation water. In areas that receive irrigation water, the water table is charged sufficiently to make wells a dependable source of supply. Here the settlers have some incentive to construct private wells. In contrast, areas like the lower ends of the Gal Oya and Uda Walawe Schemes receive very little irrigation water, have a low water table, face acute scarcity of drinking water, and provide little incentive for private well construction. Therefore, provision of more adequate irrigation to lower ends of these schemes will also enhance domestic water supplies from wells adjacent to the irrigation areas.

GOVERNMENT ORGANIZATIONS

Areas of Responsibility

The Irrigation Department has responsibility for all irrigation systems on the Island with the following exceptions:

- Major projects still at the development stage are in the hands of special area development authorities: the Mahaweli Development Board for the lands being newly settled under the Mahaweli project, and the River Valleys Development Board (RVDB) for the Uda Walawe scheme. The RVDB has, however, ceased to commit substantial attention or resources to the Uda Walawe Scheme and intends to hand it over to the Irrigation Department within the next few years.

- Minor irrigation projects, recently redefined as those with a command area of less than 200 acres, are to be the responsibility of the Department of Agrarian Services (under the Ministry of Agricultural Development and Research) after January 1979.

The proposals made in this report refer only to projects under the responsibility of the Irrigation Department. Therefore, in our analysis of Government organizations we focus on the Irrigation Department. The RVDB organization at Uda Walawe is discussed separately in Appendix Four.

Factors Affecting the Performance of the Irrigation Department(1)

The Irrigation Department has a long-established record for good work, high technical standards, and a strong sense of commitment to the civil engineering profession. Its capacity is currently being severely tested by the rapid acceleration of irrigation and power construction programs throughout the Island, and the consequent shortage of engineering resources of all kinds, especially manpower and organization.

It is generally recognized that the performance of the Irrigation Department in operation and maintenance activities (O&M) is in some respects deficient in comparison with its investigation, design, and construction (D&C) work. The following appear to be the major reasons:

- Budget allocations for O&M have been inadequate compared to those for D&C.
- Between 1970 and 1977, maintenance work and water issues on irrigation schemes were the responsibility of the Territorial Civil Engineering Organization. This organization faced many problems, and during that period, maintenance was often inadequate.
- Apart from major new construction projects, the Department has a territorial field organization in which the Chief Irrigation Engineers (of the 15 ranges) and the Irrigation Engineers (of the 59 divisions) have responsibility for both D&C and O&M operations. Although O&M activities merit greater attention than they are given, D&C work generally appears as more urgent, all the more so as completion of construction projects is the main criterion by which the performance of engineers and of the Irrigation Department as a whole is judged. The urgency of D&C activities tends to crowd out O&M activities. If timely attention is not given to D&C duties, this is likely to result in adverse reactions from colleagues in the Irrigation Department, from politicians, and from the public. This is especially true of work done under the Decentralized District Budget where

(1) For description of Irrigation Department organization, see Appendix Six.

there is strong local pressure for the rapid completion of work. However, no such vocal constituency promotes the timely completion of O&M tasks.

- The problem of competition for time between D&C and O&M activities is compounded by the fact that, due to emigration and the acceleration of irrigation construction, the Irrigation Department is suffering a shortage of experienced engineers which is likely to last for some years, at least. Engineers have also shifted from the Irrigation Department to the Mahaweli Development Board.

- The department recruits almost entirely from the civil engineering profession, which is oriented around D&C operations. D&C comprises all or almost all of the subjects examined in the training courses followed by the engineering cadres: the undergraduate degree in civil engineering at the University of Sri Lanka; the charter examinations of the Institutions of Engineers, Sri Lanka, and London; and the National Diploma in Technology (NDT) courses for Technical Assistants (TA's) held at the Katubedde Campus of the University of Sri Lanka and the Hardy Institute, Amparai. There is a strong sense of professional ethos pervading the Irrigation Department, but it emphasizes D&C activities. Staff members are led to believe that they will stand well in the eyes of their colleagues, and thus have a greater chance of promotion, if they demonstrate ability in D&C activities. Good work in the O&M field does not offer similar psychic and material rewards.

- Engineers tend to spend most of their working lives concerned primarily with D&C activities. They do not normally have the opportunity to develop experience or expertise in O&M operations, especially water management.

- The Water Management Division of the Irrigation Department has very little influence. It has only a handful of staff, an advisory role, and is under the authority of a Deputy Director who also has administrative responsibility for 4 of the 15 range offices. Except in a few special projects, there are no staff engaged full-time in water management.

- Such water management as is practiced on irrigation schemes is largely carried out by the junior cadres. These are TA's, work supervisors, and laborers. (The Irrigation Department is in the process of recruiting water-issue laborers, or "irrigators" from the latter category.) These categories of staff offer little incentive to work well done. There are no bonus payments for good work, and promotions are based largely on length of service (seniority). The only major exception to this is the demanding practical examination through which TA's can be promoted to the grade of Senior TA.

- The sanctions available to superior officers to elicit work from those below them are almost entirely negative in nature: adverse reports which might threaten otherwise nearly automatic salary increases; the threat of transfer to another post; or the very rigid application of rules about such matters as leave requests, reporting times, attendance at work. It follows that the most rational strategy for most employees wishing to make the best of their career situation is to avoid making mistakes detectable by their superiors. Objective evaluation of most D&C work is relatively easy: the end product is visible and has to be inspected. O&M tasks are generally of a different nature: opening and closing sluices, early repair of damages to bunds before water begins to leak out, reporting on silting problems or malfunctioning of gates. O&M tasks are small-scale, take place over a large geographical area, and require reaction to constantly changing conditions. It is relatively difficult to check on the performance of subordinates in O&M and relatively easy for them to attribute deficiencies to farmers. Thus a promotion system which incorporates few positive rewards but penalizes obvious work deficiencies not only discourages good work performance in general, but particularly does so in the case of O&M.

- Except at the level of laborers, school qualifications play a very major part in the process of selecting recruits, especially TA's and engineers. Because of the pressures on the Sri Lankan education system, it, more than some others, rewards students who have good memories, are prepared to work hard to charge those memories for exams, and have a capacity to respond well to to the stress of examinations. Such qualities are very useful, but they are far from the only qualities required for work in the Irrigation Department. The more emphasis that the training courses for technically qualified staff (B.S. in civil engineering, NDT, exams of the Institution of Engineers) place on successful completion of practical D&C projects, the more effective they will be in selecting persons competent to do D&C. However, O&M involves a work situation different from that of D&C, and therefore a different set of personal qualities. Above all, human relationships play a greater part in O&M work. Ability to establish good personal relationships, to organize and lead, to communicate, and to empathize with others in different situations is important to O&M work. This is not to say that such qualities are irrelevant to D&C. Existing staff selection and promotion procedures do not give adequate weight to "human relations" ability; this is not at all tested in formal school and university examinations.

- There are three categories of field irrigation staff who occupy positions of responsibility: Works Supervisors, TA's, and Engineers. Each one is recruited at very different points of exit from the formal education system. (See Appendix One.)

Most Works Supervisors are promoted from the ranks of laborers, provided they have SSC (10th grade) qualifications. Almost all TA's are recruited after successful completion of the 2-year NDT course, which can only be entered with SSC qualifications. Most Engineers are graduates. There are some very limited possibilities for promotion between ranks, but, like promotions within ranks, these are determined very largely by seniority. The great majority of staff spend all their working life in the same category into which they were originally recruited. If they are promoted to the next rank, this occurs only late in their working lives. Thus, the main categories of staff are clearly distinguished from one another by level of formal educational qualifications and are nonoverlapping in a career sense.

Consequently, the staff categories tend to comprise rather separate social groups, to interact with others of their own rank rather than between ranks, and to perceive and treat as different members of other ranks. As a result, the level of communication among the groups is lower than it might be. Communication tends to assume the form of reports and requests from below and orders and permissions from above. Effective two-way communication is essential for successful O&M activities, since the organization has to inform itself about and respond to the changing situation in the field; e.g., water availability and requirements, potential or actual defects in the physical structures, and farmer attitudes and problems.

- The existing practice of combining D&C and O&M duties in range engineer posts actively discourages the rise to senior O&M positions of TA's who have proved their competence in their work. Twenty percent of the engineering cadre is filled by promoted Senior Technical Assistants. Such people are normally posted to range offices where there is little D&C activity; they concentrate on O&M and are generally recognized to be well suited to that. However, because range posts always in some degree combine D&C with O&M, and because range engineers are expected to supervise and train young engineers, it is felt that these promoted Senior TA's (professionally nonqualified engineers), who lack theoretical background, are suitable only for a very few range posts. There is a feeling that there are already too many of them in the engineering cadre. Were there separate O&M posts, these objections would not arise.

Workplace and Residence of Staff

Partly because their educational and social backgrounds differ so much from those of the bulk of the rural population, some among the more qualified of the Irrigation Department field staff--the TA's and the Engineers--do not establish a household at their place of work, but leave their families in their places of origin, often in and around Colombo. This results in a high rate of absenteeism from work.

Relations Between Government Departments

At the field level, the Irrigation Department appears to operate to a large extent in isolation from other Government departments serving agriculture, notably the Department of Agriculture. Thus, although the Department of Agriculture has a good extension network, recently strengthened by the adoption of the Benor (or Training and Visiting) extension system, it is not normally used to give extension advice on water use, especially on ways of saving water. The Irrigation

Department has no extension network of its own; the network of personnel it has working at the local level is not well suited to give advice to farmers on water use.

LOCAL-LEVEL ORGANIZATION

In broad perspective local-level organization in major irrigation schemes is very weak in comparison with the Government agencies working there, especially the Irrigation Department.

Weakness and low effectiveness of farmer-level organization is virtually an Island-wide phenomenon and reflects deeply rooted cultural, social, and historical factors.

History

Some understanding of the current situation with farmer organization on major irrigation schemes can be reached by a very brief historical excursion.

In the last century almost the only Government agency having direct contact with, and control over, the rural population was the Revenue Department--the Government Agent, Assistant Government Agent, higher level headmen, and village headmen. (The latter two were quasi-hereditary appointive officers.) Very substantial authority was vested in this line of command. The Revenue Department was concerned with irrigation matters in four main ways:

1. Throughout the Island there existed the Vel Vidane (Irrigation Headman) system more or less parallel to the ordinary village headman system. Being appointed from families of high social and economic status and having the full backing of the entire Government via the Revenue Department, the Vel Vidane exercised enormous power and influence locally. He had the responsibility to organize and arbitrate in all cultivation-related matters and was rewarded with a crop share.

2. For irrigation projects the Government Agent or Assistant Government Agent was the organizer and chairman of water meetings to decide cultivation schedules.

3. If necessary, the GA/AGA used his powers to enforce agreed cultivation schedules.

4. The Revenue Department was responsible for a substantial program of new construction and rehabilitation of irrigation systems.

Throughout this century there has taken place a continuous process of what might be described as "atomization" in villager-Government relationships. The Government has continually increased the number of services it provides and thus its degree of involvement in village life. In order to provide these services, the number of Government agencies employing people at the village level has increased. The rural population has been fully drawn into the national political system and has found, in the form of politicians of various types, new ways of getting benefits and resources from the Government without going directly through local Government officials. Rather than approaching the Grama Seveka (new-style village headman) for, say, a particular subsidy, villagers can often go through local politicians to their Member of Parliament, and have him take up the issue.

In previous times this single powerful linkage between villager and state--the Revenue Department--did a great deal to create and sustain social cohesion at village level. It also sustained the socio-economic hierarchy. Powerful positions as headman and Vel Vidanes were given, as a matter of policy, to leading families, usually large landowners. The fact that they held these positions enabled them to sustain their dominance. Along with the multiplication of links between villager and Government, a very substantial change in social values has occurred. Social hierarchy is far less acceptable than previously. By the time it was abolished in 1958-63, the Vel Vidane system was unpopular with large sections of the population. This unpopularity was not because it was considered an inefficient system, but because it restricted local power to the hands of a small elite whose rule was widely challenged.

The reaction against Vel Vidane was in some broad sense the result of democratic sentiment. In cultivation matters the Vel Vidane was replaced by elected Cultivation Committees. These were not very successful for a number of reasons. One was that they were formally charged with a wide range of duties, but were staffed by elected volunteers, with little or no paid assistants. The members, especially the chairman, simply could not spare the time to do what was really a full-time job. More fundamental was the fact that the Cultivation Committee lacked authority in the eyes of the villagers. They had neither the "traditional" social status of the Vel Vidane nor the close and active support of Government. As has been often observed, Ceylonese (especially Sinhalese) society is relatively "loosely structured"--there is little social organization. In the absence of strong Government support after the abolition of the Vel Vidane, the new rural organizations tended to become immobilized as a natural consequence of the relatively unorganized social structure. Village life tends to be organized very much on the level of the individual or the household. There are few active groups based on kinship, community, caste, neighborhood, or occupation on which farmers' organizations could be grafted.

Realizing the weakness of elected Cultivation Committees, the 1970-77 Government tried to use political party affiliation as the bedrock on which to build active local farmers' organizations. The Cultivation Committees and the new Agricultural Productivity Committees were composed of persons nominated by local politicians. The disappointing performance of these organizations underlined the persistence of the underlying problems and the divisive effect of party political affiliation. In the irrigation colonies the problems faced by these organizations in matters related to water management were compounded by habits of water use established during early settlement. The first settlers, i.e., those at the heads of canals and distributaries, developed the habit of using abundant water. When the area was fully developed and water needed for tail-enders, there was no organization with adequate authority to enforce a less wasteful use of water on the head-enders.

Current Situation

At the time of writing, the Cultivation Committees and Agricultural Productivity Committees have been abolished for over a year. During this time, there have been no formal farmers' organizations in the irrigation colonies, although it seems that in a few places local M.P.'s have appointed "Irrigation Secretaries" to perform essential functions.

Our observations of the field situation shows the following information about local organization. First, there is very little informal organization on irrigation matters. It does not appear that farmers have in any significant degree reacted to the formal institutional vacuum by organizing themselves. Second, such informal organization or cooperation as does exist appears mainly on a very small scale: among a small group of farmers or, at the most, at the level of the small field channel. Third, there appears to be more local organization to distribute water when it is scarce. This does not, however, apply to situations of acute scarcity; i.e., to areas where scarce irrigation water is chronic. This is the situation at the lower end of the Gal Oya Scheme, where there is a great deal of fighting for water. Fourth, the kinds of organizational arrangements which were detected vary widely in form. They include formal consensus among adjacent farmers; use of accepted "natural leaders" to settle disagreements or enforce clearing of field channels; continued reliance on officers from, for example, the former Cultivation Committees after their formal abolition; use of M.P.'s nominees; and appeals to the Irrigation Department Works Overseer to settle disputes. This variety of arrangements, often evidenced on the same scheme, may reflect the social heterogenity of the population of the colonies. Fifth, the changes in farmers' organizations which are decreed in Colombo are often less complete and clear-cut on the ground. Many cultivators are not fully aware of formal changes, and the same individuals may continue to play the same roles in relation to cultivation--e.g., arbitrating water disputes, despite formal declarations which modify or even abolish their roles.

Attitudes of Settlers

The fact that farmers have made few spontaneous attempts to set up organizations to resolve the disputes which occur between them over water may be taken as an example of the common observation that the irrigation colonists, because of the circumstances of their settlement, have developed a high degree of psychological dependence on agencies of the Government. Attitudes to the Irrigation Department appear to reflect the same phenomenon. On the one hand, the Department is the subject of complaint and abuse for not supplying enough water or not doing a good job in general. On the other hand, many individual officers are very much respected, used to arbitrate disputes, and are called upon when problems arise.

Irrigation Discipline and Social Organization

It seems likely that the majority of cultivators would be prepared to accept the imposition of discipline in water distribution, provided that this does not result in their obtaining quantities that are clearly inadequate. There is a widespread view among farmers that the Vel Vidane system worked well, and that the introduction of some modern equivalent would be a good step. However, it must be emphasized that the ability of the Vel Vidane to make and enforce quick decisions and judgments, the main reason for the high regard in which he was held, depended fully on his high socio-economic status in a society where social hierarchy was far more acceptable than it is today. There is no possibility of restoring the Vel Vidane system.

Water Meetings

Of all the current institutions concerned with irrigation, it is the seasonal water meetings to decide cultivation schedules that have the longest history. They continue to be held, but the content and significance have undergone changes.

In the first place, they have ceased to be representative of cultivators. This is in large part because of the large size of new irrigation schemes. It seems that, in general, only a small fraction of farmers attend and that the majority do not think of these meetings as occasions on which they can have an influence on decisionmaking. Many farmers use them as an opportunity to express grievances. The official element seems to dominate at meetings.

In the second place, although the Revenue Officers--the Government Agents or Assistant Government Agents--still act as chairmen of these meetings, their role vis-a-vis the cultivators has changed. Formerly they were deeply involved in the decisionmaking and the enforcement of decisions; now their role is largely restricted to that of chairmen. Technical advice on feasible cultivation schedules comes from the specialists of the Irrigation and Agriculture Departments. The Revenue Officer has ceased to take much interest in prosecution for irrigation offences, since other matters connected with irrigation are out of his hands. The Revenue Officer now tends to act as spokesman for the cultivator vis-a-vis the specialist departments, and sometimes against the decisions of water meetings. For example, if cultivators require a delay in the final date for water releases because of delayed planting, then they may induce the Revenue Officer, often via the M.P., to issue instructions to this effect to the Irrigation Engineer.

Current Proposals for Farmer Organization

Apart from their very marginal involvement in scheduling and cropping decisions made at water meetings, cultivators have at present no formal institutionalized responsibility for water management or maintenance of any part of the irrigation system in the settlement schemes. It is, however, proposed to establish throughout the country a system of elected representative farmers, chosen on the basis of one for each 50 acres of paddy land. A small proportion of these people will be chosen by the Member of Parliament to sit as farmer representatives on the new Agrarian Service Committees, which are to replace the now-abolished Agricultural Productivity Committees. These arrangements will be made by the Department of Agrarian Services. That department hopes that these representative farmers will be chosen by the Department of Agriculture as their "contact farmers" for extension purposes. The Irrigation Department hopes that the "constituencies" for the representative farmers will be demarcated according to areas served by field channels. The representative farmers will then be expected to organize the cleaning and maintenance of field channels and the distribution of water from the channel to the farmers. A considerable degree of interdepartmental collaboration will be required for the fulfillment of these hopes. (For more details see Appendix Two.)

GOVERNMENT-VILLAGER INTERACTION

The Context: Supplier-Determined Water Issues

Canal irrigation systems can be categorized along what might be called a "supply-demand" continuum, relating to the degree to which decisionmaking over deliveries is determined by the supplier (e.g., the Irrigation Department) or the individual recipient (the farmer), respectively. In a pure demand system the amount and scheduling of deliveries is determined by the farmer. He orders what he requires and pays for it. Systems of this nature are found in, for example, the United States. A good organizational structure and good communication is required to operate such a system. There are also physical preconditions apart from the obvious requirement for good control and measuring devices: since the direction of water flow is continually changing, there are large percolation losses on unlined channels as they are continually wetted and dried. The higher the number of farms per unit of channel, the worse this problem is likely to be. For technical and organizational reasons, the tank irrigation schemes in Sri Lanka throughout recorded history have been supply-determined systems. The principle underlying irrigation organization is that the supplier (the Irrigation Department, the collectivity of farmers, etc.) publicly decides on a cropping schedule each season and then supplies water according to that schedule.

Responses to Supply Inadequacies

In practice, the supplier is not able to control the system and the irrigator to assure good water service. Water is often scarce, but at times it is excessive. The reasons for this are discussed at other points in this report. Not all observers would necessarily agree on whether a particular level of service (i.e., supply of water) was adequate or inadequate in particular circumstances. A given level of supply might be physically adequate to permit the farmer to get the best results from the cultivation methods he uses, but may be perceived by him to be inadequate. Again, the supply might be clearly inadequate, but necessarily so because of the need to spread scarce water among as many users as possible. This does not affect the argument below.

In principle, the actions taken by farmers to remedy their problems of inadequate supply of water can be divided into two categories: action to solve the immediate problem, and action aimed at getting a better service in the longer term. In practice, one kind of action might serve both purposes. When faced with inadequate water, there are three methods used by farmers to obtain more:

1. The usual first step is to approach an official of the Irrigation Department--a Works Overseer or a TA--to ask for more water. There is evidence that many of the irrigation systems are managed to a large extent by this "demand" approach. That is to say, although there is in principle a supply schedule for each area, considerable alterations are in fact made in this schedule if enough farmers complain enough about inadequate supplies. This may operate even at the field channel level. For example, in the "H" area of Mahaweli under Kalawewa Tank, water was issued on a very sparing rotation in the Yala 1978 season. In principle, the water in each field channel was divided up equally among the farmers, each having access to it for an equal period of time. There were, however, disputes among the farmers. Our interviews suggested that when Irrigation Overseers were called in to arbitrate these disputes, they were concerned less with whether or not the rotation schedule had been adhered to than with whether or not one farmer seemed to have less water than the others. To use the criteria of apparent need rather than correct scheduling seems in many ways more fair, especially at that low level. However, what it does is to encourage farmers to believe that if their fields are conspicuously short of water, they will--even ought--to be given more, without any regard for the question of how carefully they have used what was given. Although the systems are in principle supplier-determined, there is in the day-to-day decision-making a great deal of determination by user; i.e., demand-determination. There are no costs to the user apart from the actual cost of making the demand; i.e., walking to see the TA, agitating, etc.

The de facto use of demand-determination in the systems has two adverse effects. One, mentioned above, is lack of encouragement to economical use of water. The second is that the farmer comes to expect that his demands should be fulfilled, often does not understand why they are refused, and feels sufficiently outraged to take one or two of the more extreme steps discussed below.

2. If the Irrigation Department does not respond to farmers' requests, then it is common practice for them to appeal to other agencies--the Revenue Department and politicians. This kind of appeal is a rather uncontrolled weapon. In many cases, these other agencies do not respond to farmers' appeals, especially if, because of low numbers or some other reason, the applicants carry little political weight. However, if the appeals do get a response, then the Irrigation Department is virtually obliged to accede to orders of the Government Agent or Members of Parliament. The likely effects of this kind of appeal by the farmers are thus unpredictable, and the effect on water management decisions arbitrary. Further, if politicians decide to take action they require quick results: they are far more likely to order that farmers in X lateral canal be given more water than to authorize funds for the repair of sluice gates on Y lateral canal so that adequate water can be saved for channeling to X canal. The effects of political appeals tend to be the exacerbation of the basic problems of water scarcity and the erosion of the morale of Irrigation Department staff.

3. The other weapon available to farmers, individually or in groups, to obtain more water is to damage the physical structures of the system by breaking gates or cutting bunds. This weapon is commonly used. On the Parakrama Samudra Scheme gates are replaced at an annual rate of one per hundred acres; the figure is lower on other schemes because damaged structures are replaced less promptly. The arbitrary and destructive effects of this kind of response require no comment.

In the face of some of these more extreme kinds of farmer response, the only weapon available to the Irrigation Department is prosecution for damage to structures. This weapon is almost valueless. The Department is extremely unwilling to pursue prosecution itself but refers issues to the police or the Revenue Department, who rarely show interest. If prosecutions are pursued, the long delays in court procedure are frustrating and sometimes lead to the withdrawal or loss of a case if the original witnesses are not available. Politicians often intercede to have prosecutions withdrawn. A cultivator who damages irrigation structures will rarely be punished, and may justifiably regard it as extremely bad luck if it happens.

The Farmer and the Irrigation Department: Little Chance of a Good Bargain

These points about the weapons available to Irrigation Department officers and farmers assume relevance if one looks on Department-farmer relationships over water issues as part of a bargaining situation. If the mechanism worked perfectly, there would be no need for bargaining; the Department would supply the water and the farmers would use it. Such, however, is not the case. Because of physical and human deficiencies in the supply system, the cultivators are always potentially in a situation where they have to ask the Irrigation Department to supply more water, make physical repairs to structures, or complete maintenance operations. Were the water sold to the farmers by a company obliged to make profits, most of these bargaining problems would solve themselves automatically. Under the Sri Lanka system of bureaucratic allocation of free water, problems of bargaining arise, although they are rarely recognized as such and not explicitly tackled.

At present, the bargaining situation between farmers and the Irrigation Department is both unequal and unstable. It is unequal in the sense that the farmers have no sanctions to apply on the irrigation staff in the event that they perform poorly. However badly water is distributed, the staff of the Irrigation Department do not suffer. Damages to structures or appeals to M.P.'s do not affect the Irrigation staff personally, in the sense that there is almost no effect on their salaries, work records, or promotion prospects. Most of the farmers suffer from poor irrigation systems by less harvest, although some of the lucky ones at the heads of uncontrolled systems normally benefit from lack of control. The instability of the farmer-Department bargaining situation has been described previously. There is no way that either side can guarantee to use some of its bargaining resources and shift the other a predictable amount in the desired direction. Farmers' use of appeals to M.P.'s or damage to structures have unpredictable effects. Much of the observed bad feeling between cultivators and the Irrigation Department can be traced to this unstable bargaining situation: Neither knows what kind of behavior to expect of the other and believes the other is behaving arbitrarily and unfairly much of the time.

TRAINING

The basic training principle which seems to underlie present personnel practices in the Irrigation Department and other Government organizations concerned with irrigation is that those staff requiring technical skill (i.e., Engineers and TA's) should obtain the necessary theoretical background from formal courses in the normal school system before entering into service and receive practical job training through experience. This principle is neither formally stated nor rigidly adhered to, but it nevertheless appears dominant in actual practice.

Engineers

Basic Education. Most of the engineering cadre are recruited as fresh graduates from the degree courses in civil engineering at the Peradeniya and Katubedde campuses of the University of Sri Lanka. These courses emphasize investigation, design, and construction. The only part of the program at all specific to irrigation is an optional course in irrigation engineering which (at Katubedde) comprises one of seven courses taken in the fourth (final) year.

In their early years of service in the Irrigation Department, young engineers are closely supervised by senior staff in order to ensure effective on-the-job training. The effectiveness of this training is tested when the young engineers apply for associate membership of one of the Institutions of Engineers, usually the Sri Lanka Institution but sometimes the one at London.

The main criterion for award of membership is satisfactory performance in design and construction projects, as tested by the examiner's own reports, records, and designs and supervisors' reports. In order for candidates to be eligible to apply for membership to the Institution of Engineers, they have to have 4 years of service, including at least 1 year in design and 1 year in major construction activities. It is an informal Irrigation Department requirement that, in this initial 4 years, young engineers should spend at least 6 months in a post with substantial duties in the operation of irrigation systems. Virtually all young engineers obtain associate membership of one of the Institutions of Engineers. It is presumed that, after this, they have a thorough grounding in both theory and practice of investigation, design, and construction.

Engineers Qualifications by Charter. An alternative method of becoming a professionally qualified civil engineer is to successfully pass Parts I and II of the examinations of one of the Institutions of Engineers. In the case of the Sri Lanka Institution, weekend lectures are held in Colombo, with practical classes (at Katubedde) entering only in Part II. There is a widespread feeling that this training provides a less firm grounding in laboratory work than the undergraduate course.

Water Management in Engineers' Training. With the exception of those few engineers who have attended the special water management course formerly held at Rajangane, no engineers receive any training in water management at any stage in their career. Even such basic technical elements as water measurement comprise only a fraction of the optional final-year undergraduate course in irrigation engineering.

The Supply of Engineers. The current supply of young newly graduated engineers is adequate to meet the needs of the Irrigation Department. The shortage of experienced engineers arises from the fact that public service is used by many as an opportunity to obtain experience. There is a substantial exodus of people with a few years' experience into the private sector and, more especially, to jobs abroad. The consequent shortage of experienced engineers is not only a problem per se, but it also places limits on the number of new recruits who can receive adequate supervision.

Because of this situation it is difficult to expand substantially the cadre of persons skilled in water management by relying soley on engineers. Those already in service, especially those with experience, are already in great demand to fulfill existing work commitments. With the present training system, it is difficult to increase the intake of young engineers, and after a few years, the "leakage" to other jobs would be large.

Technical Assistants

Formal Education. Technical Assistants (TA's) are recruited after completion of the National Diploma in Technology (NDT) course in civil engineering. This was formerly called the JTO course. The first year is taught both at the Hardy Institute at Amparai and the Katubedde Campus of the University of Sri Lanka. The second year is taught only at Katubedde. Qualifications for entering the course are GCEO Level (10th Grade), with at least six subjects in one sitting, including four credits, and passes in physics and mathematics. In practice (at Katubedde) points are awarded for grades, and those applicants with the highest number of points are called for an orientation course which covers all NDT engineering courses. After orientation, applicants express their preferences for the courses they wish to follow. Since the civil enigneering course offers good prospects, it is now a popular choice. The civil engineering department makes its selection from applicants. It does so primarily by applying a simple question and answer test designed to detect actual interest in civil engineering as measured by related general knowledge. It also selects to some extent for English ability since the course is taught in English. Note, however, that this only selects applicants to do civil engineering rather than other subjects, and the persons from which this selection is made were in turn selected purely by educational achievements.

The NDT course in civil engineering is extremely broad, being designed for a wide range of possible jobs. The first year syllabus covers English, Engineering Physics and Chemistry, Principles of Electricity, Mathematics, Engineering Drawing, Workshop Theory and Practice, Engineering Mechanics, and Building Construction. The second year syllabus covers Mathematics, English, Accountancy and Business Practice, Building Construction, Surveying, Theory and Design of Structures, Strength of Materials and Hydraulics, Highways Engineering, Irrigation Engineering, and Sanitary Engineering. All courses are compulsory, and a pass must be achieved in each.

This course is oriented almost entirely to design and construction activities. Achievement is tested mainly by examinations, along with practical tests in drawing and a practical surveying examination during a 2-week field class in the second year.

It is widely recognized, by the teaching staff as well as outside, that the major weakness of the NDT course is lack of practical experience. This stems in a large part from a shortage of staff and laboratory facilities. Before the recent expansion of the number of persons in the course, field trips played a greater role.

Most students pass the first year examination. However, the failure rate is very high in the examinations at the end of the second year. In recent years, only 35 to 40 percent of students have passed. Others can repeat the examinations up to three times. This high failure rate is attributed to the rapid expansion of the course and the low staff-to-student ratio.

The NDT course lasts 3 years, with students spending the last year as trainees in Government departments under the aegis of the National Apprenticeship Board. Trainees do not necessarily spend this year in the department with which they eventually serve. The amount of training and supervision received during this year seems to vary widely. There is an examination designed to test achievement during this year, but it does not, at least in the case of the Irrigation Department, appear to be a main hurdle since virtually all students pass.

The Supply of Technical Assistants. With the acceleration of the Mahaweli Project, there has been a large increase in the demand for NDT holders to work in irrigation-related matters. Students have responded to this change in job opportunities by paying more attention to the irrigation engineering component of the course. There is likely to be a severe shortage of civil engineering technicians in the near future. There are demands for an expansion of the annual output of the course, to be achieved partly by teaching a full 2-year course at the Hardy Institute. The main constraint is the problem of recruiting teaching staff.

Rather than expanding the number of students taking the course, a more effective way of increasing the output of qualified technicians would be to strengthen the teaching staff and thus reduce the very high student failure rate.

In-Service Training and Promotion of Technical Assistants. After recruitment into the Irrigation Department, NDT holders are eligible to become Senior TA's by passing a series of rigorous tests of ability and achievement in the sphere of design and construction--surveying, construction work reports, etc. These promotion procedures give little or no weight to ability or achievement in water management or irrigation O&M activities. As in the case with Engineers, TA's receive no formal water management training throughout their careers unless they happen to be one of the minority who have attended one of the special training classes at Rajangane. Formerly, a special course in water management was offered at Rajangane.

The Quality of Technical Assistants. Until a few years ago, the Irrigation Department trained its own TA cadre by running a JTO (now NDT) course at its training school at Galgamuwa. There is a widespread feeling that the training received there was superior to that now given at Katubedde and Amparai. There seem to be two reasons why this should be so. One is that Galgamuwa is in an area where there are a large number of irrigation schemes, and so there was ample scope for field trips, demonstrations, and practical work. The second reason is that the Irrigation Department was fully committed to the Galgamuwa course and had a direct interest in providing experienced teaching staff who could give a strong practical orientation to the content of the course. Conditions at both Katubedde and Amparai are different.

Under present conditions, the content of the training courses for TA's appears to be no less firmly focused on design and construction, as opposed to operations and maintenance, than in the case of the engineers' courses.

Special Training Course in Water Management

At the time of writing, no formal training programs in water management exist for Irrigation Department staff. Such expertise as is acquired is obtained on the job. This is not a matter of deliberate policy, but arises from the collapse of the water management experiments and associated training classes at Rajangane Tank after the communal riots of August 1977. Field staff had been taken here for 2-week courses. The necessary physical facilities to resume these courses still exist. However, Rajangane Tank is no longer suitable for experiments or training classes in water management. It is now in receipt of drainage water from the "H" area of the Mahaweli Scheme and generally has an excess of water; the tank spills even in the Yala season.

The Irrigation Department is keen to resume training classes, all the more so as it is in the process of appointing a large number of "Irrigators" who have little or no experience in water management. There are, however, severe constraints of staff and facilities to conduct such a course, and the present thinking appears to focus on a series of instruction sessions for more senior staff. It is hoped that a basic set of rules about water management procedures will filter down to the Irrigators. Ultimately, the Irrigators may be able to attend such classes. Instruction classes are much narrower in scope than training classes in the usual sense.

There are three possible sites which have the residential facilities to permit the resumption of these instruction classes. The unsuitability of the Rajangane facilities was mentioned above. The Irrigation Department headquarters in Colombo is not within reach of a suitable large irrigation scheme for demonstration purposes. The former Irrigation Department training school at Galgamuwa is well sited and is in good physical condition, although no longer under the control of the Irrigation Department.

Chapter 5
WATER MANAGEMENT NEEDS, SELECTION CRITERIA, AND POTENTIAL PROGRAMS

Water management needs were identified from previous water management surveys and statements by others and from team findings from visits to eight representative schemes. Possible programs were identified in response to the needs. Because the study was planned to be used for preparation of a project paper by USAID, the criteria used by USAID for project selection were largely adopted. Principal sources for establishment of the criteria were:

- USAID documents, including the Project Assistance Handbook (No. 3, February 1978), the contract with CH2M HILL, and the Project Identification Paper (PID) for the Sri Lanka Water Management project

- Judgement of the project study team based on professional expertise and observation

Two sets of criteria were developed. One set applied to the selection of programs of water management, per se. Another set applied to the selection of irrigation schemes in which to carry out the proposed programs.

Most of the water management problems stem from the lack of operational control of the project facilities and excessive water use on the farm by those farmers located on the system where they can physically take excessive amounts of water. For these reasons, we have categorized the types of programs by the need for operational control and by the need to improve water utilization.

NEED FOR OPERATIONAL CONTROL

Operational control is defined as the ability to deliver prescheduled flows in cfs to specified farms, field channels, distributaries, branch canals, and to operational reaches of the main canal. The components necessary to possess this capability are:

- Daily delivery schedules for each field channel, which are developed from farm delivery requirements--From these schedules, releases to each field channel, distributary, branch, and main canal regulatories are computed.

- The irrigation system properly sized and maintained, and with control structures and gates that will meet the delivery schedules--Water measurement devices are required to monitor performance, to provide basis for gate adjustments, and to prepare daily, monthly, and annual water delivery records.

- A sufficient number of water management staff adequately trained to manage the system on a 24-hour 7-day-a-week basis during the issue seasons

NEED FOR IMPROVED WATER USE

With operational control needs satisfied, there will still be needs to reduce return flows now being wasted to the sea. This waste of water is caused by poor water management practices at the farm level and by the lack of planned drain recapture and reuse facilities. Although return flows can be reduced through the implementation of onfarm water management programs, planned drain recapture and reuse programs are still needed to increase the overall efficiency of the scheme. This practice is being utilized on some schemes. More planning is needed to develop a master plan for the reuse of return flows for each scheme.

A second problem interfering with good system water use is the domestic deliveries made every 10 days during the nonissue season. Large flows are required for the benefit obtained. In addition, use of the open canal system for domestic purposes is of concern to public health authorities, and domestic issues interfere with canal maintenance.

SELECTION CRITERIA

Irrigation Scheme Selection

In the selection of schemes the following criteria were adopted. First there had to be opportunities for significant water management improvement at the scheme. These opportunities for improvement were determined by observation in the field, review of documents of others who have studied the problem, and discussions with GSL and AID personnel. Secondly, the areas chosen had to represent the major dry zone irrigation schemes (more than 200 acres in command area) in physical, social, and institutional terms. Thirdly, areas already in receipt of foreign assistance for water management were avoided to prevent possible complications and duplication of effort. Mahaweli schemes were avoided due to the rapidly changing situation as well as significant foreign funding. Finally, areas selected should have a better than average chance of program completion and success, principally as demonstrated by willingness of project staff to achieve better water management.

Program Selection

In developing water management programs for selected schemes, "programs" were defined in the broadest possible sense (in accordance with contract with USAID). Physical changes (except in the tank impoundment structure), institutional and organizational revisions, training programs, and research were all considered possible candidates for the selected program. To be considered for final selection, improvements had to meet technical, institutional, and economic standards. The USAID Project Assistance Handbook provided guidance in determining criteria for final program selection. The handbook describes the following tests for project acceptance: economic feasibility, social soundness, technical feasibility, administrative feasibility, and environmental soundness. A definition of each of the tests is summarized below. For a more complete description, the handbook should be consulted.

- Economic feasibility--The improvement has benefits exceeding its costs, or it is the most cost-effective way of achieving a desired goal not quantifiable in monetary terms. Costs and benefits are all stated in terms of the 1978 price level, and for feasibility tests, a discount rate of 10 percent per annum is assumed. The rate of return on investment of costs is estimated to provide a specific expected rate of return.

- Social soundness--To meet the test of social soundness, the proposed project is evaluated for (a) its compatibility with the sociocultural environment, (b) the likelihood of diffusion of the new practices or institutions among groups other than the initial target group, and (c) the social impact or distribution of expected benefits and burdens among different groups. To be more specific with respect to criteria, program elements were selected which were expected to be compatible with social and cultural customs and to have a high likelihood of spreading to all major irrigation schemes in the dry zone after the initial trial period with the test schemes. The principal group expected to benefit from the program is the poor farmer cultivators and rural laborers of Sri Lanka. In addition to improved income, some programs result in other welfare gains; e.g., improved health through provision of domestic water supplies.

- Technical feasibility--The technology of the improvement must be physically possible under the conditions existing in the area at the present stage of development. Thus, effective technology already tried or in use is preferred to new technology untested in the area. The mix of resources recognizes resource values and availability of resources. For example, as compared to developed societies, a larger labor component is usually preferred in the resource mix for constructing and operating improvements. The high opportunity cost of items purchased with scarce foreign exchange is considered and such purchases held to the lowest level compatible with program objectives.

- Administrative feasibility--To meet the test of administrative feasibility, organizations must exist with the capability to carry out the proposed water management improvement. In the present study, the lack of administrative feasibility does not preclude an improvement, but rather, in such a case, the necessary organization or institutional change may itself be proposed as a water management improvement. This criterion applies to both the host government, Sri Lanka, and the U.S. Administrative Agency, USAID.

- Environmental soundness--Finally, the proposed program is examined by environmental criteria. Environmental effects which have significant negative impacts are noted. Significant adverse environmental effects are not expected in a program such as this because the physical works are in most cases rehabilitation or improvement of existing works. A complete environmental assessment is outside the scope of this study, and reliance should be placed on a recent environmental assessment for the Mahaweli project.

A final note is warranted on criteria for program selection. This comment is made lest the impression is left that water management improvements can be considered on a one-by-one basis. Existing problems, as discussed earlier in this report, are organizational, institutional, and social as well as physical. And interrelationships between the physical and social problems are such that solving one type without regard to the other would result in little or no gain in improved water management. Therefore, a holistic approach is called for in determining water management programs. Programs must be conceived as "packages" of social changes combined with physical improvements to achieve the desired results. The combination of social and physical programs is therefore an essential criterion for program selection and evaluation.

POTENTIAL PROGRAMS

Operational Controls: Mains, Branches, Distributaries, and Large Field Channels

A detailed list of potential programs required for Sri Lanka irrigation schemes in order to secure operational control of the project staff-operated systems is shown in Table 5-1.

Operational Controls: Farmer-Controlled Field Channels

A detailed list of potential programs required for field channels, which are farmer operated and maintained, are shown in Table 5-2.

Improved Water Use

A list of potential programs to improve water use is shown in Table 5-3.

Table 5-1
Operational Control Programs for Main, Branches, Distributaries, and Large Field Channels

1. Provide erosion control and silt removal.

2. Repair existing gate seals and add water level and gate position indication at main bifurcations.

3. Install gates, gauges, and position indication where needed at main and branch regulators.

4. Provide locking handwheels on existing branch and distributary takeouts. Add measurement devices to each takeoff considering use of weir Parshall in cutback flumes, on meter gates.

5. Furnish and install new takeoff gates with locking handwheels. Add measurement device.

6. Investigate to identify reaches where excessive losses are occurring. Determine feasibility of earth, concrete, or other lining.

7. Delineate actual command area. Regularize encroachments.

8. Prepare delivery schedules (turn on-turn off) for all takeouts for land preparation season, rotation season, and for domestic water issues. Show requirement (cfs) at each delivery point. Do this only as the capability to make reliable deliveries exists.

9. Establish separate operation and maintenance units on major schemes, with support from a strengthened Water Management branch in Colombo Head Office of the Irrigation Department.

10. Organize training classes in water measurement for existing staff.

11. Modify recruitment, training, and promotion practices to develop a cadre better adapted to and more skilled in operations and maintenance work.

12. Develop rules and regulations and operating procedure for the system.

13. Obtain M.P. support for program implementation.

14. Obtain power to quickly prosecute violators.

15. Organize and train water management staff into departments at range and division levels with water management support at Colombo.

Table 5-2
Operational Control Programs for Field Channels

1. Rehabilitate field channels where needed to restore design capacity. Provide at least one access road on each field channel. Extend takeouts. Provide berm on field side if borrow ditch is excavated for embankment work.

2. Conduct field research to pipe those field channels with excessive erosion and silting problems.

3. Recompact washed-out structures. Extend existing or add new cutoff walls where necessary. Add stilling basins where needed.

4. Conduct field research for field channel rotation.

5. Prepare alternative sets of operational rules and regulations and delivery schedules which are compatible with channel design.

6. Have irrigator or senior officer present these alternatives to farmers, discuss merits, make decisions on which to live by.

7. Assist farmers in writing their schedules, rules, and regulations governing O&M of their field channel.

8. Specify role of irrigator and inputs to be furnished by the project staff. Determine whether farmers wish to have irrigator or another arbitrate disputes not settled at the farm level.

9. Discuss program with District Minister and Government Agent, and obtain power to quickly prosecute violators.

Table 5-3
Water Use Improvement Programs

1. The investigations for and preparation of master plans for reuse of drain water, including implementation plans, costs, benefits, and environmental impact

2. Programs for initial farm development, field research extension

3. Programs to improve water use on existing farms (land leveling, farm ditch layout with construction, cropping changes, etc.)

4. Domestic well/cistern programs and provision of buffalo wallows, leading to curtailment or ending of domestic water issues into channels, thus permitting time for channel maintenance operation

Chapter 6
DESCRIPTION OF PROPOSED PROGRAM

This chapter describes six project elements comprising the proposed Sri Lanka water management program. Further information describing the overall organization and implementation of the program including the roles of the GSL staff, expatriate specialists, AID advisor, and the consultants, are included in Chapter 8, "Project Organization and Implementation." The six recommended projects to form an integrated "first step" water management program are training, extension, central support, upgrade Walawe, upgrade Gal Oya, and social research projects. The projects are described in this order for logical presentation.

The recommended program consists of the development, financing, and implementation of a phased action operation, maintenance, and rehabilitation program. The target areas are the Walawe project, a recently developed right bank system with a developing left bank system; and the Gal Oya project, an older developed major scheme. At both schemes, excessive and insufficient issues are occurring at the same time, both causing severe losses of production and contributing to a poor quality of rural living. The major features of the proposed program are organizing, staffing, training, and equipping to gain operational control; and planning, extension, and field research for improved water utilization.

A third target is training. A comprehensive training program is presented which directly benefits the entire Sri Lanka irrigation sector. Other program features which provide some direct countrywide benefits to improved water management are the central support and the extension projects.

Significant countrywide indirect benefits are obtained from the Walawe and Gal Oya programs for these are action demonstration water management programs that should form the policies and procedures necessary for effective water management to allow GSL to extend effective program elements out to the entire irrigation sector.

The locations of project elements are shown on the Vicinity Map in the Summary. Maps of the Walawe and Gal Oya target areas are included in this chapter. Detailed physical description of the two projects may be found in Appendixes three, four, and five. Refer to Chapter 4 for a description of the social-economic settings.

REASONS FOR THE CHOICE OF WALAWE AND GAL OYA

Uda Walawe and Gal Oya were chosen as project target areas after the examination of eight schemes suggested by the Director of Irrigation, and the application to those schemes of the criteria for scheme selection listed in Chapter 5. In light of those criteria, the following are the most significant features of the two projects chosen:

- There are very substantial opportunities for useful savings in water in both projects. The opportunities are particularly great in Uda Walawe because of the current very high rates of use at the tops of the system. The needs are especially great because plans to complete the development of the scheme are going ahead and, unless water can be provided to the tail ends, the project will incur very large human and economic costs.

- It did not prove possible to find two schemes which fully represented the diversity of schemes in the dry zone. There are, however, substantial contrasts between Gal Oya and Uda Walawe in age, stage of development, terrain, design, management, and cropping patterns. Both schemes are large, and in this sense they do not represent the full range.

- Neither scheme is currently in receipt of substantial foreign resources, apart from the projects proposed here, and is unlikely to do so in the forseeable future.

- In both areas, we found evidence of substantial willingness among project staff and politicians to cooperate in programs to improve water management.

Overall, the obstacles to effective water management in Gal Oya and Uda Walawe are much the same as in most irrigation schemes in Sri Lanka. The dominant needs are for operational control of the system at all levels and more efficient water use. Rehabilitation and betterment of canals and structures will be necessary before operational control can be achieved.

CHARACTERISTICS OF UDA WALAWE AND GAL OYA

Uda Walawe	Gal Oya
Only part of the project is completed. Substantial development work remains to be done on the left bank, providing opportunities for experimentation in the physical layout of distributaries, field channels, farms, and the associated water control structures.	Development work was completed in 1966.
Rolling terrain	Relatively flat terrain
The dominant soils are the porous red-brown earths, large extents of which have been scheduled for water-saving nonpaddy field crops, especially cotton. This has not been successful.	Soils are also porous red-brown earths, with high water table conditions. Substantial acreages of sugarcane are grown on the right bank.
The project remains under the control of the construction agency, the River Valleys Development Board (RVDB).	Originally constructed by the RVDB, the project passed from the hands of the Territorial Civil Engineering Organization to the Irrigation Department in 1978.
There is limited water reuse, planned on the left bank. Water use efficiency is very low.	Because of the existence of water reuse facilities on the right bank and river diversion, water use efficiencies are not very low. There is, however, no reuse on the water-scarce left bank system.
Rates of water use at the top of the right bank system are extremely high, partly because of design faults in the original system. There is an acute scarcity of water at the lower end of the system. However, with reasonable management, there is adequate water to irrigate the whole of the planned acreage.	Less water is used at the top of the system than in Uda Walawe, but, because overall water supplies are less abundant, overuse at the top has equally or more serious implications for the tail-enders. About a quarter of the total acreage at the ends of the canals receives very little water in the Yala season.

CHARACTERISTICS OF UDA WALAWE AND GAL OYA

Uda Walawe	Gal Oya
The structures are still relatively new.	The structures are between 12 and 25 years old and have received little maintenance. There are major problems of erosion from channels and siltation at the lower ends of the system.
Field channels are relatively short.	Because of the flat terrain and the long field channels, there are major problems of getting water to the tail ends of field channels.
Because the project is recent, there is only a limited divergence between planned and actual irrigated areas.	Actual irrigated area is much larger than the planned area. However, information on the latter is difficult to obtain as the original plans are not traceable.
There is an acute scarcity of drinking water at the lower end of the right bank system. Because of saline ground water, the population is heavily dependent on the irrigation system for drinking water; the main right bank canal is never closed.	The scarcity of drinking water at the lower end of the system is equally acute, but may be improved by raising the water table through provision of more irrigation water and the construction of wells. The commitment to supply canal water for domestic use is substantial, but less than in Uda Walawe.
There is a separate water management organization, but the senior staff has a purely advisory role, and the field irrigators are under the control of the project managers.	There is no separate water management organization; the system is under the control of the irrigation engineer.
The project is staffed and equipped to maintain equipment, but none is currently used in maintenance.	No equipment is available for maintenance work. The maintenance shop is not staffed or equipped.

CHARACTERISTICS OF UDA WALAWE AND GAL OYA

Uda Walawe	Gal Oya
There are facilities in the RVDB head office of training classes, and residential facilities at the Angunvicolapellessa agricultural research station.	The Hardy Institute is located on the project at Amparai; however, it has no spare physical capacity.
There are underused physical facilities for agronomic research, but GSL plans call for full staffing within 2 years.	There are no research facilities.
There are water management problems on both the left and right bank canals.	The major water management problems and potential for improvements are to be found in the left bank system.

THE TRAINING PROJECT

There are three separate components to the training project. They are discussed separately below under the headings: "The Galgamuwa Water Management Training School," "Support for the National Diploma in Technology Course (Civil Engineering)," and "Overseas Training Courses."

The Galgamuwa Water Management Training School

The Irrigation Department formerly operated this school to put their trainee Technical Assistants through the 2-year JTO course, which has now been replaced by the National Diploma in Technology (NDT). The school was taken over by the Territorial Civil Engineering Organization when it was formed in 1970. Since the abolition of the TCEO in 1977, the school has been unused. As far as we can trace, no firm plans have been drawn up for its future use. The program outlined below is based on the premise that the Irrigation Department will be able to take over the school again. Should this not be the case, the phasing of the program demands that an alternative dry zone site be rapidly identified and facilities prepared.

Apart from any historical claim it may have on the school, there is a very strong case for this to be assigned to the Irrigation Department. From the point of view of irrigation activities, Galgamuwa is probably as suitable a site as could be obtained. It is close to a large number of irrigation schemes of different sizes, and has convenient access to Colombo and to a large proportion of the dry zone irrigation schemes. There is an Irrigation Department circuit bungalow on the property. The Nikaweratiya Divisional Office of the Irrigation Department is immediately adjacent; this should prove a useful point of contact for the training school.

The school buildings at Galgamuwa are large enough for the proposed training programs. Space is available for the development of workshops and laboratory facilities. The buildings are still in good condition in most cases, and a considerable amount of housekeeping equipment is still available. The budget for the USAID program includes an allowance for rehabilitating and reequipping the building.

The purpose in reopening the Galgamuwa school is to run training courses in water management for the staff of the Irrigation Department and other Government agencies responsible for irrigation issues (the Mahaweli Development Board, the River Valleys Development Board, the Department of Agrarian Services). The need for such courses is urgent. The educational courses that qualify people for jobs as Irrigation Engineers and Technical Assistants contain very little of the technical training needed for good water management. The need for such specialized courses has long been recognized by the Irrigation Department. They were formerly organized on a regular basis at Rajangane, and ceased only due to a series of unforseen circumstances. The proposals made here are for a resumption of these courses, but at Galgamuwa, on a larger scale, with more staff and physical facilities, and in greater depth. It is also proposed that, once the Galgamuwa school becomes established, it runs an annual water management course for all newly recruited Irrigation Department Technical Assistants as a part of their apprenticeship. The intention is to induce a greater awareness of, and competence in, the water management side of irrigation work right at the beginning.

In the proposals made below, it is suggested that, once it is fully established, the Galgamuwa school operate for 11 months per year. The precise requirements of staff, even the actual numbers, cannot be specified at this stage, partly because there is a considerable scope for the use of part-time instructors, especially persons already in service with the Irrigation Department, the RVDB, and the Mahaweli Development Board. There should, however, be a core of instructors in the following subjects:

Water measurement and records	(2 persons)
Management and human relations	(1 person)
Earthwork	(1 person)
Concrete work	(1 person)
Use of equipment, machinery, and labor	(1 person)

In addition, the annual 1-month course for Irrigation Engineers and Senior Technical Assistants (Course One) would need the services of an instructor in cost accounting, and extra and/or part-time instructors would be required to cover leave absences. Provision is made in the budget to pay from foreign funds the salaries of six instructors and one expatriate advisor for 2 years. (See Table 7-2, Chapter 7.) The instructors will initially be trained in overseas training courses described later in this section.

In order to provide adequate training, the following equipment is proposed to be supplied from foreign funds:

<u>Hydraulics Laboratory</u>

- Open channel flow system
- Pipe flow system
- Measuring equipment (weirs, Parshalls, orifices) for main sluices, channels, and takeouts

<u>Soils Laboratory</u>

- Gradation equipment
- Soils testing equipment
- Concrete strength testing equipment
- Percolation and seepage test equipment

<u>Field Practice Equipment</u>

- Compactor (1)
- Track loader (1)
- Road grader (1)
- Dump truck (1)
- Hand compactors (2)

In addition to the support mentioned above, it is proposed to provide two jeeps and a 20-seat bus to take trainees on field trips; a house for the expatriate advisor; funds to maintain and operate the equipment provided; and a contribution to the general operating and maintenance costs of the school.

It is proposed to conduct the following four types of training course at the Galgamuwa school:

<u>Course One</u>

- Trainees: Irrigation Engineers and Senior Technical Assistants currently working, or about to be posted, in places with major water management responsibilities

- Number of persons attending: 15
- Duration: 4 weeks
- Frequency: Once per year
- Plan of study:
  1. Water management staff responsibilities
  2. Human and staff relations
  3. Communication
  4. Planning, organization, and management
  5. Water measurement
  6. Water delivery scheduling
  7. Water delivery records
  8. Maintenance equipment
  9. Maintenance records
  10. Design, construction, and maintenance of canal earthwork
  11. Storage, conveyance, and distribution system
  12. Canal automation
  13. Transportation

Course Two

- Trainees: Technical Assistants with water management responsibilities
- Number of persons attending: 40
- Duration: 12 weeks
- Frequency: Twice per year
- Plan of study: Six weeks of classroom and workshop study; 4 weeks of fieldwork; and 2 weeks of final classwork
  1. Maintenance of Irrigation Systems:
     - Canals
     - Canal structures
     - Rights-of-way
     - Use of equipment and labor
     - Maintenance records
  2. Operation of Irrigation Systems:
     - Water measurement and records
     - Preparation of delivery schedules
     - Delivery to farmers
     - Delivery to field channels
     - Delivery to distributaries
     - Communication
     - Transportation

3. Rehabilitation of systems
4. Operation and maintenance of drains
5. Human and staff relations

Course Three

- Trainees: Newly recruited Technical Assistants
- Number of persons attending: 40
- Duration: 12 weeks
- Frequency: Once per year
- Plan of study: Same as Course Two

The precise timing of this course in relation to the recruitment of Technical Assistants would depend on the arrangements reached between the Ministry of Higher Education, the National Apprenticeship Board, and the various public sector agencies employing Technical Assistants about the third year of the NDT course spent in on-the-job training. At present, there is no exact correspondence between the Government agencies to which students go for this year of training and the agencies for which they are finally recruited. Further, it has been proposed that students should go to more than one agency during this year to broaden their experience. The best arrangement would be for the Irrigation Department to provisionally select its recruits after the second year, put them through Course Three at some stage in the third year as part of their training, and finally select them in part on the basis of examinations and aptitude/achievement tests related to the course. If this does not prove possible, newly recruited TA's should all go through Course Three sometime in their first year of service. The inception of this course should be delayed until the training school is equipped and running smoothly--say, the third year of the USAID project.

Course Four

- Trainees: Second-year students of the NDT course in Civil Engineering at Katubedde Campus and the Hardy Institute, Amparai.
- Number of persons attending: 40

- Duration: One week

- Frequency: Four per year

- Plan of study: Lectures and demonstrations intended to familiarize students with the nature and purpose of the hydraulics laboratory, soils laboratory, and field practice equipment mentioned above.

  This course should also not be undertaken until the school is running smoothly.

The bulk of the resources at the Galgamuwa Water Management Training School should be directed to training persons of the TA rather than the Engineer level. This is primarily because, in practice, most of the water management work is undertaken by the TA cadre. A secondary consideration is that the "leakage" of experienced TA's to jobs overseas is proportionately far less than in the case of qualified engineers. However, engineers with aptitudes in leadership and management should be challenged by the training program. They are well adapted to manage schemes with major rehabilitation and improved water use needs.

The school should be run by the Irrigation Department since this is the only department with the necessary technical expertise and experience and the capacity to take on a new project of this nature. The school should be under the Deputy Director in charge of water management.

Although, at least in its early years, the school should be expected to serve primarily the needs of the Irrigation Department and the RVDB at Uda Walawe, it is almost certain that other public agencies--the Department of Agrarian Services and the Mahaweli Development Board--will be very interested in making use of the training for their own staff. Some working arrangements must be devised to allocate places and responsibilities.

Although it is proposed that the USAID fund most of the costs of opening the school and running it for 5 years, a great deal of organization, recruitment, coordination, and some finance is required on the part of the various agencies of the Government of Sri Lanka. A task force should be established at an early stage to plan the project.

Support for the National Diploma in Technology Course (Civil Engineering)

This course is conducted at the Katubedde Campus and the Hardy Institute, Amparai and is the training ground for Technical Assistants. The program suggested here is intended to alleviate the following four problems in the existing course:

- The total output is less than accelerating national needs, mainly because of the requirements of the Mahaweli project.
- The quality of the course is lower than is desirable, in large part because of the shortage of staff, laboratory equipment, and resources for field trips.
- The practical element in the course is inadequate.
- Considering that a large proportion of the successful students are recruited into the Irrigation Department and the Mahaweli Development Board, the proportion of the course relating to irrigation is inadequate.

In the face of this situation, one possible solution would be to open an NDT or similar course at the Galgamuwa training school, and under the control of the Irrigation Department or the ID/MDB/RVDB. This idea is attractive because the physical and social environment at Galgamuwa is especially suitable for a great deal of practical field work; the course content could be strongly oriented towards irrigation; the employing departments would feel a strong commitment to release experienced staff to make sure the training was thorough and had a strong practical bent; and the experience of common training in the relative social isolation of Galgamuwa would help build up a sense of common professionalism, "esprit-de corps," and commitment to the employing departments among the TA cadres.

However, this idea has not been pursued for several reasons. It runs counter to the general trend of national education policy. There is no evidence of enthusiasm for the idea in the Irrigation Department. Given the nationwide problem of shortage of teaching staff in civil engineering, there is a case for concentrating instead on the existing facilities at Katubedde and Amparai.

The suggested program for giving assistance to the existing courses have the following four objectives:

- Increasing the total output of the courses by strengthening the teaching and thus reducing the currently very high failure rates in the second year examinations
- Increasing the practical element in the course by providing laboratory facilities and field trips
- Increasing the weight given to the subjects most relevant to irrigation by providing additional teachers in these subjects
- Improving the quality of the student intake by providing for recruitment partly on the basis of aptitude and achievement tests

The following are the program elements for which it is proposed to provide financial support.

Equipment

It is proposed to provide support for establishing/expanding hydraulics laboratories at Katubedde (in the new section for nondegree courses) and the Hardy Institute, Amparai.

Buildings

Funds are provided for new buildings at the Hardy Institute. These will be required anyway if, as proposed, the Institute is to take on the teaching of the second year of the NDT courses in civil engineering.

Teaching Staff

It is proposed to provide one expatriate teacher for 2 years to work both at Katubedde and Amparai, and two local counterparts in each place for 5 years. They should teach those parts of the course most relevant to irrigation: surveying, theory and design of structures, strength of materials and hydraulics, and irrigation engineering in the second year; and engineering physics and chemistry, engineering drawing, workshop theory and practice, and engineering mechanics in the first year.

Field Visit

Funds are provided for each of the four counterpart teachers to spend a month, probably in India, examining water management and irrigation engineering training and practice. Field visits should also be made to key GSL schemes.

Recurrent Costs

Funds are provided to Katubedde and Hardy to help meet recurrent costs of the irrigation engineering element of the course--operation and maintenance of hydraulics laboratories, preparation of teaching materials, and field trips for students.

Training at Galgamuwa

As was mentioned in the description of the Galgamuwa Water Management Training School, provision is made for the second-year NDT civil engineering students from Katubedde and Amparai to spend a week (in 4 groups of 40 students) at Galgamuwa in order that they might be introduced to more advanced laboratory and field equipment used in irrigation engineering.

The above programs are proposed to be supported by the USAID. There is an additional component which is a matter for the Sri Lanka Government. This is a change in selection procedures for the NDT (civil engineering) course to put more weight on the results of aptitude tests in numeracy and human relations. The intention is to select more on criteria of personal suitability for a TA's job. Tests of this nature did formerly comprise part of the entry procedures at Katubedde, but were abandoned in the face of expansion of student numbers and high student-staff ratios. If additional teaching resources are provided, the reintroduction of such tests is likely to gain the support of teaching staff.

In conclusion, the reasons for preferring to put resources into the NDT courses for potential TA's rather that the degree courses for potential irrigation engineers are the close involvement of TA's with water management and the lower potential loss of trained personnel to jobs abroad.

Overseas Training Courses

In order to staff the Water Management Training School at Galgamuwa with instructors, to begin the planned programs at Gal Oya and Uda Walawe, and to strengthen the Water Management Division at the Irrigation Department headquarters in Colombo, it is necessary to build up rapidly a cadre of about a dozen persons with a thorough training in water management and associated skills, especially rehabilitation and maintenance work and management. A special training course is necessary, and, if this is to include practical demonstrations and first-hand acquaintance with techniques used, it must be held overseas. It is proposed to organize an intensive 3-month course in the first year of the USAID program. One month will be spent at the International Rice Research Institute (IRRI) in the Philippines and 2 months in the United States.

A great deal depends on the success of this course, and it can only be effective if great care is taken initially to recruit the right people, and then keep them in their posts after training is completed.

The course of study is the same as that proposed for Course One under the Galgamuwa program. A division of areas of responsibility must be worked out between the IRRI and the United States components of the course. The IRRI already has established facilities; the course there may be common to all the dozen people on the training program. In the United States, the trainees will be divided into three groups according to their assigned job responsibilities: systems operation and maintenance for the majority; planning for those assigned jobs in this sphere; and training for those destined to be instructors at Galgamuwa. One consultant trainer will be appointed for each of the latter two subjects, and two for O&M. The main activity on the course will be demonstration and visits to research and field sites under the close tutorship of the consultants. Trainees will be asked to produce written work in the form of reports on field visits and evaluations of observed practices and procedures in the light of their applicability to the Sri Lanka situation.

The course will be held three times--in the first, third, and fifth years of the USAID program. The repetition is intended to train those senior staff of the USAID project who did not receive a place on a previous course, to train replacements for those persons who are lost to the USAID project by "natural wastage"--transfers, promotions, resignations, etc.--and, if the situation permits, to train some of the senior water management staff on projects other than those directly incorporated into the USAID project--i.e., Gal Oya and Uda Walawe.

A 1-year overseas training experience will also be made available to the two selected professionals to become water management extension specialists. Personnel should have about 10 years' experience, be interested in onfarm water management, and be educated in soil, water, and plant relationships. Training will consist of approximately 9 months in irrigation and 3 months study on the use of visual and/or education techniques.

Training will be at IRRI, Philippines; Asian Technological Institute, Bangkok; and Irrigation Department, University of California at Davis, Oregon State University, Washington State University, or other universities with suitable courses, depending on when courses are taught and how they fit with the training time schedules.

THE EXTENSION PROJECT

There are two major phases to the proposed program to improve water management at the farm level. The first phase will be 1 year in duration. During phase one, two selected extension specialists will be given overseas training (previously described), and a film will be produced. During phase two, to be financed under the program for 4 years, the trained specialists will be responsible for onfarm water management extension programs at Gal Oya, Walawe, and other areas within the country as time permits.

A 30-minute movie is proposed which illustrates good onfarm water management practices and the benefits to be derived from such management. This extension tool is proposed on the basis of recommendations by GSL extension personnel. Movies are said to be quite popular and likely to draw a large attendance in the rural project areas. The movie would be produced in three languages--English, Sinhalese, and Tamil--to reach the largest number of farmers. An extension water management consultant would advise the film producer. The movie would be integrated into the water management extension program and shown at all dry zone irrigation schemes.

The extension specialists will be initially stationed one each at the Gal Oya and Walawe projects. In addition to working at the farm level, they will also advise the project operating department concerning water delivery requirements at the farm level. The results of field research programs at the Maha Illuppallama research station and Block H of the Mahaweli project will be applied in the extension programs as appropriate. It is expected many of the water management findings of research currently being prepared by AID's financed program in Block H will be applicable to not only Gal Oya and Walawe projects, but to most other irrigated areas of the country. It is anticipated results and recommendations from Block H of the Mahaweli project will be available throughout the remainder of that 5-year program, extending into this proposed 8-year project.

It is also expected water management information will be available from ongoing research at the Angunvicolapellessa station, especially since the station is to be fully staffed within the next 2 years.

Educational programs, field demonstrations, farmer meetings, farm visits, and training programs for extension workers will all be the duties of the water management extension specialists. The thrust of their work will be to use all the known techniques of improving yields by irrigating as efficiently as is practical, using techniques and research results found in Sri Lanka and elsewhere.

Training for the existing field extension workers on water use will not be by formal classroom instruction, but will consist of in-field demonstrations, experimental site visits, and informal local classes.

CENTRAL SUPPORT

A central support organization by both the Irrigation Department and AID project personnel will be needed. This is a $79 million, 8-year program. Much of the money will be spent developing operational control facilities, practices, and procedures not presently available in this country. Further, much can be gained by extending the successful plans to other schemes even before this program is completed. For these reasons, before implementing this program, AID should appoint the senior advisor, and the Irrigation Department should appoint the water management program director. Both should be located in Colombo.

Program Director: GSL

The program director will be responsible for all six projects under the program. He will need to know agriculture and farmers, be a professionally qualified senior engineer, and be able to work with legislation and institutional innovation. Funds are also included for his support staff. Water management specialists are proposed to coordinate the training and extension projects, the Gal Oya project, and the Walawe project.

In addition to water management division staffing, funds are provided for specialists in other divisions within the department who would be assigned to the program. This support staff would bring the department's knowledge into the projects in such areas as agricultural soils, hydrology, hydraulics engineering materials and soils, and sylvania weed control.

Senior Advisor: USAID

The senior advisor will be responsible for the technical assistance needed in the program. He will be assisted by the Gal Oya, Walawe, and Galgamuwa advisors. He will direct any consultant services required such as the master planning, equipment selection and procurement, investigations, facilities engineering, and aerial photomapping. It is expected that his time will be initially directed to program coordination and to the master plans and Gal Oya and Walawe. Included in his budget are funds for specialists in heavy equipment operation and maintenance to be available on an as-needed basis at Gal Oya and Walawe. They will advise and conduct on-job training to ensure efficient operation and maintenance of the recommended equipment, excavating, and shop unit to be used by the maintenance and rehabilitation departments.

Policy Advisory Committee

It is recommended that a policy advisory committee be formed to function throughout the duration of the program. The committee would meet two to four times per year at various project sites to:

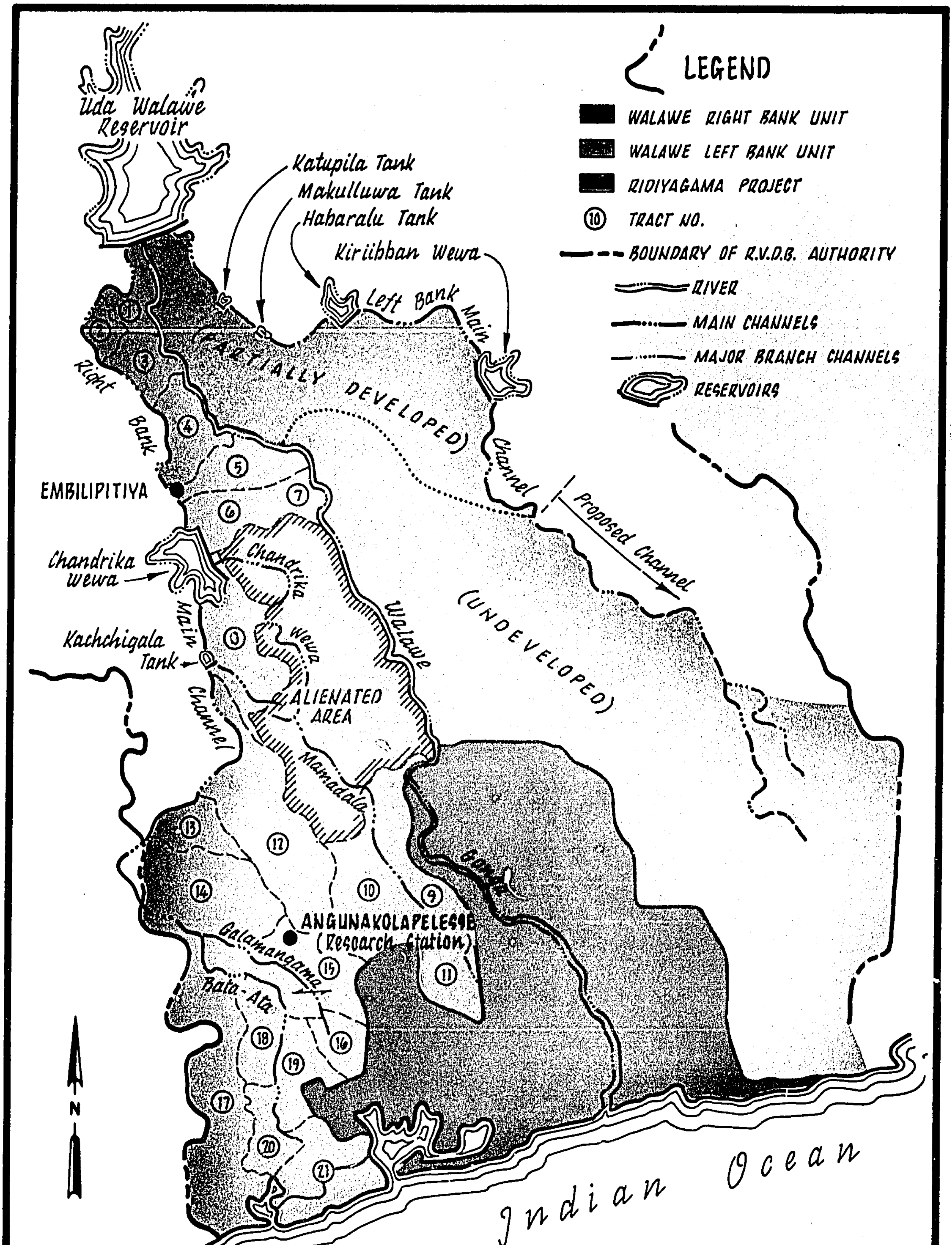
- Review project progress and performance
- Prepare progress and evaluation reports
- Give direction and support to the program

The committee could consist of the following:

Chairman - Director, Irrigation Department
Observer, Advisor - AID Mission Representative
Members - Representatives from
River Valleys Development Board
Mahaweli Development Board
Galgamuwa Training School
Agricultural Extension and Research

UPGRADING UDA WALAWE

The Walawe project is an 8-year program to develop operational control, improve service to the farmer, add water management to onfarm extension programs, develop procedures for maintenance and rehabilitation, conduct field research, and develop and implement master plans for reuse, main system operation, and improved domestic service. The project is designed to increase overall project efficiency from 15 to 31 percent, resulting in equitable service to 69,000 acres with a cropping intensity of 2. A map of the Walawa project follows this page.



WALAWE PROJECT

SRI LANKA MANAGEMENT STUDY

CH2M HILL

Operational Control

The proposed organization for water management at Walawe is shown on Figure 6-1. Under the proposed organization, the water management engineer should have the responsibility for and direction of the operation and maintenance personnel, materials, and equipment necessary to implement the project. He will be receiving support from the onsite AID technical advisor, RVDB Accounting Department, and from central support at Colombo. He will direct the activities of the Operations Department and the Maintenance Department.

There are four key positions that need to be added to the Operations Department. They are the operations supervisor, the left bank water master, the right bank water master, and the water accountant. Below this level, the presently planned and budgeted staff of one TA for every 8,000 acres, one overseer for every 2,500 acres, and one irrigator and patrol walker for every 500 acres should be adequate. It will be necessary to add 12 jeep drivers, 2 radio maintenance technicians, and up to 5 trained radio dispatchers. The water management engineer and either the Operations Department manager or the right bank water master should be made available for the initial overseas training course before the USAID technical advisor comes on the job. Project cost estimates include the above added staff for the 8-year duration of the project. In addition, funds are budgeted for needed communications and transportation equipment.

Equipment should be made available only as staffing training levels and job functions are developed.

The proposed project implementation task and schedule for the Operation Department follows.

PROJECT YEAR	TASKS AND RESPONSIBILITIES - WALAWE OPERATIONS DEPARTMENT
1	Send two key personnel to overseas training course.
	With help of central support and extension project staffs, design the delivery schedules including flows for Tract 3 field channels and distributaries. Result should be trial issue trees for Tract 3.
	Plan initial order for needed transportation and communication equipment. Specifications to be prepared by consultants.

ORGANIZATION FOR WATER MANAGEMENT

WALAWE PROJECT

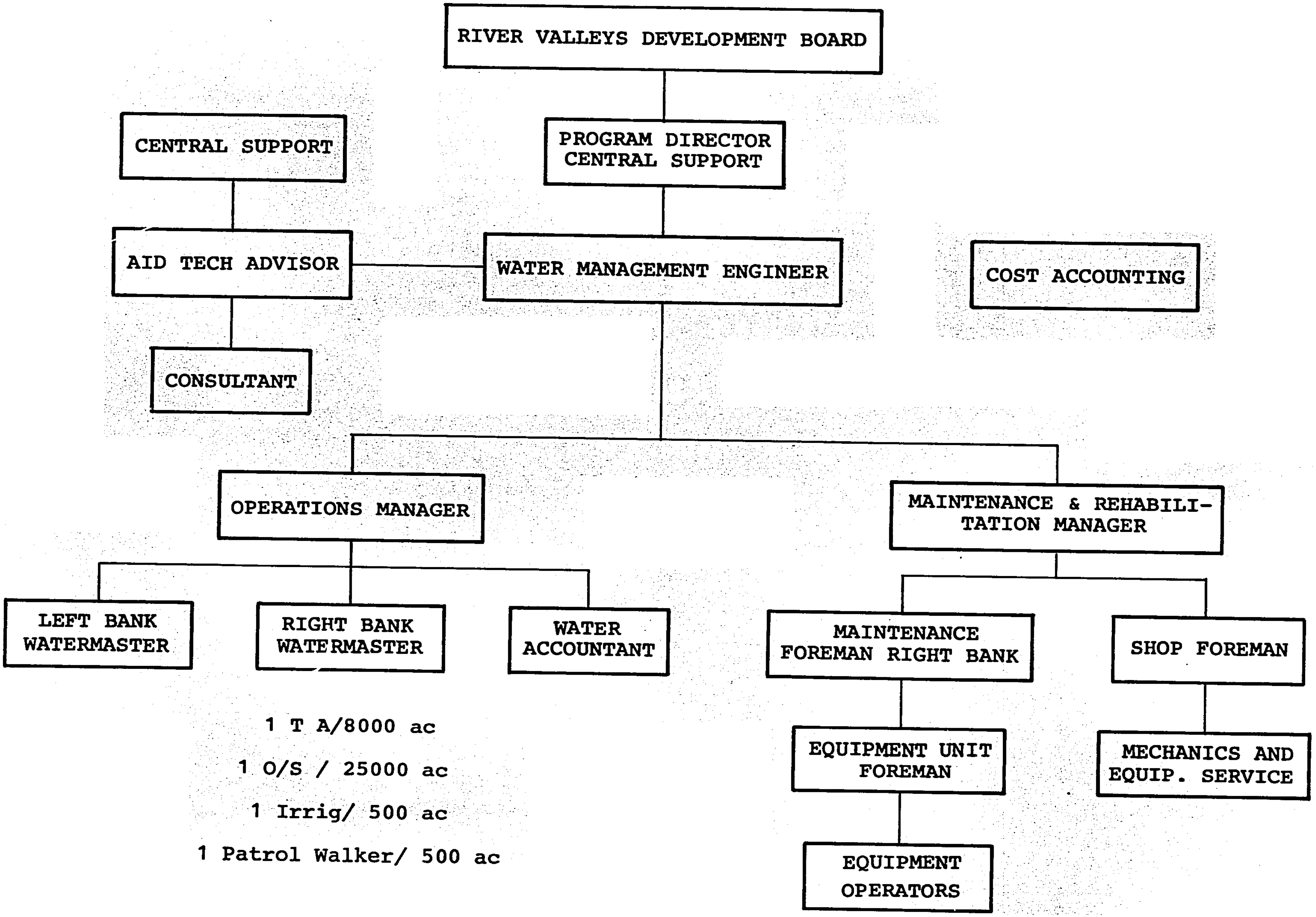


Figure 6-1

PROJECT YEAR	TASKS AND RESPONSIBILITIES - WALAWE OPERATIONS DEPARTMENT
1 (cont)	Develop interim delivery schedule for branch canals. Order measurement and control equipment for right bank branch canals. Develop plan for measuring and controlling branch canal headworks.
	Assist water management engineers (WME) with farmer information program.
	Conduct normal operational duties.
2	Operational control of Tract 3 facilities as they are ready for operation and measurement.
	Implement schedule and daily operation and water delivery record of Tract 3.
	Schedule and measure right bank branch canals on daily basis.
	Develop and implement procedures for use of transportation and communications equipment and for radio operators training.
	Prepare delivery schedules for third year operational control project.
3 to 8	Operational control, delivery schedules, and preparation of annual water delivery report each year. Bring in all tracts on right bank on a planned approved and implemented annual program basis.

Maintenance and Rehabilitation

There are three key positions to form the Maintenance and Rehabilitation Department. They are the department supervisor, the right bank maintenance foreman, and the shop foreman.

The department will construct the improvements designed for Tract 3 with strict cost accounting control so as to develop rehabilitation and maintenance costs for the different rehabilitation plans for Tract 3. Based on the results of Tract 3, the department will construct the improvements required to gain operational control of the right bank. The proposed improvements for Tract 3 are shown in Table 6-1. The Tract 3 program is designed to test the operational control and improved service performance of three types of improved canal systems. They are concrete lining, hand constructed earth lining, and machine constructed earth

Table 6-1
Tract 3 Rehabilitation Improvement Program

Item	Quantities Distributor	Field Channel
Concrete line D 031600 system	1.7 mi	2.9 mi
Hand excavated and compacted earth lining D 031500, 031000	.5 mi	2.1 mi
Machine excavated and compacted earth lining	2.8 mi	3.5 mi
TOTAL MILES for 668 acres	5.1	8.5
Take out modifications & measure devices	7 ea	57 ea
Regulator modifications	20 ea	130 ea
Farm outlet modifications	-	260 ea

lining. These systems will be evaluated for costs and performances against cleaned, unimproved canal systems. From these results, the remaining right bank tracts will be planned, designed, and constructed.

Cost estimates are based on an 8-year staged program of providing maintenance and rehabilitation "equipment units" to complement the hand labor maintenance activities and to improve construction and maintenance practices. The composi- is shown on Table 6-2.

Also included are "Maintenance and Shop Units" to maintain the equipment units and the transportation equipment for the Operations Department. One shop unit can support up to 10 jeeps, 1 excavating unit, and 2 equipment units. The shop unit would have the responsibility of transporting fuel and lubricants to the heavy equipment operating in the field. Major repairs would be performed at the centrally located existing RVDB shop facility with staff and equipment furnished under the program. Minor repairs would be performed by shop mechanics using the shop truck. Daily lubrication and maintenance would be performed by the assistant equipment operator and the lube truck driver. Table 6-3 shows the equipment and labor requirements for the typical maintenance shop unit.

Equipment and shop unit requirements must be evaluated in detail during design of improvements prior to ordering any equipment or hiring "equipment unit staff." Specifications for all equipment will be prepared by USAID consultants.

The proposed project implementation task schedule for the maintenance and rehabilitation program follows.

PROJECT YEAR	TASKS AND RESPONSIBILITIES WALAWE MAINTENANCE AND REHABILITATION DEPARTMENT
1	Select and send maintenance department manager to overseas training course.
	Prepare designs and estimates for Tract 3 (AID consultant).
	Order Equipment Unit No. 1 (AID consultant and maintenance department manager).
	Order Shop Unit No. 1.
	Select staff shop foreman and equipment foreman and crew.

Table 6-2
Typical Maintenance Equipment Unit
Sri Lanka Water Management Program

Item	Quantity	Description
Capital Equipment Requirement		
Dump Truck	4	5-cu-yd, 2-axle truck with heavy duty dump bed (to resist rock damage), air brakes, and trailer towing, accessories
Trac Loader	1	Case or John Deere (or equivalent) Trac Loader
Trac Dozer	1	Case 450 hydraulic angle blade dozer or equivalent with logging winch or ripper
Equipment Trailer	1	2-axle tilt-type, suitable for hauling behind dump truck to haul loader, vibrator roller or dozer
Grader	1	John Deere 570 (or equivalent) hydraulic grader w/short turning radius and high flotation
Hand Compactor	4	Wacker Model GVR 220Y or equivalent, gasoline operated
Jeep	1	
Labor Requirement		
Equipment Foreman	1	
Equipment Operator	3	
Truck Driver	4	
Jeep Driver	1	

Table 6-3
Typical Maintenance Shop Unit
Sri Lanka Water Management Program

Item	Quantity
Capital Equipment Requirement	
Lube/Fuel Truck	1 ea
Shop Utility Truck 4-wheel drive	1 ea
Portable Welder	1 ea
Jeep	1 ea
Machine Tools	1 Unit
Oxy/Acetylene Torch Portable Grinder Bench Grinder Small Lathe Drill Press Hydraulic Press Vehicle Hoist or Rack Tire Repair Equipment Air Compressor Hand Tools and Wrenches	
Labor Requirement	
Shop Foreman	1 ea
Mechanic/Machinist	1 ea
Mechanic	1 ea
Welder	1 ea
Jeep Driver	1 ea
Truck Driver	1 ea

PROJECT YEAR	TASKS AND RESPONSIBILITIES WALAWE MAINTENANCE AND REHABILITATION DEPARTMENT
2	Use senior advisor's central support personnel for on-the-job equipment and training.
	Construct Tract 3.
	Prepare plans and designs for next tract (AID consultant).
	Add Equipment Unit No. 2.
	Add Shop Unit No. 2.
3 to 5	Evaluate programs--set design standards.
	Continue tract improvement program.
	Add Equipment Units No. 3, 4, and 5 each year.
6 to 8	Complete right bank program with the five equipment units--move to left bank as soon as possible. Leave sufficient equipment units to maintain the system.

Master Planning

The proposed organization for the master plan is shown on Figure 6-2. The purpose of the master plan program is to conduct the necessary investigations and planning for return flow reuse, main canal plan, and domestic water plan to permit some implementation during the fourth program year. The master plan will provide the basis for program implementation. Program planning and implementation costs were developed for the purpose of this report based on judgment. Release of funds for either should be based on further technical evaluations.

Return Flow Reuse. Reuse is a must if the Walawe project is going to achieve its original design objectives. The proposed project will fund a master planning effort for this purpose. Costs are included for a planning team, equipped and staffed as shown on Figure 6-2, to conduct return flow measurements and develop a master reuse plan.

Canal System. A master plan for operation of the main canal and tank system is needed to evaluate ways to improve operational storage at Chandrikawewa, identify and correct operational deficiencies along the main canal, and develop operational criteria to reduce spills, maximize diversions, and ensure equitable distribution of flows in all reaches of the main canal.

ORGANIZATION FOR MASTER PLANNING
WALAWE PROJECT

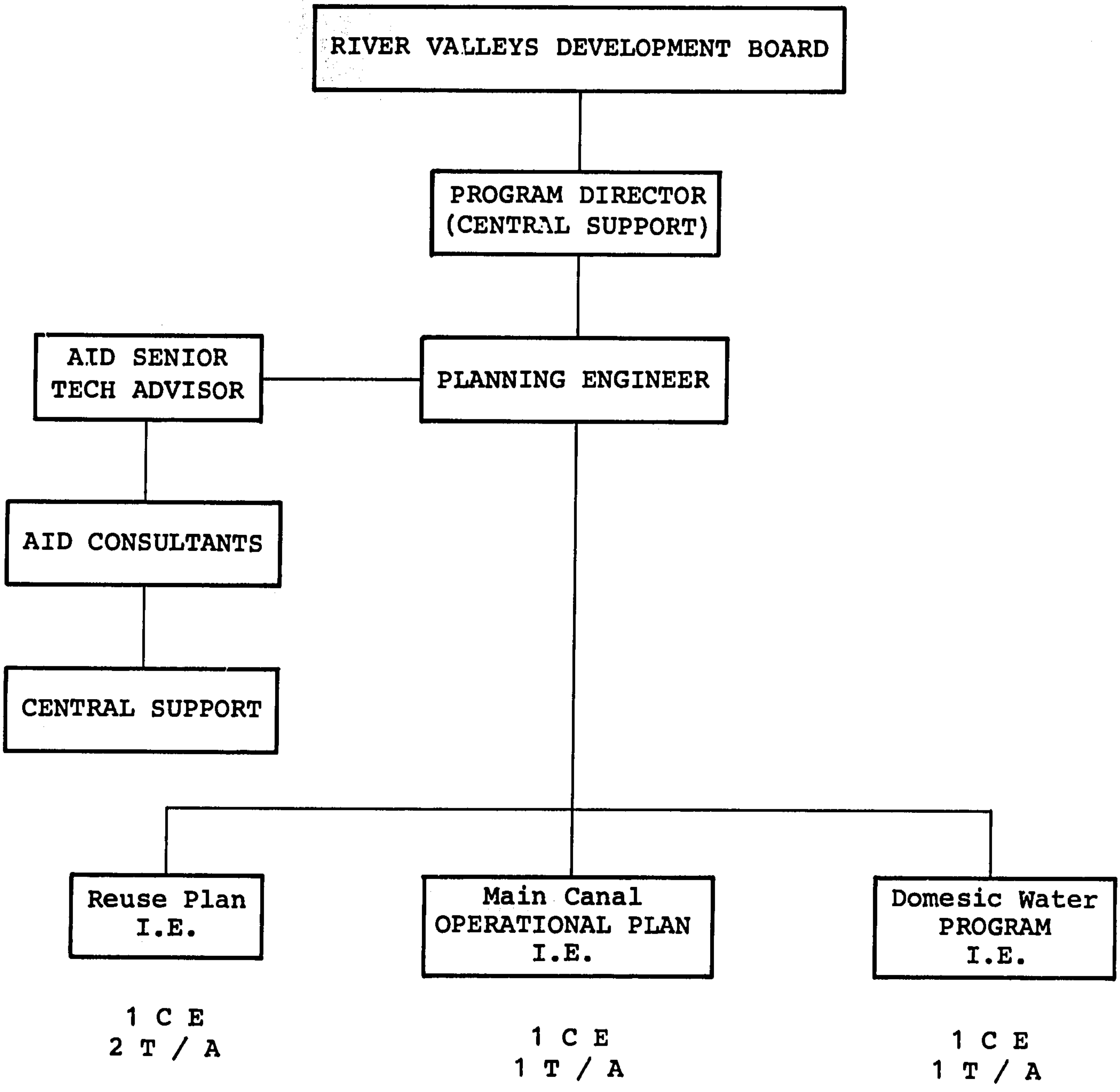


Figure 6-2

The master plan would be developed in the first 3 years of the project.

Domestic Water. A master plan for domestic water is recommended for the following reasons:

- Domestic runs cause major problems with canal operation and maintenance.
- Canals used for domestic use present health hazards.
- Loss of water for amount beneficially used is extremely high.

The plan will investigate domestic water requirements, ground-water quantities and quality, and develop and evaluate alternative plans for domestic water service. The plan will be developed concurrently with the return flow reuse plan.

The senior advisor is expected to play a major role in coordinating special investigation and master plan studies by outside consultants.

The master plan is scheduled to be complete in 3 years. A description of activities is as follows:

PROJECT YEAR	ACTIVITIES
1	Retain consultants.
	Purchase and install up to nine permanent recording gauging stations in key tributaries. Install and read selected gauges once a day at other locations.
	Develop plan of study for the master plan.
	Process data.
2	Conduct special investigations.
3	Complete master plan for reuse.
4 to 8	Design, construct, and operate facilities required to implement the master plan.

Field Research

Two field research projects are proposed at Walawe. They are:

- A program to evaluate the performance of a low head buried pipeline distribution and field channel system on the left bank
- A program to evaluate a revised field channel layout also on the left bank with onfarm land leveling and water management to permit return flows to reenter the field channels

Pipeline Field Research. Costs are included in the program to design and construct an approximately 2-mile semiclosed low-head pipeline system to serve new allotments on the left bank. Use of concrete pipe manufactured at Walawe for pipeline and for baffled control structures will be part of the project. It is estimated that this type of construction is feasible in many instances (especially where gradients are steep) and has many operating advantages.

Onfarm Improvement. Equipment, personnel, and technical assistance will be provided to pick up and reuse water efficiently on farms in newly developing areas starting in Tract 3 of the left bank, Walawe. This is to serve as a demonstration to control and make available water in long field channels which at present are not capable of serving farmers at the lower ends. This demonstration will continue for 5 years, at which time it will continue as a part of the Government of Sri Lanka's ongoing program if desired. During the 5-year period, equipment and personnel will be available to assist in onfarm development in Tract 3, right bank, as needed and accepted by farmers. Other areas may also be served if time and personnel are available.

An Extension Service professional working under the River Valleys Development Board will be in charge of a team of surveyors and a land leveling unit that will lay out model farms for best utilization of water from a field channel and/or drainageways. Objectives of the work will be to devise systems to pick up and reuse water by returning it to the field channel and/or drain by leveling fields and constructing farm ditches and drains with sufficient precision to have this kind of control. The planning on technical aspects will be done by a committee of Sri Lankan engineers and agriculturists assisted by an expatriate agricultural engineer who is trained in onfarm irrigation development. They will utilize the best known technology for water control compatible to the country and to especially design systems to fully utilize rainfall.

The team will continue developing and leveling land for a 5-year period under this program in Tract 3 and in other tracts if time permits and conditions exist that are favorable for this type of development.

Benefits will be derived from water savings that can be used on lands not now receiving sufficient amounts for full production. Savings will be from applying smaller amounts at each irrigation, better utilization of rainfall, and reuse of surface runoff from farms at the head of the field channel. Also, longer fields and larger basins will allow plowing in a shorter period of time, thus reducing the time water is needed during the planting period.

It is estimated one tractor with equipment with occasional help from the Board's grader can level and develop 100 acres per month and can operate 5 months out of a year due to weather conditions. Two tractors at 100 acres for 5 months for 5 years can provide better water management to 5,000 acres at a cost of about Rs.400 per acre.

UPGRADING GAL OYA

The recommended water management project at Gal Oya is to organize staff and equip a water management group similar to that at Walawe but with more capability to implement an initial major rehabilitation program. This is needed because canal erosion and siltation severely prevents any control over system flows. Over 30,000 acres in the lower left and right bank systems are not receiving reliable irrigation or domestic service due to extreme deterioration and siltation of main, branch, distributor, and field channels. The major elements of the Gal Oya project are:

- Design and construct a water management headquarters shop and maintenance yard.
- Implement the aerial photo land and canal inventory project. Develop delivery schedules and flow criteria.
- Organize, train, and implement an operation program.
- Organize, train, and implement a maintenance and rehabilitation program. Precede this program with planning, design, and construction activities.
- Conduct a 3-year master planning program for return flow reuse on the left bank, main canal system operational plan, and a domestic water master plan. Implement the master plans within 5 years.

With proper program planning and execution, it is estimated that the overall project efficiency will be increased from approximately 40 percent to approximately 55 percent. The result will be to increase the cropping intensity factor from 1.4 to 1.9. A map of the Gal Oya project follows this page.

The organizational and staffing requirements for operational control and improved water service are shown on Figure 6-3. The organizational requirements for planning is the same as for Walawe. (See Figure 6-2.) Program costs were developed based on the organization and implementation schedules outlined below.

Operational Control

The Operations Department will have responsibility for equitable service to all project levels. In addition, it will be developing operational procedures to be extended to other schemes. Emphasis will be to schedule, deliver, measure, and record the operation of the system and to develop the confidence and trust of the water users. Procedures will need to be developed for the operation and control of the communication and transportation equipment.

PROJECT YEAR	OPERATIONS DEPARTMENT ACTIVITIES
1	Select the assistant irrigation engineer. Select operation and maintenance and rehabilitation department manager. Send them to overseas training programs. Inspect United States irrigation projects that are using the same type of equipment during the irrigation season. Select project technical advisor (AID). Coordinate aerial photo land and canal inventory project. The project will define all service areas for each field channel, distributory, and for selected reaches of branch and main canals. The flight should be made on 15 February 1979. Coordinate the flight with the one scheduled for the Mahaweli "C" area. Flight specifications to be given by AID. Develop service areas from photo enlargements scale 1 inch to 8 chains. Prepare delivery

ORGANIZATION FOR WATER MANAGEMENT

GAL OYA PROJECT

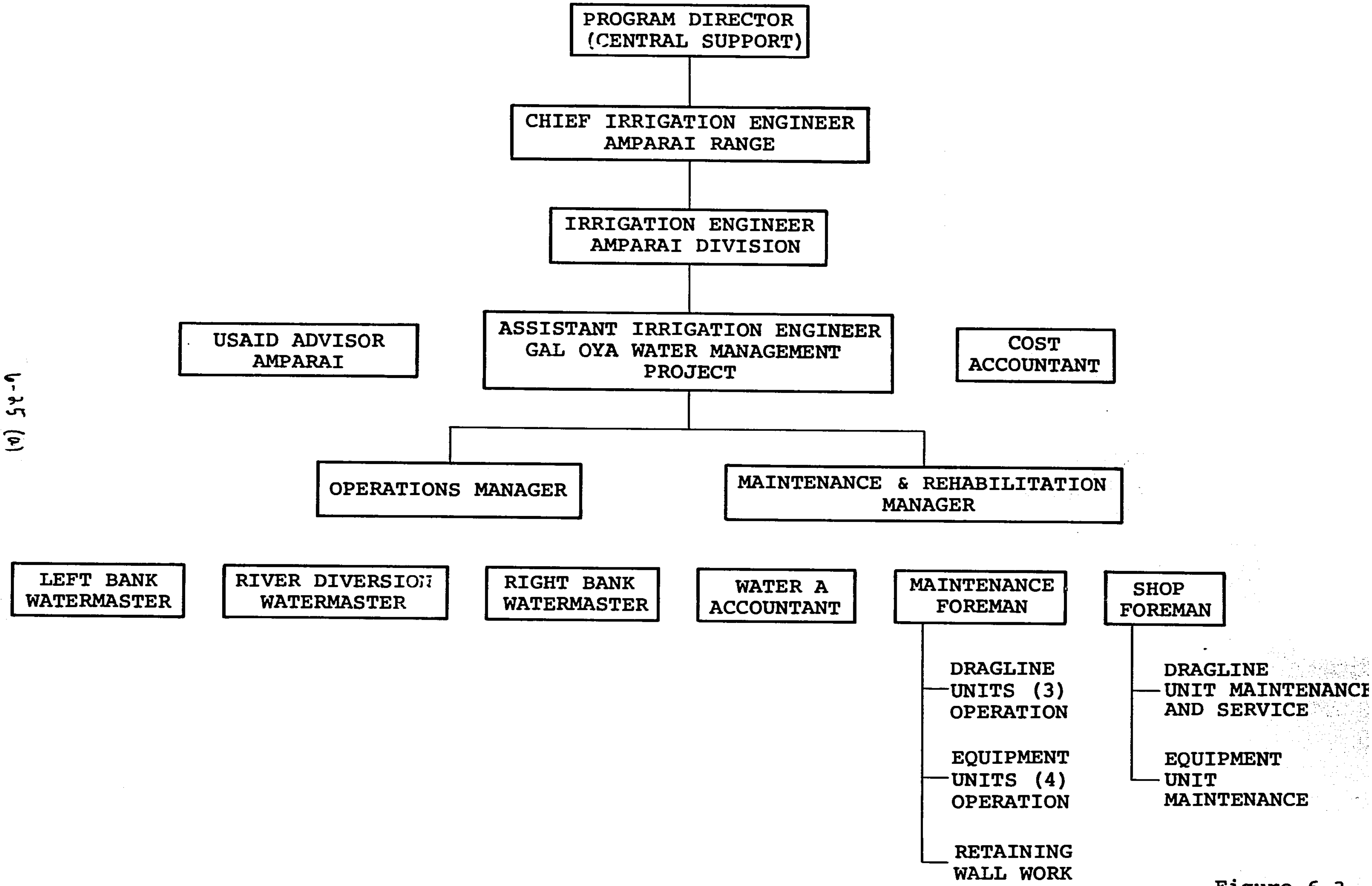
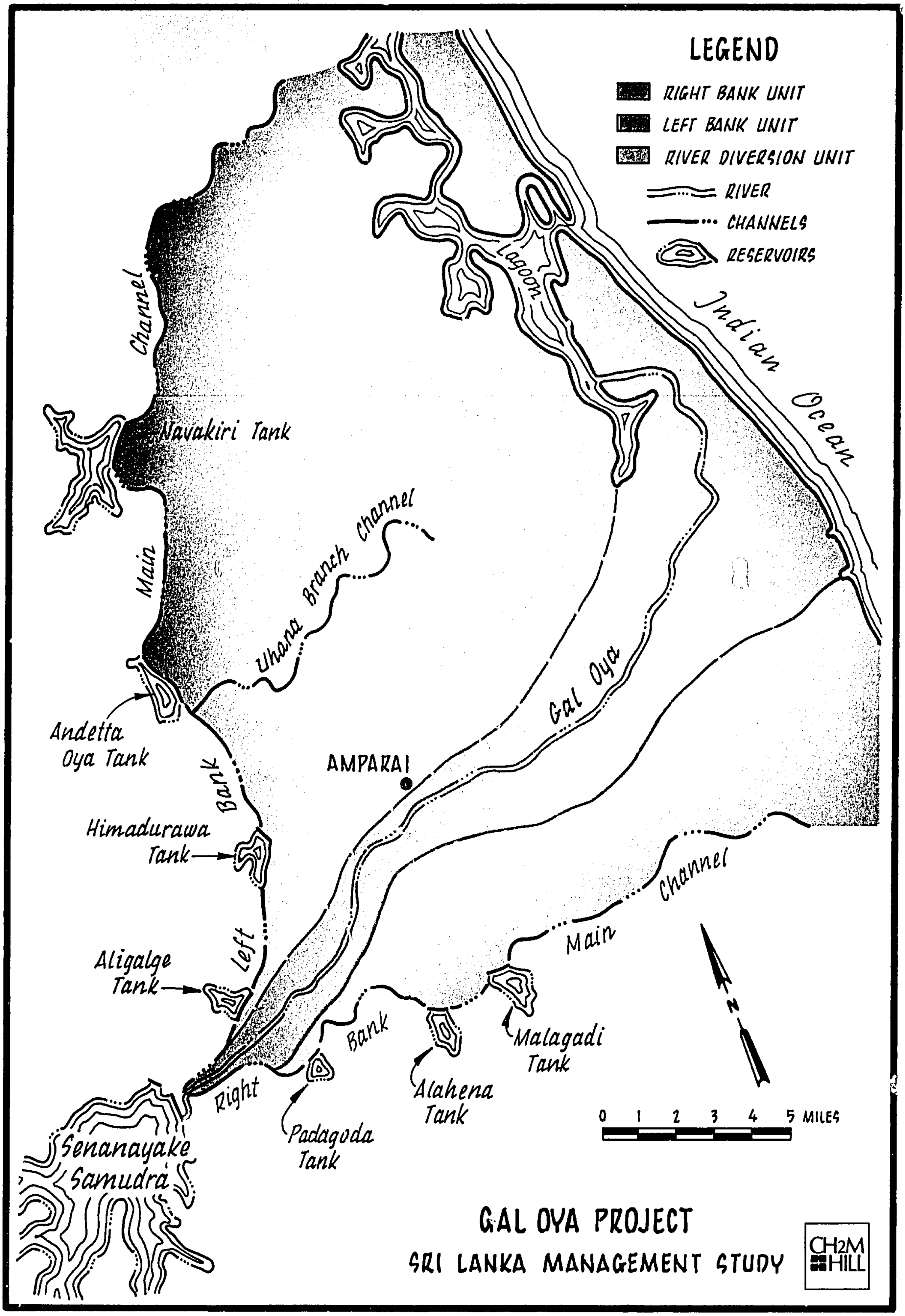


Figure 6-3


LEGEND
RIGHT BANK UNIT
LEFT BANK UNIT
RIVER DIVERSION UNIT
RIVER
CHANNELS
RESERVOIRS
Lagoon
Indian Ocean
Channel
Navakiri Tank
Main
Uhana Branch Channel
Andetta Oya Tank
Bank
AMPARAI
Gal Oya
Himadurawa Tank
Left
Aligalge Tank
Main Channel
N
Malagadi Tank
Bank
Alahena Tank
Right
Padagoda Tank
Senanayake Samudra
0 1 2 3 4 5 MILES
GAL OYA PROJECT
SRI LANKA MANAGEMENT STUDY
CH2M HILL

PROJECT YEAR	OPERATIONS DEPARTMENT ACTIVITIES
1 (cont)	schedules for an upper field channel (U1). Using assistance from extension and central support projects, prepare flow criteria for main and branch bifurcations. Install water level gauges and gate position indicators at main and branch bifurcations. With help from central support, develop measurement tables for each bifurcation.
	Coordinate ordering communication and transportation equipment from AID prepared specifications.
2	Implement initial flow scheduling and measurement program to river, left and right banks, and main and branch headworks. Record and compile daily, monthly, and annual flow data. Prepare an annual measurement report.
	Implement scheduling and measurement of initial field channel and/or distributary in Upper System (U1 or equivalent) after improvements have been made to gain operational control. Coordinate all scheduling with farmers' organization.
	Prepare and implement operating and training procedures for communication and transportation equipment.
	Select promising candidates for third year overseas training program.
3 to 8	Continue operations on staged basis left bank first, taking care not to overcommit or act prematurely. Operational control and improved service must be obtained before scheduling is implemented.

Maintenance and Rehabilitation

Selection and training of this department manager and his foreman is an all-important step, requiring input from central support project personnel. This department will be most concerned with proper execution of preplanned and predesigned activities. Special attention should be given to cost accounting, quality control, and equipment performance practices and procedures. Planning, design, survey, investigations, material selection, and compaction standards will come primarily from central support. The overall objective of this department is to build up and maintain a strong maintenance capability and to develop procedures to be extended to other schemes.

Preliminary estimates were made of the rehabilitation works required at Gal Oya in order to permit operational control of the system and equitable distribution of flows to all command areas. These were made by Gal Oya project staff without the benefit of system inventories of surveys. Gal Oya design plans were lost or destroyed. Even if they are found, they will be of little benefit because the lands irrigated are much different than originally planned as the basis for design. The estimates listed below indicate the approximate type and magnitude of work to be done.

Canal work left bank	
Silt removal, main canal 32 miles	750,000 cu yd
Silt removal branch with distributors 50 miles	750,000 cu yd
Retaining walls, stone and mortar	3 miles
Bank restoration, branch with distributory	30 miles
Field channel restoration, left bank	68 miles
Canal work right bank	280 miles
Modifications and repair to measure and control main canal regulators	218 gates
Furnish and install new gates and measuring devices	560

It is proposed that the above work will be done with project-furnished personnel and equipment. The "equipment unit" and "shop unit" proposed for Gal Oya consist of the same equipment and personnel staffing plan as previously explained for the Walawe project (see Tables 6-2 and 6-3). Four such maintenance equipment units and maintenance shop units are ultimately proposed for the Gal Oya project. In addition, the department will be equipped with the capability to desilt in the "wet" (while canal deliveries will be made). This operation will have to be carefully planned, scheduled, and executed to achieve satisfactory production and to keep from silting up what has already been desilted. Equipment selection is all-important and must be verified with detailed investigations. An estimate was made of the composition and number of excavating units that may be required. This is shown in Table 6-4.

Table 6-4
Typical Excavating Unit
Sri Lanka Water Management Program

Item	Quantity	Description
1 cu yard Dragline*	1 ea	Full tracked machine with 1 cu yd bucket, 50-foot boom, capable of double line operation for clamshell or multipart line with hook block. Crane rating of at least 20 tons. Air over hydraulic.
Backhoe, Track	1 ea	Case 980B or equivalent. Full tracked hydraulic excavator with longest standard boom option. 42-inch-toothed rock bucket and 6-foot-wide smooth (w/o teeth) bucket. Hydraulic "adjusta-bucket" knuckle. 8 to 10-foot aquatic weed rake attachment. High flotation tracks.
Backhoe/Loader Rubber Wheel	1 ea	Industrial wheel-type tractor with four front loader bucket and backhoe attachments. In addition to standard tooth bucket, provide smooth ditch cleaning bucket and 8-inch-wide curtain wall bucket. Provide hydraulically driven compactor attachment.
Lowboy Transport Truck	1 ea	Heavy-duty 3-axle truck-tractor with winch mounted amidship. 40-ton lowbed semitrailer with loading ramps or removable gooseneck.
Jeep	1 ea	4-wheel drive
Spare Parts (20%)	l.s.	
Labor Requirements		
Equipment Foreman	1	
Equipment Operator	3	
Assistant Equipment Operator	3	
Truck Driver	1	
Jeep Driver	1	

*Field and laboratory investigations of excavating requirements must be made. A small mobile dredge may be substituted depending on findings of the investigation.

The implementation schedule proposed for maintenance and rehabilitation activities follows.

PROJECT YEAR	MAINTENANCE AND REHABILITATION DEPARTMENT DEPARTMENT ACTIVITIES
1	Select maintenance department manager--send to training program including actual use of canal maintenance and rehabilitation equipment proposed for this project. With AID consultants as advisors help, make tentative equipment selection.
	Prepare specification and procure an excavating unit," "equipment unit," and "shop unit."
	Develop plan for initial stage of gate, silt removal, and retaining wall program.
	Coordinate design of improvements with central support and AID consultants.
	Select and train shop foreman. Set up equipment maintenance and repair shop. Use central support project personnel to assist.
	Select and train maintenance foreman. Use central support project personnel to assist.
2	Implement canal desilting and banks restoration program using excavating units, equipment units, and hand labor.
	After testing equipment, order two excavating units, two additional equipment units, and one additional shop unit.
	Coordinate program design and construction quality control with central support.
	Continue planning and design for gate measuring and control. Install initial gates.
	Maintain and repair equipment. Evaluate performance and correct deficiencies.
3 to 8	Order final excavating unit and equipment unit in third year.
	Coordinate planning and design of future program phases with central support.

PROJECT YEAR	MAINTENANCE AND REHABILITATION DEPARTMENT DEPARTMENT ACTIVITIES
	Execute gate, desilting, canal restoration, and retaining wall construction programs.
	Maintain, repair, and monitor equipment performance.

Master Planning

The Gal Oya project has the same needs for master planning as Walawe. This is true for all the schemes we visited in the country. Because of the different characteristics of the two projects (outlined in Chapter 6), it is expected that planning procedures, results, and implementation will be different.

The organization and conduct of the planning effort will be very similar to that proposed for Gal Oya. The needs and reasons for reuse, main canal operation, and domestic master plans is the same as for Walawe. This is also true for the implementation schedule.

THE SOCIAL RESEARCH PROJECT

Purpose

The ultimate purpose of the USAID program is to improve the level of economic and social welfare of the people of Sri Lanka, especially the populations of the project areas. There is a strong case for some kind of social research or monitoring to evaluate the actual contribution of the project to this goal.

More specifically, the aims of the research program should be defined as follows:

- To evaluate the social and economic effects on the rural population in the project areas of the implementation of the water management program
- To evaluate the effectiveness of the way in which the Government agencies concerned implement the program
- To act as a "monitoring station" in relation to the two issues listed above, with responsibilities for reporting on a continuing basis on the effectiveness of the program viewed from the field--The purpose is to improve the program while it is underway.

Method

The two main alternative methods which could be used are the "survey approach" and the "participant approach." At the extreme, the survey approach involves simply the conduct of interviews to collect baseline data from a sample of households in the project areas, followed by intermediate (possibly) and final sets of interviews with the same farmers. There are four main weaknesses of such a method: the difficulty the analyst has in detecting causal relations from survey data; the tendency of the method to limit investigation to preconceived notions of what is important, which are then embodied in the questionnaire; the fact that findings and conclusions tend to come only at the end, when they have little practical significance for the project studied; and the problems of getting reliable information in interviews between rural people and strangers. The participant method, in which the person(s) responsible for analysis live in the project areas and interact intensively with the rural population, can, if done well, cope with these problems. The danger of the participant method is excessive reliance on information gathered from small and possibly unrepresentative samples.

From the point of view of present concerns, the best method would be a combination of both survey and participant methods, but with the emphasis on the latter. In other words, the analyst(s) should spend a great deal of time in the project areas and develop ideas and precise research methods on a continuing basis in response to daily experiences. Resources will be adequate to conduct such sample surveys as are necessary. A small number of research assistants should be posted permanently in selected locations in order to provide local points of contact and source of information for the analyst(s) in a variety of different local circumstances. Precise definition of the method to be used should be left to the discretion of the analyst.

Personnel

The question of whether the social research suggested here will have any value will depend very largely on the selection of the person(s) who are to be in charge of it--the analyst(s). This is especially crucial in the present situation because of the extreme shortage of suitable persons. Experienced Ceylonese social researchers are few in number and in enormous demand, especially to evaluate foreign-funded projects. It is extremely unlikely that one could be found who would be able and willing to commit, say, half of his or her time over several years to this program. There are a number of local institutions that conduct social research, but they are very short of experienced staff and could not be expected to do more than marshall and supervise enough field assistants to do a baseline/final sample survey of the type discussed above. The main problem with using expatriates is that, unless they have previous experience of Sri Lanka, they will tend to spend a great deal of time simply learning about the country, and thus only become useful towards the end of the project. In addition, an expatriate with a family is unlikely to spend a great deal of time on participant research.

The following are, in order of preference, the ranges of acceptable choices for a chief analyst to be responsible for the research:

- An experienced Ceylonese researcher prepared to spend at least 2 person-years on the project, including at least 1-1/2 years living in the project areas

- An expatriate researcher with substantial experience in other parts of rural South Asia, and some familiarity with Sri Lanka

The question of which of the social science disciplines should be sought is subsidiary to the issue of the suitability of the person on the other criteria mentioned above.

If it does not prove possible to recruit any suitable person falling into the above categories, then it would be wise to eliminate the social research program.

The bugetary provisions made are necessarily very tentative. The following provisions are included:

- That it is possible to recruit a suitable expatriate senior analyst who will come to Sri Lanka on a visiting basis, covering 2 years in total in the 5-year program

- That a Ceylonese junior analyst can be recruited on a full-time basis

- That the project will require a jeep and 20 person-years of research assistance

Institutional Links

It is very desirable that the research be based at a local research institution. It is not appropriate to specify which one at this stage.

Chapter 7
PROGRAM COSTS

The total cost of the program is 79.6 million U.S. dollars or the equivalent of 1,233 million rupees (15.5 exchange rate). A breakdown of the program cost by project is as follows:

	U.S.$1,000	Rs.1,000
Training	2,234	34,627
Extension	228	3,534
Central Support	1,219	18,895
Walawe	38,538	597,339
Gal Oya	36,996	573,438
Social Research	359	5,565
TOTALS	79,574	1,233,398

A breakdown of estimated capital and annual costs for each project are included at the end of this chapter. Further breakdown of project elements are included in Appendix Seven. Costs are based on 1978 prices with estimated totals with inflation for later years. Equipment costs are based on U.S. manufactured equipment c.i.f. dockside Colombo. GSL salary costs are based on rates shown for 1978 in Appendix Seven, Table 7-G.

Contingency allowances and engineering costs are shown in Cost Tables 7-1 to 7-5. All costs are deemed to be of an accuracy adequate for budget purposes. Engineering activities include predesign and design services to further identify labor, equipment and materials requirements, plans, and specifications for project implementation. Project costs shown for master plan implementation cannot be estimated with confidence until the master plans are complete. The consultant arrived at costs of implementing master plans (Project Years 4 to 8) using judgment and experience based on similar programs executed elsewhere. By the end of the third project year, these costs should be known with greater accuracy.

Table 7-1
Summary of Total Program Costs
(Capital and Annual)

Project Year:	1	2	3	4	5	6	7	8	Total
Training	708	538	589	104	295	--	--	--	2,234
Extension	121	71	11	12	13	--	--	--	228
Central Support	353	276	299	98	106	27	29	31	1,219
Gal Oya	4,734	5,454	3,241	4,821	5,197	4,173	4,508	4,868	36,996
Walawe	1,240	2,595	1,932	6,179	6,811	6,094	6,581	7,106	38,538
Social Research	70	64	69	75	81	--	--	--	359
TOTAL	7,226	8,998	6,141	11,289	12,503	10,294	11,118	12,005	79,574

Table 7-2
Estimated Program Costs, Training Program for Water Management (U.S.$1,000, 1978 Price Level)

Item	Year: 1	2	3	4	5	Total
Staff Training						
Consultant	48	--	48	--	48	144
Trainee travel, U.S.	4	--	4	--	4	12
Subsistence, trainee	38	--	38	--	38	114
Air fare	24	--	24	--	24	72
Subtotal	114		114		114	342
Contingency (10%)	11		11		11	33
Inflation (8%)	10		33		59	102
Total	135		158		184	477
Extension Training						
Training cost	10					10
Trainee travel, U.S.	2					2
Subsistence	11					11
Air fare	4					4
Subtotal	27					27
Contingency (10%)	3					3
Inflation (8%/year)	2					2
Total	32					32
Galgamuwa School						
Building rehab, equipment, vehicle, house	174	116				290
Instructor salaries	10	10	10	10	10	50
Expatriate instructor salary	100	100	100	--	--	300
O&M, equipment, and facilities	30	40	50	50	50	220
Subtotal	314	266	160	60	60	860
Contingencies (10%)	31	27	16	6	6	86
Inflation (8%/year)	28	49	46	24	31	178
Total	373	342	222	90	97	1,124
Katubedda and Amparai Schools						
Equipment, building	33	42	40	--	--	115
Local staff salaries	6	6	6	6	6	30
Expatriate salary	100	100	100	--	--	300
Field trips, equipment	3	5	5	3	3	19
Subtotal	142	153	151	9	9	464
Contingency (10%)	14	15	15	1	1	46
Inflation (8%/year)	12	28	43	4	5	92
Total	168	196	209	14	15	602
Total	597	419	425	69	183	1,693
Contingency (10%)	59	42	42	7	18	168
Inflation (8%/year)	52	77	122	28	94	373
Total, Training Program	708	538	589	104	295	2,234

Table 7-3
Estimated Program Costs, Extension Water
Use Program (U.S.$1,000, 1978 Price Level)

Item	Year: 1	2	3	4	5	Total
Water management movie	97					97
Vehicles		15				15
Movie projectors, generators, associated equipment		29				29
Slide projectors, screens		2				2
Easels, blackboards, misc equipment		1				1
Expatriate salary	3					3
Staff salaries	2	2	2	2	2	10
Driver salaries		1	1	1	1	4
O&M, equipment, and vehicles		5	5	5	5	20
Total	102	55	8	8	8	181
Contingency (10%)	10	6	1	1	1	19
Inflation (8%)	9	10	2	3	4	28
Total, Extension Program	121	71	11	12	13	228

Table 7-4
Estimated Program Cost, Central Support for
Water Management Program (U.S.$1,000, 1978 Price Level)

Item	Year: 1	2	3	4	5	6	7	8	Total
Vehicles	20								20
Camera, projection equipment	3								3
Soils engineering test equipment	3								3
Hydraulics test equipment	20								20
Soils and hydrology field equipment	10								10
Budget, sr advisor	26								26
Equipment O&M, driver	4	4	4	4	4	4	4	4	32
Salary, project manager (GSL)	1	1	1	1	1	1	1	1	8
Salaries, WM specialists	4	4	4	4	4	4	4	4	32
Salaries, support staff	4	4	4	4	4	4	4	4	32
Salary, administrator	50	50	50	50	50	1	1	1	253
Salary, heavy equipment operator	75	75	75	--	--	--	--	--	225
Salary, equipment mechanic	75	75	75	--	--	--	--	--	225
Salary, secretary	1	1	1	1	1	--	--	--	5
Salary, driver	1	1	1	1	1	1	1	1	8
Total	297	215	215	65	65	15	15	15	902
Contingency (10%)	30	22	22	7	7	2	2	2	94
Inflation (8%)	26	39	62	26	34	10	12	14	223
Total, Central Support	353	276	299	98	106	27	29	31	1,219

Table 7-5
Estimated Program Costs
Walawe Water Management Project (U.S.$1,000, 1978 Price Level)

Item	Year: 1	2	3	4	5	6	7	8	Total
CAPITAL COSTS									
Operations Department									
Communications (Appendix 7, Table 7-A)		106							106
Transportation (Appendix 7, Table 7-A)		212							212
Subtotal		318							318
Contingency & Engineering (32%)		102							102
Inflation (8%/year)		70							70
Total		490							490
Maintenance and Rehabilitation Department									
Tract 3 Project RB (Appendix 7, Table 7-B)		223							223
Branch Takeout Modif RB		6							6
D Channel Takeout Modif RB		27	27	27	27				108
D Channel Regulators RB		43	43	43	43				172
Field Channel Takeout Modif RB		27	27	27	27				108
Maintenance Equipment Units RB (5 ea) (Appendix 7, Table 7-D)	357	357	357	357	357				1,785
Maintenance and Shop Units (2 ea) (Appendix 7, Table 7-E)	101	101	--	--	--				202
Subtotal	458	784	555	454	454				1,705
Contingency (30%)	137	235	167	136	136				811
Engineering (20%)	119	204	144	118	118				703
Inflation (8%/year)	57	204	225	255	332				1,073
Total	771	1,427	1,091	963	1,040				5,292
Planning Department (Master Plan)									
Reuse, Main Canal, Domestic	48								
Subtotal									
Contingency (10%)	5								
Inflation (8%/year)	4								
Total	57								57
Implementation									
Reuse Plan				1,800	1,800	1,800	1,800	1,800	9,000
Main Canal				800	800	800	800	800	4,000
Domestic Use				300	300	300	300	300	1,500
Subtotal				2,900	2,900	2,900	2,900	2,900	14,500
Contingency (10%)				290	290	290	290	290	1,450
Inflation (8%/year)				1,150	1,497	1,872	2,277	2,714	9,510
Total				4,340	4,687	5,062	5,467	5,904	25,460
Field Research									
Pipeline LB (Appendix 7, Table 7-C)		34							34
Onfarm (Appendix 7, Table 7-C)	28								28
Subtotal	28	34							62
Contingency (10%)	3	3							6
Inflation (8%/year)	2	6							8
Total	33	43							76
TOTAL CAPITAL COSTS	861	1,960	1,091	5,303	5,727	5,062	5,467	5,904	31,375

Table 7-5 (continued)

Item	Year: 1	2	3	4	5	6	7	8	Total
Operations Department									
Additional Staff (Appendix 7, Table 7-H)	11	11	11	11	11	11	11	11	88
Communications (Appendix 7, Table 7-A)	8	8	8	8	8	8	8	8	64
Transportation (Appendix 7, Table 7-A)	52	52	52	52	52	52	52	52	416
Subtotal	71	71	71	71	71	71	71	71	568
Contingency (10%)	7	7	7	7	7	7	7	7	56
Inflation (8%/year)	6	13	20	28	37	46	56	66	272
Total	84	91	98	106	115	124	134	144	896
Maintenance Department									
Maintenance Supervisor & Shop Foreman	2	2	2	2	2	2	2	2	16
Fuel, Oil, Parts, Supplies	84	168	252	336	419	419	419	419	2,516
Equipment Foreman, Mechanic, Operator	6	12	18	24	30	30	30	30	180
Shop Foreman, Mechanic, Operator	3	6	6	6	6	6	6	6	45
Subtotal	95	188	278	368	457	457	457	457	2,757
Contingency (10%)	9	19	28	37	46	46	46	46	277
Inflation (8%/year)	8	34	79	146	236	295	359	428	1,585
Total	112	241	385	551	739	798	862	931	4,619
Planning Department									
Staff (GSL)	10	18	10	8	3	3	3	3	58
Senior Advisor Budget (Colombo)									
Salary	18	18	18	30	30	30	30	30	204
Consultant Budget	0	63	122	0	0	0	0	0	185
Maintenance of Equipment, Supplies	1	1	1	1	1	1	1	1	8
Subtotal	29	100	151	39	34	34	34	34	455
Contingency (10%)	3	10	15	4	3	3	3	3	44
Inflation (8%/year)	3	18	43	16	17	22	26	31	176
Total	35	128	209	59	54	59	63	68	675
Field Research									
Pipeline		1	1	1	3				6
Onfarm	34	44	15	15	15				123
Subtotal	34	45	16	16	18				129
Contingency (10%)	3	5	2	2	2				14
Inflation (8%/year)	3	8	5	6	9				31
Total	40	58	23	24	29				174
Water Management Advisor	100	100	100	100	100	32	32	32	596
Inflation (8%/year)	8	17	26	36	47	19	23	27	203
Total	108	117	126	136	147	51	55	59	799
TOTAL ANNUAL COSTS	379	635	841	876	1,084	1,032	1,114	1,202	7,163
TOTAL CAPITAL AND ANNUAL COSTS	1,240	2,595	1,932	6,179	6,811	6,094	6,581	7,106	38,538

Table 7-6
Estimated Project Costs
Gal Oya Water Management Project (U.S.$1,000, 1978 Price Level)

Item	Year: 1	2	3	4	5	6	7	8	Total
CAPITAL COSTS									
Operations Department									
Aerial Photomapping System Inventory	250								250
Communications (Appendix 7, Table 7-A)	155								155
Transportation (Appendix 7, Table 7-A)	345								345
Subtotal	750								750
Contingency & Engineering (32%)	240								240
Inflation (8%/year)	79								79
Total	1,069								1,069
Maintenance and Rehabilitation Department									
Excavating Units for Silt Removal (3) (Appendix 7, Table 7-F)	443	886							1,329
Maintenance Equipment Units for Silt and Bank Work (4) (Appendix 7, Table 7-D) (4)	357	714	357						1,428
Maintenance Shop Units (4) (Appendix 7, Table 7-E)	202	202							404
Main Canal Regulator Gates	131								131
Branch, District Field Channel Gates	140	140	140	140	140	140	140	140	1,120
Retaining Walls, Main and Branch	510	510	510	510	510				2,580
Subtotal	1,783	2,452	1,007	650	650	140	140	140	6,962
Contingency (30%)	535	736	302	195	195	42	42	42	2,089
Engineering (20%)	464	638	262	169	169	36	36	36	1,810
Inflation (8%/year)	223	637	408	366	476	128	156	186	2,580
Total	3,005	4,463	1,979	1,380	1,490	346	374	404	13,441
Planning Department (Master Plan)									
Reuse, Main Canal, Domestic	48								48
Contingency (10%)	5								5
Inflation (8%/year)	4								4
Total	57								57
Implementation									
Reuse Plan				1,000	1,000	1,000	1,000	1,000	5,000
Main Canal				400	400	400	400	400	2,000
Domestic Use				100	100	100	100	100	500
Subtotal				1,500	1,500	1,500	1,500	1,500	7,500
Contingency (10%)				150	150	150	150	150	750
Inflation (8%/yr)				595	774	968	1,178	1,404	4,919
Total				2,245	2,424	2,618	2,828	3,054	13,169
Building, Yard, Workshop Facility	100								100
Contingency & Engineering (30%)	30								30
Inflation (8%/yr)	10								10
Total	140								
TOTAL CAPITAL COSTS	4,271	4,463	1,979	3,625	3,914	2,964	3,202	3,458	27,876
ANNUAL COSTS									
Operations Department									
Additional Staff (Appendix 7, Table 7-I)	18	18	18	18	18	18	18	18	144
Communications (Appendix 7, Table 7-A)	12	12	12	12	12	12	12	12	96
Transportation (Appendix 7, Table 7-A)	84	84	84	84	84	84	84	84	672
Subtotal	114	114	114	114	114	114	114	114	912
Contingency (10%)	11	11	11	11	11	11	11	11	88
Inflation (8%/yr)	10	21	32	45	59	73	89	106	435
Total	135	146	157	170	184	198	214	231	1,435

Table 7-6 (continued)

Item	Year: 1	2	3	4	5	6	7	8	Total
Maintenance Department									
Maintenance Supervisor, Shop Foreman, & Crew	4	8	8	8	8	8	8	8	60
Dragline Unit Operating	58	174	174	174	174	174	174	174	1,276
Equipment Unit Operating	84	252	335	335	335	335	335	335	2,346
Foreman, Operator, Mechanic Dragline Units	6	18	18	18	18	18	18	18	132
Foreman, Operator, Mechanic Equipment Units	5	15	20	20	20	20	20	20	140
Subtotal	157	467	555	555	555	555	555	555	3,954
Contingency (10%)	16	47	56	56	56	56	56	56	399
Inflation (8%/yr)	14	86	159	220	287	359	436	520	2,081
Total	187	600	770	831	898	970	1,047	1,131	6,434
Planning Department									
Staff (GSL)	10	18	10	8	3	3	3	3	58
Senior Advisor Budget									
Salary	17	17	17	30	30	10	10	10	141
Consultant Budget	0	64	123	0	0	0	0	0	187
Maintenance of Equipment, Supplies	1	1	1	1	1	1	1	1	8
Subtotal	28	100	151	39	34	14	14	14	394
Contingency (10%)	3	10	15	4	3	1	1	1	38
Inflation (8%/yr)	2	18	43	16	17	9	11	13	129
Total	33	128	209	59	54	24	26	28	561
Water Management Advisor	100	100	100	100	100	11	11	11	533
Inflation (8%/yr)	8	17	26	36	47	6	8	9	157
Total	108	117	126	136	147	17	19	20	690
TOTAL ANNUAL COSTS	463	991	1,262	1,196	1,283	1,209	1,306	1,410	9,120
TOTAL CAPITAL & ANNUAL COSTS	4,734	5,454	3,241	4,821	5,197	4,173	4,508	1,868	36,996

Table 7-7
Estimated Program Costs, Social Research on Water Management
(U.S.$1,000, 1978 Price Level)

Item	Year: 1	2	3	4	5	Total
Vehicle	9					9
Salary, Expatriot Analyst	40	40	40	40	40	200
Salary, Ceylonese Analyst	2	2	2	2	2	10
Salary, Research Assistance	4	4	4	4	4	20
Air Fare	2	2	2	2	2	10
Travel, Driver, Typing, Other	2	2	2	2	2	10
Total	59	50	50	50	50	259
Contingency (10%)	6	5	5	5	5	26
Inflation (8%)	5	9	14	20	26	74
Total, Social Research	70	64	69	75	81	359

Chapter 8
ORGANIZATION AND IMPLEMENTATION OF PROPOSED WATER MANAGEMENT PROGRAM

This chapter contains the recommended plan for program organization and implementation. The program suggested here is in no sense radical or far-reaching. It is not intended to remedy more than a fraction of the institutional and organizational problems diagnosed in Chapter 4. To do more in this direction may not be necessary at this stage, even if it were possible. There is so much water available in Sri Lanka's irrigation tanks that even modest improvements in water management practices on a national basis should be adequate to provide enough water for two crops a year on almost all irrigable land. If this were achieved, rice should be available in abundance.

It is difficult to identify the institutional and administrative reorganization required to achieve an acceptable level of water management. The important thing is to start to move in the right direction. This is what the measures suggested below are intended to achieve.

DESIRABLE INSTITUTIONAL AND ADMINISTRATIVE CHANGES

These proposals for changes by the Government of Sri Lanka are complementary to, and in some cases elaborate on, the proposals included in USAID-funded project.

1. The Water Management Division at the Irrigation Department headquarters in Colombo should be considerably strengthened by increasing and training the number of staff, granting it executive authority (i.e., for the USAID Water Management Project), and placing it under the authority of a deputy director who has no other responsibilities. This is consistent with the direction of current policy. The Director of Irrigation is proposing to appoint advisory water management engineers to each of the 15 ranges in the coming year. The ultimate objective should be to place all operations and maintenance activities in major schemes in the hands of staff responsible to the Deputy Director, Water Management. It will require time and resources to train the

necessary staff and complete the administrative reorganization. However, a declaration that this is the ultimate objective would be very helpful, since it would alert staff to the possibilities of shaping a career by performing well in water management.

2. As a complementary measure to the proposals made above, the promotion channel from Senior Technical Assistants to Professionally Nonqualified Engineers should be both widened and made dependent on performance as well as seniority. This would provide Technical Assistants with incentive to perform well, establish a cadre of experienced senior staff capable of manning operations and maintenance posts, and help solve the problem of the shortage of experienced field staff.

3. Steps should be taken to revise the criteria used for selecting Technical Assistant recruits in order to acquire people whose personal abilities suit the nature of the job. This would mean placing less weight on pure academic examination performance, and more on tests of actual numeracy and of aptitude in human relations. The best point at which to apply these tests would be during the process of selection of students for the National Diploma in Technology courses--all courses, not just civil engineering--at Katubedde and the Hardy Institute, Amparai. It is likely that, if given the necessary resources, the teaching institutions would welcome such a measure.

4. The Department of Agrarian Services, Agriculture, and Irrigation must be asked to carefully coordinate their plans and programs for farmer-level organizations to ensure that they are consistent with each other.

   This would ensure that the contact farmer used by the field officers of each department is one and the same man and that the boundaries of his constituency are the same in each of his roles. Thus, the representative farmer to be elected by the farmers under the supervision of the Cultivation Officer (Agrarian Services) should also be the contact farmer used by the extension worker (Agriculture), and he should serve exactly the same group of farmers in each role.

This coordination measure would also ensure that the representative farmer serves an area which comprises as far as possible a separate and manageable unit from the point of view of irrigation. In irrigation schemes, this would mean that the constituencies would be field channels--single channels, two or more channels if small, or half a channel if large.

Coordination of this kind will give the farmer representative authority and establish a clear channel of communication between farmers and the various Government departments serving agriculture.

5. Cultivation meetings on irrigation schemes do not represent farmers adequately. They represent only the individuals who attend. They are also rather unwieldy assemblies, with little decisionmaking ability or authority. A proposal has officially been made to establish elected Tank Management Committees, meeting on a regular basis to discuss irrigation issues, hear grievances, etc. This should be implemented. Care will have to be taken, however, lest this duplicate the Agrarian Services Committees to be established in the old Agricultural Productivity Committee areas by the Department of Agrarian Services. The relationship between the two should be specified.

6. The Government agencies responsible for issuing irrigation water--the Irrigation Department, the River Valleys Development Board, and the Mahaweli Development Board--should recognize that willingness to use the weapon of prosecution for damage is essential if discipline is to be restored on irrigation schemes, and no other part of the public service has any direct interest in irrigation or, therefore, in pursuing prosecutions.

The procedures involved in prosecutions will be very much simplified by the establishment of the new Primary Courts in the Judicature Act. No. 2 of 1978. In addition, the Irrigation Ordinance is to be amended. The agencies responsible for water issues should seek support from the highest authorities for the recruitment of legal officers to conduct prosecutions and a public declaration of support for these officers, with an explanation of the reasons for their appointment.

CONDITIONS PRECEDENT TO INITIATION OF WATER MANAGEMENT PROGRAM

It would greatly enhance the chances for success of the water management program if the above measures were carried out by the Sri Lankan Government prior to execution of the program. However, this would be impractical for some measures because of the long-term requirement for the changes. This conclusion does not apply to the suggestions to strengthen the Water Management Division (Proposal 1) and setting up farmer-level organizations (Proposal 4). Therefore, it is suggested that the above measures, except (1) and (4), be discussed with Government officials and that a time schedule be developed for their initiation and implementation at an early date. Agreement on the necessity of the measures and the time schedule for their implementation should be a condition precedent to initiation of the water management program.

In the case of the suggested strengthening of the Water Management Division of the Irrigation Department, this measure is considered essential for proper administration of the water management program. Therefore, it should be accomplished before the program is initiated. In addition, viable farmer-level organizations--at least at Uda Walawe and Gal Oya--will provide a mechanism for communication between the Government agencies and farmers which has been missing in the recent past. Without such communication, the chance of success of the program is diminished considerably. Thus, this measure is also considered to be necessary before execution of the project agreement.

Before the formal project agreement is consummated, several steps appear to be warranted to get the project off to a good start. The following are suggested:

1. Discussion with GSL and agreement on the specific elements of the water management program, the resource requirements, and the timing of the program.

2. Agreement on the organizations necessary, staffing, budgets, and division of responsibilities between GSL and USAID.

3. Issue by GSL of policy statements to the press and to special meetings at major irrigation schemes explaining and promoting the new emphasis on improving water management.

4. Establishment of a program advisory committee (similar to the policy advisory committee suggested in Chapter 6) to launch the program and review its progress.

PROGRAM ORGANIZATION CHARTS

Based on the program descriptions presented in Chapter 6 and the organizational discussion in preceding sections of this chapter, a recommended structure for program implementation was developed. Figure 8-1 shows the proposed organization, supervisory roles, and functions of the GSL for program implementation. Figure 8-2 shows the proposed organization, advisory roles, and functions of AID, expatriate advisors, and consultants for the program.

PROGRAM IMPLEMENTATION SCHEDULE

Figure 8-3 is a schedule of activities during the 8-year program period that are necessary for program implementation. The schedule is a framework upon which to develop detailed work plans for each major activity. The schedule summarizes the tasks presented in Chapter 6.

PROPOSED GSL ORGANIZATION
SRI LANKA WATER MANAGEMENT PROGRAM

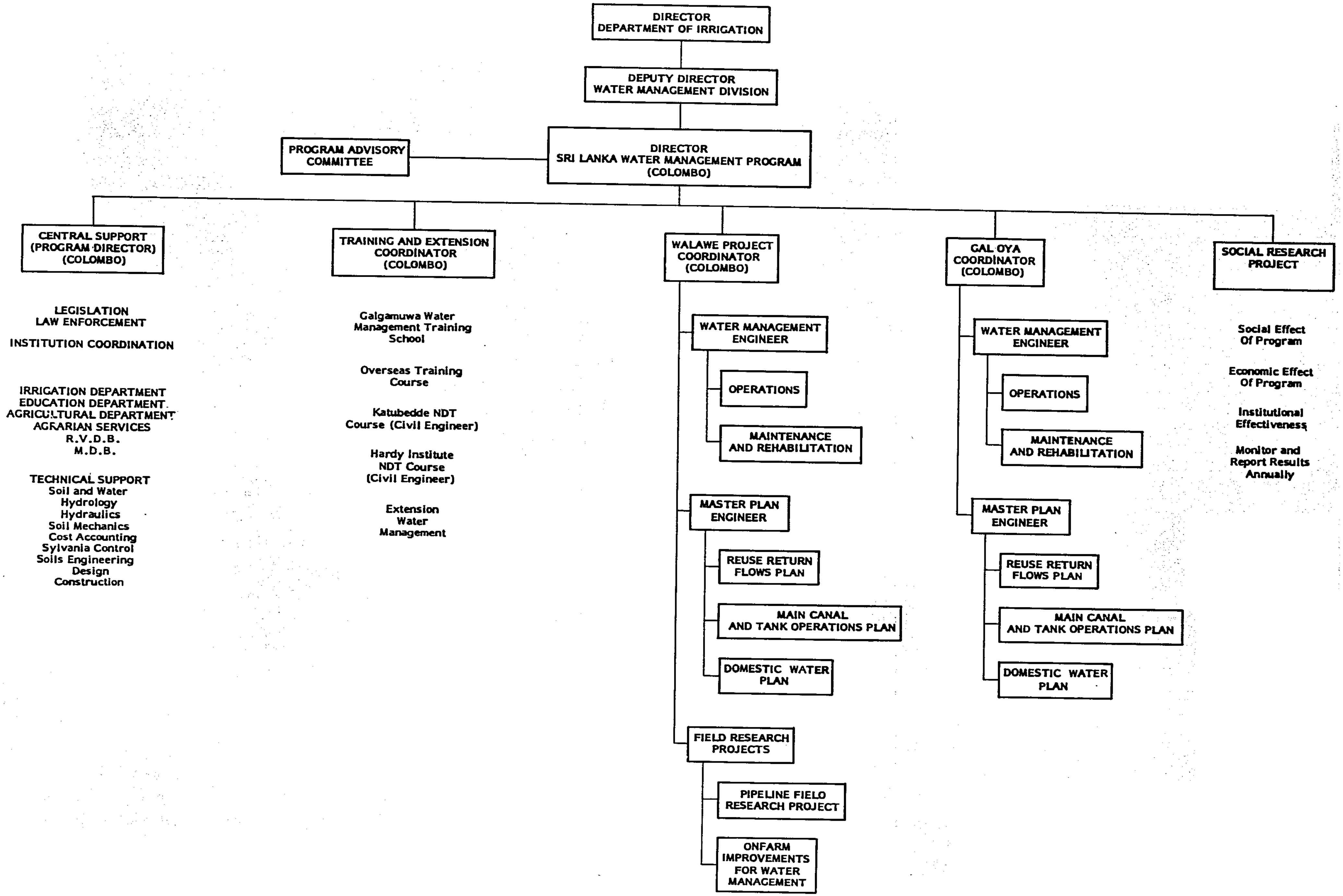


FIGURE 8-1

PROPOSED EXPATRIATE ADVISOR ORGANIZATION
SRI LANKA WATER MANAGEMENT PROGRAM

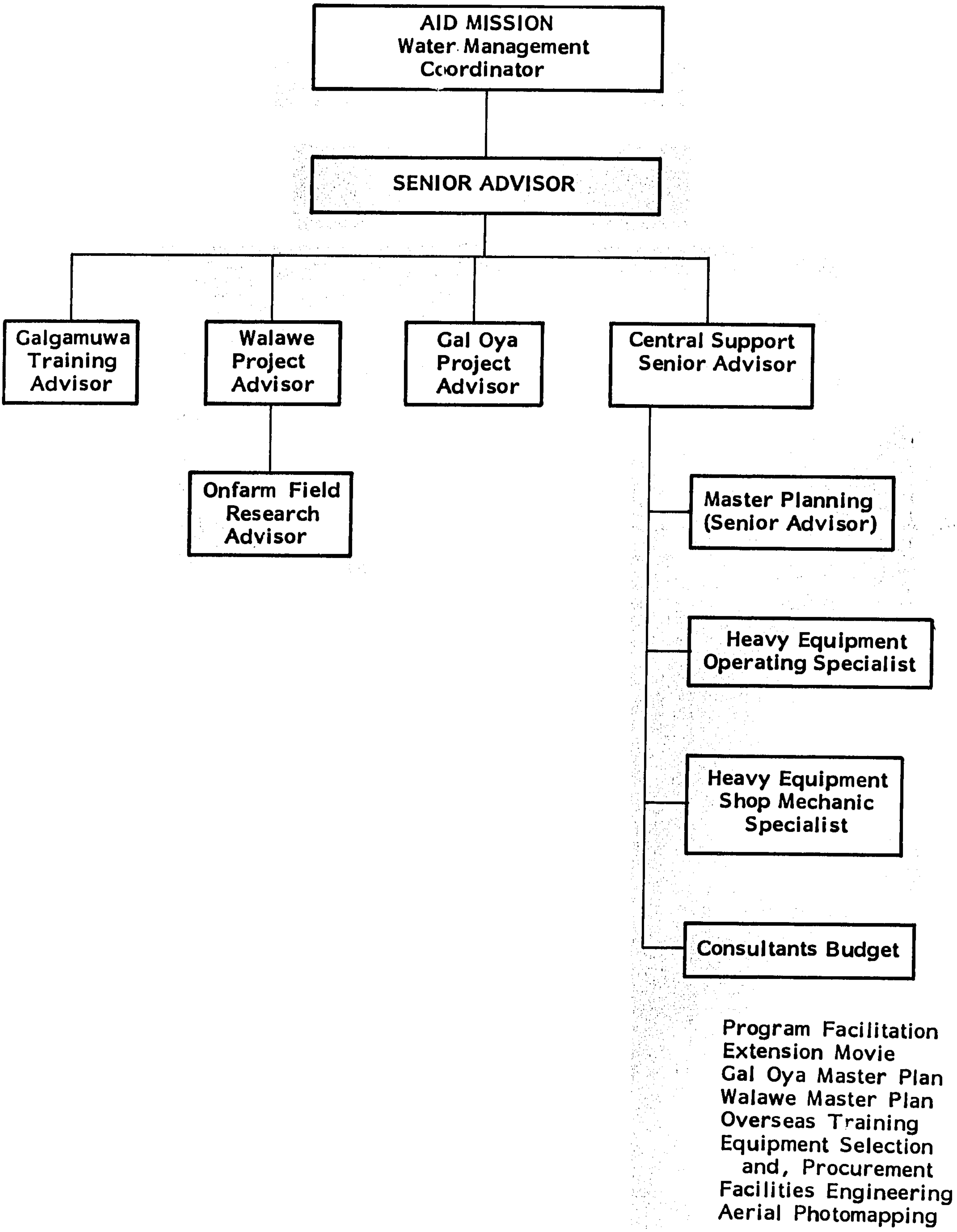
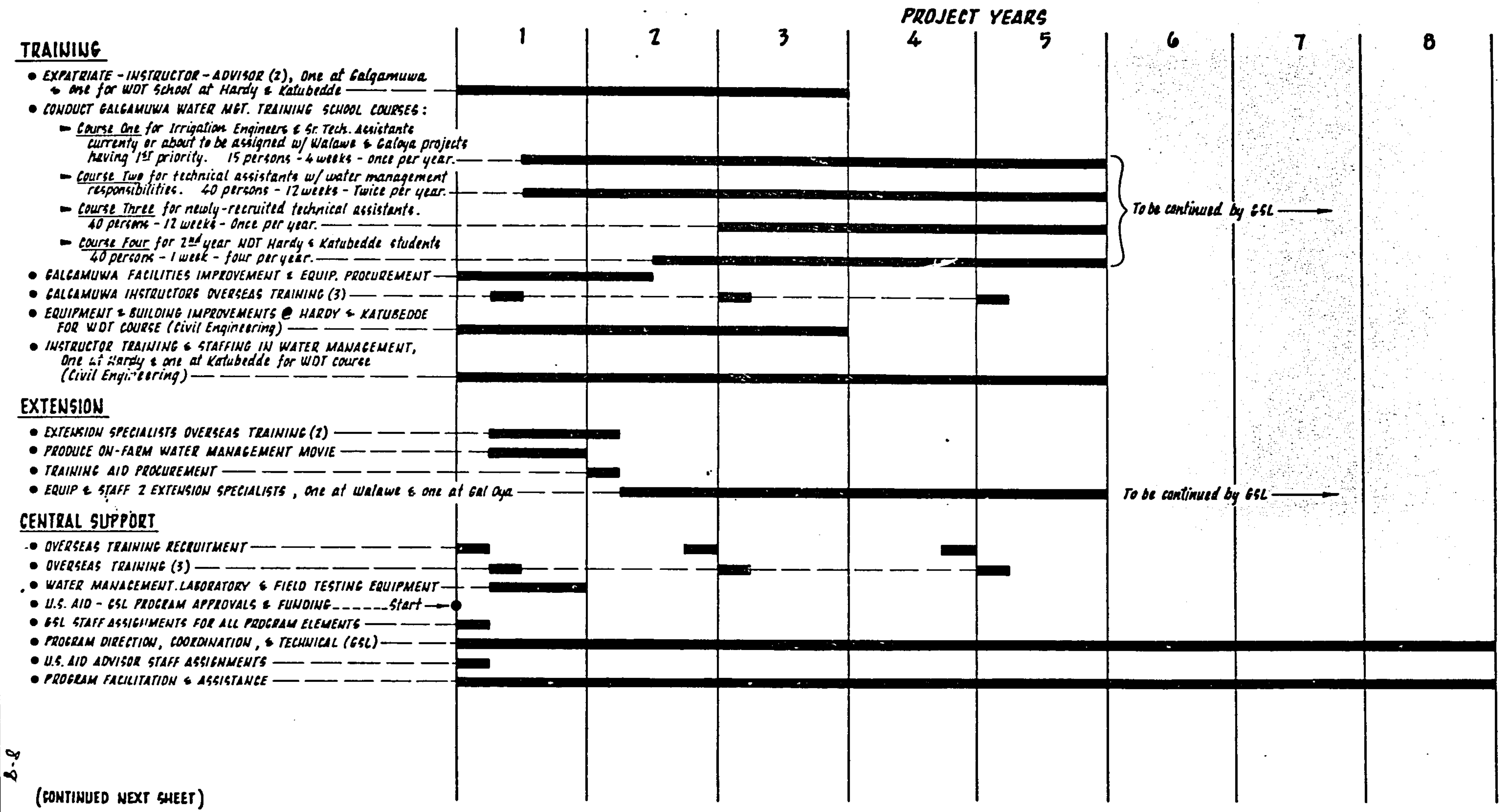


FIGURE 8-2

SRI LANKA WATER MANAGEMENT PROGRAM

PROJECT IMPLEMENTATION SCHEDULE



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(CONTINUED NEXT SHEET)

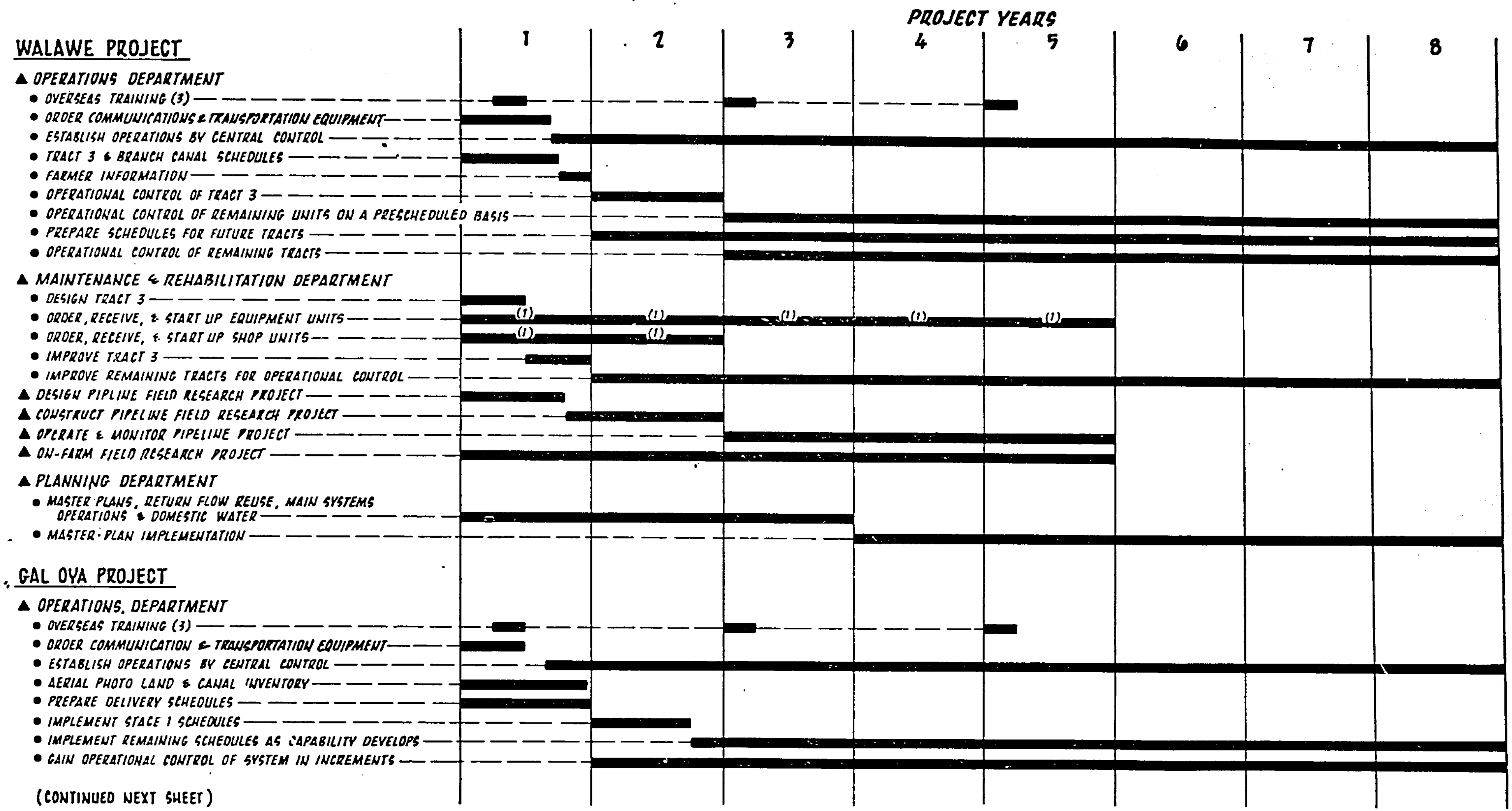
IMPLEMENTATION SCHEDULE (1)

CH2M HILL

FIGURE 8-3

SRI LANKA WATER MANAGEMENT PROGRAM

PROJECT IMPLEMENTATION SCHEDULE (Con't.)



(CONTINUED NEXT SHEET)

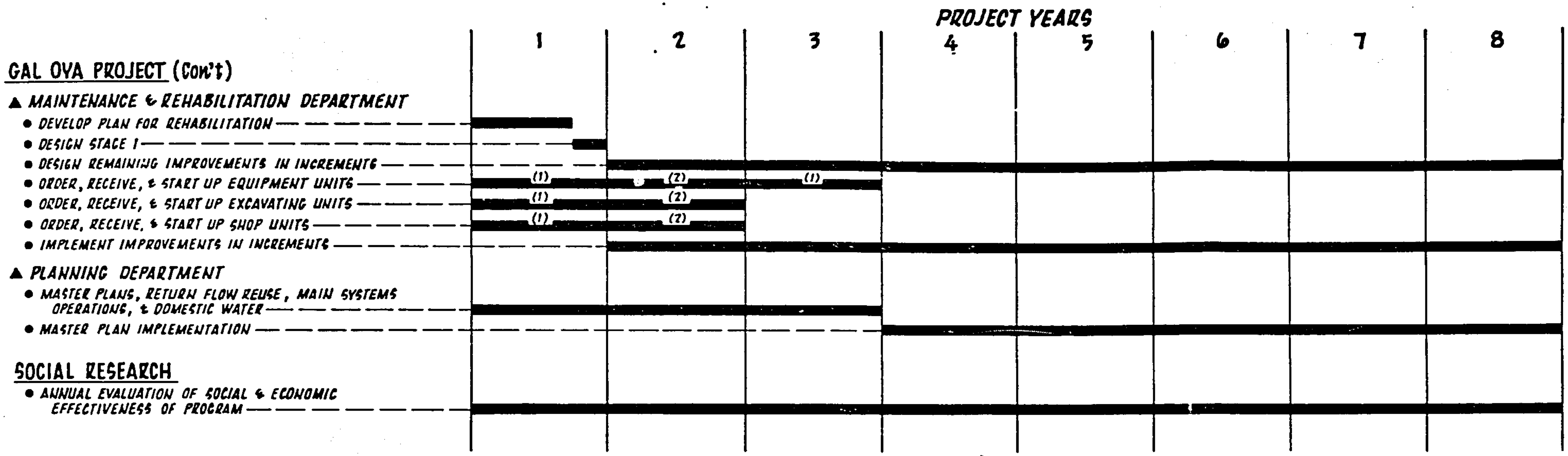
IMPLEMENTATION SCHEDULE (2)

CH2M HILL

FIGURE 8-3

SRI LANKA WATER MANAGEMENT PROGRAM

PROJECT IMPLEMENTATION SCHEDULE (Con't.)



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A - 10

IMPLEMENTATION SCHEDULE (3)

CH2M HILL

FIGURE 8-3

Chapter 9
EVALUATION OF PROPOSED PROGRAM

In this final chapter the criteria presented in Chapter 5 are applied to the proposed program of water management (Chapter 6) to test its effectiveness in terms of technical, social, economic, financial, administrative, and environmental standards.

TECHNICAL EVALUATION

This section sets forth the the basis for choice of technologies recommended for the water management program. From the point of view of technical evaluation, the program suggested here is subdivided into five topics. They are:

- Training present and future water management personnel
- Extension programs to improve onfarm water use
- Field research projects on farm leveling use and reuse
- Field research projects on pipelined field channels
- Operations departmental program
- Maintenance and rehabilitation departmental programs

Training

The proposed training program is designed to increase Sri Lankan Junior Technical Assistants (JTA) training institutions' capability to produce more technical assistants, which are in very short supply. This conversion of unskilled to skilled workers will increase overall employment.

Most of the training dollars will be spent on an Irrigation Department training school at Galgamuwa. The techniques proposed here are short duration, field and laboratory intensive workshop programs directed to management and skilled labor people involved in operating and maintaining schemes. This program will have a high spread effect to all schemes in the country. The methodology used is to train the instructors at Galgamuwa before reopening the institution under the initial direction of an expatriate. Success of this program will depend on ability of the training staff to fill the voids that now exist. This can be done by the senior program advisor closely coordinating the program activities at Walawe and Gal Oya with the training school activities. The number of persons in the overseas training program is intentionally kept small enough to allow considerable time for the trainees to see good operation and maintenance practices in action in the United States.

The kind of training proposed in the program is similar to Irrigators Conference tours and workshops which are attended in large numbers by irrigation operators in the United States.

Extension

As the extension service is already functioning with renewed strength from World Bank funds, the water management project should blend into present technologies but increase the effectiveness of existing extension programs. Techniques of extension programs are presently technically sound and have been demonstrated in this country as well as other less developed countries. Costing is reasonably accurate except perhaps for funds necessary to produce a film on water management at the farm level, for which insufficient data were available.

Field Research on Farm Leveling, Use, and Reuse

Much of the farm leveling has been done in small basins by hand, taking many years of work by the farmer before the land is level enough to get uniform water application. By leveling in large fields, better control will be gained from initial development and will raise yields and save water. Labor saved will be primarily that of the farmer. This type of research and demonstration can be adopted by nearly all irrigation schemes in the country and will be adopted more quickly as more ploughing is done by tractor.

Proposed costs are reasonably accurate, and results take into consideration inclement weather which will prevent full-time use of equipment.

Field Research on Pipelines for Field Channels

More labor will be required for fabricating and installing concrete pipelines than would be required for open channels. But once the pipelines are installed, they should require less labor for maintenance, with net results of little difference in total labor.

There are many places throughout the country where pipelines should have been installed, and with this project, experience and testing should encourage a more vigorous program of manufacturing better pipe and using it in many schemes. At present, the country is capable of producing concrete pipe but needs some modification in design of the pipe and will probably need more rock crushing ability if a big program is undertaken.

Operation Practices

In response to a crying need for operational communication and transportation, radios and vehicles are proposed to be furnished down to TA levels responsible for deliveries to some 8,000 acres. This may raise a question regarding effective use of the equipment. By carefully staging equipment delivery and with very strict operating and use procedures, irrigation managers have accepted radios as an absolute necessity to operational control. With check-in check-out procedures, disposition of project personnel is known at all times, and access to their capabilities is instant. Much time was found wasted on present schemes because six TA's had only one vehicle. The common practice, due to vehicle shortage, is to ride together over the project. Six TA's in six vehicles accessible and under the direction of a water master by radio will be 10 to 20 times more effective.

The second crying need is to convert the operation from "uncontrolled river canals" to an operationally controlled and water accounted-for system. This will not be easy and will require the full resources of the training project, the central support project, the water management engineer, and his USAID counterpart. There will be periods when TA's and management will question water scheduling and water measurement practices. Much damage to the program could result if delivery schedules are not adequate, or cannot be physically met. Every effort must be made to "not bite off more than one can chew" at any one issue and to closely coordinate the development and implementation of the delivery schedule for field channels with the farmers, the Maintenance Rehabilitation Department, and the ability of the system and the staff to deliver measured flows.

Rehabilitation Practices

The equipment management operation and maintenance requirements as a result of the program will provide a real challenge to project personnel. The program includes the precaution of supervisor training, expatriate mechanic and operator support for on-job training, and staging of equipment arrival to match the capability of project personnel to keep it running. There will be much pressure, especially at Gal Oya, to get the equipment moving. This must not be done without prior predesign and survey activities to specify equipment requirements and anticipate its performance. A properly executed predesign, equipment selection, maintenance shop program, and operator and training program will avoid major pitfalls.

Equipment units proposed are to supplement, not replace, hand labor maintenance techniques. Maintenance activities to hand clean canals must continue, and at even an accelerated pace. This should be possible because O&M budgets are expected to increase from Rs.20 to Rs.60 per acre. As long as the equipment units are used for work not suitable for hand techniques or in instances where hand labor is in short supply, then the program will be beneficial. Unskilled hand labor is not always available to the project when it is needed most. More unskilled labor might be available to the Irrigation Department if they paid higher wages. Farmers pay Rs.15 to 20 per day plus one meal, whereas the Irrigation Department pays no more than Rs.8.5 per day.

Part of the Tract 3 program at Walawe is to restore a distributor and field channel system using hand excavation and compaction techniques. This should be carefully evaluated before buying additional equipment.

Scheduling of the work will be a major problem at both projects because the systems are issuing so much of the time. It will be essential that the water management engineer (project manager) coordinate and direct the activities of the Operation and Maintenance and Rehabilitation Department closely with field ditch and distributor "farmer commands." With carefully planned explanation of the rehabilitation of a canal followed by the implementation of a scheduled canal that will reasonably meet farmers' water needs, farmer acceptance can be anticipated.

SOCIAL EVALUATION

From the point of view of social evaluation the program suggested here is subdivided into six main components:

- Socio-cultural feasibility: cultivators
- Socio-cultural feasibility: public service

- Socio-cultural feasibility: educators
- Spread effects
- Nonmaterial benefits
- Disadvantages

Socio-Cultural Feasibility: Cultivators

The components in the program which most directly impinge on the lives of the cultivating population, and which require their support, tacit or active, are water delivery schedules, farmers' organizations, and domestic water.

Water Delivery Schedules. The first item, that of the enforcement of delivery schedules, is the one most likely to run into resistance. The primary issue is that of conflicts of interest between top-enders and tail-enders. The first tend to get water and the latter not. The high water use by top-enders does save them some expense and effort in land preparation, weed control, and adherence to cultivation schedules. However, some experimental evidence for Gal Oya suggests that the large water applications used by many farmers cause actual crop losses, presumably by leaching away of chemical fertilizers and saturating the paddy plant root zone. If this finding has general validity and this can be demonstrated to the top-end cultivators, then much of their resistance to adherence to water delivery schedules may evaporate. However, it is safe to assume that there will be some resistance from top-enders, as well as from persons trying to grow paddy on land to which water cannot reasonably be delivered even after the regularization of acceptable encroachments.

There is then little question that the implementation of delivery schedules will meet resistance. The first few seasons will be critical. If the schedules can be implemented without interference and water delivered in adequate quantities to all cultivators, then positive moral and political support is almost certain to be forthcoming from those farmers who currently receive inadequate water, and the opposition of top-enders is likely to abate. In order to get over this critical period, the Government organizations in charge of water issues will have to act firmly, laying themselves open to the charge of authoritarianism. It is not a matter of being authoritarian in reaching decisions about such matters as cultivation schedules. The suggested Tank Management Committees would ensure a stronger element of representative democracy in these decisions than is now attained in the unwieldy open cultivation meetings. The need for firm decisions arises in drawing up and sticking to delivery schedules in the face of farmer requests for more water.

In Sri Lankan culture there are two very different traditions relating to the management of irrigation systems. The older tradition is broadly one of democratic decisionmaking over cultivation schedules, extents to be irrigated, etc., and authoritarian implementation of these decisions by the Vel Vidane and Revenue Officers. The newer tradition, which appears to be most developed in the large new irrigation colonies, is one of less farmer involvement in the decisions of cultivation meetings, lack of adherence to decisions, provision of water to a large extent on demand if it is available, 'self-help' to the extent of damaging irrigation structures, lack of punishment for damages, and appeal to politicians against the decisions of Government officers.

The need and the proposal made here is for a strengthening of the older tradition which, it should be noted, is no less democratic than the newer one. It requires more participation-more collective decisionmaking and adherence to collective agreements. There is considerable evidence, from our own observations and those of others, of a considerable sense of regret among cultivators at the disappearance of the old water management tradition. There is also in Sri Lanka a strong sense that in the ancient dry zone civilizations based materially on tank irrigation are to be found the roots of the Island's culture. Both recent personal experiences and cultural traditions may serve to provide support for a firmer irrigation policy involving more discipline. If correctly used, these could gain acceptance for better water management during the few seasons that it will require to demonstrate that it is a paying proposition for almost everyone concerned.

There is then some doubt about the initial acceptability of water scheduling to top-end farmers. Their resistance is, however, based partly on false beliefs and partly as a compulsion to take as much water as possible derived from past experiences of erratic supplies. Few of the top-enders are likely to be significantly worse off as the result of the implementation of the program proposed here.

Farmers' Organizations. Two main proposals are made about farmers' organizations in this report. The first is for elected Tank Management Committees. These are likely to be welcomed by farmers as they should provide some genuine farmer representation in decisions relating to irrigation scheduling, etc. The committees will provide legitimate channels for farmers to express grievances about their treatment by water management staff. There are no doubt legitimate grievances, and, even if they are not valid or justified, grievances that can be conveyed through some recognized channel to some authority are less likely to lead to resentment and damage to irrigation structures than are grievances which have no legitimate institutional outlet. The existing once-a-season cultivation meetings cannot by their nature serve these two functions, and some local experience with Tank Management Committees on the Tank Modernization project seems encouraging.

The second proposal is for coordination of the activities and proposals of the various Government departments to ensure that the proposed elected representative farmers should each be the point of contact in a single locality for all the agencies serving agriculture. The evidence suggests that farmers prefer to deal with a person rather than a committee and to deal with one institution representing all Government agencies rather than many.

The pace of change in rural institutions in recent years has been too rapid for many farmers to fully comprehend. Experience of elected representative farmers on the 'H' area of the Mahaweli Scheme gives reason to hope that, even without legal authority, they may have adequate status to ensure regular cleaning of field channels by farmers.

Domestic Water. Proposals are made for planning to determine whether there are cheaper ways of providing domestic water to the population of settlement schemes than issuing water through canals. Master planning is suggested as the initial effort in the program. If alternative supplies can be guaranteed and arrangements made to provide buffalo wallows, there is no reason to expect much resistance. There is a fairly wide awareness of the health risks of drinking canal water.

Socio-Cultural Feasibility: The Public Service

The proposals for improved water management depend, apart from physical investments, largely on enhancing the capability, resources, and freedom of action of Government agencies, especially the Irrigation Department. Apart from the provision of financial resources and equipment, changes are proposed in organization, training, and operating procedures. It follows that the proposals affect the staff of the Irrigation Department more immediately than they affect the farmers, although both are expected to benefit in the long run.

There is little doubt that the staff of the Irrigation Department and the RVDB will generally welcome the extra resources and equipment which will permit them to do a better (and more interesting) job and the in-service training programs at Galgamuwa and in the Philippines and U.S.A. More attention and resources for water management are fully in line with Irrigation Department policy. The elements in the proposed program that may be questioned in some quarters are the eventual establishment of a separate Water Management Branch with executive authority for operations and maintenance in major schemes, enhanced promotion prospects from the TA cadre to engineer levels, and the assumption by the Irrigation Department (and the RDVB) of responsibility for prosecuting irrigation offenders in schemes under their control. The first two of these proposals, in particular, imply considerable administrative reorganization. It is not wise to rush into this without careful thought. Hopefully, a convincing case has been made that not all problems in water management can be traced to the farmers, that the Government organizations have it in their power to improve their own performance, and that the proposals made would help achieve this.

Socio-Cultural Feasibility: The Educators

The only proposal requiring appreciable change in the practices of educational institutions is for the recruitment of students into the National Diploma in Technology courses to be more on criteria of aptitude and achievement as revealed by tests, and less by performance in school examinations. There is a widespread recognition in the teaching profession of the desirability of this change. Lack of staff is a major obstacle to implementation.

Spread Effects

The main items in the proposed program which could have potential spread effects are:

- Improved water management procedures
- Improved water management skills
- Improved water management training techniques
- Improved procedures for selecting and motivating staff
- New construction, maintenance, and rehabilitation practices on irrigation schemes

The potential target of spread effects are farmer cultivators, professional staff employed by the Irrigation Department, the Mahaweli Development Board, the River Valleys Development Board, and the Department of Agrarian Services. The Government groups concerned number less than two thousand, and contacts within the group are extensive. Given the proposal to establish the training school at Galgamuwa and run regular training classes, there seems every reason to expect that information about successful innovations will spread rapidly.

Farm cultivators on Walawe and Gal Oya, the direct beneficiaries, can be expected to spread the news about improved water management to farmers on other irrigation schemes. In this manner, the farmers on the other schemes will learn of and undoubtedly try out new water management techniques and organizations.

The main group that will benefit from the proposed program are the small farm cultivators towards the tail ends of the Uda Walawe and Gal Oya irrigation schemes, the rural laborers, the potential recipients of land allocations of the Uda Walawe Left Bank Scheme, the people at the ends of the Uda Walawe and Gal Oya Schemes who do not now have enough drinking water, and possibly even the top-end cultivators.

Small Farmers. Small farm households cultivating land towards the tail ends of canals, distributaries, and field channels in Uda Walawe and Gal Oya, provided with regular and adequate supplies of irrigation water, will be able to increase their incomes by cultivating more often and by using improved practices (more fertilizer, better tillage, transplanting). These improvements yield higher net incomes but were not previously adopted because of the risk of loss due to unreliable water supplies. Almost all the cultivators in the water-scarce areas of Walawe and Gal Oya are small farmers cultivating 3 to 5 acres.

Rural Laborers. This includes many households with land of their own. They will be provided with more work through an increase in the cultivated acreage, the high manpower requirements of the relatively labor-intensive rehabilitation programs planned, and the adoption of improved cultivation practices, especially more thorough land tillage and the adoption of transplanting--which will especially benefit female laborers because this is the principal group involved in the transplanting activity.

Potential Recipients of Land Allocations on the Yet-Undeveloped Portion of the Uda Walawe Left Bank Scheme. At present there is little water available to irrigate these lands, and, partly for this reason, the pace of development has been slow.

People Experiencing a Shortage of Drinking Water. The entire population of the tail-end portions of the Uda Walawe and Gal Oya Schemes presently suffer serious shortages of drinking water because they are dependent on the canal, and water issues often do not reach them. Any increase in the amount of water reaching the tail ends will benefit people of both areas immediately and indirectly, by raising the ground-water table and thus increasing the potential use of domestic wells. In addition, the program proposes an investigation of ways to provide a reliable source of domestic water--e.g., wells or cisterns--which is not dependent on continual canal issues. Any improvement in the supply of domestic water will especially benefit women since they suffer disproportionately from water scarcity. They have to carry domestic water long distances; they nurse family members who are ill from drinking bad water; and they are least free to walk the long distances which are sometimes necessary in order to bathe--men are more likely to cycle.

Very rough estimates suggest that there are 30,000 people suffering a serious shortage of domestic water at the tail end of the Uda Walawe right bank system, and considerably more on the Gal Oya left bank system.

Top-End Cultivators. Possibly, those top-end cultivators who at present unwittingly use such large quantities of water that they reduce their paddy yields will also benefit.

The proposed projects will materially benefit almost all the populations of the proposed areas, especially the poorer tail-enders who currently receive little or no water. Possible exceptions are those whose welfare cannot be directly improved by production programs; i.e., the old and the sick who have neither land or other productive assets nor labor to sell. And even the ill will benefit directly from improvements in the supply of domestic water, and perhaps indirectly by the increased incomes of their neighbors and relatives. The rural populations of the project areas are among the poorest half of Sri Lanka's population, and, in the case of the main beneficiaries--the tail-enders, most are probably in the poorest third. From the point of view of its effect on income distribution and on the material welfare of the poor and of socially disadvantaged groups (e.g., poor rural women), the impact of the proposed project is extremely favorable.

Nonmaterial Benefits

It is proposed to regularize the position of those land encroachers who can be provided with irrigation, thus providing a little more security for a category of persons whose lives are often clouded by fears of eviction.

The provision of equipment, resources, and training to the staff of the Irrigation Department and the RVDB will enable them to do a better job of water management and provide more job satisfaction.

Two of the proposals allow for more constructive participation by farmers in decisionmaking related to irrigation. The first is the proposal for formally elected Tank Management Committees. The second is the provision for supply of materials and technical advice to groups of farmers who are prepared to rehabilitate their field channels with their own labor.

Disadvantages

The disadvantages of this project are few. A relatively small number of top-end cultivators will experience an increase in the effort and expense they have to put into clearing field ditches, repairing leaky bunds, leveling fields, and cultivation as a result of less abundant supplies of water being available to them. The cost is low, since most can be done with more effort on the farmer's own part. Weedicides may require higher cash costs. However, according to Wickham (Supplementary Report on Water Management, 1978, USAID) water applications in excess of 20 to 30 percent over field requirements have no effect on weed growth.

It is possible that, with the rigid enforcement of water delivery and crop timing schedules, a small number of farmers in a weak economic or physical position--the old, the sick, those who cannot affort to hire labor, buffaloes, or tractors--may lose part of their harvest because water is not supplied to meet their late cultivations.

Conclusion

The project offers very substantial benefits, mainly material, to a category of households who are among the poorest in the country. Prominent among the target group are rural women laborers and female members of farm households. The potential material losers are few. In terms of the socio-economic impact, the project is very positive. The spread effects should also be substantial. There is some question about the acceptability of the program to a relatively small group of farmers who believe, perhaps not always accurately, that they stand to lose. These objections are likely to weaken considerably if sufficient high-level support can be given to permit the benefits of the program to be demonstrated in a few crop seasons.

ECONOMIC EVALUATION

The purpose of the economic evaluation is to examine the costs and benefits of the proposed program and to arrive at a conclusion concerning the economic desirability of incurring the estimated costs. The perspective taken is that of the society of Sri Lanka as a whole rather than any individual parts of it, although benefits will accrue to some parts more than others. In the financial analysis, considered later, the incidence of costs and benefits is evaluated. As discussed in the criteria section of Chapter 5, a holistic approach is taken with the economic evaluation, considering the economic feasibility of the program in its entirety rather than in its individual parts. For example, the organizational changes and the training aspects of the programs are considered to be as necessary as the physical improvements to achieve the benefits, and neither aspect will bear fruit without the other. Before considering costs and benefits, cropland use is evaluated with and without the program.

Present and Projected Crop Land Use

At the Walawe Scheme, 33,000 acres are developed for cultivation at present (Table 9-1). About 32,500 acres are used for production of paddy and 500 acres for sugar during Maha season. In Yala, 19,200 are in paddy and 500 are in sugar. Thus, cropping intensity is 1.60. Plans of the RVDB call for development of 65,000 acres over the next 8 years. Without improved water management, total cultivated land will be limited to 46,600 acres, at 1.6 cropping intensity, because of a water limitation (assumes 650,000 acre-feet available and a water duty of 8.7 acre-feet per acre). With the proposed water management program and associated reduced water duty, it is estimated that 69,000 acres can be cropped in both seasons, for an increase of 22,400 acres in Maha and 41,000 acres in Yala cropped annually.

The Gal Oya Scheme is essentially fully developed at 125,000 acres officially and about 110,000 acres actual. However, only 60,000 acres are cropped in Yala, for a cropping intensity of about 1.55 crops per acre per year. Paddy is raised on 100,000 acres in Maha and only 50,000 acres in Yala. There are 10,000 acres in sugar cane in both seasons. With adequate water management, about 10,000 additional acres can be cultivated in Maha and 60,000 acres in Yala. Cropping intensity can be increased to two crops per acre annually with the program.

The total gain in cultivated acres for both schemes is 133,400 acres, 32,400 acres for Maha and 101,000 acres for Yala. Cropping intensity can be two crops per acre per year.

Table 9-1
Land Uses, Present and Projected Without and With the Program, Walawe and Gal Oya Schemes

	Scheme		
	Walawe	Gal Oya	Total
Existing land use			
Cultivated			
Maha	33,000	110,000	143,000
Yala	19,700	60,000	79,700
Crop Use			
Maha - Paddy	32,500	100,000	132,500
Sugar	500	10,000	10,500
Yala - Paddy	19,200	50,000	69,200
Sugar	500	10,000	10,500
Cropping intensity	1.60	1.55	1.56
Projected land use without program			
Cultivated			
Maha	46,600	110,000	156,600
Yala	28,000	60,000	88,000
Cropping Intensity	1.60	1.55	1.56
Projected land use with program			
Cultivated			
Maha	69,000	120,000	189,000
Yala	69,000	120,000	189,000
Cropping intensity	2.0	2.0	2.0
Increased cultivation due to program			
Maha	22,400	10,000	32,400
Yala	41,000	60,000	101,000
Total	63,400	70,000	133,400

Evaluation of Costs of Proposed Program

Program costs are summarized in Table 9-2. The program proposes a cost without inflation of $55.5 million (Rs.859.7 million). Thus, the average cost per year is $6.93 million (Rs.107,458).

Because of the expected long-term effects of the program, an evaluation period of 20 years was chosen for the cost and benefit evaluations. Therefore, costs of continuing operation and maintenance and water management by GSL beyond the program period are estimated. These costs are estimated as costs in addition to those that might be expected in the absence of the proposed program. During the 8-year program period, in addition, project budgets of the Irrigation Department and the River Valleys Development Board are considered.

It was not possible to obtain complete budget information on operation and maintenance of the schemes. Accounting methods used by the agencies did not, in general, separate annual costs of operation and maintenance from costs associated with capital improvements. The budgets shown in Tables 9-3 and 9-4 are based on the best information available. For the Gal Oya Scheme, O&M is about Rs.3.1 million, or Rs.28.2 per acre (110,000 acres developed). For Walawe, the budget is considerably larger--about Rs.7.2 million, or Rs.218 per acre (33,000 acres developed). However, the Walawe O&M budget is projected to decline to Rs.5.3 million in 1979 (Rs.160 per acre developed).

The Irrigation Department has requested a sum of Rs.100 per acre for O&M on the major schemes it manages and is planning to budget Rs.60 in 1979.

In view of the nature of the information on O&M expenditures, an annual budget of Rs.80 per acre is used in the economic evaluation for the program period of 8 years and Rs.100 per acre in subsequent years. This cost standard results in total expenditures of Rs.17.8 million in the first year of the program and Rs.37.8 in the 20th year of the evaluation period. Since the concern here is with added costs and the 1978 cost of O&M averages about Rs.72 per acre, Rs.8 per acre is used as the added cost during the 8-year project phase and Rs.28 per acre in subsequent years.

An additional cost item is the capital cost necessary to develop the additional irrigated land at the Walawe Scheme, made possible as a result of the water management program. Because it is estimated that 46,600 acres would be cultivated without the program and 69,000 acres with the program,

Table 9-2
Summary of Costs of Proposed Water Management Programs
(U.S.$1,000, 1978 Price Level)

Year:	1	2	3	4	5	6	7	8	Total	Foreign Exchange %	Foreign Exchange Amount
WALAWE											
Capital	$ 708	1,680	866	3,900	3,898	3,190	3,190	3,190	20,622	71	14,642
Annual	351	545	668	644	738	650	650	650	4,896	92	4,504
TOTAL	$1,059	2,225	1,534	4,544	4,636	3,840	3,840	3,840	25,518		19,146
GAL OYA											
Capital	3,955	3,826	1,571	2,664	2,664	1,868	1,868	1,868	20,284	75	15,213
Annual	429	849	1,002	879	873	762	762	762	6,318	87	5,497
TOTAL	$4,384	4,675	2,573	3,543	3,537	2,630	2,630	2,630	26,602		20,710
TRAINING PROGRAM	656	461	467	76	210	-	-	-	1,861	81	1,507
EXTENSION PROGRAM	112	61	9	9	9	-	-	-	200	62	124
CENTRAL SUPPORT	327	237	237	72	72	17	17	17	996	90	896
SOCIAL RESEARCH	65	55	55	55	55	-	-	-	285	88	250
TOTAL	$6,603	7,714	4,875	8,299	8,510	6,487	6,487	6,487	55,462	77	42,633
FOREIGN EXCHANGE	$5,116	5,975	3,923	6,305	6,488	4,942	4,942	4,942			42,633

Table 9-3
Irrigation Department Budget for Gal Oya Scheme, 1978

Item	Rs. (1,000)	U.S.$ (1,000)
Personnel		
Salaries and wages	1,751.1	113.0
Overtime, holiday, allowances	845.0	54.5
Travel	40.0	2.6
Supplies and requisites	295.0	19.0
Repairs and maintenance of capital assets	50.0	3.2
Transportation, communications, utilities, other services	125.4	8.1
TOTAL	3,106.5 (1)	200.4

Source:

(1) This sum equals about Rs.28 per acre developed. The Irrigation Department is requesting a budget of Rs.60 per acre for major schemes in 1979 and has requested Rs.100 as an adequate amount.

Table 9-4
River Valleys Development Board Budgets for Walawe Scheme, 1978-79

Item	Rs. (1,000)	U.S.$ (1,000)
Total 1978	7,187.1	463.7
1979 (projected)		
Personnel		
Salaries and wages	2,385.7	153.9
Overtime, holiday, allowances	726.0	46.8
Travel	26.6	1.7
Office supplies, uniforms	9.4	.6
Repairs and maintenance	1,775.5	114.6
Transportation, communications, utilities, miscellaneous	357.7	23.1
	5,280.9	340.7

Source: River Valleys Development Board, Colombo

Table 9-5
Total Water Management Program and Associated Costs

(U.S.$1,000, 1978 Price Level)

Year	Water Management Program(1)	Increased O&M(2)	Increased Development(3)	Total
1	8,138	115	-	8,253
2	9,507	117	1,645	11,269
3	6,052	123	1,645	7,820
4	10,191	138	1,645	11,974
5	10,456	156	1,645	12,257
6	7,969	167	1,645	9,781
7	7,970	181	1,645	9,796
8	7,970	195	2,413	10,578
9 - 20	-	683	-	683

(1) From Table 9-2. A shadow price factor of .3 was applied to the foreign exchange component.

(2) Assumed to be Rs.8 per acre for years 1 to 8 and Rs.28 per acre for years 9 to 20. Exchange rate Rs.15.5 = $1.00.

(3) Added investment cost for 22,400 acres at Uda Walawe at Rs.8,500 per acre, including foreign exchange shadow cost factor of Rs.1,500 per acre. It is assumed 3,000 acres are developed per year for years 2-7 and 4,400 acres are developed in year 8. Exchange rate Rs.15.5 = $1.00.

22,400 acres are assumed to be added. The cost assumed for the added acres is Rs.7,000 per acre based on costs for other projects in Sri Lanka. To this cost is added Rs.1,500 to allow for purchases with foreign exchange. This assumes 70 percent of the cost is foreign purchases and a shadow price factor of .3. Thus, Rs.190.4 million of investment is estimated (Rs.8,500 per acre).

Total costs associated with the water management program and associated operation, maintenance, and land development are shown in Table 9-5. The costs in Table 9-5 are in 1978 dollars because the economic evaluation is made in constant dollars. Shadow price adjustments are made for capital cost of developing additional irrigated acres at Walawe, and for Foreign purchases for the water management program. A shadow price adjustment was considered for labor but was rejected because unskilled labor for which there is high unemployment, is used less than skilled labor in the construction and operation of these schemes, and the latter is more than likely underpaid and in short supply in the country. Therefore, any shadow price effect for labor was considered to be a wash.

Evaluation of Benefits of Proposed Program

Although many tangible and intangible benefits of the proposed program can be cited (see Social Evaluation), the principal benefit amenable to monetary calculation is the increased production of food. This increase in food production will result from more complete utilization of cultivated acres during Maha season, and therefore more average production per acre. Also, cultivation of more acres during Yala season and more complete utilization of acres irrigated, will raise average production of each acre cultivated in that season.

The benefits presented in this section are based on the increased paddy production as a direct result of upgrading Gal Oya and Walawe target areas. The total water management program includes other elements (training, central support, extension, field research, etc.) that will result in increased production in the other schemes. No attempt was made to place monetary values to this additional benefit, so the benefits presented should be taken as conservative values, with higher actual benefits being likely to occur.

At present, during Maha, water is poorly distributed among the lands, some getting too much water and some too little. The program will result in a proper distribution to all lands and therefore increase average production per acre: the lands now receiving too much water will have as much or more production, and lands now receiving too little water will have more production. By improved crop cultural practices less water will be required. Irrigation will be used to supplement rainfall for crop growth. By using less water in Maha more water can be carried over to Yala.

In the Yala season, by having a larger water supply available and by reducing use per acre, many more acres can be cultivated than at present. In addition, the improved distribution of water among all lands cultivated will increase the production from each acre cultivated.

The amount that production may increase due to the influences above is estimated by projecting land use with and without the water management program in effect, estimating the additional acres that are cultivated as a result of the program (see Table 9-1) and projecting the production from the added acres. The benefit resulting from the increased production is estimated by applying a net value to the production. Net value of production is estimated by deducting farm production and other costs necessary to obtain the production. Shadow price adjustments are made.

Increased Crop Production. Increases in crop production were estimated by multiplying increased cultivated acres (Table 9-1) by higher yields resulting from the program.

Projections of crop use and yields on the added acres are speculative (as is the case with all projections). As to type of crop, paddy seems an obvious possibility, especially for Gal Oya where paddy is already grown once a year on essentially all the land that would be added to cultivation in Yala. In addition, the profitability of sugar production is questionable and was not proven in the past on Gal Oya. (See Report of the Gal Oya Project Evaluation Committee, Sessional Paper No. 1 - 1970.) For these reasons it was assumed that the increased acres cropped would grow paddy in the Gal Oya Scheme. On the Walawe Scheme, future crop use on acres added seems less clear than for Gal Oya. Original plans for Walawe called for significant acreages of sugar and cotton. In addition, the soil suitability for paddy production on all lands is questionable. However, because nonpaddy crops are not presently grown, sugar is questionable from a profit standpoint, cotton is unknown, and farmers prefer paddy, paddy was assumed to be grown on acres added due to the program.

Paddy yields at both schemes were reported by local government personnel to be about 55 bushels per acre at present. Although known trends in yields show little change, it is believed that without the proposed program or similar efforts, extension efforts may result in some increase due to improved varieties, more fertilization, better weed control, and more timely operations. Therefore, it is assumed that paddy yields will increase at 1 percent per year without the program. With the program, yields may show a dramatic change in a short period of time. Reports were given in the field of farmers achieving yields of 100 bushels or more per acre. Experimentally, this yield is considerably exceeded. For present purposes, it is assumed that yields will not be affected the first 3 years of the program, then will increase at a uniform rate to 85 bushels per acre by the end of 8 years of the water management program, and increase at 1 percent per year thereafter.

Cultivated acres were projected without the program to increase only due to development of added acres at Walawe (Table 9-1). A total of 21,900 acres were assumed added over an 8-year period, then number of acres was held constant for the 20-year evaluation period (Table 9-6). Cultivated acres with the program were assumed to increase by 155,300 acres over an 8-year period at a rate judged to be realistic, considering the program schedule and expenditures:

Year	Program Accomplishment (%)
1	0
2	2.5
3	10.0
4	28.0
5	51.0
6	65.0
7	82.0
8 - 20	100.0

Production due to the water management program is projected to increase by year 20 by 19,900,000 bushels of paddy. The increase is due both to increased yields and to more acres cultivated in both seasons. Beginning with 12.5 million bushels approximate present production, production is projected, with the program, to reach 36.3 million bushels in year 20, a 190 percent increase over year 1. This is an average annual increase of 5.48 percent.

Table 9-6
Estimate of Increased Paddy Production at Walawe and Gal Oya Due to Water Management Program

	Without Program			With Program			
Year	Acres[1] (1,000)	Yield	Production (1,000 bu)	Acres[1] (1,000)	Yield	Production (1,000 bu)	Increased Production (1,000 bu)
1	222.7	56	12,471	222.7	56	12,471	--
2	225.4	56	12,622	226.6	56	12,689	67
3	228.2	57	13,007	238.2	57	13,577	570
5	234.3	58	13,589	302.5	67	20,268	6,679
6	237.5	58	13,775	322.9	72	23,249	9,474
7	241.0	59	14,219	350.4	78	27,331	13,112
8	244.6	60	14,676	378.0	85	32,130	17,454
9	244.6	60	14,676	378.0	86	32,508	17,832
10	244.6	61	14,921	378.0	87	32,886	17,965
11	244.6	61	14,921	378.0	88	33,264	18,343
12	244.6	62	15,165	378.0	88	33,264	18,099
13	244.6	63	15,410	378.0	89	33,642	18,232
14	244.6	63	15,410	378.0	90	34,020	18,610
15	244.6	64	15,654	378,9	91	34,398	18,744
16	244.6	64	15,654	378.0	92	34,776	19,122
17	244.6	65	15,899	378.0	93	35,154	19,255
18	244.6	66	16,144	378.0	94	35,532	19,388
19	244.6	66	16,144	378.0	95	35,910	19,766
20	244.6	67	16,388	378.0	96	36,288	19,900

(1) Acres cultivated in both seasons

Value of Increased Crop Production. To place a value on the increased crop production resulting from the program, the beginning point was the approximate present world price of rice. Although prices on the world market vary from year to year, depending on world production and other factors, a price of $260 (Rs.4,030) per metric ton was used (assumes purchase in Asia, 70 percent whole kernels). Net farm value of paddy per bushel was estimated to be $1.17 (Rs.18.11) (Table 9-7).

To obtain the net farm value of paddy, the worls "price" of paddy was adjusted for farm and marketing costs and for use of foreign exchange to purchase needed fertilizer. chemicals, and tractors. Fertilizer, chemical, and tractor costs were increased by 30 percent foreign exchange factor. A labor shadow price adjustment was made because of the high rate of unemployment in Sri Lanka. The social value or opportunity cost of labor is below the market wage rate. The cost of labor used thus was reduced by 30 percent; i.e., added back to the value of paddy.

Value of increased production, net of costs of achieving it, increases rapidly during the 8-year program period to $20.4 million (Rs.316 million). (See Table 9-8.) By the end of the 20-year evaluation period, annual benefits are $23.3 million (Rs.360.4 million).

Return to Program and Associated Activities

The economic desirability of the program is judged first by estimation of the internal rate of return on costs incurred and benefits received, then by an evaluation of the sensitivity of the rate of return to changes in critical variables.

Internal Rate of Return. The internal rate of return is defined as the rate at which the discounted cash flow, considering all costs and returns, is exactly zero. The rate estimated for the water management program is 20.6 percent (Table 9-9). The cash flow, based on data presented in Tables 9-5 and 9-8, is negative for the first 5 years of the program. The highest level is $22.6 million, achieved in the 20th year of the evaluation period (Table 9-9).

Sensitivity of Rate of Return. Rates of return were estimated under three assumptions alternative to the base case: (1) Benefits are 25 percent less than projected originally; for example, if some combination of yields, prices, or acreage were reduced below projections. (2) Costs are 25 percent higher than projected originally. This might result from understatement of program costs, O&M, or development costs

Table 9-7
Derivation of Net Farm Value per Bushel of Paddy Produced

Price:

World price, c.i.f. Colombo[(a)] $260/metric ton

Price per pound $ .116 (Rs.1.80)

Price per cwt Rs.1.80

Paddy equivalent Rs.124.20/cwt (69 lb rice = 100 lb paddy)

Paddy price per bushel = Rs.57.13

Costs:[(b)]		
Transport, handling, marketing, milling		Rs. 5.87
Farm production costs		40.00
Fertilizer shadow price adjustment		.70
Chemical shadow price adjustment		1.10
Tractor shadow price adjustment		.35
TOTAL		Rs.48.02
Labor shadow price adjustment[(c)]	(+)	9.00
Net farm value per bushel paddy		Rs.18.11 ($1.17)

(a) World Price: based on discussion with International Rice Research Institute, Colombo (IRRI) personnel

(b) Costs:

Transport, handling, etc. - from IRRI

Farm production cost - Agrarian Research and Training Institute, Colombo (ARTI), other, see Finance section

Fertilizer shadow price adjustment - based on average fertilizer cost per bushel of paddy of Rs.2.24 and .3 factor

Agrochemicals - average cost of Rs.3.69/bushel and .3 factor

Tractor shadow price adjustment - assumed tractor price Rs.100,000, 16 tractors per 2,500 acres, average yield 70 bushels, annual cost 10 percent of investment, and .3 factor

(c) Labor shadow price adjustment - labor cost, including farmer and family, of Rs.27/bushel on farm and Rs.3 off farm and .3 factor

Table 9-8
Estimated Program Benefits
From Increased Paddy Production

Year	Value[1] (Rs.1,000)	($1,000)
1	-	-
2	1,213	78
3	10,323	666
4	60,687	3,915
5	120,957	7,804
6	171,574	11,069
7	237,458	15,320
8	316,092	20,393
10	325,346	20,990
15	339,454	21,900
20	360,389	23,251

(1) Value at net value per bushel of $1.17 (Rs.18.11). See Tables 9-6 and 9-7.

for Uda Walawe. (3) Both higher costs and lower benefits. The results were:

	Rate of Return
Benefits 25 percent lower	15.1%
Costs 25 percent higher	16.3%
Both occurrences	11.2%

Conclusion

It is concluded from the economic evaluation that the proposed water management program and associated activities are justified at a rate of return of 11 to 21 percent. This conclusion is based on an opportunity cost of capital of 10 percent in Sri Lanka.

FINANCIAL EVALUATION

In the financial evaluation, income and expenditure schedules are developed at farm and Government levels. These statements illustrate the financial consequences of the proposed program in terms of flows of funds during the first 8 years of the program. Thereby, the likely incentive for farmers to participate is assessed. At the Government and project levels, financial requirements and benefits are illustrated. The incentive for the Government to participate is judged.

Farm Level Evaluation

Although there is considerable variation in farm size on the schemes, 3-acre farms are present in large numbers and this size could be considered typical. Many colonists received 3-acre allotments. The budget for the farm unit indicates a return at present of Rs.3,953.70, slightly more than the poverty level of Rs.3,600, below which free weekly rice rations are provided. For a family of six, about average, the income per member would be Rs.658.95 ($42.51), considerably below estimated countrywide per capita income of Rs.2,325 ($150). It is little wonder that many farmers and their families seek off-farm income, and engage in chena (slash and burn) cultivation and other farm work.

Average farm income is expected to increase under the proposed water management program due to higher crop yields and greater land use intensity. Better operation and maintenance of the irrigation systems can result in water distribution and timing according to crop requirements. Farm extension and training at the farm level can result in improved farm management and inputs necessary for larger yields. A projected farm budget for average 85-bushel yields per

Table 9-9
Net Benefits, Costs, and Cash Flow of
Water Management and Associated Activities
($1,000, 1978 Price Level)

Year	Net Benefits	Costs	Cash Flow
1	-	$8,253	(8,253)
2	78	11,269	(11,191)
3	666	7,820	(7,154)
4	3,915	11,974	(8,059)
5	7,804	12,257	(4,453)
6	11,069	9,781	1,288
7	15,320	9,796	5,524
8	20,393	10,578	9,815
9-20	20,835 to 23,251	683	20,152 to 22,568

Rate of return 20.6 percent

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[1] Parenthesis marks indicate a negative number.

harvested acre and double cropping indicates a possible return to the farmer and family labor of Rs.8,419.50 per year, an increase of 113 percent over present returns (Table 9-10). It would raise income per person for a family of six to Rs.1,403.25 ($90.53). Although still not a wealth-inducing income, the farm family would be raised from mere subsistence to a position where there would be some surplus income above food requirements (a family of six consumes about 46 bushels of paddy per year, and other food requirements were estimated by an extension worker at one scheme to be Rs.3,600).

The projected farm budget and income would appear to provide positive incentive to the farmer to participate in the program. The added cash costs are returned and the typical farmer's income is increased from Rs.867 to Rs.1,403 per acre cultivated, 62 percent. The farm family labor effort would be increased by perhaps one-third (from 4.56 acres cultivated per year to 6). The conclusion on incentive is based on the 1978 price-cost relationship; therefore, for the incentive to become effective, paddy prices must be increased at a rate of at least as large as inflation in costs of farm production. It would be preferable for the Government to increase the guaranteed price for paddy relative to costs of production to provide a higher income and greater incentive. Many farm units are smaller than 3 acres and submarginal under present price-cost relationships.

Government Level Evaluation

The greatest single incentive for Government participation in the program is the opportunity to substitute domestic rice for imported rice. As noted in the economic evaluation section, the import price of rice is equivalent to Rs.57.13 per bushel of paddy. Recent data from IRRI indicate that paddy grown in Sri Lanka costs about Rs.48 per bushel (Rs.40 to purchase paddy, Rs.6 for transport, handling, marketing, and milling, and Rs.2 for foreign purchase shadow price adjustments). Thus, there is a potential saving of about Rs.9 per bushel for domestic rice as compared to imports.

Under present conditions, all of the increased paddy production resulting from the proposed program could be substituted for imported rice. Average production for the past 5 years is about 70 million bushels, and consumption is about 100 million bushels.

Return on Government expenditures in the program, using 1978 prices is about 50 percent for the 8-year program period (Table 9-11). The expenditures would pay a 10-percent

Table 9-10
Average Farm Income and Expense Schedules
for 3-Acre Irrigated Paddy Unit, (1978 Price Level)

	Present	Projected
Yield per harvested acre	55 bu	85 bu
Production	250.8 bu[1]	510 bu[2]
Value of production[3]	Rs.9,028.8	Rs.18,360.0
Expenses Rs./acre		
Land preparation	334.40	440.00
Seeding	182.40	350.00
Fertilization (50%)	106.40	195.00
Weed and pest control	250.80	950.00
Harvest & threshing	410.40	700.00
Transport, incidental	190.00	320.00
Water charge (Rs.25/ac)[4]	75.00	75.00
Interest[5]	142.30	283.50
Total expenses/acre	1,691.70[1]	3,313.50[2]
Expenses for 3 acres	5,075.10	9,940.50
Return to farmer	Rs.3,953.70	Rs.8,419.50
	($ 255.08)	($ 543.19)

(1) Assumes a cropping intensity of 1.52, the present average

(2) Assumes a cropping intensity of 2.0

(3) Price received for paddy assumed to be Rs.36/bu

(4) Water charge has been scheduled to begin on Gal Oya beginning 1 January 1979.

(5) Interest is based on a loan of 75 percent of cash production costs at an interest rate of 12 percent per annum.

Source: Based on information from agricultural officers at Gal Oya and Morawewa and from the Agrarian Research and Training Institute, Colombo.

Table 9-11
Net Import Substitution Gain from Domestic Paddy Production (Rs.1,000)

Year	Import Substitution Savings[1]	Cost[2]	Net Gain
1	--	1,782	- 1,782
2	603	27,312	- 26,709
3	5,130	27,406	- 22,276
4	30,159	27,633	2,526
5	60,111	27,920	32,191
6	85,266	28,083	57,183
7	118,008	28,303	89,705
8	157,086	40,424	116,662

Rate of return = 49.8 for 8 years only.

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(1) Savings calculated at Rs.9 per bushel. See Table 9-6 for production.

(2) Assuming payment of O&M costs for Gal Oya and Walawe and capital costs for development of irrigated acreage at Walawe. See Table 9-5. Exchange rate assumed to be Rs.15.5 = $1.00.

return in the sixth year. This rate of return should provide sufficient incentive to the Government to participate in the program.

Cost Flow in Current Dollars

The timing of current cash requirements for the water management and associated activities is illustrated in Table 9-12. Rates of inflation in costs of 8 and 10 percent are assumed. Costs in the first year are Rs.114.0 million ($7.4 million) and rise to Rs.272.7 million ($17.6 million) in the eighth year. The water management program costs alone are Rs.112.0 million ($7.2 million) in year 1 and rise to Rs.186.1 million ($12.0 million) in year 8. As indicated previously, costs decline appreciably after the 8-year program period.

ADMINISTRATIVE FEASIBILITY

This project is aimed at the rehabilitation of existing large irrigation schemes and the identification and implementation of the mechanisms and procedures required to operate them correctly and efficiently. The fact that this should be necessary indicates that there is in some sense an administrative problem. Some aspects of this problem have been discussed in Chapter 4.

Due to the way in which water issues have been managed and the mechanisms farmers have used when dissatisfied with water allocations, relationships between farmers and Government officers who have attempted to manage water issues have generally become somewhat strained. The farmers' contribution to water issues has been largely confined to stratagems to get more. This has become a self-perpetuating impasse, since it is partly because of the farmers' demands and reactions against rationing that overall water issues have been little controlled, water arrivals have often been unpredictable, and scarcity has been an ever-present threat. Farmers respond to scarcity by taking as much water as they can when it is available.

One possible response to problems of allocating resources like water to small farmers via bureaucratic organizations is to try to involve farmer organizations as much as possible, turning control over to them. The "irrigation associations" which are common in East and Southeast Asia are an example. Such organizations have the added appeal of appearing very democratic. However, in the case of Sri Lanka at the present time, such a strategy would not be wise. The experiences, behavior patterns, and expectations

Table 9-12
Cash Requirements[1] for Added Costs of Water Management Program and Associated Activities, Years 1 to 9 (Rs.1,000)

Year	Water Management Program	Increased O&M	Increased Development	Total Rs.1,000	Total $1,000
1	112,003	1,960	--	113,963	7,352
2	139,469	2,193	30,855	172,517	11,130
3	95,186	2,537	33,940	131,663	8,494
4	174,980	3,123	37,335	215,438	13,899
5	193,796	3,897	41,068	238,761	15,404
6	159,557	4,576	45,175	209,308	13,504
7	172,329	5,462	49,692	227,483	14,676
8	186,078	6,482	80,170	272,730	17,595

(1) Current rupee inflation rate of 10 percent per year for O&M and increased development costs and 8 percent for water management program

that have accumulated in recent decades leave the farmers neither mentally prepared nor, even in a rudimentary sense, organized to take over control at the local level and assume a major responsibility in allocations of water. Therefore, while farmer participation is considered essential to program success, turning over control to farmer organizations is not considered practical at present.

There already exists in the Irrigation Department and the RVDB a cadre of professionals with experience and interest in water management. The best chance of improving water management in the medium term lies in building on this base. As was noted previously, there is an established tradition of water allocation under discipline in the context of relatively widespread farmer participation in cultivation meetings to decide on cultivation schedules. The administrative base is there, and valued traditions may be called upon to legitimatize firm administrative water allocation. The need is to build up that administrative base. If that is to be done successfully, five kinds of measures are required:

1. An increase in the status and authority of the staff in charge of operation and maintenance of irrigation systems

2. An increase in the numbers and quality of staff allocated to operation and maintenance duties

3. Training of staff in techniques related to water management

4. Measures to motivate staff to work well in operations and maintenance

5. Strong external support for the decisions and actions of water management staff so that they can do their job and maintain moral

The need for such measures and the form they should take have been discussed in detail in this report. The funds and staff provided by the proposed USAID project will help in some degree with points 1 through 4. If the Government of Sri Lanka can make the contributions outlined in Chapter 2, then it becomes likely that the program will meet its targets.

For the elements of the proposed program which involve direct expenditure of USAID funds, adequate administrative support has been provided.

ENVIRONMENTAL SOUNDNESS

The purpose of an environmental soundness evaluation of a project is normally to define concerns in terms of specific project activities and affected environmental systems. The evaluation of environmental soundness of the proposed water management program in this study is extremely limited because a complete environmental assessment was outside the scope of the study. There was no detailed inventory of human or natural environments for the study area. The approach taken here was to use a recent environment assessment study (environmental assessment of Stage II of the Mahaweli Ganga development project sponsored by the USAID and the Mahaweli Development Board of the Government of Sri Lanka, 1977).

Although information is drawn from the Mahaweli Ganga environmental assessment, such information is not entirely appropriate for the present water management program because of the different nature of the two projects. In particular, the Mahaweli Ganga develops new areas for intensive agriculture, whereas the present water management project construction activities are to rehabilitate old, presently developed irrigated areas. Although the water management program proposed here includes improved operation and maintenance of irrigation systems, training, extension, field research, upgrading portions of the Mahaweli and master plannings, and social research, the following discussion applies only to the activities associated with upgrading the two irrigation schemes. The reason for this is that the water management project elements are essentially bringing the level of management, operation, and maintenance of onfarm distribution, and conveyance systems up to an acceptable level. This can only have positive impacts over what is now occurring.

The following impacts are identified in the Mahaweli Ganga environmental assessment. Their relevance to the present program is indicated in the discussion.

1. Increase in the incidence of malaria. This is a possible effect in the present program due to a wider distribution of water than at present. The presence of more water, especially at the tail end of projects may increase the number of mosquito breeding places. This may be offset by removal of excessive water in upper portions of the system.

2. Increase in water-borne disease. In the Mahaweli Ganga environmental assessment, this impact was

expected, principally due to increased population density. In the case of the present program, population density is not likely to change much, and, therefore, this would not be expected to be a factor. The suggested domestic well program would be expected to have a positive effect--that is, reduce the incidence of water-borne disease because of the provision of higher quality drinking water.

3. Increased risk of pesticide residues through increased use of agrochemicals. This is a possible consequence of the proposed program due to greater use of weedicides as water levels are reduced and general increase in use of agrochemicals because of higher incomes.

4. Increased soil loss through erosion. For the present project, soil erosion is likely to be reduced because of more proper water applications and less incidence of large quantities of flowing water through fields.

5. Increased waterlogging of soils and salinity buildup. For the present project, it is expected that water application will be less or no more than at present. Therefore, water logging of soils and salinity buildup will likely be lessened because of better water distribution and reduced quantities of water in areas which are presently watered excessively.

6. Decline in variety and number of birds and animals. This is a possible slight effect because of more intense agricultural production, particularly at the tail ends of projects. Since little or no additional agricultural land will be diverted from natural uses, this effect is expected to be slight.

7. Energy loss locally and greater demand for energy. This is not a likely effect because no significant increase in population is expected.

8. Changes in stream flows. No effect. The program does not suggest any changes in stream flows. The timing in level of flows in canals will be changed, however.

9. More agrochemicals in agricultural runoff and deleterious effect on tank fish. This is a likely effect of the proposed program for reasons indicated in No. 3 above.

The next section illustrates by means of an environmental checklist expected environmental impacts.

Land Use	Impact
1. Changing the character of the land through:	
(a) Increasing the population	None
(b) Extracting natural resources	None
(c) Land clearing	None
(d) Changing soil character	None
2. Altering natural defenses	None
3. Foreclosing important uses	None
4. Jeopardizing man or his works	None
5. Reducing soil erosion	Positive
6. Other factors	None
Water Quality	
1. Physical state of water	Slight negative
2. Chemical or biological states	Slight negative
3. Ecological balance	None
4. Reduction of leaching of chemical fertilizers	Positive
5. Other factors	None
Atmospheric	
1. Air additives	Slight negative
2. Air pollution	Slight negative
3. Noise pollution	Slight negative
4. Other factors	Slight negative
Natural Resources	
1. Diversion, altered use of water	Some, neutral
2. Irreversible, inefficient commitments	None
3. More efficient use of water	Positive
4. Other factors	None
Cultural	
1. Altering physical symbols	None
2. Dilution of cultural traditions	None
3. Enhancement of cultural traditions	Positive
4. Other factors	None

Socio-Economic

1.	Changes in economic/employment patterns	Positive
2.	Change in population	None
3.	Others	None

Health

1.	Changing natural environment	Some negative
2.	Eliminating an ecosystem element	None
3.	Providing more and better domestic water	Positive
4.	Other factors	None

General

1.	International impacts	None
2.	Controversial impacts	Some, neutral
3.	Larger program impacts	None
4.	Other impacts	None

APPENDIX ONE: (SIMPLIFIED) ——> EXISTING PERSONNEL STRUCTURE FOR IRRIGATION DEPARTMENT FIELD STAFF

RANK	MINIMUM EDUCATIONAL QUALIFICATIONS	SOURCE OF RECRUITS
1. Labourers, casual and permanent	None	Direct
2. Kanganies, casual and permanent	None	Promotion from labourers
3. Works Supervisors	10th Grade with passes in mathematics, physics and chemistry and 4 credits	20% by open entrance and 80% by promotions from kanganies who have the educational qualifications and 3 years' service.
4. Technical Assistant	Except those promoted, one requires the 2-year J.T.O.* certificate and a pass in the examination of the one year of training given initially by the Irrigation Department. Passes in the latter examination are nearly 100%.	90% of vacancies are filled by holders of the J.T.O.* and 10% by Works Supervisors with 10 years' service and 6 10th Grade passes
5. Senior Technical Assistants	As above	All posts filled by T.A.'s after successful completion of a rigorous practical examination.
6. Engineers	Except those promoted, one requires a recognised civil engineering degree <u>or</u> a charter from the Sri Lanka or London Institution of Engineers	20% of posts are reserved for Senior T.A.'s, appointed on seniority. They cannot rise beyond Class-2, Grade-2. Most of the posts are filled by graduates, and a few by charter holders from one of the Institutions of Engineers. Some of these are former T.A.'s

* Now called the NDT - National Diploma in Technology

APPENDIX TWO

LOCAL-LEVEL GOVERNMENT AND FARMERS' ORGANIZATION AFFECTING AGRICULTURE (EXCLUDING MAHAWELI, UDA WALAWE, AND OTHER SPECIAL SCHEMES)

	Irrigation Department	Agriculture Department (Basically Extension)	Agrarian Services Department: Ordinary Arrangements	Agrarian Services Department: Extras for Minor Irrigation Schemes	Revenue Department (Government Agent)	Rural Development	Ministry of Justice
As of October 1978	T.A. (1) ↓ Overseer (1) ↓ Laborers (2)	A.I. (1) ↓ K.V.S. (1) ↓ Contact Farmer (3)	Cultivation Officer (C.O.) (5)		Tank Water Meetings	Rural Development Officer (1) ↓ Rural Development Societies	
Current Proposals	T.A. (1) ↓ Overseer ↓ ↘ Laborers (2) → Irrigators (1)	Same	Agrarian Services Committee (6) ↓ C.O. (5) ↓ Representative Farmers (4)	T.A. (1) ↓ Overseer (1) ↓ Laborer ↓ 'Farmer Irrigator' (3)	Tank Management Committee	Same	Primary Courts

(1) = Regular Government Officer
(2) = Regular and Casual Government Employees
(3) = Farmer nominated by Government Officer concerned
(4) = Elected Farmers
(5) = Government Officer – Political Appointee
(6) = Committee of Government Officers and elected/nominated Farmers

APPENDIX THREE

THE UDA WALAWE SCHEME

PERSONS CONTACTED

Tilak Palmakumbura	Chairman, River Valley Development Board
Mr.Cader	General Manager, River Valley Development Board
J.P.Nanayakkara	Deputy General Manager, River Valley Development Board
A.Rajalingam	Irrigation Engineer, Irrigation Department
R.Anandappa	Agricultural Officer, Chandrikawewa
K.Nadarajah	Animal Husbandry Officer
C.Samaraweera	Cultivation Officer, Murawashena
R.M.S.B.Seneviratne	Bin Kema Agricultural Officer TR.12
D.J.D.W.Ratnayake	Agricultural Officer, Left Bank
A.S.D.de Silva	Agricultural Officer, Tracts 2 - 7
D.D.J.Gunawardane	Assistant General Manager (Agricultural Instructor)
W.T.Raj Kumar	Technical Assistant Water Management (Chandrikawewa project)
J.L.A.Premadasa	Draughtsman (Water Management)
Marcos Perera	Water Management Engineer
Mr.Dias	Senior Technical Assistant (Water Management)

INTRODUCTION

The Uda Walawe Scheme is located on the Walawe River, and is being developed by the River Valleys Development Board (RVDB), which has its headquarters in Embilipitiya. Within the project area is an ancient scheme diverting from the river below the Uda Walawe reservoir through the Liyangahatola to the Ridiyagama tank. This tank serves several thousand acres that are excluded from the Walawe project area and is located in the middle of the southern part of the project on the left bank.

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Development of the Right Bank system began eight years ago, and is now complete. The Left Bank system is now under construction, although there has been no new land developed for the past two or three years.

THE SYSTEM

The main reservoir has a capacity of 218,000 feet under full supply conditions. The Right Bank system comprises 25 miles of main canal, including a return to the river and a syphon at the front end. There are two tanks, Chandrika and Kachchigala, which act as balancing reservoirs. The inclusion of the Chandrika tank with so much dead storage is causing operational problems and is indirectly one of the causes of very heavy water use rates at the top end of the Right Bank canal.

At several points the main RB canal has only a down-side (left-bank) bund. Tributaries are intersected by the canal creating many small lakes. Although the capacity at the front end of the system is 850 cfs, 800 cfs from the sluice is the actual maximum safe capacity. There are insufficient regulators contributing to a sluggish, uncontrolled canal and lake system as the main conveyance. A study is needed to develop a plan to improve operation of storage and main conveyance system.

Feeding from the right bank main canal is a system of branch channels, distributors and field ditches to distribute the water to 3 acre allotments, of which 2 1/2 acres are for crops and one half acre for homestead and garden. There are 43 miles of main branch channels, 172 miles of distributor channels and 381 miles of field channels totalling 621 miles. The total irrigated acreage of the Right Bank system is presently 25,522 acres.

generally higher in this area than in Uda Walawe because it is an older irrigated area and there is less slope. Some of the main canals and distributaries are excavated in rock so that seepage losses would tend to be minor. The lower areas appear to be excavated in moderately fine soils underlain by rock. The drainage on the left bank system is to the river and the river diversion units primarily return back to the river. The left bank drainage is directly to the ocean and lagoon areas.

PROJECT WATER BUDGET

LAND IRRIGATED

About 120,000 acres were planned for irrigation under this scheme. Department of Irrigation officials said that encroachments by farmers on rights of ways for canals, roads, ditches and on areas "reserved" for grazing, irrigation of land just above channels scheduled as highland and pumping water from canals and drains etc. have increased the total area provided with irrigation water by 10 or 20%. They suggested that surveying the area to determine the area irrigated and establishing the legality of irrigation withdrawals from the channels should be a first priority in any program to improve the system and its operation.

Estimates of average acres cultivated during the Maha and Yala season were :-

		Acres Irrigated	
Season		Legally	Encroachments
Maha	..	100,000	10,000 to 25,000
Yala	..	57,000	3,000 (approx)

SYSTEM OPERATION AND WATER RELEASED FOR IRRIGATION

The Senanayake Samudra Reservoir has a capacity of 770,000 acre feet and, as described in Table 1 ,is the largest reservoir

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in Sri Lanka. There are several smaller reservoirs in the system including:

Naakiri	with 47,500 acre feet of storage capacity
Namal Oya	with 37,000 " " " " "
Palang Oya	with 93,000 " " " " "
Pannalagama Oya	with 35,000 " " " " "
Ambalan Oya	with 35,000 " " " " "
Ekgal Aru	with 21,000 " " " " "

Many smaller tanks are used as municipal supplies, balancing tanks etc. However, storage in Senanayake Samudra reservoir provides the water for 100,000 of the 120,000 acres irrigated.

Figures on release for irrigation were available on Senanayake Samudra and are shown by year in Table 1. Average yearly deliveries for the period 1952-1977 were about 580,000 acre feet. Hwever, since 1968 the rainfall has averaged below normal and the sluice deliveries have averaged only about 490,000 acre feet per year. Total project irrigation deliveries from "primary" reservoirs are probably about 120% of the issue from Senanayake Samudra.

Several of the smaller reservoirs were constructed with flood control as a major priority. Operational instructions are that Senanayake Samudra itself should be filled to 75% capacity and fillings beyond that level are done only with the advice of the Chief Irrigation Engineer.

A unique feature of this system is that distributaries in many areas were designed so that they could serve as drainage channels for the area above them, as well as supply channels for the areas below them. On the Right Bank and River Diversion systems there are also "dozens" of anicuts on the channels of drains and rivers which now bring drainage water back into the supply constructed and is not being managed at the present time. The observed disadvantage of the concept is that a drainage way is being used as a distribution system. This interferes with the function of drainage ways and presents many potential operational problems.

PROJECT WATER BUDGET

IRRIGATED LANDS

The Right Bank system presently irrigates 29,000 acres (includes 3,500 acres estimated encroachment) during Maha season and 16,000 acres during Yala season. The Left Bank system now irrigates 4,000 acres during Maha and 3,700 during Yala. Totals are about 33,000 during Maha and 18,700 during Yala. The ultimate planned design development is for 65,000 acres.

IRRIGATION INFLOWS AND RELEASES

The average flow into Uda Walawe during the last 5 years (1972 - 1976) has been 903,000 AF. The average release to the RB and LB System to Walawe lands during the same period was approximately 571,000. Direct releases at the bypasses are also made for downstream anicut diversion to the Ridiyagama Tank. These requirements are about 22,000 to 32,000 AF per year. Reservoir capacity is only 218,000 acre feet. Ratios of inflow to reservoir capacity has averaged about 4.2. Ratio of inflow to irrigation release has been about 1.5. The Right Bank System is now operated at maximum capacity of 800 cusecs. Original design capacity is 850 cusecs. The Left Bank has a design capacity of about 1100 cusecs. The constraint is due to bank problems below the syphon.

A summary of release and inflow are shown below :-

Year	Uda Walawe Reservoir Capacity	Yala and Maha Release for Irrigation		Uda Walawe inflow
		Uda Walawe RB and LB	Bypass to River	
1968	217,800			569,000
1969	217,800			985,000
1970	217,800			1,118,000
1971	217,800			1,291,000
1972	217,800	619,000	595,000	987,000
1973	217,800	552,250	159,000	845,000
1974	217,800	646,500	105,400	865,000
1975	217,800	524,000	32,800	1,099,000
1976	217,800	514,000	22,400	723,000
1977	217,800		22,000	1,363,650

WATER DELIVERED TO THE FARMER

Since the first year of operation, water diversions per acre irrigated have been slightly reduced to the following :-

		Right Bank	Left Bank
Average diversion per acre, Maha		8.6	14.9
Average diversion per acre, Yala		13.5	13.3
Average diversion per acre, Total	=	22.1	28.2

A more detailed summary of water and land data is shown on Table A.

CONVEYANCE EFFICIENCIES

No good records exist to determine system conveyance efficiency. The main canal and tank systems do receive significant inflows from tributaries below Uda Walawe that intersect the main LB and RB canal system. These provide significant additional water supplies from rainfall. Spillways are provided to prevent banks overflowing as a result. This design can cause major O & M problems by introducing silt and debris into the system, increasing problems of siltation and erosion of banks.

Since most of the canals are located in well-drained ridge soils, seepage losses may range from 20 to 40%.

VALIDITY OF DATA

Data where it exists appears to be reliable. It is available only for releases from the Uda Walawe, Chandrika, and Kachchigala tanks. Sufficient data does exist to estimate the equitability of distribution to the Upper, Middle and Lower thirds of the Right Bank system or the operating portion of the Left Bank System.

TABLE A: SUMMARY OF WATER USE ON UDA WALAWE SCHEME

Season	Area Irrigated		Acre feet diverted at Uda Walawe tank		Duty AF/ac.	
	RB acres	LB acres	RB	LB	RB	LB
1972 Yala	8,418	514	253,550	47,760	30.2	92.8
72/73 Maha	11,340	1,692	260,590	57,590	23.2	34.2
1973 Yala	10,307	1,920	244,650	44,815	23.7	23.4
73/74 Maha	17,424	2,224	235,490	27,270	13.5	12.3
1974 Yala	13,772	4,075	259,500	75,040	18.8	18.5
74/75 Maha	20,547	4,272	251,690	60,300	12.3	14.1
1975 Yala	15,570	3,769	232,200	46,590	14.9	12.4
75/76 Maha	22,836	4,036	222,250	22,836	9.7	13.9
1976 Yala	16,179	3,640	219,620	34,090	13.5	14.9
76/77 Maha	22,948	3,088	198,674	41,160	8.6	13.3

ON-FARM EFFICIENCY AND WHERE WATER IS GOING

We observed water going into field channels at a rate of nearly one cusec per thirty acres on two channels in tracts 4 and 6. Top end farmers were generally finding methods of taking more than their share. These meth ds included: blocking check structures with rocks or grass, and refusing to clean sections of channel allocated to them so that water level in their section of the channel was higher and flow from their outlets was greater. They had not used the more subtle, but legal and equally effective alternative of lowering the water level on their field side of the outlet to pull more water through the submerged pipes. Many canals in the upper tracts are being operated at rates of one cusec per 10 acres.

Limited observation of water leaving the irrigated areas via drains indicated that about 2/3 of the water being delivered by the canal system was leaving via the drains. The monsoon rains had not yet begun. Such high rates of drainage indicate farm irrigation efficiencies (delivery efficiency x application efficiency) of less than 33%.

Apparently it was the magnitude of this run-off which led the former manager, Douglas Laduwahetty, to install an experimental on the Left Bank system in which a series of anicuts on the drains push the water back on to the land. This system is basically sound, but a few problems have arisen. The installers were not closely supervised and they took the water down to the drain channel rather than starting it on the highest commandable land to begin with. This resulted in several areas at the top of the tract being uncommanded; this could have been avoided. Farmers have begun cultivating illegally in this experimental area before allotments were made. Their insistence on having flowing water in the system has prevented completion of the last anicut. This experiment should be given a fair trial. This would require assigning a man to it, training him so he was fully aware of the objectives and purposes of the design, and then having him work closely with the farmers and law enforcement officers to gain their co-operation in completing the design and operating the system properly.

The primary cause of poor application efficiencies is the high permeability of soils on the upper lands. The puddling methods used apparently do not adequately restrict downward movement of the water. One farmer pleads his case for more water by saying that he could put 4" of water on his field in the morning and it would all have infiltrated before evening. Water levels observed in wells on these uplands were commonly within one foot of the soil surface. This indicates that the present irrigation practice is raising the water table level to near the soil surface. This, rather than creating impermeable soil through puddling is the method used to hold water in the paddies. Water requirements on these high areas to maintain the water levels near the surface appear to be 4 to 10 times the evapo-transperational requirement. Water percolating down through these permeable soils and eventually emerging in the drains comprises a major portion of the water entering the drains. The other major portion appears to be leakage through bunds and deliberate emptying of water from paddy to drains for various purposes.

CROP IRRIGATION REQUIREMENT

Specific information on evapo-transpiration for crops in the area is not available. However, 20 years data from Ridiyagama shows evaporation to be 70.36 inches per year. Month by month averages are as indicated in the attached table (in inches).

	Jan	Feb	Mar	April	May	June	July	Aug	Sep	Oct	Nov	Dec	Total
EVAPORATION	5.27	5.46	6.08	5.30	6.32	6.36	6.51	7.53	6.55	5.85	4.68	4.95	70.36
RAINFALL	3.37	2.98	5.56	7.99	4.79	1.88	1.48	1.18	2.24	7.58	11.35	6.95	47.13

ASSUMING A 50% EFFECTIVENESS LEVEL OF RAINFALL OVER 2" PER MONTH

	Jan	Feb	Mar	April	May	June	July	Aug	Sep	Oct	Nov	Dec	Total
RAINFALL	1.68	1.49	2.78	3.99	2.39	1.88	1.48	1.18	2.00	3.79	5.67	3.97	
IRRIG REQ	3.59	3.97	3.33	1.31	3.93	4.48	5.03	6.35	4.55	2.06	-	0.98	39.55

The long-term average rainfall for Embilipitiya is 47.13 inches per year. Theoretically, the irrigation requirement is the amount of water required (PET) minus the effective rainfall for the same period of time. Effective rainfall depends on its occurrence in relation to its ability to be used. This is highly variable, but can be manipulated in paddy culture to a certain extent. On-farm irrigation management should be directed for best utilization of rainfall.

Computations showing irrigation requirements for full year, full canopy after considering effective rainfall shows a 39 inch requirement. Maha and Yala breakdown can be done from these data, and would be approximately 18 and 24 inches respectively.

Computations using the Papadakis formula at Hambantota is 43.21 inches for the year. Personnel at the Angunvicolapellessa Research station suggested an evapo-transpiration rate of 2.2 - 2.5 acre feet. Duties are around 13 acre ft. Regardless of precise PET and irrigation requirements, there is clearly a tremendous difference between water needs and the amounts being issued.

WATER MANAGEMENT

OVERALL SITUATION

On the Right Bank system the upper 15% (tracts 2 - 7) of the command area receives almost half of the water issued. No good internal control facilities exist within branch channels, distributaries and field channels. Almost the only effective control is at the entrance to blocks of about 2000 acres. Most water is used at the upper ends of channels at each level in the distribution system. There is substantial fall in the terrain, and the system overlays granite at a depth of 20 to 40 feet. Thus most of the excess water used at the top ends returns eventually to the Walawe river. There is no system, planned or unplanned, for re-use of return flows.

ORGANISATION

There is a newly formed water management branch in the project office, but this comprises only an Engineer and a Technical Assistant. Because of the problems and opposition it has previously encountered in attempting to manage the water, it has been reduced to a purely monitoring and advisory role.

Early in 1978 some Irrigators were recruited. The original intention was to assign one to each 300 acres, but fewer were recruited than had been hoped, and each is at present responsible for 500 acres. Over 50 have been appointed. Two supervisors were also appointed, but one has been released for other duties. The Irrigators are under the control of the Project Managers, each of whom is responsible for the overall management of all RVDB activities in a group of tracts. There are 4 Project Managers on the RB system. There are proposals for nine water management Technical Assistants, but there is only one at present, and he has no executive powers. There is little supervision of Irrigators. It is intended to provide Irrigators with bicycles, rain-proof clothing and housing in their work areas; funds are however not yet available. The Irrigators received some training after appointment.

ROTATION PRACTICES

The rotations which are adhered to in principle but not in flow rates are as follows :-

<u>Tracts 2 - 4</u>: Short distributors are rotated on 2 day intervals

after puddling. No rotation during puddling 1 cusec/30 acres. Long distributors have rotations 3 days off and 4 days on. 1 cusec/30 acres.

Tracts 5 - 7: Internal Rotation on long field channels every 2 days. 2 day Rotation on short channels with no internal Rotation. 1 cusec per 30 acres.

Tract 8 - Chandrika: Internal 2 1/2 day rotation in long field channels and 2 days on short field channels.

Tracts 9 - 11: Subsidiary and paddy Rotation at average rate of 1 cusec per 62 acres.

Tracts 12 - 19: Lower Main out of Kachchigala. 8,162 acres paddy and 2,356 subsidiary crops. 180 cusec acres or 1 CFS to 58 acres is average diversion into the area.

In practice there is very little effective control of water use. The scheme is operated mainly by responding to demands for water all the time that water is available.

The commitment to supply water for domestic use and use of animals is substantial; the main RB canal is never closed; there is a 6-day rotation between the two laterals arising from the bifurcation towards the lower end.

CONDITION OF MAIN CANALS AND TANKS

Most of the important points have already been made above. We have no information on design criteria, but the apparent reason for the fact that the RB canal is operated to supply 1 cfs per 30 acres in tracts 2 - 8 and 1 cfs per 60 acres in tracts 9 - 19 is the problem incurred with Chandrika tank.

There are spills along the main canal for bank protection near points where storm run-off enters the canal. The water level is maintained about 6 inches below culvert. Bypass releases are made on each bank canal based on requests made by the IE on the RIDIYAGAMA Tank Project. These releases are picked up half way down the river by an ancient anicut. No record of spills, river, drain, or even Main Regulator flows are kept. Records are kept at 3 tanks and about 4 branch canals.

CONDITION OF BRANCH AND DISTRIBUTOR CANALS

Very few regulators (checks) occur in main branch canals. No control or measurement is made at these locations. Distributors headworks do have gates, but issues are not measured. Gauge posts are to be installed, but these won't work without stream gauging. Staff are aware of methods available to use turnouts as measuring points. No weirs or parshalls exist below turnouts. Gates at distributor headworks are flat, square, metal or wood plates, againtst a round, flush opening with screw 11 CT. Some main branches are in poor condition with inadequate maintenance.

A significant percentage of distributors in the lower tracts (8 - 19) are now flowing at less than design capacity due to lack of cleaning. Some of the regulators are washed out and none are controlled with flash boards. All field channels and farm turnouts along the distributor are uncontrolled (without gate) and many were destroyed or even dug out. The result is that upper portion of distributor supply more than twice the water to field ditches and turnouts than the lower portion of the distributors. In the Chandrika area 40% of the field channels are silted up.

Distributors serving less than 100 acres are to be cleaned by farmers. This is spotty operation. Tracts 2 - 7 farmers have pushed for and are getting lining on their field channels. A shramadana was recently held to get the cleaning done. The Cultivation Officer, the Irrigator, and in some cases the Village Priest organised these. It is estimated that their method is about 30% effective on a total project basis.

CONDITION OF FIELD CHANNELS

The field channels and structures appeared to be designed to handle at least twice the amount of water flowing in them. Perhaps this is a result of the concept that 1.5 feet of free-board are needed on a channel carrying 1 cusec of water. This has been stated at other schemes in Sri Lanka. Rectangular openings for water flow in check and drop structures were commonly 24 to 30" high, with provision for use of check boards, but the check boards are not in use.

The base of these structures were generally constructed of rubble masonry, plastered in the original above ground surfaces. Some of the upper portions appeared to be made of poured concrete. Washouts had occurred around about 25% of these structures, leaving portions of them unsupported. About half of those which were unsupported were badly cracked or broken.

Channels were often overgrown with bushes and considerable amounts of weeds and grass were common in the stream channels. Toward the bottom ends of some of these field channels, water was not flowing and some of the bottom end farmers had apparently not received water during the past few seasons.

One field channel was completely lined with 'L' shaped preformed reinforced concrete sections which are mortared together in the field to form a channel which was 4 feet wide at the top end, 3 feet wide in the middle section and 2 feet wide at the bottom end. This channel was one year old and in good repair. Farmers at the tail end indicated that they were satisfied with their water supply and it appeared to be about equal to that received at the top end.

The field channels are normally run on a continuous flow basis during land preparation for paddy. Following seeding when there is no rainfall, the field channels are given water on a rotation schedule, receiving water about half of the time. Some of the long field channels receive water continuously and it is used for 3 1/2 days in the bottom half, then 3 1/2 days in the top half etc. However, on many channels, little or no water reaches the lower end.

Part of the reason for distributional inequity is the relative ease with which a farmer can take more than his share through a pipe outlet when the level of water in the channel is low. The observed head difference on some of the 3" outlets was only about 1 inch. Raising this to two inches by placing a rock or a few weeds in the opening of the check structure increases the flow through the farmers outlet by over 40%. Openings in these structures are two to three feet tall and the head of water in front of them was probably designed to be about 7" higher than the water in the outlet. If the normal operating level provided 7" of head difference to push the water through a pipe, increasing the water level by one inch would increase the rate of flow through the pipe by only 7%.

Consequently, equity of distribution in these field channels could be improved if the operational level of the water was raised about 6". This could be done by giving each farmer a properly designed check board and issuing twice the flow rate of water through the channel for half of the time during which it is presently issued. Masonry repair on several of the structures and careful packing of earth around these structures would be necessary to put them in shape to handle this flow of water.

One of the factors hindering maintenance of the channel and structures is encroachment on the channel right of way by the farmers. Already short of staff, the RVDB has not had time to force these farmers to keep crops out of these rights of way. Moreover, when breaks occur the Irrigation Department people do not feel they are able to borrow soil from the rights of way to make the repair because it will damage the farmers crop. Consequently, if the repair is to be made, the earth must often be hauled in from considerable distance, increasing the cost of repair several fold, or causing an indefinite delay of the repair and extensive soil erosion.

EXTENSION SERVICE

As with other organizations and agencies on this project, extension activities are under the overall direction of the River Valley Development Board. Extension activities seem to be the same, organizational and subject matter-wise, here as in other parts of the country at the district level, middle and farmer levels. There are no water management specialists or programs although extension workers are active in crop variety selection, planting dates and weed control all of which have water management implications.

Facilities for a large staff of extension workers have been constructed at Angunvicolapellessa, but are not being used due partially to lack of funding.

APPENDIX FOUR

THE GAL OYA SCHEME

PEOPLE CONTACTED:

1. Mr.K.Thurairajarathan, Chief Irrigation Engineer, Amparai
2. Mr.M.A.Mirza, Irrigation Engineer, Kalmunai
3. Mr.S.Senthilanathan, Irrigation Engineer, Amparai
4. Mr.D.B.Ekanayake, Divisional Assistant, Amparai (Sr.Tech. Asst)
5. Mr.W.Amarakoon, Technical Assistant, Amparai Office
6. Mr.E.R.Martin, Division Agricultural Extension Officer
7. Mr.Y.W.Gunawardena, Government Agent, Amparai District
8. Mr.P.Dayaratne, District Minister, Amparai District

GENERAL DESCRIPTION OF THE PROJECT AND STAGE OF DEVELOPMENT

The Gal Oya project was started in 1952 and the left bank development was completed by about 1958. The right bank was completed in 1960. Portions of river diversion unit predated the rest of the scheme and additional anicuts have been built on the river and its tributaries during the intervening time. The main tank is the Senanayake Samudra. The tank has a capacity 770,000 acre feet. The average annual inflow into the tank over the years since it has been developed has been 697,000 acre feet and the average release has been 580,000 acre feet. The minimum inflow was 264,000 and the release that year (1976-7) was 274,000 acre feet. The outlet works of the main tank has a capacity of 1600 cfs and can be diverted either through the hydro-electric facility or directly through an outlet works to the control structures that divert water to the left bank, which has a maximum capacity of 1,100 dfs, the right bank, or the river diversion lands. The left bank is all in paddy. The canal serves some 40,500 acres, including the 6,000 acres served to the Kalmunai division which is at the end of the left bank main canal and in Batticaloa District. The river diversion unit feeds substantially from return flows and diversions made to a series of tanks as well as from direct releases made into the river. There is a total of 40,000 acres served by the river diversion. The right bank diversion serves a total of approximately 30,000 acres. The right bank and river diversion unit are quite heavily developed with return flow systems. The return flows from the upper distributaries are diverted into the supply canals for the lower distributaries so that reuse can take place in these two units as many as six times. The left bank unit does have some small lower area anicuts but mostly return flows go to the lagoon area.

There is a total of about 4 to 6 feet of fall per mile in the system. The soils appear to be fairly well drained with some swelling clays in the bottom lands. However, the water table is

A 25<

generally higher in this area than in Uda Walawe because it is an older irrigated area and there is less slope. Some of the main canals and distributaries are excavated in rock so that seepage losses would tend to be minor. The lower areas appear to be excavated in moderately fine soils underlain by rock. The drainage on the left bank system is to the river and the river diversion units primarily return back to the river. The left bank drainage is directly to the ocean and lagoon areas.

PROJECT WATER BUDGET

LAND IRRIGATED

About 120,000 acres were planned for irrigation under this scheme. Department of Irrigation officials said that encroachments by farmers on rights of ways for canals, roads, ditches and on areas "reserved" for grazing, irrigation of land just above channels scheduled as highland and pumping water from canals and drains etc. have increased the total area provided with irrigation water by 10 or 20%. They suggested that surveying the area to determine the area irrigated and establishing the legality of irrigation withdrawals from the channels should be a first priority in any program to improve the system and its operation.

Estimates of average acres cultivated during the Maha and Yala season were :-

Season		Acres Irrigated: Legally	Acres Irrigated: Encroachments
Maha	..	100,000	10,000 to 25,000
Yala	..	57,000	3,000 (approx)

SYSTEM OPERATION AND WATER RELEASED FOR IRRIGATION

The Senanayake Samudra Reservoir has a capacity of 770,000 acre feet and, as described in Table 1 ,is the largest reservoir in Sri Lanka. There are several smaller reservoirs in the system including:

Naakiri	with 47,500	acre	feet	of	storage	capacity
Namal Oya	with 37,000	"	"	"	"	"
Palang Oya	with 93,000	"	"	"	"	"
Pannalagama Oya	with 35,000	"	"	"	"	"
Ambalan Oya	with 35,000	"	"	"	"	"
Ekgal Aru	with 21,000	"	"	"	"	"

Many smaller tanks are used as municipal supplies, balancing tanks etc. However, storage in Senanayake Samudra reservoir provides the water for 100,000 of the 120,000 acres irrigated.

Figures on release for irrigation were available on Senanayake Samudra and are shown by year in Table 1. Average yearly deliveries for the period 1952-1977 were about 580,000 acre feet. Hwever, since 1968 the rainfall has averaged below normal and the sluice deliveries have averaged only about 490,000 acre feet per year. Total project irrigation deliveries from "primary" reservoirs are probably about 120% of the issue from Senanayake Samudra.

Several of the smaller reservoirs were constructed with flood control as a major priority. Operational instructions are that Senanayake Samudra itself should be filled to 75% capacity and fillings beyond that level are done only with the advice of the Chief Irrigation Engineer.

A unique feature of this system is that distributaries in many areas were designed so that they could serve as drainage channels for the area above them, as well as supply channels for the areas below them. On the Right Bank and River Diversion systems there are also "dozens" of anicuts on the channels of drains and rivers which now bring drainage water back into the supply

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system. These anicuts range in permanency from stick dams, replaced almost yearly, to concrete and masonry structures with removable planks which have been functioning for over 100 years. A large portion of the stick dams on drains are privately built and illegal, but accepted. They often supply water to private cane growers who do not have water delivery from the Irrigation Department during the dry months.

At the extreme bottom end of the Left Bank system the drains flow into a large lagoon which is separated from the sea during the dry months by a sand bar which is built by wave action. Since the irrigation system was built, more of the water from the main Gal Oya river is brought from the irrigation area to drain into this lagoon. The salt content of the lagoon has diminished. Water levels build up in this lagoon during flood season and when there is water in the canals during the Maha season about 3000 acres of low-lying land surrounding the lagoon are inundated. During the Yala season the water level in the lagoon is controlled by a pump and check structures such that water can be backed up through ditches to this 3000 acres for irrigation purposes.

These consectuve reuse facilities on parts of the system cause the actual deliveries to the farms to be far in excess of the amount that would be calculated per acre by dividing the average reservoir releases (about 700,000 for all the reservoirs) by the acres of crop irrigated during the year (estimated at about 187,000 acres) which indicates an average of only about 3.8 acre feet of water per acre delivered to each crop. As discussed earlier, the actual distribution is about 2.5' of water during Maha and about 5.2' during the Yala season.

Since there are no calibrated measurement structures below the Senanayake Samudra sluice, and since water was not being issued for rice cultivation at the time of transplanting, the following treatment is qualitative in nature, based on estimates obtained from the Irrigation Department personnel and observations for howfar the domestic issues of water were travelling along the distribution system.

As a model of the system, consider figures A1 and A2 for the Maha and Yala season respectively.

For the Maha season, the average issue for the system is about 2.5' (acre feet/acre). This is used to get crops started when the monsoon rains do not begin early enough to provide regular water, to serve about 18,000 acres of sugar cane from September through March, and to provide water to finish rice crops, beginning about January 15 and ending about the end of March.

Because of higher losses from the canals and distributaries at the top end and from farmers tampering with and destorying control structures, the amount of water entering the field channel systems in the top third of the system is estimated to be about 1/3 more (a total of 40") than the 30" average, for the total system. The middle section receives about the average delivery and the bottom section receives only 2/3 as much as the average (i.e. 20").

ON-FARM EFFICIENCY AND WHERE THE WATER IS GOING

Heavy monsoon rains during November, December, and the first part of January normally provide for more water than the evapo-transpirational needs. Little of this excess can be saved unless storage tanks are built along the middle reaches of the system. This excess rainfall accounts for a major portion of the drain water indicated as issuing from the lower right hand corners of each block. Some of the excess rain is used to moisten the lower portions of the soil profile if the rice is dry-sown and given a light irrigation to achieve germination - as is done in the lower portions of some branches of the system. Building and maintenance of bunds with the capacity to hold 8 to 12" of water before overflowing is also practised in some areas to hold and utilise more of this rain water.

Persons in charge of managing the water level in the lagoon at the bottom of this drainage system report that its level begins to rise rapidly whenever irrigation water is delivered to the rice area which feeds these drains. Leakage from the delivery system, and particularly the flooding of highly permeable paddies on the red brown earths, contributes substantially to the ground water which moves down hill toward the drains. These farmers at the upper ends generally wet sow their paddy, against the recommendations of the Irrigation Department, because they have access to sufficient water to do this. The extra water costs them nothing and therefore they substitute it for the extra power that dry land preparation and sowing is believed to require. Farmers at the top ends of the system also often fill their paddies for final puddling and then drain them for sowing. They are also reported to occasionally drain their paddies and refill them with cooler water from the distribution system if they feel that the water in the paddies is becoming too hot. The water going to the drains from these several sources is wasted if the drainage water goes directly to the sea.

Excessive use of water by those at the heads of large field channels and distributaries also occurs at the expense of those at the ends of these channels. The inequity reported on field channels is even greater than that in the main canal system. There are field channels where the farmers at the head of the channel are growing paddy rice with its accompanying high water use while the farmers toward the tail end of these channels are not able to get sufficient water to grow any crop.

On the other hand, there are a few cases where the field channels flow in the same direction as the natural subsurface drainage. In these areas, extra irrigation provided at the top end moves underground to the bottom lands and the bottom lands need little additional water to provide good paddy yields. In the cases discussed with farmers, it appears that the direct distribution of water through the field channels was only about 1/3 as large at the bottom end as at the top. This is indicated in Figure A1, where the inputs from the supply channels are indicated by the arrows coming into the top left hand corners of the small rectangles which represent top, middle and lower reaches of the large field channels (or small distributaries with short field channels).

Assuming the same amount of evapo-transpiration and rain on these reaches of the field channels, the amount of drainage issuing from each of them is indicated by the figure beside the solid arrow issuing from the bottom right hand corner of the small rectangles.

In many sections of the Right Bank and River Diversion Systems anicuts have been built on the large drains and lower river channels to push the water back into the supply system as indicated by the vertical dashed arrows shown in figures A1 and A2. The same objectives are attained on the small drains by stick dams many of which are serving lands originally planned for grazing reservations etc. In some sections the series of field channels are designed so that they serve as the supply channel for the strip of land below them and as the surface drain channel for the land above them. These return flow provisions are indicated by the small dashed arrows connecting drain to supply lines in Figures A1 and A2. Few of the distributaries or channels observed were constructed down to bedrock and consequently, some of the sub-surface drainage wate was not forced back on to the land. However, the surface drain water recovered from these channels was providing sufficient water to many tail end portions of the system to permit cultivation.

There are portions of the Gal Oya project where farmers are dry sowing rice and managing their water with great care. In most of the rest of the project the farmers (and the Sugar Corporation employees) who have sufficient water to do so are pouring large quantities of water through their system. Application efficiencies, calculated as the amount of the applied water retained in the plant root zones, are low. The product of conveyance efficiency times application efficiency for the project as a whole can be estimated from the facts that the design criteria for the channels are to supply one cusec of water for every 30 acres. Thus, when these channels are flowing at full capacity, (and this is reported to be the case for much of the dry season) they are providing an average of twenty four acre inches of water per acre per month. Evapo-transpiration uses only about 0.20" per day and, even during the driest seasons, occasional rains lower the average net water requirement to less than 0.20" per day, or about 6" per month. Consequently, the actual on farm efficiencies of these systems are apparently down around 6"/24" = 25%.

The overall system efficiency can be calculated from the average crop irrigation requirements of 2 1/2 feet year, average sluice emissions (about 540,000 acre ft/year), and total acres cropped (about 170,000 acres per year including about 110,000 during Maha and 60,000 during Yala). This overall estimate of system efficiency of 40% is higher than the product of the field channel delivery and farm application efficiency because of use of return flows as discussed above.

About 75% of the water is being "wasted" by the average farmer through leakage from his delivery channels and deep percolation from his paddy and cane fields. However, pickup and reuse of this water by anicuts in drain channels or some supply channels acting as drainage channels for areas above them is allowing a 40% system efficiency. The department staff indicate that there are more opportunities for constructing additional anicuts to provide water to tail end farmers if funds were available to do so.

CURRENT PRACTICES AND SITUATION

CROPPING SYSTEMS

There are three areas of differing water regimes and thus three cropping patterns. The Left Bank, Right Bank, and Central River Diversion.

The central area, subject to flooding, is basically a mono-crop area during the Yala season. The other two areas are primarily paddy with 10,000 acres of sugar cane grown by the Sugar Cane Corporation on the Right Bank, and another 2,500 acres of privately grown sugar cane grown mainly in the upper portion of the Right Bank where flooding is not a problem. These private growers of cane face the problem that water is issued during August and September only for the Sugar Cane Corporation and consequently they have to either get their water from the drains for these months or steal it from the supply system leading to the Corporation lands.

Maha paddy is normally grown October, November, December and January. Yala paddy is normally grown April, May, June, July. Variations occur in both seasons.

Sugar cane is grown pretty much as a continuous crop. Conflicts due to cropping patterns occur:

1. When more than one type of crop is grown in one delivery system

2. When planting and/or harvest dates vary widely within one delivery system.

Due to shortages of water, the Maha planting is often delayed. A better cropping pattern could be effected by timely planting.

A delayed Maha planting eventually affects a late Yala season when irrigation requirements are highest. It would appear much effort should be directed toward having water available for an early planting of the Maha season.

The government employed Sugar Corporation irrigators will not irrigate at night - therefore for full water utilisation, water must be diverted from cane to paddy at night, or be used at night by the private growers in the months of August and September. It is easier to irrigate bordered basins of the paddies at night than to irrigate the furrowed sugar cane.

ON FARM WATER MANAGEMENT

Water is used to make ploughing easier. Water is used to puddle the soil to prevent seepage losses. Water is used to control weeds, i.e. the deeper the water, the fewer weeds. Irrigation water is often used for domestic purposes.

In land preparation water is introduced to the small basins at the high point of the field, is moved down slope as the sequence of ploughing, puddling, draining, seeding occurs. When irrigating the crop, the same pattern is used except water is left standing and thus upper basins get more water than needed.

Paddy basins are usually hand constructed. Much of the paddy areas are on sloping lands. There is often several inches difference in levels (ECEU) within a single liyadde. To ensure complete water cover, excess water depth is applied.

Due to uncertainty of delivery times and/or quantities, farmers irrigate when they can and apply more than is needed by the crop. This type of "self preservations" or "insurance" leads to waste of both irrigation supplies and to rainfall.

If water deliveries were dependable both in quantity and in time, smaller applications would be possible and thus rainfall would be more effective. Liyaddes should be levelled better. When irrigation is on rotation basis, water should be introduced at low liyaddes first, filled to desired depth, shut off and the next higher liyadde filled - this prevents water standing too long in upper liyaddes. This concept needs further study.

To best utilise rainfall with present methods of on-farm distribution, two sets of spiles could be installed, one at may be 2" above ground level and one at 6" above ground level. The lower spiles could be plugged between irrigations to better store rainfall.

SYSTEM ORGANISATION

The project is under the general direction of the Divisional

Engineer known as Chief Irrigation Engineer (or CIE). He has a Divisional Assistant who is a senior Technical Assistant and a Irrigation Engineer (IE). The left bank system is generally supervised by the Divisional Assistant and the right bank system is generally supervised by the IE. There are 12 Technical Assistants and these men oversee new construction, operation and maintenance work activities within the division which includes areas other than the Amparai project. There are 20 maintenance overseers supervised by the Technical Assistants and there are about 100 maintenance labourers. Other labourers are hired for cleaning and maintenance on daily or monthly bases as needed and as funds allow. The Technical Assistants have general responsibility for operation, maintenance and new construction activity in blocks varying from 2000 to 6000 acres in size.

In addition, there is some technical assistance under the direction of one engineer on rehabilitation work that is being undertaken. The rehabilitation consists primarily of putting in some control structures and replacing sand anicuts in the river diversion with concrete anicuts to eliminate having to reconstruct these anicuts every year. These are small anicuts for reuse of the drainage water.

The I.E. has been told by the Irrigation Department, Colombo, that they will receive approximately 160 Irrigators. These

Irrigators will work under the direction of the overseers and Technical Assistants to distribute the water.

SYSTEM OPERATION

When the water meetings take place the amount of area to be cultivated is based on the amount of storage in the main tanks and an assumed average duty of 8 acre feet per acre. The Range Engineer stated that with better water management he could base allocation on a number closer to 6 acre feet per acre and they could irrigate some 25 per cent more land. The primary reason for this is the extensive reuse of drainage water. Farmers are encouraged to prepare and seed their lands using light rains in early October to moisten the land for what is called dry seeding. The department issues water to be used for light irrigations if the monsoon rains do not arrive to sustain such seedings. The objective is to have the farmers grow their crops primarily on rain water during Maha. The first diversions for irrigation following the monsoon rains are generally started about January 15 for the paddy and are continued through March to finish off the Maha. If all the farmers would seed as recommended in early October the paddy rice would be ripening by late January and the major Maha issue from the tanks could be saved for Yala season. Then irrigation diversions are made during the Yala season.

The dates for the Maha cultivation and Yala cultivation are set in the cultivation meeting. Here the Irrigation Department recommends the acreage to be cultivated, the type, and the duration of the crops to be grown. The farmers express their needs and desires. The Advisory Committee eventually sets the opening date and date of closures. The Government Agent and the Assistant Government Agent approve them.

The Project personnel do not have the facilities to operate the system by cubic feet per second. Instead, it is roughly distributed throughout the system based on trying to maintain water levels and move the water down the system. There has been a considerable amount of damage to the control facilities due to lack of discipline on the part of the farmers. Control gates have been destroyed or removed and the project is basically uncontrolled. Subsequently, the upper end of the main channels and distributors and field ditches get most of the water and the lower ends are short of water. Some of the lower areas only attempt to grow crops in the Maha season when rainfall provides most of the water needed. About 110,000 acres is cultivated in Maha and about 72,000 in Yala in average years. An improved water management program is needed to increase production for the Maha season and to improve the carrying over of the main tank to ensure a more reliable supply for Maha each year.

The right bank units are partly under sugar cane, which receives water 10 months of the year and has priority over rice. April through August is the water scarce period. The average estimated diversion is about 3 acre feet per acre for Maha and about 5 1/2 acre feet per acre for the Yala. In addition to the irrigation runs there are domestic runs made approximately every 10 days. These runs are 2 days in duration. "Domestic releases" are made into the left bank system of approximately 600 cusecs for two days every ten days during the non-irrigation season, which uses about 10,000 acre feet of water on this side alone. Water management is complicated by these releases since proper maintenance activities cannot be carried out. Irrigation releases are rotated and domestic runs are spread all over the district. These domestic releases do not reach many of the lower reaches of the system because the water is used illegally by farmers in the top reaches for irrigation.

FIELD CHANNELS: GENERAL CONDITION AND OPERATIONAL CONTROL

Field channels observed carrying water were losing substantial amounts. Many of them were running with less than an inch of free board and were above the level of the surrounding ground. The banks are riddled with crab and insect holes. Research has demonstrated that under such conditions the loss can be substantially reduced by lowering the operational levels of water in the channel. This could be accomplished through regular cleaning (i.e. every two months). However, the recommended cleaning schedules are twice a year, and these are not always achieved. Irrigation Department personnel indicated that some field channels shown to us had not been cleaned for five years.

About half the field channels observed had extremely broad bottoms and the water runs in them only a few inches deep. Department personnel said that they were built that way because the only mechanised equipment available to the Development Board for ditch building at the time of construction was caterpillars with a wide dozer blade. Considering that these channels could have been hand dug to proper cross sections at a cost of less than one rupee per foot, this expensive and inappropriate mechanical construction was not justified. Farmers' field ditches leading from the field channels to the farmers' fields were also inadequately cleaned. It is probably that 30 or 40% of the water leaving the distributaries is lost in the field channels and ditches leading to the farmers' fields. While not all of this loss is a loss to the system because of downstream reuse, it is a loss to the individual farmer. This is an acute loss to farmers at the ends of the field channels and distributaries where they have short supply.

FIELD CHANNELS: SPECIFIC OBSERVATIONS

The first channel visited was the U1 which is 9 miles down from the main headworks of the left bank system. The individual outlets to the farms are concrete pipes and we saw much recent evidence that they had been moved by the farmers without opposition from the Irrigation Department. They were moved to different locations. They were lowered so they could tap the low domestic water issues and slope of the pipes had been changed so as to substantially increase the flow. One farm at the upper end of the field channel had relocated and regraded his turnout so that it was at a very steep slope and its capacity was limited only by the entrance conditions of the pipes so it would carry several times more water than the pipes installed by the government that are flat graded. The field ditch cross-section had completely deteriorated, being 12 to 15 feet wide with an operating water depth of about one foot. Although the right bank side of the field ditch is not supposed to be irrigated, many farmers had graded and removed the right banks so as to create narrow paddies along this upper-side of the channel. The headworks gate from the field channel had been removed by farmers and there were no regulators in the field ditch system. There were two spillways which had been raised. These were originally drainage points and the farmers had put paddy below these points. This field ditch receives a 15-day irrigation at the beginning of the Maha irrigation season without rotation and then it is rotated at 5 day intervals. Because this field ditch is long, the upper portion receives water every two days during its 5 day rotation and the lower portion receives water for three days. Because there are no regulators and no gates on the turnouts, success of rotation is dependent upon perseverence of the Technical Assistant operating the ditch. There is no way he can cover these ditches daily because his area is too large. Farmers at the upper end of the ditch were taking for paddy the water issued for domestic purposes. The people at the lower end of the ditch that were to receive domestic water were not getting it because the upper-reach farmers had put in small dams to divert the water into their fields. This way they can start paddy cultivation earlier. The farmer contacted explained that they needed to do this because they had many farms to cultivate with their animals and they needed to start early for the good of everybody. He is the "organiser" in this area, where the animals are pooled and farmers without buffalo depend on other farmers to help cultivate the land. Animals are apparently in short supply and these are reasons for the lack of objection to this misuse of the water. Another field ditch visited was the M-18 field ditch. This was a long field ditch with many sub-field ditches leading out from it. It is at the lower end of the left bank system and it is on this system they only get water for three irrigations during Maha, starting January and February. This field ditch cross section has been practically destroyed by bank sloughing and siltation. The field ditch serves some 400 acres. There is no regulation on this system either. The ability of the farmer to get water on this field ditch system, especially the lower ends of the sub-field ditches and of the field ditch itself, depends entirely upon the perseverence of the Technical Assistant. The farmers consider themselves fortunate if they get water during one of the three irrigations that are made even though they are entitled to all three irrigations.

One field channel which lead to the Sugar Corporation farm was followed. In some sections where the water level was appreciably higher than the level of the surrounding land, this ditch was leaking appreciably. The adjacent land was private, and some of the leakage may have been intentional because a farmer was using this water to irrigate newly planted sugar cane.

This channel was well designed and maintained when it entered the Corporation farm. It was carrying about one cusec of water in the area of the private farm and about 0.8 cusecs was reaching a point where they were supplementing the water by pumping from a drain. The supplemented water amounted to about 0.4 cusecs. Two Corporation employees were tending the pump. The water was entering a newly planted cane field about 1/2 mile below the pump. No one was attending this water and practically all of it was being wasted. A previous irrigation had obviously been misused in the same manner.

In general, farmers are supposed to maintain and clean field ditches less than one half mile long, or which serve less than 50 acres. The Irrigation Department is responsible for the rest of the channels.

DISTRIBUTORS

Distributors visited are in poor condition. The original cross-sections are destroyed. Now the channels are very wide, with very low water depths, and bank erosion is quite common. The structures for field channel take-outs are set 10 or 15 feet out into the distributor because bank erosion has taken place. Many places were observed where only one half of the ditch bank is left. Erosion is caused by animals and people using the ditches and by the sloughing that has occurred throughout the years, primarily due to lack of compaction and consolidation during construction. There is no regulation on the distributors and no regulation of headworks to the distributors. Distributors are generally rotated on five day intervals during the irrigation season. The lower distributors do not receive the same amount of water as the distributors in the upper portions of the project. The reasons for this are dirty channels and uncontrolled take-offs. Maintenance activities consist of cleaning the channels of weeds just prior to the January 15 delivery. At this time, cleaning operations in the upper portions of the project are taking priority in preparation for some early runs. Maintenance is very limited because the I.E. has Rs.18/- per acre allocated to O & M.

MAIN CANALS

The Right Bank main canal is operated at less than its design capacity because of bank erosion in the upper portion of the reach and siltation in the lower portion. The Left Bank main canal is not to the original design grade in some rocky areas. A master plan is needed for the operation of the three main canals in conjunction with the line tanks.

EXTENSION PROGRAMS

Mr.E.R.Martyn, Divisional Agricultural Extension Officer, Amparai, was visited.

There are 20 Agricultural Extension Officers (A.I.'s)
83 Village Extension Officers (K.V.'s)

A.I.'s have B.Sc. or Agricultural Diploma (2 years). The Government has scholarships to assist diploma people to get advanced education.

There are no water management extension programs to train extension personnel or farmers.

Mr.Martyn said FAO had conducted a good study and written a report on water management of this district. It was done by a Mr.Hooten. Mr.Martyn said the main problems at farm level are:-

1. Land is not level enough to apply small amounts of irrigation water although small depths are best.

2. Farmers irrigate too often because they cannot depend on deliveries being available.

3. Farmers use deep water to control weeds in their paddy fields, but could use other methods.

FARMER ORGANISATION

Farmer organisation in this system appeared to be negligible. Apparently the co-operative voluntary program of watercourse cleaning which was reasonably successful at Walawe and Polonnaruwa have not yet been significantly initiated.

Farmers observed cleaning distributaries and field channels were in crews that were being paid by the government. They were working efficiently since they were assigned to do a specified reasonable amount of work and were then free to leave and take care of their farming.

The district Government Agent stated a lack of and need for village level government including village level courts which would handle problems between farmers and between government agencies and farmers quickly, rather than requiring two or three years for settlement in the District Court which is now the case. The District Minister concurred in a need for teaching farmers what the irrigation system can do and of input of such enlightened farmers into rules and decision making which would optimise the use of this resource to increase crop production.

Village water management boards which would work with the village summary court as a jury when needed and would help the irrigator(s) identify rules and improvements needed, were also suggested.

TABLE 1

GAL OYA RESERVOIR (SENANAYAKE SAMUDRA)
(Amparai District)

Area of catchment: 384 Square miles

Capacity 770,000 acre feet

Reservoir area at fully supply level = 19,250

Full supply depth = 112 feet

Command area, Left Bank 82,475 acres and 40,000 on Right Bank

October/ September	Inches Rainfall	Catchment Yield Inches	Catchment Yield Acre feet	Issues from sluices Acre feet
1952 - 53	80	24	493,000	349,000
1953 - 54	94	33	678,000	556,000
1954 - 55	106	47	966,000	611,000
1955 - 56	52	10	213,000	493,000
1956 - 57	77	32	653,000	360,000
1957 - 58	113	102	2,096,000	1,385,000
1958 - 59	65	31	630,000	642,000
1959 - 60	103	66	1,340,000	816,000
1960 - 61	82	37	755,000	627,000
1961 - 62	86	63	1,295,000	954,000
1962 - 63	92	31	632,000	356,000
1964 - 65	71	16	318,000	475,000
1965 - 66	82	34	692,000	506,000
1966 - 67	71	26	541,000	674,000
1967 - 68	65	29	591,000	657,000
1968 - 69	64	17	355,000	297,000
1969 - 70	102	45	926,000	429,000
1970 - 71	73	27	562,000	708,000
1971 - 72	56	24	482,000	661,000

October/ September	Inches Rainfall	Catchment Yield Inches	Catchment Yield Acre feet	Issues from sluices Acre feet
1972 - 73	71	27	548,000	553,000
1973 - 74	91	33	673,000	555,000
1974 - 75	61	23	477,000	457,000
1975 - 76	63	27	548,000	513,000
1976 - 77	62	13	264,000	274,000
TOTALS ..	1882	817	16,728,000	13,908,000
24 year Average ..	78.4	34	697,000	579,500

MOISTURE REGIME FOR GAL OYA

	Jan	Feb	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Evaporation	3.51	3.48	4.45	4.52	5.07	5.97	6.32	6.16	5.81	4.45	3.55	3.12	56.39
Rainfall	12.81	9.12	3.68	4.40	2.87	1.34	1.65	2.77	2.84	7.52	10.7	14.27	73.97
Assuming a 50% effectiveness level of rainfall over 2" per month													
Rainfall	6.4	4.5	1.9	2.2	1.4	1.31	1.7	1.9	1.9	3.7	5.3	7.1	
Irrigation Requirement	-	-	2.5	2.3	3.7	4.6	5.7	4.3	3.9	7.5	-	-	27.8

APPENDIX FIVE

AG:DP/SRL/72/001
Terminal Report

WATER MANAGEMENT FOR IRRIGATED AGRICULTURE (GAL OYA IRRIGATION SCHEME)

SRI LANKA

PROJECT FINDINGS AND RECOMMENDATIONS

UNITED NATIONS DEVELOPMENT PROGRAMME

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS ROME, 1975

A- 54<

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Terminal Report

WATER MANAGEMENT FOR IRRIGATED AGRICULTURE (GAL OYA IRRIGATION SCHEME)

S R I L A N K A

PROJECT FINDINGS AND RECOMMENDATIONS

Report prepared for
the Government of Sri Lanka
by
the Food and Agriculture Organization of the United Nations
acting as executing agency for
the United Nations Development Programme

UNITED NATIONS DEVELOPMENT PROGRAMME

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

Rome, 1975

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1. INTRODUCTION

Improved water management for more efficient operation of the irrigated agriculture in Sri Lanka would make a significant contribution to the country's priority programme of food production, particularly for achieving self-sufficiency in rice at relatively little additional expense in terms of foreign exchange. To assist in this programme, the Government of Sri Lanka requested assistance through the United Nations Development Programme and the UNDP project "Water Management for Irrigated Agriculture" was established to become operational in May 1972. This project is included in the Country Programme 1972-76. The Gal Oya Irrigation Scheme, which was selected to form the nucleus of project activities, has a storage capacity of about 1 million ac ft of water and provides irrigation facilities for some 100 000 ac. The land is largely under paddy, with sugarcane second in importance. The objectives of the project, which concluded in October 1974, were to:

- enable farmers in the dry zone to derive maximum benefit from available water supplies through improved water management techniques and irrigation practices;
- increase the extent of irrigated land in the major season 1/ by reducing wasteful use of irrigation water and by maximizing the efficiency of water use;
- increase the area of irrigated cultivation in the minor season and thus augment the intensity of cropping over the entire year;
- improve water control measures through better drainage works;
- expand the production of subsidiary field crops such as chillies, onions and pulses.

The Food and Agriculture Organization of the United Nations was designated as executing agency of the project, with the Ministry of Agriculture and Lands an government counterpart agency. Project staff consisted of Mr. Charles W. Houghton, FAO/UNDP Water Management Expert (1 May 1972 to 30 October 1974) and two government counterpart officers, Mr. Stanley H. Perrer, District Agriculture Extension Officer (1 June 1972 to 31 December 1972) and by Mr. Aloy G. Rajanayagam, Additional District Agriculture Extension Officer (1 January 1973 to 30 October 1974).

1/ Major season - Maha; minor season - Yala. A-57<

The final UNDP contribution, after revision of the project in May 1974 which extended activities for a further seven months, was US$ 83 991. The government contribution in kind was Rs 252 000. The major items of equipment supplied by the UNDP to the project were a Toyota Land Cruiser, an engineering level, a land measurer, a Bouyoucos moisture measure with gypsum blocks, an electrical conductivity bridge and soil augers.

2. RESULTS AND CONCLUSIONS

2.1 GAL OYA IRRIGATION SCHEME

2.1.1 General description

The Gal Oya Irrigation Scheme covers a geographic area of some 600 mi^2. It is located in the eastern 'dry zone', mainly in Amparai District with a part lying in the south Batticaloa District. Major construction began in 1948 and around 1965/66 development was essentially completed and the operation and maintenance phase began. The catchment area has an average rainfall of 83 in, of which 63 in comes during the northeast monsoon period, October to March. The main demand for irrigation water is from March to September.

The Scheme was planned as a multipurpose project to cover irrigation, power production and flood control, along with wildlife and watershed protection, but was primarily for the resettlement of landless people from other areas of the Island. However, even though the climate, soil and water resources are generally favourable, there are many conditions in the Scheme which restrict the efficient use of these resources. While many of the original objectives such as the settlement of people and increase in paddy production have at least been partially realized, the Gal Oya Scheme today reflects only little of its real potential. The Scheme is the most recently constructed major irrigation project in Sri Lanka but it is no longer a new one. Since inception, insufficient attention has been given to the coordination of the overall management of the water and land resources.

The main dam and power house cross the Gal Oya River at Inginiyagala. The lake so formed is named Senanayake Samudra and has a total of 770 000 ac ft capacity, (Appendixes 1 and 2). Deductions for dead storage, normal and emergency domestic supply, flood control, seepage losses, evaporation losses, transmission losses and other requirements must be made to determine the usable capacity which varies from year to year depending upon the rainfall. An analysis for the year 1952/53

(Gal Oya Development Board, Annual Report) showed that for an 'average' year there would be (discounting for dead storage and emergency domestic use) approximately 530 000 ac ft of water available for power production, domestic use and irrigation. This compares favourably with the actual release records for the past nine years (1965 through 1973) of 540 000 ac ft per year.

An additional series of small tanks was estimated to have a gross storage capacity of 81 000 ac ft; however, in practice, these smaller tanks are normally fed from the main tank and are of questionable value as a dependable source of additional supply. The only exception may be Navakiri Tank with a purported 28 000 ac ft of usable water available per year. Further, these small tanks have a total water surface acreage of approximately 10 000 ac. With an evaporation rate of 5 ft per year, there conceivably could be a loss of 50 000 ac ft, not considering seepage losses.

The priority of use of the available water supply is first for domestic use, second for sugarcane, third for paddy, fourth for other crops, with power being produced in all categories.

It is not known with any certainty how much land has been developed for irrigation under the Scheme. Previous estimates have suggested 115 000 ac. The estimate below is based on an intensive study by the present project. Appendixes 6 and 7 give details and breakdown by irrigation units and kandams.

ESTIMATED AREA DEVELOPED FOR IRRIGATION
IN THE GAL OYA IRRIGATION SCHEME
(includes land with and without water rights)

	ac
Left Bank Division	46 267 1/
River Division	32 048
Right Bank Division	17 082
	95 397

1/ Includes an estimated 3 000 ac of encroached land

Note: There are an estimated 700 ac in the Left Bank and 1 300 ac in the River Division, included above, which are submerged and not normally irrigated.

The difference of approximately 20 000 ac between previous estimates of 115 000 ac and the present estimate is significant, not only from the water management point of view and the setting of planting targets, but also for any economic analysis which might be made of the project.

2.1.2 Problems encountered

(a) Need to improve basic records

Planting and harvesting continue side by side during every month of the year and it is not accurately known at any given time how many acres are being cultivated and in need of irrigation water. The persons responsible for these figures, principally the District Revenue Officers and the Agriculture Instructors, cannot provide accurate current information as they have no adequate staff, no suitable maps, no time, and no transport, and the reports of the Cultivation Committees are often not reliable. A portion of the acreage once reported as 'maha' will later be reported as 'yala' and vice-versa.

(b) Difficulty in meeting targets

Whether they have been realistic or not the acreage, planting date, and production targets have consistently not been met. The reasons given are various - late starting of the northeast monsoon rains, shortage of water during the growing periods caused by droughts during both the maha and yala seasons; unseasonable heavy rains and floods, rains during harvest, shortage of or poor germination of seed, shortage of fertilizers and agro-chemicals, lack of power for tillage, tardy loan processing, cultivators not eligible for loans, and tardiness on the part of the cultivator himself who in many cases may simply be waiting for an 'auspicious' day before working the field.

(c) Inadequacies in operation and maintenance

The irrigation Section of the TCEO (Territorial Civil Engineering Office), Amparai, which is within the Ministry of Irrigation, Power and Highways, is under-financed and under-equipped to meet all of its obligations. The operation and maintenance activities are broken down into four divisions with the Executive Engineer at Amparai having the responsibility of water releases from the main tank. There are telephone communications between these divisions, but within the divisions themselves communications are difficult as there are essentially no phones, no radio communications or adequate transport, and most communications are carried out in relay on bicycles.

As funds for normal maintenance have historically been inadequate, much of the maintenance work now being carried out in the form of emergency repairs to canals and structures, and the irrigation and drainage facilities are deteriorating at a faster rate than they are being rehabilitated. Most canal bunds have not been graded since they were constructed. Many canals have scoured out, and many others have silted in; others, some in the primary system, are in almost immediate danger of washing out completely. The Left Bank main channel was originally designed for 1 145 ft^3/s and the Right Bank channel for 545 ft^3/s. The TCEO, Amparai, estimates that today the Left Bank capacity has been reduced to $850^3/s$ and the Right Bank to 350 ft^3/s, a reduction of nearly 30 percent. Drainage facilities earlier installed have become so clogged and closed, some purposefully by cultivators and encroachers, that they have largely ceased to function. Canal rights of way have been encroached, resulting in even more difficult maintenance problems. All of the main control gates and turnout structures ('minor off-takes') were once calibrated but because of lack of maintenance and deterioration water flow can now only be measured at the main bifurcation structures 1/ and nearly all gates leak 24 h a day. Padlocks have disappeared, gates have been damaged and destroyed, extra pipes and siphons have been installed and canal banks have been cut by the cultivators - there is very little discipline or enforcement.

1/ Since April 1969 recordings of water levels and gate openings have been maintained at the main water division points. Conversions of these recordings into flow and quantity units, however, have not been made with the exception of releases to the Left and Right Bank main channels and the Inginiyagala Waste, for which conversions have been computed for the past nine years.

The Irrigation Section is responsible for the distribution of water and maintenance of canals to the point of delivery to the irrigation 'units' and 'blocks' which are composed of groups of cultivators and average about 450 ac. (In the colonization areas the individual allotment is generally 3 to 4 ac irrigable land plus one acre as a homesite - which is many cases is now actually being irrigated.) These units are normally served by one turnout from the main canal and from this point it is the responsibility of the cultivators to distribute the water among themselves and to maintain the internal canal system. In practice this is generally very poorly, even rarely done as the cultivators believe it should be the responsibility of the Irrigation Section. In some of these units no separate delivery system for each farm allotment exists and the cultivator furtherest down the line receives the least water and sometimes no water; or sometimes receives it when he does not want it as it comes uncontrolled from the fields above.

Areas exist at the far reaches of most of the main distributory canals which have never received water since the construction of the facilities - there are large areas in the Right Bank system where the secondary and tertiary distribution systems have not yet been installed. Other areas have never received assured supplies of water, for example J Block where only about 500 ac are receiving water for the yala 1974 and where 3 300 ac with water rights have been developed for irrigation. When there is water in the canals even if only for domestic purposes, it is used for irrigation. The cultivators near the main canals receive water and those further away may not - unless they have 'influence'.

(d) Unsatisfactory position of the cultivator

The cultivator is partially a victim of and a party to the above conditions. He probably did not have any previous experience in farming or at least in irrigated farming before he was resettled and he probably did not receive sufficient technical assistance or financing. He is bombarded to grow more but may be complacent with what he has. Knowing that water is a 'gift of the gods' he is not charged for it; he therefore has little appreciation for it and is likely to be indifferent except when he does not receive it. When he takes water 'out of turn' he is not apt to think of it as 'theft' but only as his right to water. He plants where, when, and if he wants, often in isolation when others around him are not planting thus often requiring that irrigation water be transported long distances for relatively few acres. He is dependent not only on the Irrigation Section for water but also on the cultivators above him. He practices continuous flow flooding as long as there is water available - even if he wanted to practice intermittent irrigation he could not because his neighbours above him would continue to pour water on him. He has to remain with paddy cultivation primarily because he cannot control the water. He does not generally dry plough and uses large amounts of water for tillage operations and weed control and sometimes floods fields to keep his neighbours' cattle out or to drown insects. Some fields are literally never dry. He does not normally cut off the water until three to four days before harvest, partially due to lack of knowledge and indifference, and partially because he is unable to do so.

His farm irrigation efficiency is generally very low due mainly to the custom of continuous flow irrigation on predominately sandy loam soils, no internal distribution system on his allotment, lack of organized collection and re-use of drainage and run-off water, and more often than not inadequate land levelling. He may or may not know the advantage of land levelling either to himself or to the project as a whole, but in some cases at least he is reluctant to invest in permanent type improvements because his ownership boundary-markings have not yet been set and he is afraid someone else will claim the land after it is well developed.

2.2 ANALYSIS OF DATA

Due to the paucity of reliable data, particularly relating to acreages sown at any given time, any precise analysis of past project performance is difficult. However enough data are available to make some fairly reliable observations. These are given below.

2.2.1 Water release from Senanayake Samudra

Water release from Senanayake Samudra is shown in Appendixes 1 and 2 together with rainfall and crop demand. Rainfall is more than adequate for crop needs during January, November and December. Crop irrigation needs are minimal during February and October, although in some years a certain amount of water for land preparation may be required during these two months depending on the vagaries of the monsoon season.

A nine-year average from 1965 through 1973 is used (Appendix 1) as records of water releases prior to 1965 are not available. These releases were to the Left Bank and Right Bank Channels and the Inginiyagala Waste. Records are not available during this period to calculate separately the release to the River Division. In the nine-year average 155 477 ac ft (28.9%) of the yearly release took place during the monsoon season of January, February, October, November and December when 54 in (77.9%) of the yearly rainfall occurs.

A four-year average from 1970 through 1973 is used because previous to 1970 no records are available with which to calculate releases to the River Division. This period also coincides with acreage and yield data available for the same period. It is not possible, however, to relate acreages and water use to the different systems, Left Bank, River Division and Right Bank. Further references in this text relate to the four-year period.

The four-year average shows that 179 042 ac ft (30.7%) of the yearly release occurred during the monsoon which supplies 54 in of rainfall and when crop water demand is only 8.9% of the yearly demand. There appears to be a conflict between the release of water, presumably for power production during this period, and the need for irrigation water from March through September. (However, according to the Electrical Engineer at the Inginiyagala Power House, all water is released at the order of the Executive Engineer at Amparai.) Water released during October, November and December 1972 and January and February 1973 totalled 202 799 ac ft, considerably higher than average with a resultant crisis for the following irrigation season - there were only 2 350 ac ft of usable water in the main tank at the end of September 1973. No reason is apparent for having released water during this period for flood control as there is an emergency spillway and the maximum recorded storage for any of these months was only 385 000 ac ft in January 1973. Visual observation would indicate that a minimum of 400 ft^3/s is continually flowing to the ocean from the natural drainage (river) systems.

Distribution of water released was:

Left Bank Division: 64.3% of water released, for 37.8% of the irrigable land (with water rights);

River Division: 18.0% of water released, for 40.6% of the irrigable land. It might appear that this division is the most efficient in the use of water, but there are no data available to substantiate such an assumption;

Right Bank Division: 17.7% of water released, for 21.6% of the irrigable land.

Of the 95 000 ac developed for irrigation, only 56 000 ac (see Appendix 5) or 59% have been reported to have been irrigated for the yala season.

2.2.2 Irrigation water requirements

Due to the lack of climatological data for the area, the Blaney-Criddle formula was used in computing the consumptive use and irrigation water requirements (Appendix 4). A seasonal coefficient (K) of 1.00 was selected.

The 'effective rainfall' in this report refers only to the amount of the average rainfall that is considered available for plant use and not to puddling requirements. The 'effective rainfall at 80% probability' is that amount of the effective rainfall that will occur or be exceeded in eight out of ten years and is less than the effective rainfall. The effective rainfall will exceed crop requirements during the months of January, November and December at this 80% probability.

Consumptive use data are important in the planning of irrigation projects and for the planning of the improvement of water management and irrigation practices in existing projects, but do not solve the problem of distributing water to where it is needed, at the time it is needed, and in the amounts needed.

2.2.3 Analysis of past performance

The crop irrigation water requirement for paddy (Appendix 4b) during the months of peak water use of May, June and July, assuming an irrigation period for the full 90 days, is 1.54 ac ft. If an additional 1.0 ac ft is added to this for land preparation there will be a total irrigation demand of 2.54 ac ft at 100% efficiency. (Each 1 ac ft for land preparation requires 2.5 ac ft at 40% efficiency.) The irrigation water requirement for sugarcane (Appendix 4c) for the full year is 2.51 ac ft at 100% efficiency (6.23 ac ft at 40% efficiency). For ease of analysis, since paddy is the dominant crop, it is assumed that 2.54 ac ft is the demand for both crops.

The average water release presumably for irrigation for the months of February through October was 494 397 ac ft and the average irrigated acreage was 56 000 ac. This is equal to an average water use of 8.8 ac ft/ac per year. Any additional supply that may have been available from the small tanks is not included.

The overall water use efficiency of the project is defined as the ratio between the amount of water needed by the crop and the amount of water used. If 2.54 ac ft were needed and 8.8 ac ft were used, then the overall efficiency would be 28.9% for the past four years. It may not be reasonable to expect high irrigation efficiencies in the Gal Oya Scheme, but efficiency somewhat above 30% could certainly be considered a reasonable target.

The figures below illustrate the difference in irrigation water requirements at various overall efficiencies:

PADDY IRRIGATION WATER REQUIREMENTS
(including one ac ft for land preparation)

(ac ft)
at overall efficiencies of

100%	60%	50%	40%	30%	20%	10%
2.54	4.22	5.08	6.35	8.46 1/	12.7	25.4

1/ This 8.46 ac ft at 30% efficiency closely approximates the 8.8 ac ft at 28.9% efficiency shown above.

Relatively small increases in efficiency can yield significant increases in water savings and resultant increases in acreage which may be irrigated. If the system is operating at 28.9% efficiency, 8.8 ac ft are required to irrigate the 56 000 ac; if the efficiency is raised to 40% the requirement would be for 6.35 ac ft which would irrigate 77 935 ac with the same 494 397 ac ft of water. This is an increase of 21 935 ac.

Further, using the average yield of 51.3 bushels per acre (Appendix 3) for the past four years and assuming that all the increase of 21 935 were planted to paddy, then this increase in acreage irrigated would yield an additional 1 125 000 bushels of paddy with no additional capital outlay.

2.2.4 Trial plan of irrigation

The trial plan of irrigation (Appendix 5) with the assumptions and limitations as given closely parallels the discussion above and illustrates the potential for improvement. It also illustrates that the quantity of water available at the source does not appear to be the limiting factor to increasing the number of acres to be irrigated, but rather the capacity of the distribution system. If the efficiency of the scheme were increased much above 40% then the capacity of the canals would have to be increased, if possible, to their original design capacities. According to this plan, land preparation begins in February, the last date of planting is 30 July and irrigation is terminated in October. Any water remaining in the main tank would then be carried over - with only releases for authentic power requirements within the national grid being permitted - to the following irrigation season. There is no reason to release water for irrigation during November, December and January and there would appear little necessity to release water for domestic use since an average of 39 in rainfall occurs on 45 rain days during the period.

Other factors such as availability of credit, seeds, and power to allow for timely planting may become limiting and may contribute, as seems to be the case already, to inefficient use of the available water.

2.2.5 Paddy irrigation trials

More water is generally used for paddy production than is actually required. This is illustrated in Table 1 which gives the results of paddy irrigation trials undertaken by the project on cultivators' fields near Uhana and Central Camp during yala 1973 and 1974. Results are given in descending order of yield. All trials were carried out with the 90-day variety BG-34-8.

Table 1
PADDY IRRIGATION TRIALS 1973 AND 1974

Trial number	Total water applied (including rain)		Yield	
	ac in	ac ft	bu/ac	bu/ac in
1	29	2.42	100	3.49
2	28	2.33	95	3.39
3	34	2.83	109	3.21
4	30	2.50	93	3.10
5	32	2.67	92	2.87
6	44	3.67	75	1.70
7	67	5.58	53	0.79
1/	76	6.35	51	0.67 (at 40.0% efficiency)
1/	106	8.80	51	0.48 (at 28.9% efficiency)
8	147	12.25	58	0.39
9	115	9.85	41	0.36
10	231	19.25	62	0.27

1/ Inserted to indicate the relative position of the Gal Oya Scheme, as analysed in the text.

Trials 7 and 9 (side by side) were seriously affected by weeds but the relationship of water applied to yield obtained was the same as in other trials.

It can be seen that decreased amounts of water resulted in an increase in yield.

3. RECOMMENDATIONS

Investigations undertaken by the project have indicated that an improvement in the management of the basic resources of soil, water and climate available to the Gal Goya Irrigation Scheme could result in significant water savings and in an increase in the irrigated acreage without immediate additional capital outlay.

1. To improve the efficiency of the scheme, it is recommended that a Water Manager who is technically qualified and experienced in all aspects of water management be made responsible for directing and coordinating the work through existing institutions.

2. The institutions to collaborate with the Water Manager would principally be the Irrigation Department, the District Agriculture Extension Office, the Kachcheri and the law enforcement agencies. Additional qualified staff should be added to these institutions to undertake the work as assigned by the Water Manager.

Every effort should be made to strengthen the Irrigation Section, Amparai.

3. The programme, which should be established and in which the Water Manager, assisted by his team, would be directly or indirectly involved, would have the following objectives:

(a) Prepare an annual planting and water-use plan, balancing acreage to be planted with available water supplies according to irrigation units and blocks. Note: This normally cannot be done before 1 February when a reliable estimate may be made of the amount of water that will be available.

(b) Initiate and keep current studies on:

- the number of acres which have been developed for irrigation, both with and without water rights, and their location;
- the number of acres which are being cultivated and irrigated at any given time and their location;
- the number of acre feet released from the main tank to the principal divisions - Right Bank, River Division, Left Bank;

- the number of acre feet released from the small tanks;
- the number of acre feet diverted to each major distributory;
- calculations of water released to individual irrigation units.

(c) Correlate conflicting demands for water and determine priorities for crops and water use.

(d) Study reasons why some areas are chronically short of water and devise means to alleviate.

(e) Study the feasibility of re-designing the system of small tanks so as to reduce (or eliminate) the necessity of replenishing them from the main tank.

(f) Study existing drainage facilities and effects of poor drainage during both the maha and yala seasons, including dates of and period of inundation and location.

(g) Initiate soil surveys and land classifications interpreted in terms of soil, crop and water management needs - and drainage relationships.

(h) Consider alternative cropping systems and cultural practices according to kinds of soils to achieve a more favourable soil-crop-water relationship.

(i) Undertake a thorough study of the availability of water supplies, the quality of the soils and drainage conditions, and other factors, before any new lands are brought under cultivation.

(j) Intensify maintenance of the physical facilities including recalibration of all gates, and where necessary initiate cultivation.

(k) Investigate and install alternative water supplies, e.g., shallow wells, for domestic needs.

(l) Install stream gauging facilities on all the major natural drainage-ways.

(m) Install an adequate communications system within the Scheme (radio and/or telephone).

(n) Correlate all inputs, e.g., credit, seeds, agro-chemicals.

(o) Ensure concentration of animal and/or mechanical power so that planting dates are met.

(p) Locate impediments or causes of low farm irrigation efficiencies such as land poorly developed for irrigation, poor distribution systems within the irrigation units and the individual allotments, customs of or lack of knowledge of cultivators, highly permeable soils, etc.

(q) Conduct trials and demonstrations of improved water application practices on demonstration farms and at the farm level, and intensify technical assistance in farm water management practices to the cultivators. Present practices which should be discouraged are wet ploughing and inundation of fields for weed control and continuous flow irrigation.

(r) Intensify control of Salvinia and other water-wasting vegetation.

(s) Study a plan of charges for irrigation water. Here is should be remembered that the water-user when charged may expect service to improve and to receive water in reasonable amounts when and where he needs it.

(t) Strengthen discipline and enforcement measures.

4. The Water Manager, while responsible for many of the activities outlined above, would be involved in an advisory capacity only in certain parts of the programme. For instance, he may not make the final decision as to when water releases should begin or cease, but his technical advice, based on existing conditions, would allow for the final decisions to be made on a rational basis by the persons responsible. He would not be responsible for the maintenance of the distribution system, nor would he be a law enforcement agent. It is however essential that the whole programme be carefully supervised under central control and that the various components be fully synchronized so that the highest efficiency possible can be achieved in the Gal Oya Irrigation Scheme.

Appendix 1

WATER RELEASE FROM SENANAYAKE SAMUDRA
(770 000-ac ft storage)

Month	9-year average		4-year average 1970 through 1973								Average rainfall	
	All divisions		Left Bank		River Division		Right Bank		Total			
	ac ft	%	ac ft	%	ac ft	%	ac ft	%	ac ft	%	in	%
Jan.	36 625	6.8	25 010	6.7	12 982	12.3	7 921	7.7	45 913	7.9	12.8	18.5
Feb.	45 788	8.5	33 980	9.1	16 751	10.2	10 255	9.9	54 956	9.4	8.2	11.8
Mar.	53 134	9.8	39 400	10.4	11 288	10.7	10 833	10.4	61 521	10.5	3.5	5.1
Apr.	46 010	8.5	33 952	9.0	10 388	9.9	7 708	7.5	51 048	8.9	3.2	4.6
May	56 294	10.4	35 901	9.6	12 800	12.2	11 551	11.2	60 252	10.3	1.9	2.7
June	65 309	12.0	40 012	10.6	15 131	14.4	11 695	11.3	66 838	11.4	1.1	1.6
July	63 041	11.7	40 506	10.8	9 569	9.1	12 786	12.3	62 861	10.8	1.5	2.2
Aug.	57 058	10.6	40 267	10.7	8 946	8.5	10 410	10.0	59 623	10.2	2.1	3.0
Sep.	43 581	8.1	28 528	7.6	5 406	5.1	8 057	7.8	41 991	7.2	2.0	2.9
Oct.	34 142	6.3	24 669	6.6	3 800	3.6	5 838	5.7	34 307	5.9	6.6	9.5
Nov.	20 491	3.8	19 442	5.2	1 237	1.2	3 291	3.3	24 070	4.1	10.8	15.6
Dec.	18 831	3.5	13 843	3.7	2 985	2.8	2 968	2.9	19 796	3.4	15.6	22.5
Totals	540 254	100	375 510	100	105 283	100	103 383	100	584 176	100	69.3	100

Note: 9-year average - 155 477 ac ft or 28.9% of release occurred during the monsoon season Jan., Feb., Oct., Nov., Dec. when 77.9% of the yearly rainfall occurs.

4-year average - 179 042 ac ft or 30.7% of release occurred during the monsoon season of Jan., Feb., Oct., Nov. and Dec. when 77.9% of the yearly rainfall occurs.

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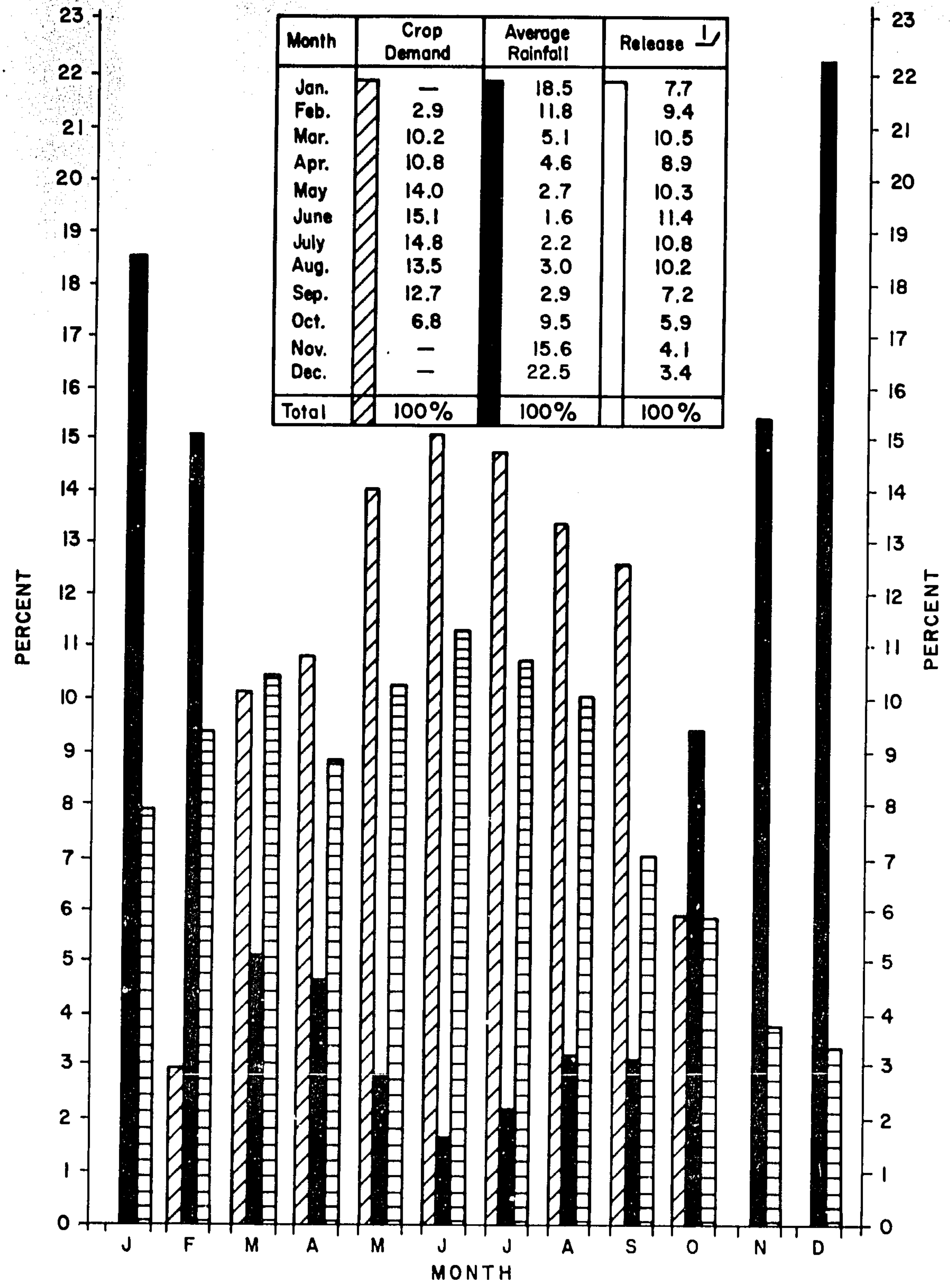
Appendix 2

CROP WATER DEMAND RAINFALL AND WATER RELEASE
(in percent per month)



Month	Crop Demand	Average Rainfall	Release 1/
Jan.	—	18.5	7.7
Feb.	2.9	11.8	9.4
Mar.	10.2	5.1	10.5
Apr.	10.8	4.6	8.9
May	14.0	2.7	10.3
June	15.1	1.6	11.4
July	14.8	2.2	10.8
Aug.	13.5	3.0	10.2
Sep.	12.7	2.9	7.2
Oct.	6.8	9.5	5.9
Nov.	—	15.6	4.1
Dec.	—	22.5	3.4
Total	100%	100%	100%

1/ AVERAGE RELEASE FROM SENANAYAKE SUMUDRA 1970 THRU 1973. 30.7% OF YEARLY RELEASE OCCURS DURING JANUARY, FEBRUARY, OCTOBER, NOVEMBER AND DECEMBER WHEN CROP DEMAND IS FOR ONLY 8.9% DURING THE SAME PERIOD.

Appendix 3

DERIVATION OF AVERAGE IRRIGATED ACREAGES, GAL OYA IRRIGATION SCHEME - YALA (PADDY)

Year	Planting target (ac)	Performance (ac)	Net extent harvested (ac)	Average yield (bu/ac)
1970	58 395	58 192	49 164	55.4
1971	65 514	54 039	42 263	57.4
1972	68 000	50 661	42 050	46.6
1973	70 000	51 759	43 081	45.2
Averages	-	53 663	-	51.3

ource: DRO, Amparai Kachcheri, Amparai District.

Estimation of total irrigated acreage Gal Oya Irrigation Scheme

	ac
Four-year average Amparai District - paddy	53 663
Minor schemes outside Gal Oya - yala acreage	-2 215
	52 448
Periphery schemes outside Gal Oya - estimated	-5 448
Total paddy, Gal Oya, Amparai District	46 000
Total paddy, Gal Oya, Batticaloa District - estimated	+4 000
Total paddy acreage - Gal Oya Scheme	50 000
Sugarcane acreage - estimated	+6 000
Total irrigated acreage - four-year average - Gal Oya Scheme	56 000

Appendix 4

IRRIGATION WATER REQUIREMENTS, GAL OYA IRRIGATION SCHEME
(based on Blaney-Criddle formula) 1/

(a) Calculated consumptive use (CU) and irrigation requirements

Month	Average temperature	Daytime hours 7°20'N	Factor	Rainfall					CU K=1.0	CU minus effective rainfall at 80%	
				Average	Rain days	by month	Effective 2/	Effective at 80% 3/			
	°F	%	f	in	no.	%	in	probability	ac in	ac in	ac ft
Jan.	77.3	8.17	6.32	12.8	14	18.5	-4/	-	-	-	-
Feb.	78.3	7.46	5.84	8.2	8	11.8	5.24	4.61	5.84	1.23	0.10
Mar.	80.3	8.45	6.79	3.5	6	5.1	2.76	2.42	6.79	4.37	0.36
Apr.	82.4	8.39	6.83	3.2	6	4.6	2.53	2.23	6.83	4.60	0.38
May	84.2	8.74	7.36	1.9	4	2.7	1.56	1.37	7.36	5.99	0.49
June	85.1	8.50	7.23	1.1	2	1.6	0.89	0.78	7.23	6.45	0.53
July	84.4	8.76	7.39	1.5	3	2.2	1.23	1.08	7.39	6.31	0.52
Aug.	83.6	8.70	7.27	2.1	4	3.0	1.71	1.50	7.27	5.77	0.48
Sep.	83.0	8.25	6.85	2.0	4	2.9	1.60	1.41	6.85	5.44	0.45
Oct.	81.0	8.37	6.77	6.6	10	9.5	4.78	4.21	6.77	2.56	0.21
Nov.	79.2	7.92	6.27	10.8	15	15.6	-	-	-	-	-
Dec.	77.9	8.15	6.35	15.6	16	22.5	-	-	-	-	-
Totals	81.4	100	-	69.3	92	100	-	-	-	-	-

1/ See also U.S. Dept. of Agriculture. Soil Conservation Service Technical Release No. 21.

2/ Effective rainfall - the amount of rainfall which is considered available for plant use.

3/ Effective rainfall at 80% probability - that amount of the effective rainfall that will occur or be exceeded in 8 out of 10 years (and used here for design purposes).

4/ - effective rainfall exceeds crop water requirements.

Average (mean) temperature - Batticaloa Meteorological Station (30-year record)

(b) Irrigation water requirements - paddy (K = 1.0)

Month	CU minus effective rainfall at 80% probability		Water requirement per acre at overall efficiency of:											
			60%		50%		40%		30%		20%		10%	
	ac in	ac ft	ac in	ac ft	ac in	ac ft	ac in	ac ft	ac in	ac ft	ac in	ac ft	ac in	ac ft
Jan.	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Feb.	1.23	0.10	2.05	0.17	2.46	0.21	3.08	0.25	4.10	0.34	6.15	0.51	12.30	1.02
Mar.	4.37	0.36	7.29	0.60	8.74	0.73	10.93	0.91	14.57	1.21	21.85	1.82	43.70	3.64
Apr.	4.60	0.38	7.68	0.63	9.20	0.77	11.50	0.92	15.33	1.28	23.00	1.91	46.00	3.83
May	5.99	0.49	9.94	0.62	11.98	1.00	14.98	1.24	19.96	1.66	29.95	2.49	59.90	4.99
June	6.45	0.58	10.71	0.89	12.90	1.07	16.13	1.34	21.50	1.79	32.35	2.68	64.50	5.37
July	6.31	0.52	10.47	0.87	12.62	1.05	15.78	1.31	21.03	1.75	31.55	2.62	63.10	5.26
Aug.	5.77	0.48	9.58	0.79	11.54	0.96	14.43	1.20	19.23	1.60	28.85	2.40	52.70	4.81
Sep.	5.44	0.45	9.03	0.75	10.88	0.91	13.60	1.13	18.13	1.51	27.20	2.26	54.40	4.53
Oct.	2.56	0.21	4.25	0.35	5.12	0.43	6.40	0.53	8.53	0.71	12.80	1.06	25.60	2.13
Nov.	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dec.	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	12.00	1.00	19.92	1.66	24.00	2.00	30.00	2.50	39.96	3.38	60.00	5.00	120.00	10.00 1/

1/ For each 1 ac ft for land preparation add the above values to the total of the irrigation period.

Month	Water release requirements (continuous flow) at overall efficiency of:											
	60%		50%		40%		30%		20%		10%	
	$ft^3/s/$ 1 000 ac	gpm/ ac	$ft^3/s/$ 1 000 ac	gpm/ ac	$ft^3/s/$ 1 000 ac	gpm/ ac	$ft^3/s/$ 1 000 ac	gpm/ ac	$ft^3/s/$ 1 000 ac	gpm/ ac	$ft^3/s/$ 1 000 ac	gpm/ ac
Jan.	-	-	-	-	-	-	-	-	-	-	-	-
Feb.	2.84	1.28	3.41	1.54	4.27	1.92	5.69	2.56	8.54	3.84	16.65	7.49
Mar.	10.12	4.55	12.13	5.46	5.17	6.83	20.22	9.10	30.34	13.65	60.66	27.30
Apr.	10.66	4.80	12.76	5.74	15.97	7.19	27.28	9.58	31.94	14.37	63.85	28.73
May	13.80	6.21	16.33	7.48	20.80	9.36	27.70	12.47	41.59	18.72	83.14	37.41
June	14.87	6.69	17.90	8.00	22.40	10.08	29.84	13.43	41.78	20.15	63.52	40.28
July	14.54	6.54	17.52	7.88	21.91	9.86	29.19	13.14	43.81	19.71	87.58	39.41
Aug.	13.20	5.99	16.02	7.21	19.90	8.96	26.69	12.01	40.06	13.03	80.89	36.04
Sep.	12.54	5.64	15.10	6.80	18.88	8.50	20.96	9.43	37.77	17.00	75.71	33.98
Oct.	5.90	2.86	7.51	3.20	8.88	4.00	11.84	5.33	17.77	8.00	35.53	15.99
Nov.	-	-	-	-	-	-	-	-	-	-	-	-
Dec.	-	-	-	-	-	-	-	-	-	-	-	-
	0.47	0.21	0.56	0.25	0.71	0.32	0.94	0.42	1.42	0.64	2.84	1.28

Month	Water requirement ac ft per month at:					
	60% 1 000 ac	50% 1 000 ac	40% 1 000 ac	30% 1 000 ac	20% 1 000 ac	10% 1 000 ac
Jan.	-	-	-	-	-	-
Feb.	170	205	214	341	512	999
Mar.	607	728	910	1 213	1 820	3 840
Apr.	640	766	958	1 277	1 916	3 831
May	828	998	1 248	1 662	2 495	4 988
June	892	1 074	1 344	1 790	2 687	5 371
July	872	1 051	1 315	1 751	2 629	5 255
Aug.	798	961	1 194	1 601	2 404	4 853
Sep.	752	906	1 133	1 510	2 266	4 543
Oct.	354	432	533	710	1 066	2 120
Nov.	-	-	-	-	-	-
Dec.	-	-	-	-	-	-
	282	340	425	566	850	1 170 1/

1/ For each 1 ac ft for land preparation: add the above values to the total of the irrigation period.

(c) Irrigation of water requirements - subsidiary crops

Month	Onion				Groundnut, soybean greengram, blackgram cowpea				Sorghum				Maize, chilli				Sugarcane			
	K = 0.50				K = 0.60				K = 0.70				K = 0.75				K = 0.80			
	CU	CU minus effective rain	Water required per ac at 50% efficiency		CU	CU minus effective rain	Water required per ac at 50% efficiency		CU	CU minus effective rain	Water required per ac at 50% efficiency		CU	CU minus effective rain	Water required per ac at 50% efficiency		CU	CU minus effective rain	Water required per ac at 40% efficiency	
	ac in	ac in	ac in	ac ft	ac in	ac in	ac in	ac ft	ac in	ac in	ac in	ac ft	ac in	ac in	ac in	ac ft	ac in	ac in	ac in	ac ft
Jan.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Feb.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mar.	-	-	-	-	4.07	1.65	3.30	0.27	4.75	2.33	4.66	0.38	5.09	2.67	5.34	0.44	5.43	3.01	7.52	0.62
Apr.	3.41	0.99	1.98	0.16	4.09	1.86	3.72	0.30	4.78	2.55	5.10	0.42	5.12	2.89	5.78	0.48	5.46	3.23	8.07	0.67
May	3.68	2.31	4.62	0.38	4.41	3.04	6.08	0.50	5.15	3.78	7.56	0.62	5.52	3.85	7.70	0.64	5.88	4.51	11.27	0.93
June	3.61	2.83	5.66	0.47	4.33	3.55	7.10	0.59	5.06	4.28	8.56	0.71	5.42	4.60	9.20	0.76	5.78	5.00	12.50	1.04
July	3.69	2.61	5.22	0.43	4.43	3.35	8.70	0.55	5.17	4.09	8.18	0.68	5.54	4.46	8.92	0.74	5.91	4.83	12.07	1.00
Aug.	3.63	2.13	4.26	0.35	4.36	2.86	5.72	0.47	5.08	3.58	7.16	0.59	5.46	3.96	7.82	0.65	5.81	4.31	10.77	0.89
Sep.	3.42	2.01	4.02	0.33	4.11	2.70	5.40	0.44	4.79	3.38	6.76	0.56	5.13	3.72	6.44	0.53	5.48	4.07	10.17	0.84
Oct.	-	-	-	-	-	-	-	-	4.73	0.52	1.04	0.08	5.00	0.79	1.58	0.13	5.41	1.20	3.00	0.24
Nov.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dec.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Appendix 5

TRIAL PLAN OF IRRIGATION, GAL OYA IRRIGATION SCHEME

1) Acres land preparation (paddy)
2) ac ft/ac land preparation (paddy)
3) Total ac ft land preparation (paddy)
4) 1/ Acres irrigated (paddy)
5) ac ft/ac irrigation (paddy)
6) Total ac ft (paddy)
7) Total requirements ac ft (paddy)
8) Acres irrigated (cane)
9) ac ft/ac (cane
10) Total ac ft (cane)
11) Total requirement ac ft (paddy + cane)
12) ft^3/s continuous flow
13) Acres harvested (paddy)

Given:

- Channel capacities: ft^3/s
  - Left Bank 850
  - River Division 250
  - Right Bank 250
  - 1 350
- Three-month paddy variety - 75-day irrigation period
- Sugarcane - 8 month irrigation period
- (One) ac ft/ac for land preparation (paddy)
- Cane acreage 75% of projected 1975 acreage at 40% overall efficiency

Feb. Mar. Apr. May June July 1/ Aug. Sep. Oct. Totals ac ft/ac

Land preparation and irrigation diagram

– – –, Land preparation ('000 ac)

———, Irrigation (2 week intervals)

, – 5 –, – 5 –, 5 , 5 , 5 , 5 , 5 ,

, – 5 –, – 5 , 5 , 5 , 5 , 5 , 5 ,

, – 5 –, – 5 –, 5 , 5 , 5 , 5 , 5 ,

, – 5 –, – 5 –, 5 , 5 , 5 , 5 , 5 ,

, – 5 –, – 5 –, 5 , 5 , 5 , 5 , 5 ,

, – 5 –, – 5 –, 5 , 5 , 5 , 5 , 5 ,

, 7.5 , 7.5 , 7.5 , 7.5 , 7.5 , 7.5 , 7.5 ,

	Feb.	Mar.	Apr.	May	June	July 1/	Aug.	Sep.	Oct.	Totals	ac ft/ac
1)	3 000	20 000	15 000	10 000	10 000	15 000	-	-	-	75 000	-
2)	2.50	2.50	2.50	2.50	2.50	2.50	-	-	-	187 500	2.5
3)	12 500	50 000	37 500	25 000	25 000	37 500	-	-	-	-	-
4) 2/	-	5 000	25 000	40 000	35 000	25 000	30 000	20 000	7 500	-	-
5)	-	0.91	0.95	1.24	1.34	1.31	1.20	1.13	0.53	-	-
6)	-	4 550	42 750	49 600	46 900	32 750	36 000	22 600	3 975	220 125	2.9
7)	12 500	54 550	92 750	74 600	71 900	70 250	36 000	22 600	3 975	407 625	5.4
8)	-	11 500	11 500	11 500	11 500	11 500	11 500	11 500	11 500	-	-
9)	-	0.62	0.67	0.93	1.04	1.00	0.89	0.84	0.24	-	-
10)	-	7 130	7 705	10 695	11 960	11 500	10 235	9 660	2 760	71 645	6.2
11)	12 500	61 680	100 455	85 293	83 860	81 750	46 235	32 260	6 735	479 270	5.5
12)	208	1 028	1 674	1 421 3/	1 398 3/	1 363 3/	771	537	112	-	-
13)	-	-	-	-	20 000	20 000	10 000	10 000	15 000	75 000	-

Appendix 6

IRRIGABLE ACREAGES - GAL OYA AND PERIPHERY IRRIGATION SCHEME

LEFT BANK

Map No. 1/ COLONIZATION SCHEMES:	Designed irrigable extent (ac)	Without water rights private land paddy excluded (ac)	With water rights private land paddy included (ac)	Without water rights private land outside units (ac)	With Water rights irrigable extent (ac)	District Amparai/	Batticaloa	Map location
. 1.	605				605	x		D-18
. 2.	612				612	x		E-17
. 3.	510	23			510	x		L-9
. 4.	576	10			576	x		M-9
. 5.	570				570	x		M-9
. 6.	553	277			553	x		N-9
. 7.	551	311			551	x		N-8
. 8.	600	81			600	x		J-9
. 9.	568	24			568	x		K-9
.10.)	491	216			491	x		K-8
)		160					x	
.11.	633	18			633	x		L-8
.12.	581	58			581	x		K-8
.13.)	425	101			425	x		L-7
)	105	132			105		x	
.14.	345	137			345		x	L-6
.15.	550	123			550	x		M-7
.16.	620	95			620	x		H-9
.17.	571				571	x		H-10
.18.	319				319	x		J-11
.19.	600	100			600	x		K-10
.20.	583	31			583	x		G-10
.21.	572				572	x		G-11
.22.	607	50			607	x		F-12
.23.	574	9			574	x		E-11
.24.	520	107			530	x		F-10
.25.	148				148		x	H-9
.26.	591	56			591	x		K-11

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1/ ____________________ .. Left Bank; -- River Division; s sugarcane (present); (s) sugarcane (by 1975).

LEFT BANK

Map No. COLONIZATION SCHEMES:	Designed irrigable extent (ac)	Without water rights private land paddy excluded (ac)	With water rights private land paddy included (ac)	Without water rights private land outside units (ac)	With Water rights irrigable extent (ac)	District Amparai/	Batticaloa	Map location
.27.	658	160			658	x		E-10
.28.	444	31			444	x		E-9
.29.	482				482	x		F-9
.30.	479				479	x		F-8
.31	463	82			463	x		G-8
.32.	536	434			536	x		G-7
.33.	454	182			454	x		E-7
.34.	439	178			439	x		F-5
.35.	562	329			350		x	H-5
.36.	509				509	x		G-4
.37.	565	344			400		x	H-5
.38.	500	95			400		x	H-4
.39.	503	162			400		x	G-3
.40.	465	38			300		x	H-3
.41. Kotmale	315				260	x		G-8
.42. Block DN (Kakachivaddai)	504	154			80		x	K-5
.43. Block DS (Sinnawatte)	384	148			280		x	J-6
.44. Middle Class Block	2 667	150			588		x	H-7
.45. Himidurawa I	216				216	x		E-13
.46. Himidurawa II	100				100	x		E-14
.47. Mahakandya Lift	100				100	x		D-12
.48. Lift Scheme	150				150		x	J-2
.49. Block E	2 394	831			1 038		x	K-2

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LEFT BANK

Map No. COLONIZATION SCHEMES:	Designed irrigable extent (ac)	Without water rights private land paddy excluded (ac)	With water rights private land paddy included (ac)	Without water rights private land outside units (ac)	With Water rights irrigable extent (ac)	District Amparai/ Batticaloa	Map location
Block J:							
.J1.	486)			)			P-12
.J2.	447)			)			N-12
.J3.	450)			)			N-12
.J4.	450)			)	3 336		M-12
.J5.	450) 4 536			)		x	K-12
.J6.	453)			)			M-12
.J7.	450)			)			L-12
.J8.	450)			)			M-11
.J9.	450)			)			M-10
.J10.	450)			)			N-10
.J11.	1 633						N-11
GOVERNMENT FARMS							
.50. Malwatta	306				306	x	L-11
.51. Sammanthurai	100				100	x	N-12
PRIVATE LANDS							
Chadiyantalawa Scheme:							
. i.Chadiyantalawa West	514)	)	514)	)			M-10
. ii. " N. Central	294)	170)	294)	)			M-10
. iii. " S. Central	553)	)	553)	)			N-10
. iv. " N. East	450)	)	450)	)			P-10
. v. " S. East	425) 2 413	) 570	425) 2 413	)	2 413		P-10
. vi.Neendakaraik	177)	)	177)	)			P-10

LEFT BANK

Map No. COLONIZATION SCHEMES:	Designed irrigable extent (ac)	Without water rights private land paddy excluded (ac)	With water rights private land paddy included (ac)	Without water rights private land outside units (ac)	With Water rights irrigable extent (ac)	District Amparai/	Batticaloa	Map location
. vii. Millathvvaddai	)	150)	)	)				L-10
.viii. Kallimadu	)	250)	)	)				L-10
Miscellaneous:								
.52. Kondavattavan	310		310		310	x		F-16
.53. Kombushanthi	23		23		23	x		H-15
.54. Raddla	41		41		41	x		H-15
.55. Amparai Karangawa	51		51		51	x		C-16
.56. Neddiramvillu	58		58		58	x		H-15
.57. Sambumadu	75		75		75	x		N-12
.58. Sulaiyanchenai	19		19		19	x		P-12
.59. Veddu Kadu	52		52		52	x		P-13
Andella Oya:								
.60. Kalimadu		No irrigation				x	x	H-8
.61. Irrakathuvattai		-do-					x	J-7
Narakiri Aru:								
.62. Gonagola	- do -					x		F-7
.63. Konniyambai				180		x		G-6
.64. Vidanak Adu	- do -						x	H-6
.65. Nathana Karyakamk				555			x	L-5
.66. Oddadimunmari				285			x	L-5
.67. Mandur Vadathan				580			x	M-5

LEFT BANK

Map No. COLONIZATION SCHEMES:	Designed irrigable extent (ac)	Without water rights private land paddy excluded (ac)	With water rights private land paddy included (ac)	Without water rights private land outside units (ac)	With Water rights irrigable extent (ac)	District Amparai/	Batticaloa	Map location
Miscellaneous (Near Lagoon)								
.68. Ethlaineenda Karai				205		x		P-9
(Muniyaveli)								
(Navithanvelli)								
(Anamalai)								
.69. (Parraiyadivaddai)				444		x		P-8
(Alan Kulam)								
(Munaivelli)								
(Kavadativu North				225		x		
.70. (" South				178		x		N-7
(" Central				165		x		
.71. Karai Kudu				375			x	M-16
.72. Mandur Then				90			x	M-6
Porativu Pattu:								
.73. Maruthadimanmari				244			x	G-3
.74. Thikkadai				737			x	H-3
(Puthumunmarichollai)								
.75. (Kanthakuddahmaddu)				400			x	J-4
(Inniyapparchumai)								
.76. Nayaru Kandam				180			x	J-4
.77. Nathanai Vadda				200			x	K-4
.78. Thumpankerni				281			x	L-3
.79. Innipityvellivadathen				413			x	I-3
Total	(35 853)	7 640	(3 042)	5 737	29 800			

Map No. COLONIZATION SCHEMES:	Designed irrigable extent (ac)	Without water rights private land paddy excluded (ac)	With water rights private land paddy included (ac)	Without water rights private land outside units (ac)	With Water rights irrigable extent (ac)	District Amparai/ Batticaloa	Map location

Left Bank Summary:

		With water rights	Without water rights
Colonization Schemes:	Batticaloa District	4 584	2 680
	Amparai District	21 858	2 757
Government Farms:	Amparai District	406	-
Private Land: In scheme:	Amparai District	3 042	2 203
Outside scheme:	Amparai District	-	1 397
	Batticaloa District	-	4 340
		29 890	13 377

Left Bank with and without water rights:		
	Amparai District:	31 603
	Batticaloa District:	11 604
		43 207

Note: In addition, there is an estimated 3 000 ac of encroached land.

RIVER DIVISION

Map No.	Name	Acres	Map location
KURUNALANJI DIVISION (6 085 acres)			
-1-	(Meduvaddi East	225	Q-7
	(Meduvaddi West	208	
	(Meduvaddi North	366	
-2-	(Naipaddimunai East.	235	Q-9
	(Naipaddimunai West	265	
-3-	Kolmunai	364	R-9
-4-	Iraveli	264	R-10
-5-	Kudakarai East	422	R-10
-6-	Kudakarai West	326	Q-11
-7-	(Valainthavaddai West	361	
	(Valainthavaddai East	416	R-11
	(Valainthavaddai South	437	
-8-	Vedukadu	57	Q-11
-9-	Korakollai	123	Q-11
-10-	Puranpuri	292	Q-12
		198	B-9

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RIVER DIVISION

Map No.	Name	Acres	Map location
-33-	Ibrahimpallam	425	S-17
-34-	Sambukalapu	340	R-17
-35-	Medduveli	252	R-18
-36-	(Kudakarai East	320	S-18
	(Kudakarai West	320	
-37-	Karunkodithivu	175	R-20
-38-	Vakkathivu	110	R-15

SENGAPADAI DIVISION (6 247 acres)

-39-	Manakon	540	Q-14
-40-	(Poravan North East	320	
	(Poravan North West	330	R-12
	(Poravan Central	664	
	(Poravan South	651	
-41-	(Nadukwddy East	600	R-13
	(Nadukwddy Central	478	
	(Nadukwddy West	497	
-42-	(Sengapadai East	548	R-14
	(Sengapadai Central	578	
	(Sengapadai West	274	
-43-	Vammickalai	97	Q-15
-44-	(Maddupalai North	355	S-14
	(Maddupalai South	375	

MORAVIL DIVISION (6 570 acres)

-45-	(Mallikaithivu	45	K-15
	(Palavely	62	
-46-	(Valathapiddy Old	225	
	(Valathapiddy New	475	L-14
	(Valathapiddy North	125	
-47-	(Malwatta Velli)	310	L-13
	(Malwatta Puthumkada)		
	(Malwatta Kulam)		
-48-	Kinnarayanveli	20	L-13
-49-	Vaddipiddy	120	M-12
-50-	Killveddy	141	M-13
-51-	Neindula	629	M-13
-52-	Neindula Puthu	670	M-13
-53-	Neindula Puthuchenai	535	M-14
-54-	(Melveli-Pallaveli	612	L-15
	(Perriyanaindula	330	

RIVER DIVISION

Map No.	Name	Acres	Map location
-55-	Periyakokunarai	480	M-15
-56-	Sinnakokunarai	389	M-15
-57-	Valatapiddy Karangawa	200	K-14
-58-	(Kalliyanpathai	505	L-16
	(Vadaseriya	280	
-59-	Thinniyandimadu	160	L-15
-60-	Kalmunaiyar Palavelli West	200	K-15
-61-	Kalmunaiyar Palavelli East	47	L-15
-62-	Vinnankandu Farm	-	N-15
GALMADU DIVISION (1 810 acres)			
-63-	Kuduvil	150	M-16
-64-	Oddukuduvil	60	M-16
-65-	Periyavisarai	125	P-16
-66-	Sinnavisarai	120	P-15
-67(s)-	Viculamadu Kandami	510	K-16
-68(s)-	Peruveli Kandam	270	J-17
69	(Thirraioddai Aru	250	
	(Hospital Chona	175	N-15
	(Kochikalandu	150	
OTHER (1 242 acres)			
-765-	Madugaha Ela (pump) cane	225	G-16
-715(AB)-	) cane	1 017	J-15

Total Paddy	30 806
Total Cane	1 242
Total River Division	32 048

RIGHT BANK

Map No.	Name	Paddy (ac)	Cane (ac)	Map location
A1	Colonization	160		N-15
A2		-		N-16
A3	Permittee	235		Q-16
A4	Permittee	235		Q-17
A5	Colonization	346		N-17
A6	Permittee	235		P-18
A7	Permittee	500		Q-18
A8	Permittee	500		P-19
A9	Permittee	500		N-19
A10(s)	Colonization	661		L-19
A11(s)	Colonization	546		L-20
A12	Permittee	150		N-19
A13	Permittee	500		P-19
A14	Permittee	500		Q-20
A15	Permittee	400		N-20
A16	Permittee	500		N-20
A17	Permittee	400		M-20
A18	Permittee	361		H-18
A19	Permittee	450		F-19
A20	Permittee	-		B-19
A21	Padagoda	337		D-19
A22(s)	Malayadi and Muddiark (private land)	420		H-18
A23(s)			915	H-16
A24(s)			2 169	G-18
A25(s)			365	J-18
A26(s)			1 251	L-20
A27(s)			392	J-16
A28(s)			1 051	K-18
A29(s)			450	L-21
A30(s)			1 256	M-19
A31(s)			629	N-18
A32(s)			668	N-17
	Total Right Bank	7 936	9 146	(= 17 082 acres)

Note: Units A2 through A9 and A12 through A18 and A20 have no tertiary canal system.

PERIPHERY SCHEMES

	Map No.	Paddy ac	Cane	Map Location
NAMALOYA				
	B1	459		A-15
	B2	267		A-17
	B3	182		B-18
	B4	182		B-17
	B5	450		B-16
	B6	495		B-16
	B7	324		C-16
	B8	72		D-16
	B9	-		C-15
	Total	2 431		
EKGALARU				
	C1s		523	F-21
	C2s		871	J-21
	C3(s)	660		G-22
	C4(s)	513		J-20
	Total	1 173	1 394 (=2 567 acres)	
PALLANG OYA				
	D1	981		B-21
	D2	500		C-20
	D3	413		D-19
	Total	1 894		
PANNALAGAMMA				
	E1	555		G-25
	Total	555		
AMBALAM OYA				
	F1	633		K-22
	F2	430		M-21
	F3	600		M-21
	F4	600		N-22
	F5	-		N-22
	Total	2 263		

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PERIPHERY SCHEMES

	Map No.	Paddy (ac)	Cane	Map Location
SAGAMAN				
	(Paddi Meddu N	545		
	(Paddi Meddu S	430		
	G1 (Moddiyakal	597		G-22
	(Chenai Kandu	360		
	(Urukkai	640		
	Total	2 572		
RUFUS KULAN				
	H1)	350		P-25
	H2)	350		Q-25
Total Periphery Schemes		11 238	1 394 (= 12 632 ac)	

MINOR SCHEMES

	Normal/Yala Extent
ROTTAI KULAM	550
LAHUGALLA	370
PANAMA TANK	450
NAULLA TANK	195
NAVAL ARU	250
Miscellaneous	400
Total	2 215

SUMMARY OF ALL PROJECTS

Gal Oya Left Bank	29 890	(with water rights)
Gal Oya Left Bank	13 377	(without water rights)
Gal Oya River Division	32 048	
Gal Oya Right Bank	17 082	
Total Gal Oya	79 020	(with water rights)
Total Gal Oya	92 397	(with and without rights)
Periphery Schemes	12 632	
Minor Schemes	2 215	
Total	107 244	
Less Batticaloa District	11 604	(with and without rights)
Total Amparai District	95 640	

SUGARCANE AVERAGE

	Present	New 1975	Total
River Division	1 242	780	2 022
Left Bank	9 146	1 627	10 773
Ekgal Aru	1 394	1 173	2 567
Total by 1975			15 362

Source: Superintending Engineer, Executive Engineers, Agriculture Instructors, Colonization Officers, Cultivation Committees, Agriculture Productivity Centres, Sri Lanka Sugar Corporation.

APPENDIX 7

MAP OF GAL OYA AND PERIPHERY IRRIGATION SCHEMES

Map references (for map see back pocket)

LEFT BANK SYSTEM

Unit No.	Name	Location	Unit No.	Name	Location
Colonization Schemes			Government Farms		
.1.		D-18	.50.	Walwatta	L-11
.2.		E-17	.51.	Sammanthurai	N-12
.3.		L-9	Private Lands		
.4.		M.9	Chadiyantalawa Scheme:		
.5.		M.9	.i.	Chadiyantalawa West	M-10
.6.		N.9	.ii.	Chadiyantalawa N. Central	M-10
.7.		N.8	.iii.	Chadiyantalawa S. Central	N-10
.8.		J-9	.iv.	Chadiyantalawa N. East	P-10
.9.		K-9	.v.	Chadiyantalawa S. East	P-10
.10.		K-8	.vi.	Neendakorai K	P-10
.11.		L-8	.vii.	Millathuvaddai	L-10
.12.		K-8	.viii.	Kallimadu	L-10
.13.		L-7	Miscellaneous (Amp. Dist.):		
.14.		L-6	.52.	Kondaratlavan	F-16
.15.		M-7	.53.	Komkushanthi	H-15
.16.		H.9	.54.	Raddia	H-15
.17.		H.10	.55.	Amparaikorangawa	G-16
.18.		J.11	.56.	Neddiramriffu	H-15
.19.		K-10	.57.	Sambumadu	N-12
.20.		G-10	.58.	Sulaivanchenai	P-12
.21.		G-11	.59.	Veddukadu	P-13
.22.		F-12	Andella Oya:		
.23.		E-11	.60.	Kalimadu	H-8

.24.		F-10
.25.		H-9
.26.		K-11
.27.		E-10
.28.		E-9
.29.		F-9
.30.		F-8
.31.		G-8
.32.		G-7
.33.		E-7
.34.		F-5
.35.		H-5
.36.		G-4
.37.		H-5
.38.		H-4
.39.		G-3
.40.		H-3
.41.	Kotmole	G-8
.42.	Block DN (Kakachivuddai)	K.5
.43.	Block S (Sinnawatte)	J-6
.44.	Middle Class Block	H-7
.45.	Himidurawa I	E-13
.46.	Himidurawa II	E-14
.47.	Mahakandya Lift	D-12
.48.	Lift Scheme	J-2
.49.	Block E	K-2
	Block J:	
.J1.		P-12
.J2.		N-12
.J3.		N-12
.J4.		M-12
.J5.		K-12
.J6.		M-12
.J7.		L-12
.J8.		M-11
.J9.		M-10
.J10.		N-10
.J11.		N-11

.61.	Irrakathuvattan	J-7
Navakiri Aru:		
.62.	Gonegola	E-7
.63.	Kanniyambai	C-6
.64.	Vidanak Adu	H-6
.65.	Nathana Karynkam	L-5
.66.	Oddadimunmari	L-5
.67.	Mandur Vada Then	M-5
Miscellaneous (near Lagoon):		
.68.	Ethlaineendakarai	P-9
.69.	(Muniyaveli (Narithanvelli (Anamalai (Parraiyadivaddai (Alankulam (Munaivelli	P-8
.70.	(Kardativu North (Kardativu South (Kardativu Central	N-7
.71.	(Karaikudu	M-6
.72.	Mandur Then	M-6
Porativu Pattu:		
.73.	Maruthadimumarai	G-3
.74.	Thikkodai	H-3
Puthumunmarichallai:		
.75.	Kanthakuddahmaddu Inniyapparchumai	J-4
.76.	Nayarukandam	J-4
.77.	Nathanai Vadda	K-4
.78.	Thumpankerni	L-3
.79.	Innipityvelli Vedathon	L-3

RIVER SYSTEM

Unit No.	Name (old map No.)	Location
Kurunalkangi Division		
-1-	(Meduvaddi East (Meduvaddi West (Meduvaddi North	Q-7
-2-	(Naipaddimunai East (1) (West (1)	Q-9
-3-	Kalmunai (2)	R-9
-4-	Iraveli (3)	R-10
-5-	Kudakarai East (4)	R-10
-6-	Kudakarai West (5)	Q-11
-7-	(Valainthavaddai West (6) (Valainthavaddai East (6) (Valainthavaddai South (6)	R-11
-8-	Vedukadu (7)	Q-11
-9-	Karakollai (8)	Q-11
-10-	Puranpuri (9)	Q-12
-11-	Manalmedu (10)	P-9
-12-	Pandithivu (11)	Q-10
-13-	Sevugapathu (12)	Q-11
-14-	Anothokorai (13)	Q-11
Pattampiddy Division		
-15-	Thoyanvattai East (14)	Q-13
-16-	Thoyanvattai West (15)	Q-13
-17-	Chenaikandam (16)	N-13
-18-	Nelluchenai (17)	P-13
-19-	Periavelli and Solmadu (18)	P-13
-20-	Malcumpiddy (19)	P-14
-21-	Salambai (21)	P-14
-22-	Kandaveli (22)	P-14
Veeraivadi Division		
-23-	Idaikandam (23)	P-15
-24-	Sinnavisarai (57)	P-15
-25-	Sangathapallam (24)	Q-15
-26-	Kavattaiyadi (25)	P-15
-27-	Alimdakadu (59)	R-15
-28-	Vilankadu (60)	R-15
-29-	Seenampiddy (61)	S-15
-30-	Valalavaikulam (62)	R-16
-31-	(Kattuvali East (63) (Kattuveli West (63)	R-16
-32-	(Valalavai East (64) (Valalavai West (64)	R-16
-33-	Ibrahimpallam (65)	S-17
-34-	Sambukalapu (66)	R-17
-35-	Medduveli (67)	R-18
-36-	(Kudakarai East (68) (Kudakarai West (68)	S-18
-39-	Karunkodithivu (69)	R-20
-38-	Vakkathivu (60A)	R-15

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Unit No.	Name (old map No.)	Location
Sengapadai Division		
-39-	Manakan (20)	Q-14
-40-	(Paravan North East (53) (Paravan North West (53) (Paravan Central (53) (Paravan South (53)	R-12
-41-	(Nadukuddy East 54) (Nadukuddy Central (54) (Nadukuddy West (54)	R-13
-42-	Sengapadai East (55) (Sengapadai Central (55) (Sengapadai West (55)	R-14
-43-	Vammicholai (26)	Q-15
-44-	(Maddupalai North (56) (Maddupalai South (56)	S-14
Moravil Division		
-45-	(Mallikaithiru (32) (Palavoly	K-15
-46-	(Valathapiddy Old (33) (Valathapiddy New (33) (Valathapiddy North (33)	L-14
-47-	(Malwatta Velli (34) (Malwatta Pathumkada (34) (Malwatta Kulem (34)	L-13
-48-	Kinnorayanveli (35)	L-13
-49-	Vaddipiddy (37)	M-12
-50-	Kiliveddy (38)	M-13
-51-	Neindula (39)	N-13
-52-	Neindula Puthu (40)	M-13
-53-	Neindula Puthu Chenai (41)	M-14
-54-	(Melveli - Pallaveli (42) (Perriyaneindula (48)	L-15
-55-	Periyakokunarai (45)	M-15
-56-	Sinnakokunarai (46)	M-15
-57-	Valatapiddy Karangawa (32A)	K-14
-58-	(Kalliyampathai (48) (Vadaseriya (48)	L-16
-59-	Thinniyandimadu	L-15
-60-	Kalmunaiyar Palavelli West	K-15
-61-	Kalmunaiyar Palavelli East	L-15
-62-	Vinnankandu Farm	N-15
Galmadu Division		
-63-	Kuduvil	M-16
-64-	Oddukuduvil	M-16
-65-	Periyavisarai (56)	P-16
-66-	Sinnavisarai (58A)	P-15
-67(s)-	Viculamadu Kandam	K-16
-68(s)-	Peruveli Kandam	J-17
-69-	(Thirraiaddai Aru (Hospital Chena (Kochikalandu	N-15
Other		
-70s-	Madugaha Ela (pump)	G-16
-71s-	(AB)	J-15

RIGHT BANK

Unit No.	Name	(Old No.)	Location
A1		1A	N-15
A2		2A	N-16
A3		3A	Q-16
A4		4A	Q-17
A5		5A	N-17
A6		6A	P-18
A7		7A	Q-18
A8		8A	P-19
A9		9A	N-19
A10(s)		10A	L-19
A11(s)		11A	L-20
A12		12A	N-19
A13		13A	P-19
A14		14A	Q-20
A15		15A	N-20
A16		16A	N-20
A17		17A	M-20
A18		22A	F-19
A19		23A	C-19
A20		28A	B-19
A21	Padagoda S		D-19
A22(s)	Malayadik		H-18
	Middiork		H-18
A23s		AC	H-16
A24s		AD	G-18
A25S		AE	J-18
A26s		AI	L-20
A27s		AJ	J-16
A28s		AK	K-18
A29s		AL	L-21
A30s		AM	M-19
A32s		AN	N-28
A32s		AP	N-17
Periphery Schemes			
Namal Oya			
B1		IB	A-15
B2		2B	A-17
B3		3B	8-18
B4		4B	8-17
B5		5B	B-16
B6		6B	B-16
B7		7B	C-16
B8		8B	D-16
B9		9B	C-15
Ekgal Aru			
C1s		AH	F-21
C2s		AI	J-21
C3(s)		25A	G-22
C4(s)		26A	J-20
Pallang Oya			
D1		24A	B-21
D2		29A	C-20
D3		31A	D-19

Unit No.	Name	(Old No.)	Location
Pannalagama			
E1			G-25
Ambalam Oya			
F1		18A	K-22
F2		19A	M-21
F3		20A	M-21
F4		21A	N-22
F5		27A	N-22
Sagamam			
	(Paddi Medu North		
	(Paddi Medu South		
G1	(Maddiyakal		G-22
	(Chennai Kandam		
	(Urakkai Kandam		
Rufus Kulam			
H1			P-25
H2			Q-25

REFERENCE MAPS:

1. Land utilization and programme of development of the Gal Oya Scheme, Plan No. 207 Gal Oya Development Board. 1957.
2. Basic Plan Left Bank. Plan No. 296. 1963.
3. Gal Oya Left Bank Scheme. TIC/E.O. Undated.
4. Maintenance Diagram. Left Bank Area of G.O.S. Channel Division. Irrigation Department (with acreages listed or colonization units as of 1964). 1965.
5. Maintenance Diagram. Left Bank Area of G.O.S. River Division. (With acreages as of 1919). 1965.
6. Land Utilization Right Bank. Plan No. 317 (showing land status as of 1957 and revised 1968).
7. Map of area of scale 1/2 in = 1 mi (not identified - undated).
8. Block J. Plan No. 289. 1962.

Note: There are errors and omissions on this map. Users should make corrections and additions as information becomes available.

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APPENDIX SIX

IRRIGATION DEPARTMENT

ORGANISATION AND WORK PROGRAMME

IRRIGATION DEPARTMENT - ORGANISATION & WORK PROGRAMME

1. Introduction

This note presents the organisation of the Irrigation Department consequent to the dissolution of the Territorial Civil Engineering Organisation. Up to 31st March, 1978, the Irrigation Department was mainly engaged in the investigation and construction of Major Irrigation & Drainage Schemes costing over Rs. 3 millions, construction of Lift Irrigation Schemes and providing specialised services in Hydrology, Geology, Engineering Materials (soils, concrete aggregates) Hydraulic model testing and land use surveys. Planning and construction of the R.B. canal (Minipe to Ulhitiya Oya) and the Irrigation system in Area C was also undertaken under the Mahaweli Accelerated Program.

Work on Ground water and wind energy development, which formed part of the activities of the Department was handed over to the Water Resources Board from 1st January, 1978. The dissolution of the TCEO (effective 01-04-78) placed heavy responsibility on the Department. Responsibility for all irrigation and drainage works in the country (with the exception of areas under the authority of the R.V.D.B. and M.D.B.) was assigned to the Department. In addition to the irrigation works under Heads 27 and 28, all works on irrigation programmed under the decentralised budget are to be executed by the Department.

2. Reorganisation

In order to meet the increased scope of activities, a revised decentralised organisation has been introduced. In doing so, technical adequacy, financial control and correct administrative procedures have to be ensured without causing obstacles to speedy execution of works.

Sixty (59) Divisional Offices, each under the charge of an engineer or a Senior T.A. have been set up in a various parts of the Island. Wherever large areas have to covered by a divisional office, a sub-office has also been provided. There are thirteen (13) such sub-offices each under the charge of a Senior Technical Assistant (designated Divisional Assistants).

A group of about 4 divisions is formed into a 'Range' and placed in charge of a Chief Irrigation Engineer. There are fifteen (15) such Ranges controlling the sixty (59) Divisions.

These fifteen (15) regions are assigned to one of three Geographical Zones (North, South and Central) under the charge of a Deputy Director.

The location of the offices and the organisation chart of the Department are shown in annexes 1-5. It will be noticed that construction of Major Projects like Lunuganvshera and Inginimitiya Reservoir Projects are assigned to a Deputy Director other than those in charge of Zones. Similarly Deputy Directors are assigned for Budget and Programme Implementation, Research, Planning & Designs (other than Mahaweli) and Mahweli Designs.

3. Investigations & Study

The Department carries out investigations, studies and Designs for projects to be executed by its own staff; at the same time it also acts as an agency for such services for other Departments and Corporations. A full complement of staff and equipment are available for Geological investigations, Engineering Material Investigations, Hydrological Studies, Hydraulic Model Studies and Land Use Surveys.

(a) Geological Investigations

Practically all the drilling work undertaken is for the Mahaweli Accelerated Programme as shown below:-

		No. of parties	No. of drills
1.	Victoria Reservoir	3	10
2.	Maduru Oya Reservoir	2	6
3.	Moregahakande Reservoir	1	2
4.	Badulu Oya Reservoir	1	1
5.	Heppola Oya Reservoir	1	1
6.	Ulhitiya Oya Reservoir	1	2
7.	Loggal Oya Reservoir	1	1
8.	Jaffna Ground Water	1	1
		11	24

Additional equipment received recently will enable the formation of two more parties with 5 drills (combined) These machines are being reserved (at the request of CECB) for use at Kandakadu Anicut and Randenigala Reservoir.

(b) Engineering Material Investigation.

Investigations for design and future construction are carried but by the Department. In addition, quality control work for works under construction is also undertaken. The project work assignments are as follows:-

1. Investigation work

Victoria Reservoir
Moragahakande Reservoir
Maduru Oya Reservoir
Ulhitiya Oya Reservoir
Loggal Oya Reservoir
Heppola Oya Reservoir
Pettah Market
Colombo Marshes

2. Quality Control Work
   Kalawewa
   Dambula Oya Reservoir
   Ranawe Tank
   Dewahuwa Augmentation
   Ginganga Flood Protection
   Bomurella Reservoir
   Mahadivulwewa Reservoir
   Muthukandiya Reservoir
   Piramenthal Aru Reservoir
   Erige Oya Reservoir

(c) Hydrology Studies

In addition to processing and furnishing data for projects designed by the Irrigation Department, works on the following are also carried out:-

i. Furnishing processed data to Nedeco Team
ii. - do - Victoria Consultants
iii. - do - C.E.C.B.
iv. Research Studies at Rajangane Scheme.

(d) Hydraulic Model Studies.

Staff and space available for Hydraulic Model Studies are limited. However the following studies are in progress:-

1. Minipe Anicut
2. Mahamodera Sea Outfall
3. Victoria Model (preparatory work)
4. Miscellaneous Studies.

(e) Land Use

The soil surveys and classification work are being carried out on the following:-

1. Mahaweli systems H, B & C.
2. Mahadiulwewa Project
3. Inginimitiya Reservoir Project
4. Lunuganwehera Reservoir Project
5. Muthukandiya Reservoir Project
6. Monaragala Rainfed Sugar Project
7. Nation Soil Surveys

Additional capacity is not available for work on scheme other than those listed above.

(f) Designs

Design work being carried out can be classified under four categories, viz. (a) for works on construction program of the Irrigation Department, (b) for work on the Mahaweli accelerated program, (c) for work on items for which token provision will be made in the budget for 1979, and (d) Design of integrated regional development programs.

(a) Designs of works on construction Program.

These works would include the following:-

1. Bomurella Reservoir
2. Yan Oya Anicut
3. Urugodawatte Pump House
4. Lunuganwehera Reservoir Project
5. Mahadiulwewa Reservoir Project
6. Muthukandiya Reservoir Project
7. Devahuwa Augmentation
8. 5 Tank Modernisation Project
9. Inginimitiya Reservoir Project.

(b) Design on Mahaweli Accelerated Program

Initially the work entrusted to the Irrigation Department consisted of Minipe R.C. Canal and System C. However, the latter work has now been taken over the the M.D.B. The balance work entrusted to the Department is as follows:-

1. Minipe Anicut
2. Badula Oya Crossing
3. Heppola Oya Reservoir
4. Loggal Oya Reservoir
5. Minipa R.B. Transbasin Canals
6. Ulhitiya & Rathkinde Reservoirs.

(c) Designs of New Irrigation Schemes

There are 46 new irrigation schemes and 9 new drainage schemes proposed to be taken up for construction in 1979, as listed in annex 6. Preliminary studies on some of these schemes have commenced. The standard procedure adopted for the preliminary and detail investigations on a minor irrigation scheme depicted in a line diagram is given in Annex 7. From this diagram it will be seen that the time taken for the preliminary investigations for a minor irrigation scheme is about 6 weeks, 23 weeks for detail investigations, designs and preparation of drawings for the headworks (i.e. tank bundk spill, sluice, and access road) and approval by the C.I.E. Investigations, designs and preparation of drawings and estimates for the channel system under the scheme could be done in about 18 weeks.

Investigations and designs and plan work involved in a major irrigation scheme which would benefit more than 200 acres will depend on the magnitude of the scheme. Special studies and investigations such as hydrological studies, model studies, detail investigations of the foundation, etc. have to be carried out. Time taken for such investigations, designs and preparation of drawings and estimate could vary from one year to several years.

(d) <u>Design of Integrated Rural Development Program</u>
Several integrated Rural Development Programs are contemplated. These investigation and designs are undertaken at the Range Level. Programs already identified and taken up are as follows:-

1. Kurunegala Integrated Rural Development
2. Kirama Oya " " "
3. Hambantota Dist. " "
4. Matara District " "
5. Udunuwara " "
6. Lower Uva Development

4. <u>Construction Capacity</u>
Prior to 1971, the Department was fully equipped to undertake investigations, designs, construction and operation of Irrigation and Drainage Projects. With the setting up of the TCEO, the Government decided to separate the Mechanical Branch of the Department works to form the Department of Machinery and Equipment. The newly formed Department of Machinery was assigned the task of providing services to the TCEO. The Irrigation Department was required to entrust its construction works to private contractors or state agencies like the BVDB, SD & CC and occasionally to the Army and the Department of Machinery and Equipment.

A few items of earthmoving and other equipment were made available under project aid programs and in order to maintain these equipment a small workshop was established at Borupana Road.

With the amalgamation of the TCEO, some of the equipment available with the D/M & E have been assigned to work for the Department. Four machine units with a capacity of about 1,000 cubes per day are now working for the Department. One of these units was deployed for work on the Mahaweli Accelerated Program at Ulhitiya Oya; it is intended that this last mentioned unit will continue to work on the accelerated program, for the Mahaweli Development Board.

A few items of equipment are also hired from the D/ME for work in isolated areas. The field organisation of the Department is geared to supervise work on contract or check roll. The latter method of execution of work is not encouraged because of the inherent weakness of this method of construction by a State Department. During 1978/79 several items of equipment are expected under Aid projects as follows:-

Muthukandiya Reservoir Project	-	Australian Aid
Lunuganwehera Reservoir Project	-	ADB/FAD Loan
Inginimitiya Reservoir Project	-	Japanese Govt. Loan.

It is anticipated that the Department of Machinery and Equipment would assist the I.D. to maintain and operate these machines obtained on loans.

5. **Budgets**

The Department is committed to the execution of several works during 1978 as indicated below:-

Description	Allocation for Financial Year in Rs. Millions			
	North Zone	Central Zone	South Zone	Total
Capital Works (Itemised)	35.89	17.56	36.09	89.54
Capital Block Vote	2.20	3.70	1.54	7.24
Decentralised Budget	16.72	8.70	4.53	29.95
Operation & Maintenance	9.48	6.98	6.32	22.78
Mahaweli Rehabilitation	4.75	-	-	4.75
Lower Uva Development	-	2.34	-	2.34
				156.60

Following new items of construction are contemplated during the current year:-

Lunuganvehera Reservoir Project
Polwatta Ganga Flood Protection Scheme
Inginimitiya Reservoir Project.
Kurunegala Integrated Development
Kirama Oya Integrated Development.

The total capital budget for 1979, as provided in the draft estimates is Rs. 313 Million plus Token Vote items.

6. **Conclusion**

The Irrigation Department is performing the functions associated with Irrigation and Drainage Development Schemes, has also proved to be a training ground for Engineers and other Technical Staff required for employment in Boards and Corporations. Top Managerial positions in the M.D.B., C.E.C.B. and R.V.D.B. are held by staff trained in the Department. In this process, the Department has sometimes lost some strength required for work in the Department itself.

Acute shortage of clerical and accounting staff has hindered progress to such an extent that output of work by the Technical staff has been seriously affected. The need for a fully equipped and competent "Machinery branch" is strongly felt. In the absence of private contractors to undertake large scale works, it is very necessary that a fully strengthened Machinery Branch should be made available for the execution of the vast program of work entrusted to the Department.

Prepared by the Director of Irrigation

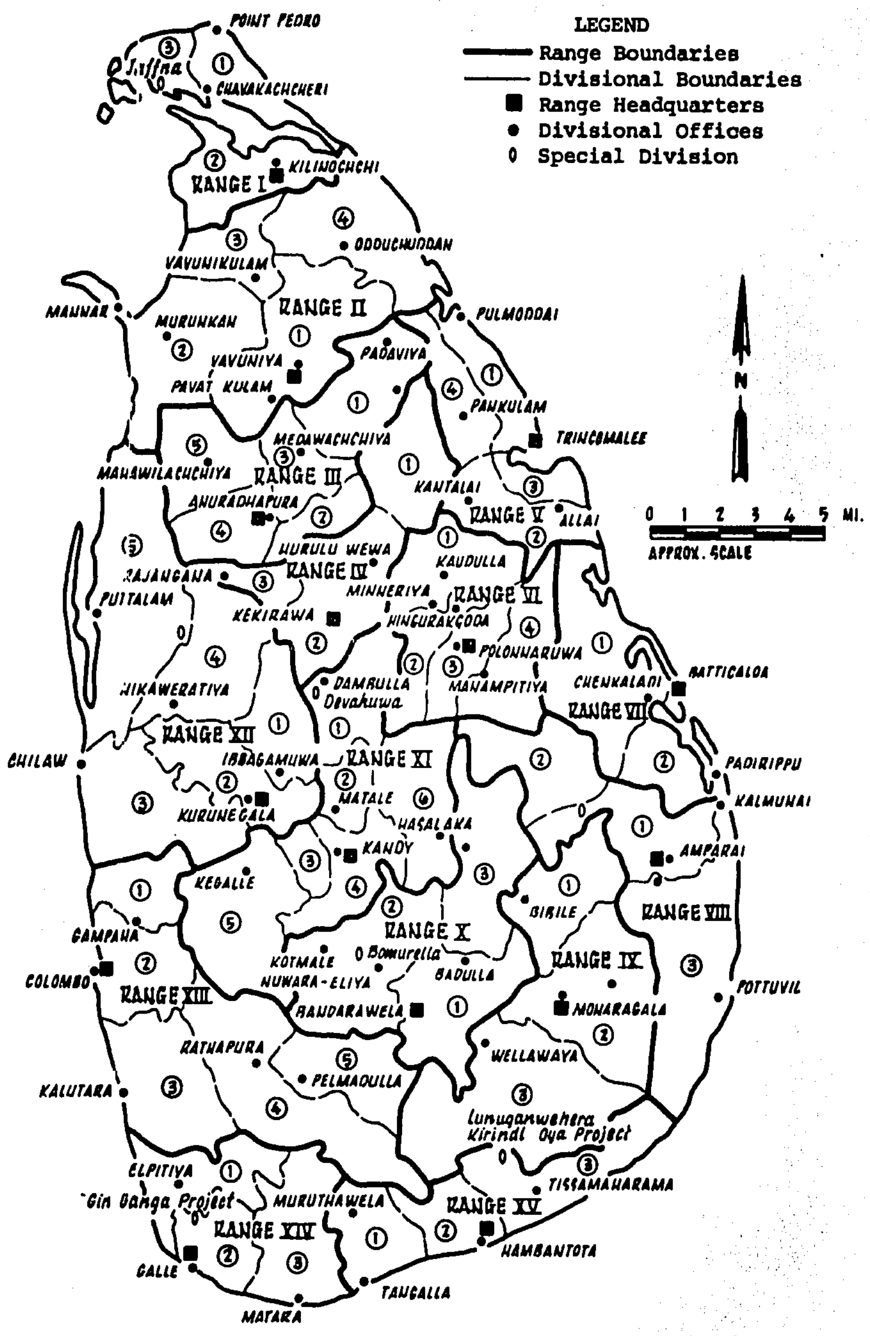
Colombo.
1978-09-15.

YEDS./

MAP OF SRI LANKA

showing

RESTRUCTURED IRRIGATION DEPT.



RANGE I- KILINOCHCHI
1. Pt. Pedro
2. Kilinochchi
3. Jaffna

RANGE II-VAVUNIYA
1. Vuavuniya
2. Murunkan
3. Vavunikulam
4. M.I.K.

RANGE III-ANURADHAPURA
1. Padaviya
2. Rambewa
3. Anuradhapura East
4. -DO- West
5. Mahawilachchiya

RANGE IV-KEKIRAWA
1. Hurulu Wewa
2. Mahailluppallama
3. Rajangana

RANGE V-TRINCOMALEE
1. Trincomalee
2. Kantalai
3. Mutur
4. Gomarankadawela

RANGE VI-POLONNARUWA
1. Kaudulla
2. Hingurakgoda
3. Polonnaruwa
4. Manampitiya

RANGE VII-BATTICALOA
1. Chenkaladi
2. Padirippu

RANGE VIII-AMPARAI
1. Amparai
2. Maha Oya
3. Kalmunai

RANGE IX-MONARAGALA
1. Madulla
2. Monaragala
3. Wellawaya

RANGE X-BANDARAWELA
1. Badulla
2. Nuwara-Eliya
3. Mapakada
0 Bomurella

RANGE XI-KANDY
1. Dambulla
2. Matale
3. Kadusannawa
4. Kandy
5. Kegalle
6. Devahuwa
0 Minipe

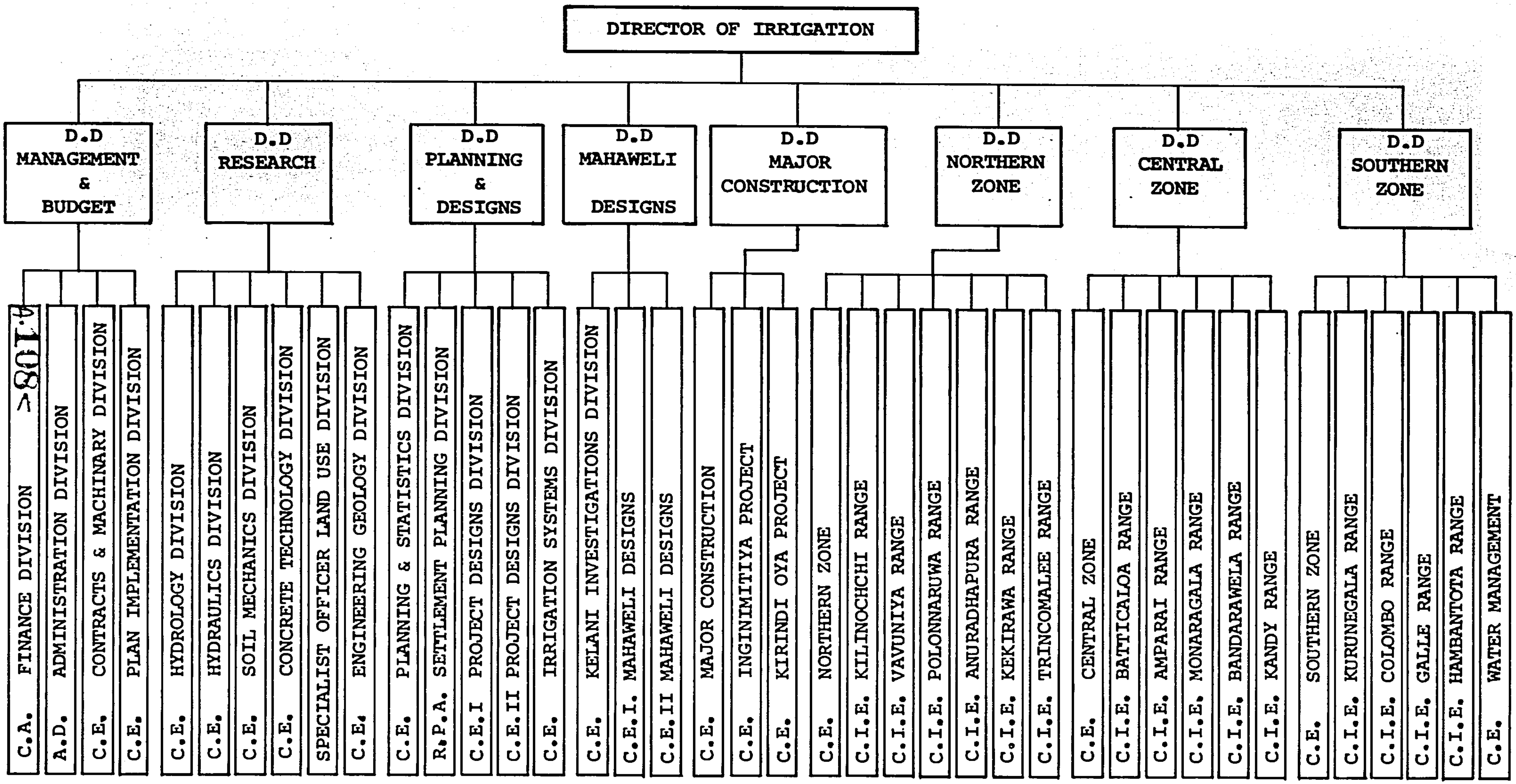
RANGE XII-KURUNEGALA
1. Hiriyala
2. Kurunegala
3. Katugampola
4. Nikaweratiya
5. Puttalam

RANGE XIII-COLOMBO
1. Gampaha
2. Colombo
3. Kalutara
4. Ratnapura
5. Balangoda

RANGE XIV-GALLE
1. Ambalangoda
2. Galle
3. Matara
0 Gin Ganga

RANGE XV-HAMBANTOTA
1. Weeraketiya
2. Hambantota
3. Tissamaharama

ORGANIGRAM OF THE IRRIGATION DEPARTMENT



ABBREVIATIONS

D.D - DEPUTY DIRECTOR

A.D. - ASSISTANT DIRECTOR

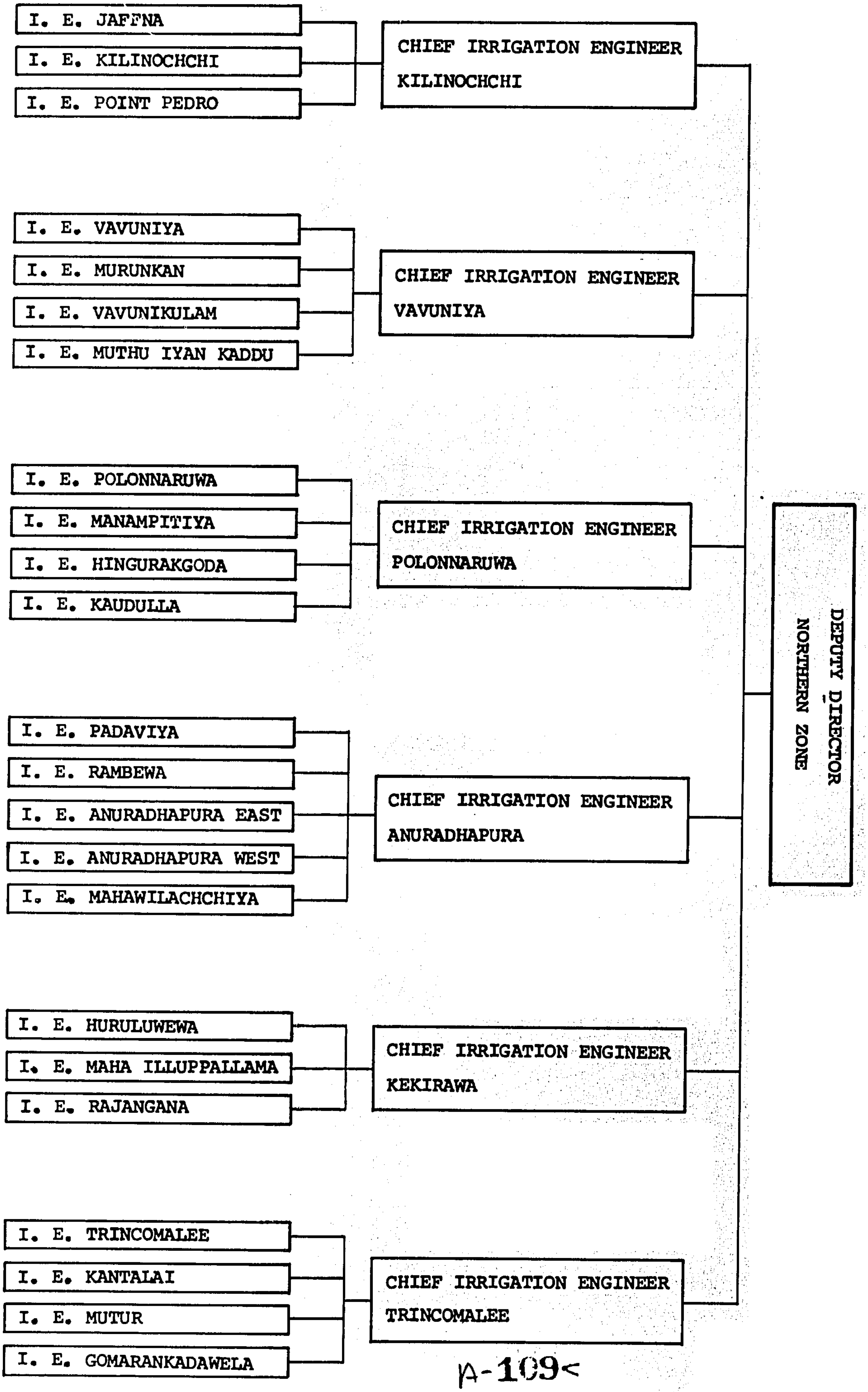
C.E. - CHIEF ENGINEER

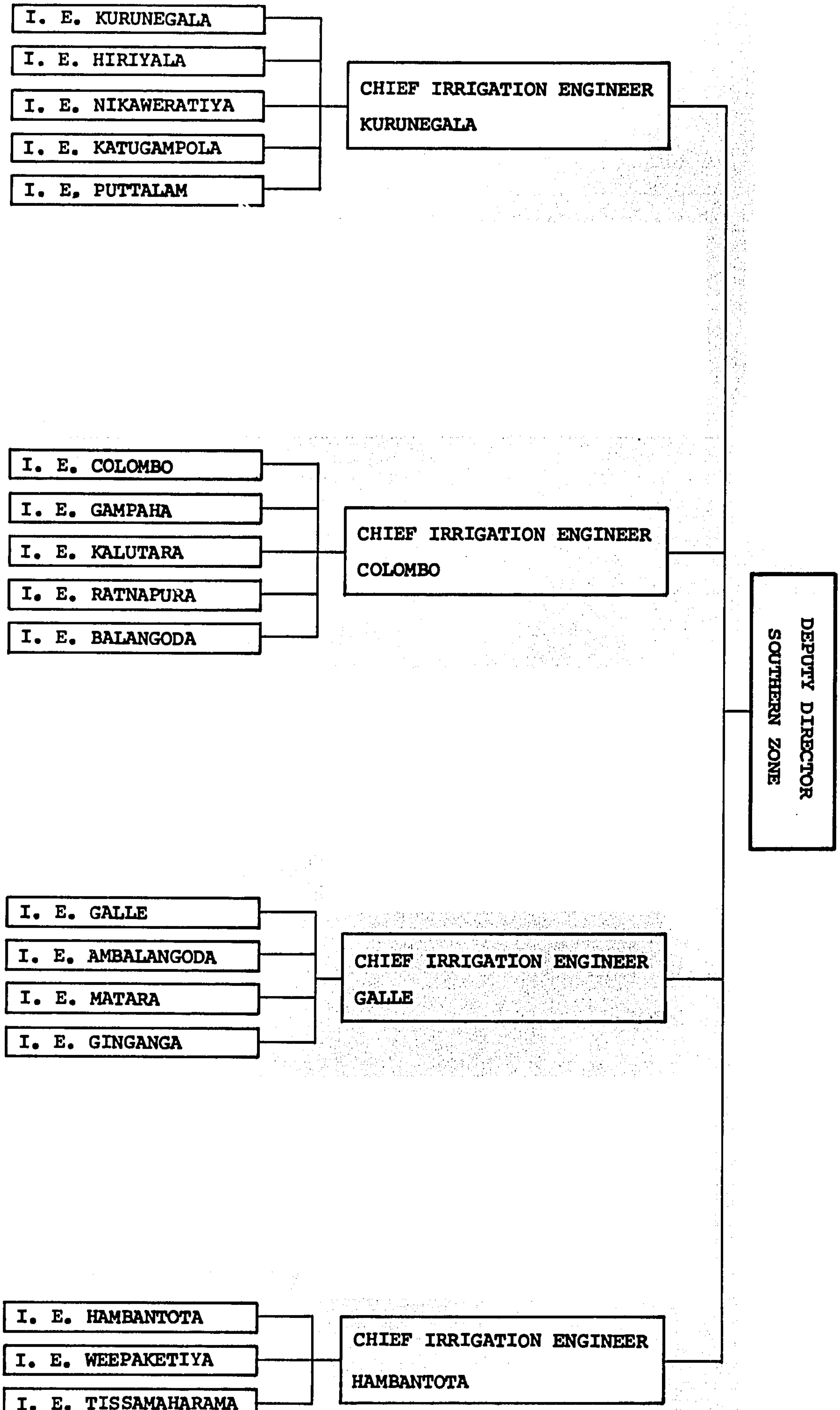
C.I.E. - CHIEF IRRIGATION ENGINEER

C.A - CHIEF ACCOUNTANT

R.P.A. - RURAL PLANNING ARCHITECT

Revised 1978


I. E. JAFFNA
I. E. KILINOCHCHI
I. E. POINT PEDRO
CHIEF IRRIGATION ENGINEER KILINOCHCHI
I. E. VAVUNIYA
I. E. MURUNKAN
I. E. VAVUNIKULAM
I. E. MUTHU IYAN KADDU
CHIEF IRRIGATION ENGINEER VAVUNIYA
I. E. POLONNARUWA
I. E. MANAMPITIYA
I. E. HINGURAKGODA
I. E. KAUDULLA
CHIEF IRRIGATION ENGINEER POLONNARUWA
I. E. PADAVIYA
I. E. RAMBEWA
I. E. ANURADHAPURA EAST
I. E. ANURADHAPURA WEST
I. E. MAHAWILACHCHIYA
CHIEF IRRIGATION ENGINEER ANURADHAPURA
I. E. HURULUWEWA
I. E. MAHA ILLUPPALLAMA
I. E. RAJANGANA
CHIEF IRRIGATION ENGINEER KEKIRAWA
I. E. TRINCOMALEE
I. E. KANTALAI
I. E. MUTUR
I. E. GOMARANKADAWELA
CHIEF IRRIGATION ENGINEER TRINCOMALEE
DEPUTY DIRECTOR NORTHERN ZONE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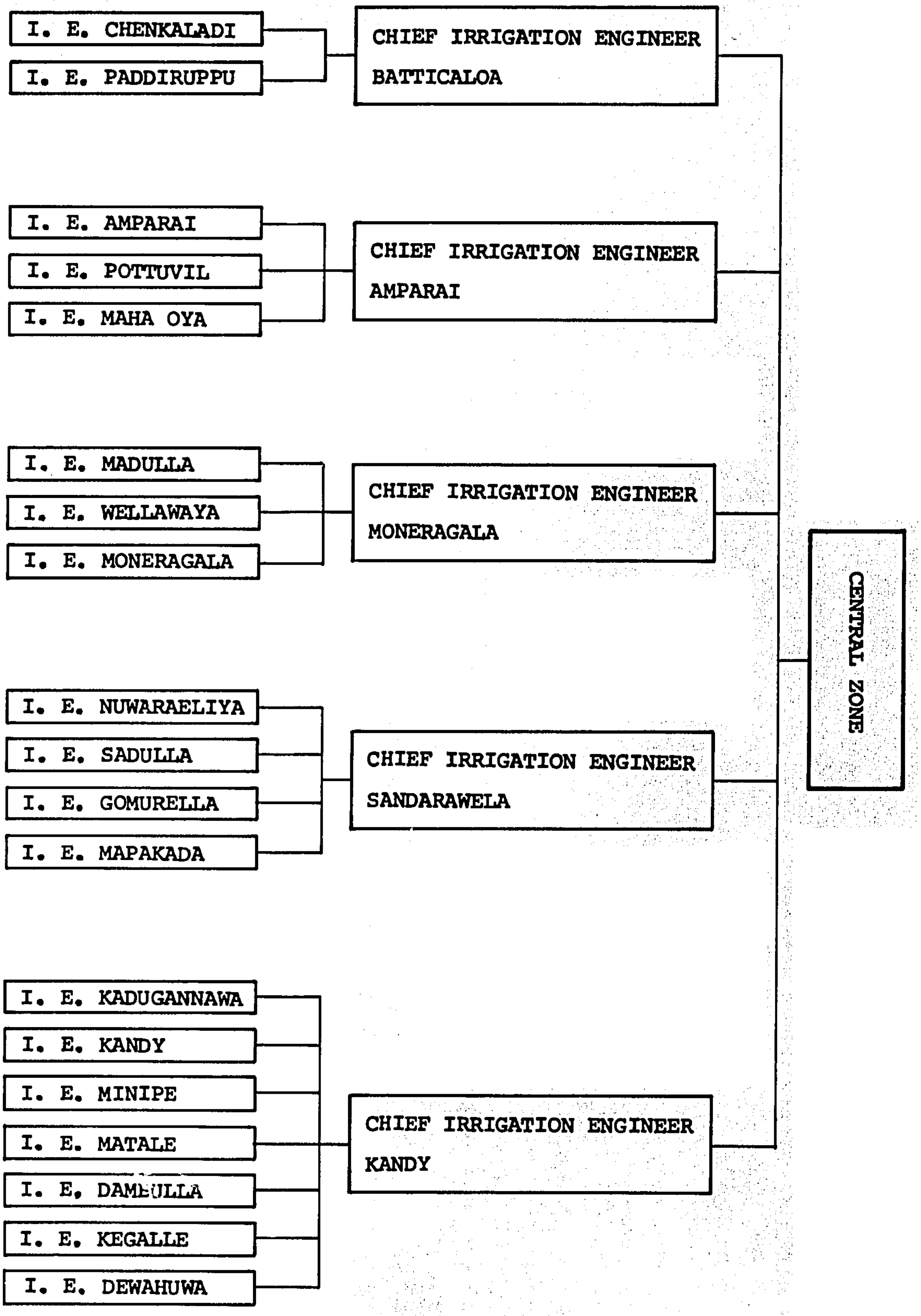
I. E. HIRIYALA
I. E. NIKAWERATIYA
I. E. KATUGAMPOLA
I. E. PUTTALAM
CHIEF IRRIGATION ENGINEER KURUNEGALA
I. E. COLOMBO
I. E. GAMPAHA
I. E. KALUTARA
I. E. RATNAPURA
I. E. BALANGODA
CHIEF IRRIGATION ENGINEER COLOMBO
DEPUTY DIRECTOR SOUTHERN ZONE
I. E. GALLE
I. E. AMBALANGODA
I. E. MATARA
I. E. GINGANGA
CHIEF IRRIGATION ENGINEER GALLE
I. E. HAMBANTOTA
I. E. WEEPAKETIYA
I. E. TISSAMAHARAMA
CHIEF IRRIGATION ENGINEER HAMBANTOTA


I. E. CHENKALADI
I. E. PADDIRUPPU
CHIEF IRRIGATION ENGINEER BATTICALOA
I. E. AMPARAI
I. E. POTTUVIL
I. E. MAHA OYA
CHIEF IRRIGATION ENGINEER AMPARAI
I. E. MADULLA
I. E. WELLAWAYA
I. E. MONERAGALA
CHIEF IRRIGATION ENGINEER MONERAGALA
I. E. NUWARAELIYA
I. E. SADULLA
I. E. GOMURELLA
I. E. MAPAKADA
CHIEF IRRIGATION ENGINEER SANDARAWELA
I. E. KADUGANNAWA
I. E. KANDY
I. E. MINIPE
I. E. MATALE
I. E. DAMBULLA
I. E. KEGALLE
I. E. DEWAHUWA
CHIEF IRRIGATION ENGINEER KANDY
CENTRAL ZONE

Work	Approximate Cost	Acreage Bene-fitted	Nature of Scheme
Polennaruwa Range			
1. Restoration of Perawaduwewa	3,000,000	650	Restoration of tank.
2. Restoration of Aluthwewa	2,100,000	450	Restoration of tank.
3. Construction of Distributory and Field Canals for provision of I.FF to Kotikapitiya 450 acres.	1,250,000	450	Construction of channel system.
4. Restoration of Kadurupitiya Wewa	1,200,000	150	Restoration of tank.
5. Restoration of Katulutu Wewa	490,000	250	-do-

NOTHERN ZONE

Work	Approximate Cost	Acreage Bene-fitted	Nature of Scheme
Anuradhapura Range			
1. Improvements to Nachchaduwa Head Works.	1,500,000	5,889	Replacement of lifting gates with radial gates.
2. Provision of I.FF to R.B. Tr.18 in Rajangana Scheme.	1,500,000	544	Extension of I.FF.
3. Restoration of Kalugala Mahawewa	1,625,000	450	
Vavuniya Range			
1. Restoration of Thanyan Kulau	2,700,000		Restoration of tank.
2. Re-conditioning of channel system under Giant's Tank Scheme.	6,000,000	30,000	Reconditioning of channel system and the inlet channel from Takkam.
Kilinochchi Range			
1. Restoration of Kudamuruddi Tank	10,500,000	1,600	Construction of tank.
2. Restoration of Chalampan Aru	600,000	100	Restoration of tank.
3. Restoration of Kakkaraya Kulam	700,000	120	Restoration of tank.
4. Rehabilitation of channel system under Iranamadu tank	2,000,000	25,000	Rehabilitation of channel system
5. Restoration of Pilliay Kulam.	1,350,000	180	Restoration of tank

Work	Approximate Cost	Acreage Bene-fitted	Nature of Scheme
Polennaruwa Range			
1. Restoration of Perawaduwewa	3,000,000	650	Restoration of tank.
2. Restoration of Aluthwewa	2,100,000	450	Restoration of tank.
3. Construction of Distributory and Field Canals for provision of I.FF to Kotikapitiya 450 acres.	1,250,000	450	Construction of channel system.
4. Restoration of Kadurupitiya Wewa	1,200,000	150	Restoration of tank.
5. Restoration of Katulutu Wewa	490,000	250	-do-

A-115<

NOTHERN ZONE

Work	Approximate Cost	Acreage Bene-fitted	Nature of Scheme
Anuradhapura Range			
1. Improvements to Nachchaduwa Head Works.	1,500,000	5,889	Replacement of lifting gates with radial gates.
2. Provision of I.FF to R.B. Tr.18 in Rajangana Scheme.	1,500,000	544	Extension of I.FF.
3. Restoration of Kalugala Mahawewa	1,625,000	450	
Vavuniya Range			
1. Restoration of Thanyan Kulau	2,700,000		Restoration of tank.
2. Re-conditioning of channel system under Giant's Tank Scheme.	6,000,000	30,000	Reconditioning of channel system and the inlet channel from Takkam.
Kilinochchi Range			
1. Restoration of Kudamuruddi Tank	10,500,000	1,600	Construction of tank.
2. Restoration of Chalampan Aru	600,000	100	Restoration of tank.
3. Restoration of Kakkaraya Kulam	700,000	120	Restoration of tank.
4. Rehabilitation of channel system under Iranamadu tank	2,000,000	25,000	Rehabilitation of channel system.
5. Restoration of Pilliay Kulam.	1,350,000	180	Restoration of tank

Work	Approximate Cost	Acreage Bene-fitted	Nature of Scheme
Kandy Range			
1. Murapola Augmentation Scheme	5,000,000	820	New tank to be constructed to augment supply to existing scheme.
2. Mahara Bandarage Wewa	1,800,000	400	Restoration of an abandoned tank to irrigate existing paddy fields.
3. Udattewa Wewa	4,000,000	1,000	Restoration of an ancient tank 3,000 Ac.ft.
4. Himbiliyakade Reservoir	6,000,000	700	Restoration of an ancient tank 2,100 Ac.ft.
5. Palutawa Egoda Wewa in Ihalanaluwa	600,000	125	Restoration of an ancient tank.
6. Keenagahawewa in Inamaluwa	400,000	150	Restoration of abandoned tank.
7. Paluthawa Meewewa Marichcha	425,000	100	-do- -do-
8. Radagalpotha & Anicut	800,000	200	Anicut and canal construction.
9. Construction of irrigation works for Integrated Development in Udunuwara Electorate.	750,000	300	Restoration of tanks.
10. Restoration of Namini Wewa	900,000	150	Restoration of tank.
Bandarawela Range			
1. Demodera-Perani Kandiyawewa	6,000,000	400	-do-
2. Improvements to Ambewela Scheme. Badulla District.	900,000	955	Improvements to Link and R.B. Channel. Construction of D.Chl. and F.Chl

Work	Approximate Cost	Acreage Bene-fitted	Nature of Scheme
Moneragala Range			
1. Restoration of Mallipotha Wewa	500,000	475	Construction of tank.
2. Restoration of Kandiyapita Wewa	2,750,000	300	-do-
Amparai Range			
1. Restoration of Wadamoosa Kulam	3,000,000	500	Tank restoration to 1,600 Ac.ft.
2. Augmentation of Kanchikudichi Aru Reservoir	1,000,000	1,200	Existing reservoir to be augmented to 3,600 Ac.ft.
3. Restoration of Udahalawa Tank	2,000,000	400	Tank restoration - capacity 1,560 Ac.ft.
Batticaloa Range			
1. Restoration of Mavadduvan Tank	2,000,000	435	Tank restoration.
2. Augmentation of Rugan Tank	16,000,000	7,300 (Existing)	Increase storage of Rugam Tank by combining with Kitul Wewa.
3. Restoration of Pariya Murivu tank	3,500,000	700	Restoration of an abandoned tank.

Work	Approximate Cost	Acreage Bene-fitted	Nature of Scheme
Kurunegala Range			
1. Restoration of Mahagalketiyawa Tank	550,000	100	Construction of tank.
2. Restoration of Ottupallama Tank	4,800,000	1,000	-do-
3. Restoration of Panduwasnuwara Tank	1,500,000	60	
Galle Range			
1. Construction of Nagahadola Reservoir in Akuressa Electorate	1,000,000	800	-do-
2. Improvements to Kekanadura Tank	1,500,000	775 (Existing) 420 (New)	Increase in capacity of Reservoir by raising F.S.L.
Hambantota Range			
1. Reconditioning of channels in Walawe R.B. Scheme	1,100,000	6,770	Extensive repairs to the channel system.
2. Rehabilitation of Urubokka Oya Scheme	1,200,000		Repairs to existing major structures and improvements to channel system.

ADDITIONAL TOKEN VOTE ITEM

Works	Cost	Acreage bene-fitted	Nature of Scheme
Badarawela Range			
1. Pilot Lift Irrigation Project in Welimade for the cultivation of high value vegetable crops.	T.V.		Lift Irrigation Project.
Galle Range			
1. Nugaduwa Kaduruduwa Yaya Drainage Scheme.	1,000,000		Drainage Scheme.
2. Drainage facilities to Galle Town complex inclusive of reconditioning of Purana Ela, Kepulla and Osanugoda Ela and providing regulator and drainage pump.	5,000,000		
3. Koggala Lake Scheme - Improvements to sca outfalls and peripheral S.W.E. bund and toe drain round lake with control structure.	2,500,000		
4. Drainage and reclamation of Akurala Swamp and providing permanent 5 Bay regulator and pump house and dredging Lanka Ela and link canal and protection to bund at sea outfall.	500,000		
5. Pilot L.I. Scheme in Rakwana for cultivation of cash crops.			
Kilinochchi Range			
1. Thiruvai Aru Educated Girls' Scheme to provide L.I. facilities to 310 Acs.	2,000,000		

TYPICAL PROGRAMME FOR INVESTIGATION AND DESIGN OF A MINOR IRRIGATION SCHEME

NOTE:

1. The Minor Irrigation Scheme considered here relates to a Tank and Irrigation System for cultivation of an extent not exceeding 200 farm acres recovered from jungle and includes infra-structure for new settlers to operate the scheme.

2. Modifications are necessary in the programme when the Minor Irrigation Scheme relates to a Flood Protection/ Drainage Salt Water Exclusion Scheme or to repair/improvement/reconditioning/rehabilitation of existing schemes of any of the above categories.

3. A Lift Irrigation Scheme is excluded from the definition of a Minor Irrigation Scheme.

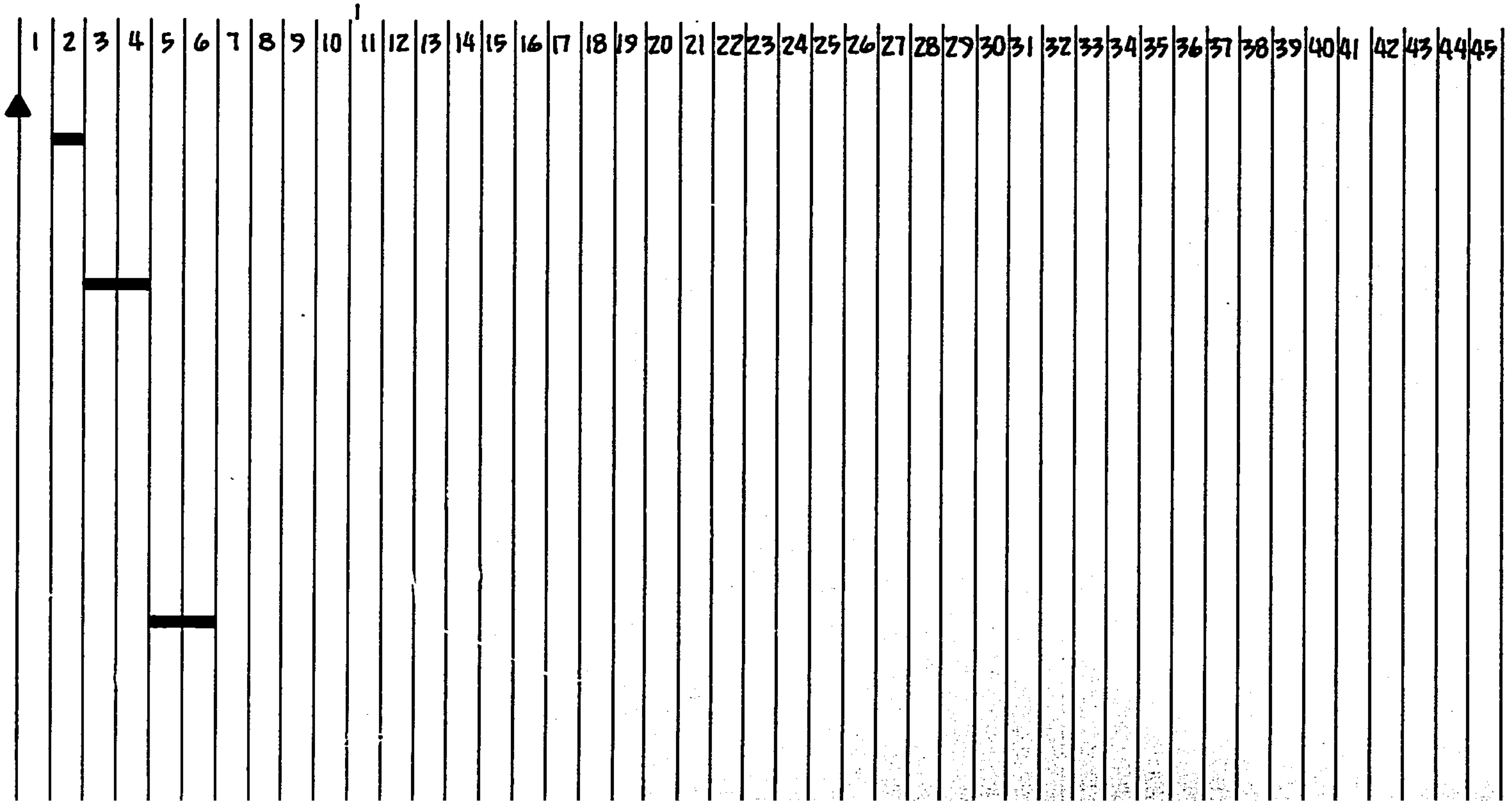
4. The execution of the program will be the responsibility of the I.E. of the Division subject to guidance, direction, and approval by the C.I.E. of the Range with H.O. participation to the extent required by the C.I.E.

5. Figures in circles indicate separate investigating teams.

A. PRELIMINARY INVESTIGATIONS

Time in Weeks

1. Request for Scheme
2. Inspection by IE
3. Office studies
   - (1) Catchment Area
   - (ii) Rainfall records
   - (iii) Yield Computations
   - (iv) Location of irrigable area
4. Field Investigations:
   - (i) Access facilities
   - (ii) Condition of existing works for spill
   - (iii) Site
   - (iv) Availability of const. materials
   - (v) Sociology aspects of Scheme

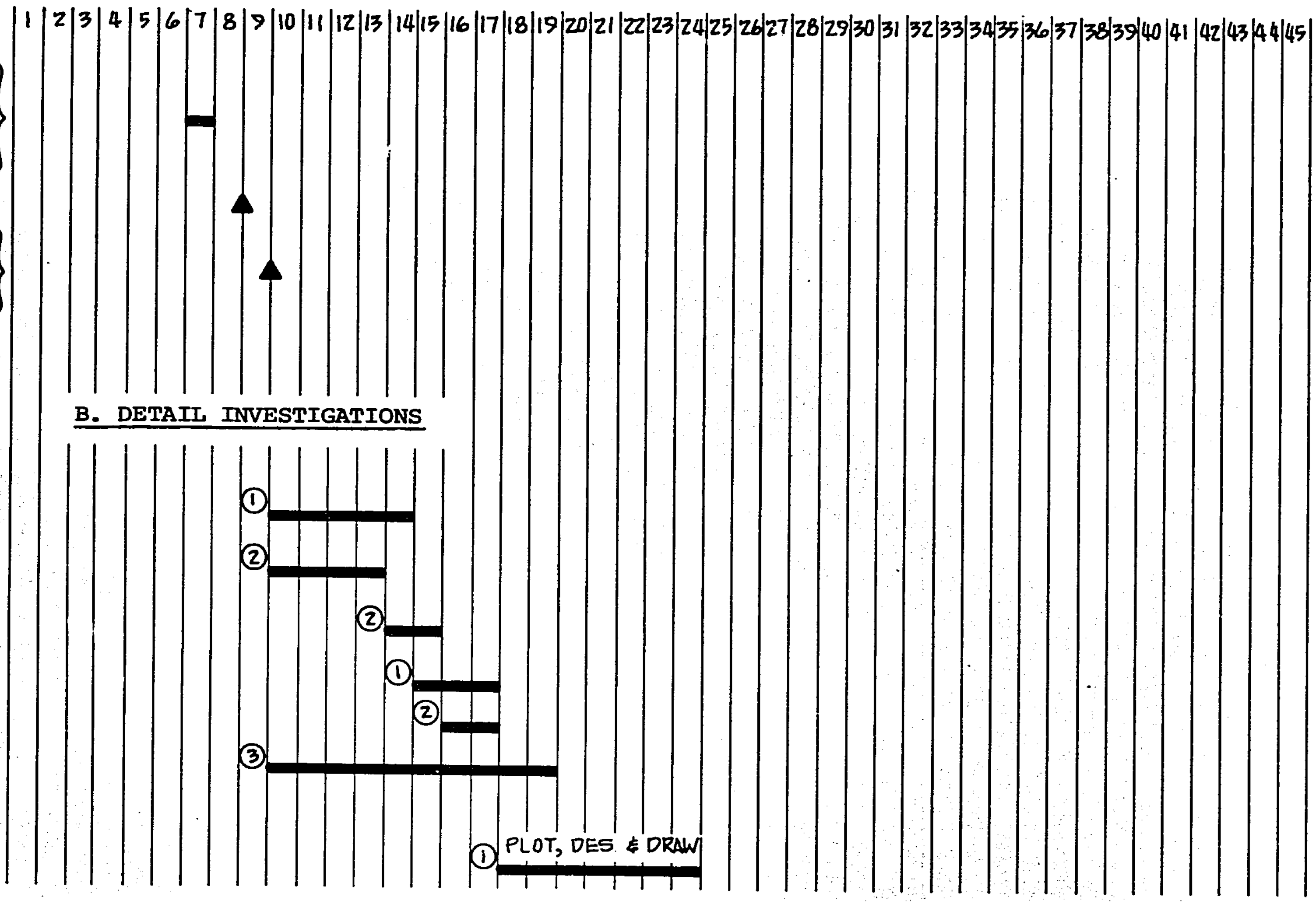


Time in Weeks

5. Formulation of proposals, preparation of costs and benefit/cost ratio
6. Submission of reports to CIE
7. Review by CIE and approval of detail investigations

B. DETAIL INVESTIGATIONS

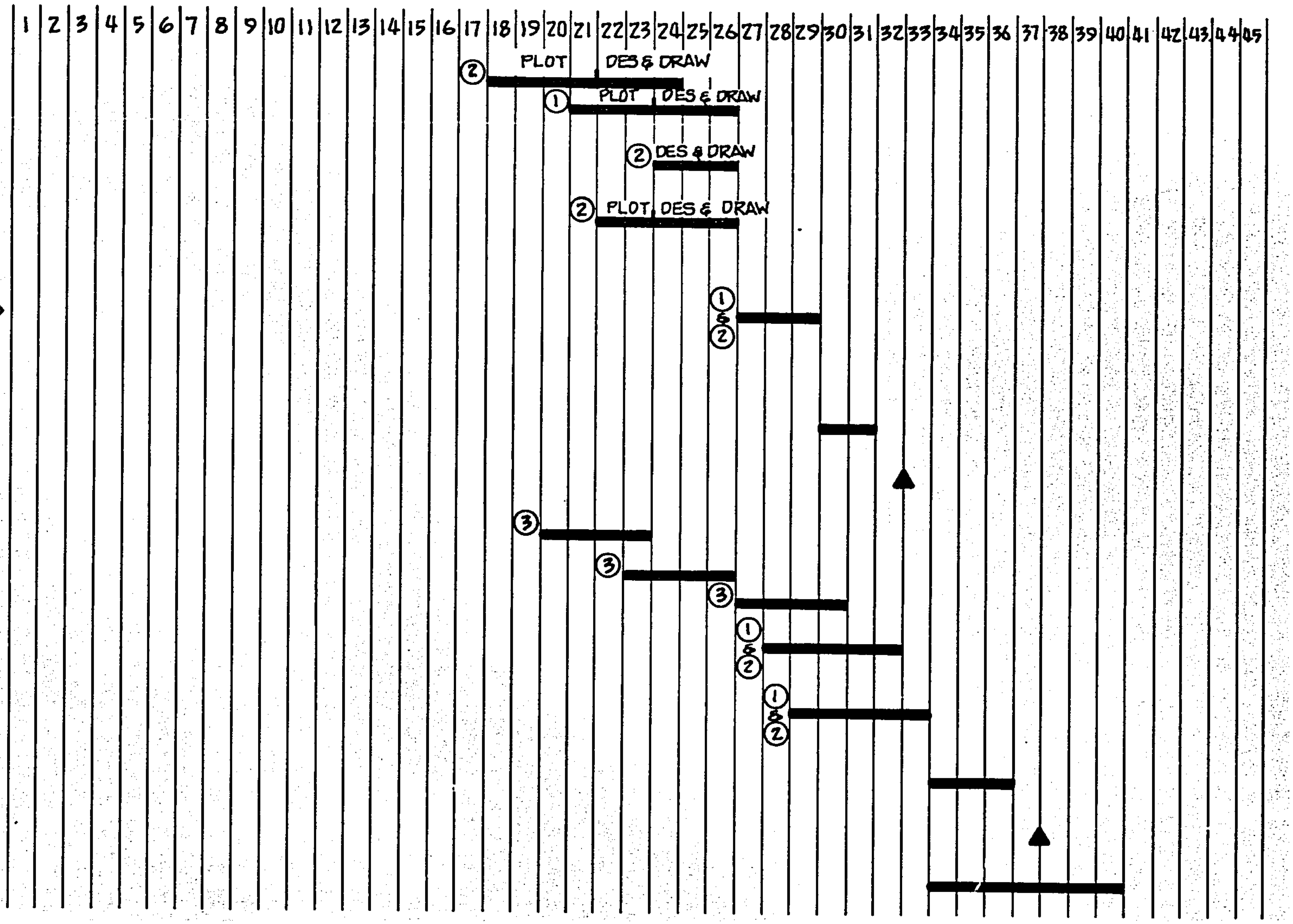
1. Site Surveys
   (i) Tank bed contours
   (ii) Bund traverse, L.S. and C.SS.
   (iii) Breach sites and Trial pits
   (iv) Spill sites and Trial pits
   (v) Acess road
2. Contour survey of service area
3. Designs and Drawings of HW:
   (i) General arrangement



Time in Weeks

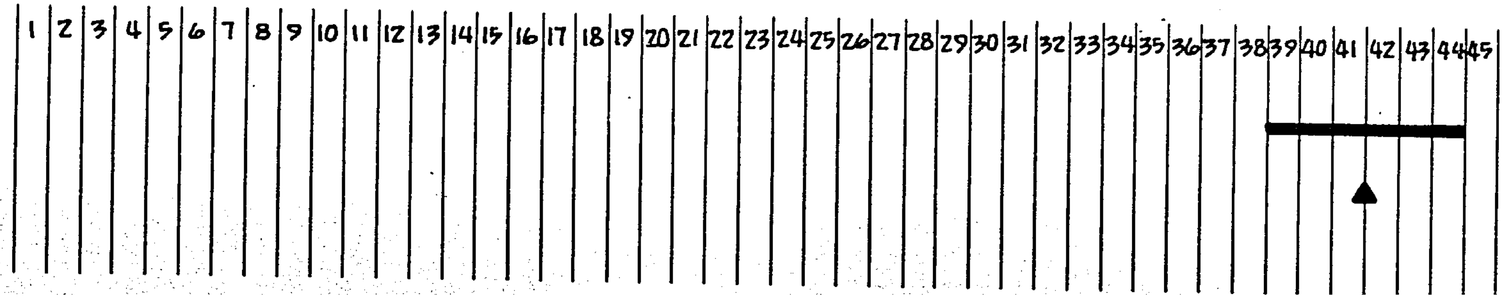
(ii) Bund
(iii) Spill
(iv) Sluices incorporating Type Plan
(v) Access Road

4. Computation of quantities and preparation and construction Est. for HW and pro-rata costing for irrigation and settlement.
5. Review and approval of Est. by CIE
6. Headworks ready for construction
7. Plotting of contour survey
8. Layout of canals
9. Survey of canals
10. Designs and Drawings of canals
11. Computation of quantities of const. est. for canals
12. Review and approval of Est. by CIE
13. Canals ready for construction
14. Blocking out of farms.



Time in Weeks

15. Blocking out of hamlets
16. Farms ready for staking out
17. Settlements ready for staking out



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Appendix Seven Table 7-A
Capital and Annual Costs, Communications, and Transportation Equipment
U.S. Dollars FIC, 1978 Prices

Item	Walawe Project (69,000 ac)				Gal Oya Project (110,000 ac)			
Capital Costs Communications Equipment	Quantity	Unit Cost	Subtotal	Total	Quantity	Unit Cost	Subtotal	Total
Base Station UHF-FM 50W with line and tower	1	2,000	2,000		1	2,000	2,000	
Repeater VHF FM 60W with line and tower	1	4,000	4,050		1	4,000	4,000	
Mobile Radio, Pickups, 50W	18	900	16,200		29	900	26,100	
Mobile Radio, Motorcycles 15W	28	1,350	37,800		46	1,350	62,100	
Portable Radio, 10W	5	1,670	8,350		8	1,670	13,360	
Portable Radio, 5W	5	800	4,000		8	800	6,400	
Insurance and Freight	--	L.S.	4,000			L.S.	5,000	
Spare Parts and Test Equipment			10,000				12,000	
Installation			20,000				24,000	
Total Communications Equipment				106,300				155,000
Transportation Equipment								
Motorcycles	28	1,200	33,600		46	1,200	55,200	
Bicycles	138	120	16,600		240	120	28,800	
Pickups	18	9,000	162,000		29	9,000	261,000	
Total Transportation Equipment				212,200				345,000
ANNUAL COSTS								
Grand Total Communications and Transportation Equipment				318,500				500,000
Annual Costs								
Communication				7,740				11,900
Transportation				51,960				84,600
				59,700				96,500

Appendix Seven Table 7-B
Capital Cost Breakdown
Tract 3, Project Right Bank

Item	Quantities		Unit Cost		Total (Rs.)	Cost (US$)
Maintenance and Rehabilitation, Tract 3	Distributor	Field Channel	Distributor	Field Channel		
Concrete Line D031610 System						
Place concrete lining	1.7 mi	2.9 mi	83,600 R/mi	92,240 R/mi	264,500	17,[illegible]00
Machine earthwork (shape distributor, redo field channel)	1.7 mi	2.9 mi	216,000 R/mi	180,600 R/mi	396,500	25,600
Hand Constructed Earth Lining D131500, D031800						
Excavation for lining placement	.5 mi	2.1 mi	64,000 R/mi	53,000 R/mi	143,000	9,200
Hand excavation and place compacted lining	.5 mi	2.1 mi	250,000 R/mi	211,000 R/mi	568,000	36,600
Machine Constructed Earth Lining D031610						
Machine excavation of ditch section	2.8 mi	3.5 mi	62,000 R/mi	51,500 R/mi	354,000	22,800
Machine excavation, placement, and compaction	2.8 mi	3.5 mi	220,000 R/mi	183,600 R/mi	1,258,000	81,200
Takeout Modification and Measurement	7 mi	57 mi	4,500 R/ea	3,000 R/ea	202,000	13,000
Regulator Modifications	20 mi	130 mi	4,500 R/ea	1,010	220,000	14,200
Farm Outlet Modification	--	260 mi		2,202/ea	57,000	3,700
Totals (for 668 ac)	5.1 mi	8.5 mi			3,463,000	223,400

Appendix Seven Table 7-C
Capital Cost Breakdown
Field Research--Walawe

	Unit Cost		Total Cost	
	Quantity	Rs.	Rs.	U.S. Dollars
Field Research Pipeline Project Left Bank (assumed 130 ac)				
Distributor--(assume .40 mi of 15" dia cone pipeline)				
Hand excavation and backfill	.4 mi	10,000	4,000	300
8-ft joints banded in place	.4 mi	325,000	130,000	8,400
Gated overflow structure w/field channel takeoff	11 ea	6,000	66,000	4,300
Headworks with meter	1 ea	13,000	13,000	800
Field Channel--(assume 1.6 mi of field channels)	72			
Hand excavation and backfill	1.6 mi	6,625	10,600	700
9" dia cone pipe w/8-ft joints banded in place	1.6 mi	178,000	285,000	18,400
Structures	52 ea	225	15,600	1,000
Total (for assumed 130 ac)			524,000	33,900
Field Research--Onfarm				
Tractor, diesel, 3 point hitch 35-50 hp	2 ea	126,100	252,200	16,300
Blade, rear mount, 3 point	2 ea	14,400	28,800	1,900
Ditcher, rear mount vee	1 ea	34,000	34,000	2,200
Vehicle, 4-wheel drive	1 ea	90,000	90,000	5,800
Ridger, 3 point	1 ea	15,000	15,000	1,000
Survey equipment	L.S.	12,000	12,000	800
Total			434,000	28,000
Total Field Research				62,000

Appendix Seven Table 7-D
Capital Cost Breakdown
Maintenance Equipment Unit
U.S. Dollars

Item	Quantity	Unit Cost	Total
Dump Truck (5 yd)	4	22,000	88,000
Loader & Trailer	1	59,000	59,000
Case 450 Dozer	1	42,000	50,000
Vibratory Roller	1	14,000	14,000
John Deere 570 Grader	1	69,000	69,000
Hand Co[illegible]tor GVR220Y	4	2,500	10,000
Jeep w/Radio	1	9,000	9,000
			291,000
Spare Parts (20% of total)			58,000
Total Cost			357,000

Appendix Seven Table 7-E
Capital Cost Breakdown
Maintenance and Shop Unit
U.S. Dollars

Item	Quantity	Unit Cost	Total
Lube/Fuel Truck	1	20,000	20,000
Shop Utility Truck 4-wheel drive	1	30,000	30,000
Portable Welder	1	5,000	5,000
Jeep w/Radio	1	9,000	9,000
Machine Tools		20,000	20,000
			84,000
Spare Parts (20% of total)			17,000
Total Cost			101,000

Appendix Seven Table 7-F
Capital Cost Breakdown
Excavating Unit
U.S. Dollars

Item	Quantity	Unit Cost	Total
1 cu yd Dragline*	1	115,000	115,000
Case 980B Backhoe	1	134,000	134,000
Rubber-Tired Backhoe/Loader	1	60,000	60,000
Lowboy Transport Truck	1	50,000	50,000
Jeep w/Radio	1	10,000	10,000
			369,000
Spare Parts (20% of total)			74,000
Total Cost			443,000

*Small dredge may be substituted based on preorder investigations

Appendix Seven Table 7-G
Salary Rates for GSL
1978

Position	Annual Salary Rs.	Cost U.S. Dollars
Branch Head, Chief Irrigation Eng	23,000	$1,550
Irrigation Engineer	20,000	1,350
Resident Engineer	16,000	1,100
Senior Technical Assistant	13,000	838
Assistant Engineer	11,000	750
Technical Assistant	9,000	580
Junior Technical Assistant	8,000	516
Surveyor	8,000	516
Draftsman	6,000	387
Irrigator, Overseer	4,500	290
Heavy Equipment Foreman	18,200	1,174
Heavy Equipment Operator	13,000	839
Assistant Equipment Operator	11,500	739
Truck Driver	6,300	405
Jeep Driver	5,700	369
Shop Foreman	13,000	839
Mechanic/Machinist/Welder	5,000	322

Appendix Seven Table 7-H
Annual Cost Estimate for Added Staff
Walawe Operations Department
(1978 Labor Rates)

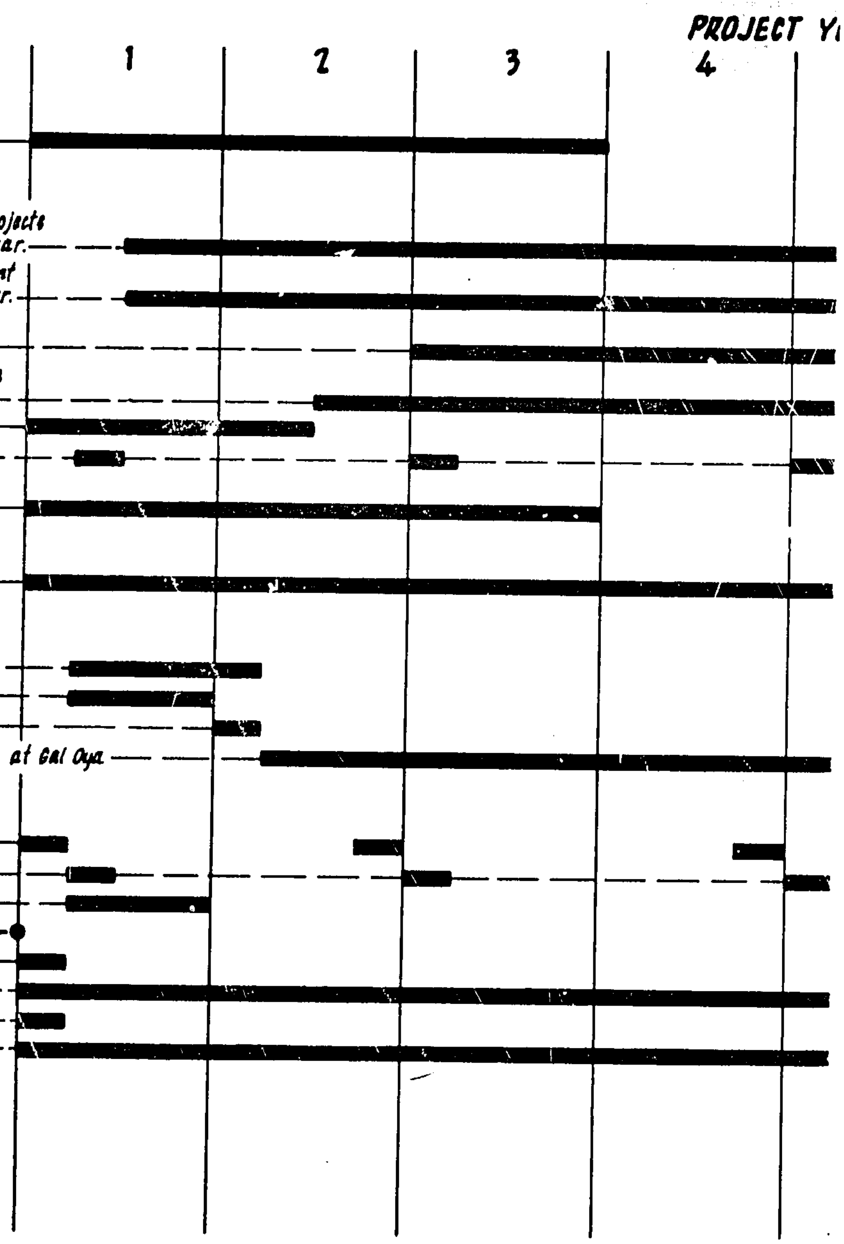
Operation	Unit Rs.	Total Rs.
1 Water Management Engineer, II	--	--
1 Operations Dept Mgr, III	23,400	23,400
1 Left Bank Water Master, V	13,000	13,000
1 Right Bank Water Master, V	13,000	13,000
1 Water Schedules and Records, V	13,000	13,000
	62,400	
12 Jeep Driver	4,800	58,000
2 Radio Maintenance	8,000	16,000
5 Radio Dispatcher, VI	8,000	40,000
Total Annual Cost Rs.		176,000
Equivalent Annual Cost U.S. Dollars 1978		$11,000

Appendix Seven Table 7-I
Annual Cost Estimate for Added Staff
Gal Oya Operations Department
(1978 Labor Rates)

Operation	Unit	Total Rs.
1 Water Management Engineer, II	27,300	27,300
1 Operations Dept Mgr 1 LB Water Master, V 1 RB Water Master, V 1 River Div Water Master, V	13,000	39,000
1 Water Schedules and Records, V	13,000	13,000
3 Water Sched. T.A., VI	10,400	31,000
21 Jeep Drivers	4,800	100,800
3 Radio Maintenance	8,000	24,000
5 Radio Dispatcher, VI	8,000	40,000
Total Annual Cost Rs.		275,000
Equivalent Annual Costs U.S. Dollars 1978		$18,000

SRI LANKA WATER MANAGEMENT PRO

PROJECT IMPLEMENTATION SCH



TRAINING

- EXPATRIATE - INSTRUCTOR - ADVISOR (2), One at Galgamuwa & one for WDT School at Hardy & Katubedde
- CONDUCT GALGAMUWA WATER MGT. TRAINING SCHOOL COURSES:
  - Course One for Irrigation Engineers & Sr. Tech. Assistants currently or about to be assigned w/ Walawe & Galoya projects having 1st priority. 15 persons - 4 weeks - once per year.
  - Course Two for technical assistants w/ water management responsibilities. 40 persons - 12 weeks - Twice per year.
  - Course Three for newly-recruited technical assistants. 40 persons - 12 weeks - Once per year.
  - Course Four for 2nd year WDT Hardy & Katubedde students 40 persons - 1 week - four per year.
- GALGAMUWA FACILITIES IMPROVEMENT & EQUIP. PROCUREMENT
- GALGAMUWA INSTRUCTORS OVERSEAS TRAINING (3)
- EQUIPMENT & BUILDING IMPROVEMENTS @ HARDY & KATUBEDDE FOR WDT COURSE (Civil Engineering)
- INSTRUCTOR TRAINING & STAFFING IN WATER MANAGEMENT, One at Hardy & one at Katubedde for WDT course (Civil Engineering)

EXTENSION

- EXTENSION SPECIALISTS OVERSEAS TRAINING (2)
- PRODUCE ON-FARM WATER MANAGEMENT MOVIE
- TRAINING AID PROCUREMENT
- EQUIP & STAFF 2 EXTENSION SPECIALISTS, One at Walawe & one at Gal Oya

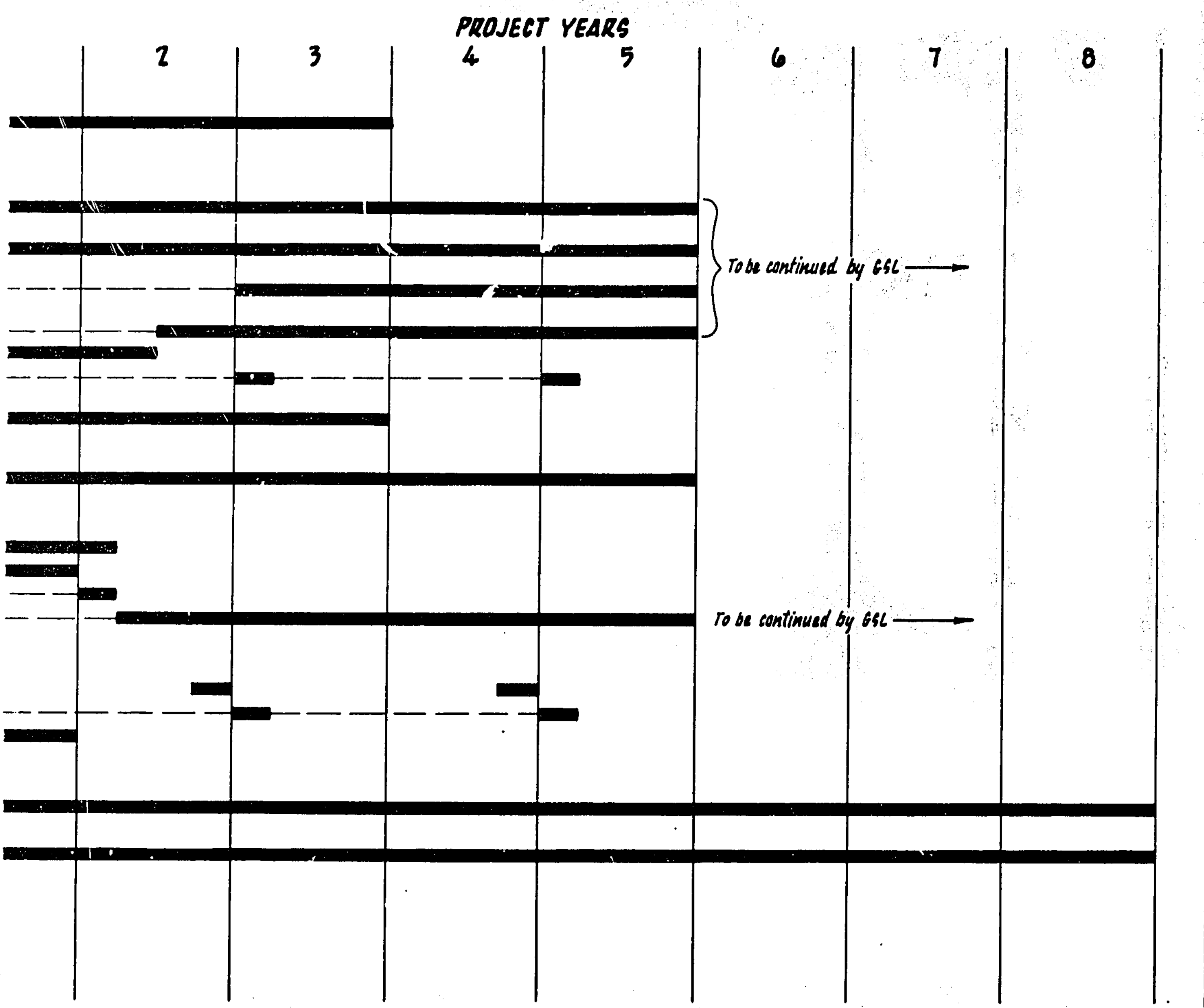
CENTRAL SUPPORT

- OVERSEAS TRAINING RECRUITMENT
- OVERSEAS TRAINING (3)
- WATER MANAGEMENT LABORATORY & FIELD TESTING EQUIPMENT
- U.S. AID - GSL PROGRAM APPROVALS & FUNDING ------Start
- GSL STAFF ASSIGNMENTS FOR ALL PROGRAM ELEMENTS
- PROGRAM DIRECTION, COORDINATION, & TECHNICAL (GSL)
- U.S. AID ADVISOR STAFF ASSIGNMENTS
- PROGRAM FACILITATION & ASSISTANCE

(CONTINUED NEXT SHEET)

LANKA WATER MANAGEMENT PROGRAM

CT IMPLEMENTATION SCHEDULE



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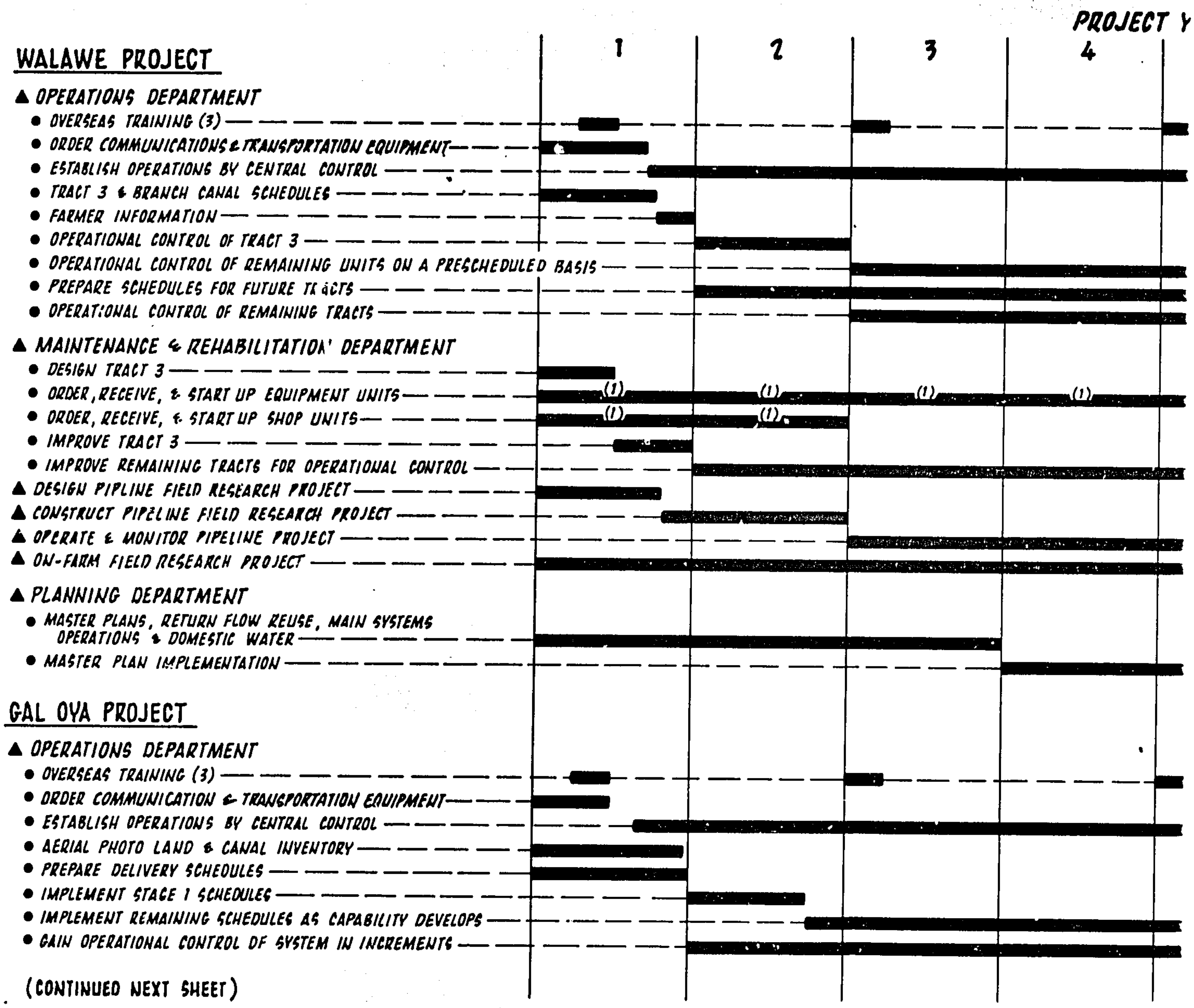
IMPLEMENTATION SCHEDULE (1)

CH2M HILL

FIGURE 8-3

SRI LANKA WATER MANAGEMENT PRC

PROJECT IMPLEMENTATION SCH



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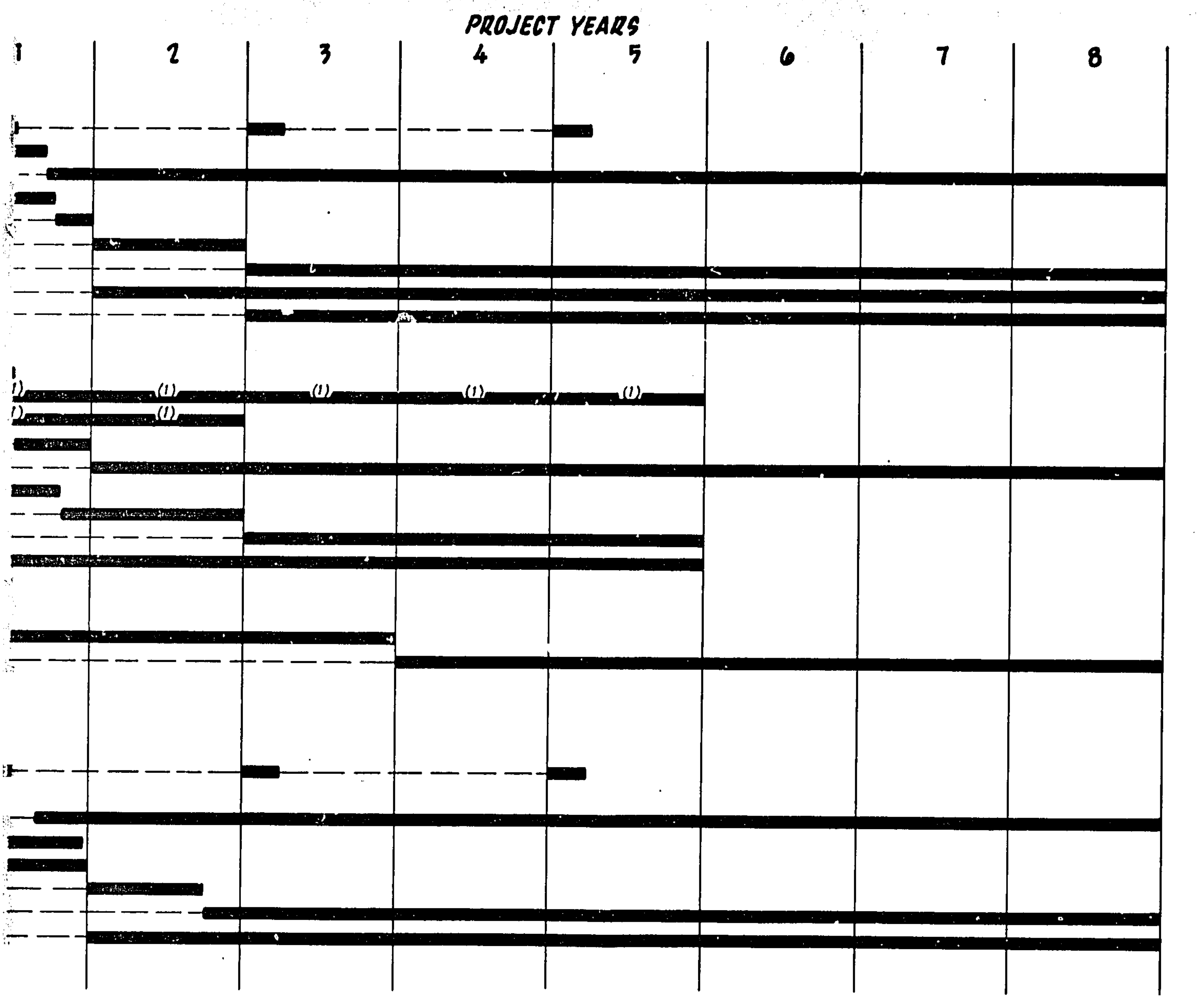
LANKA WATER MANAGEMENT PROGRAM

CT IMPLEMENTATION SCHEDULE (Con't.)



IMPLEMENTATION SCHEDULE (2)

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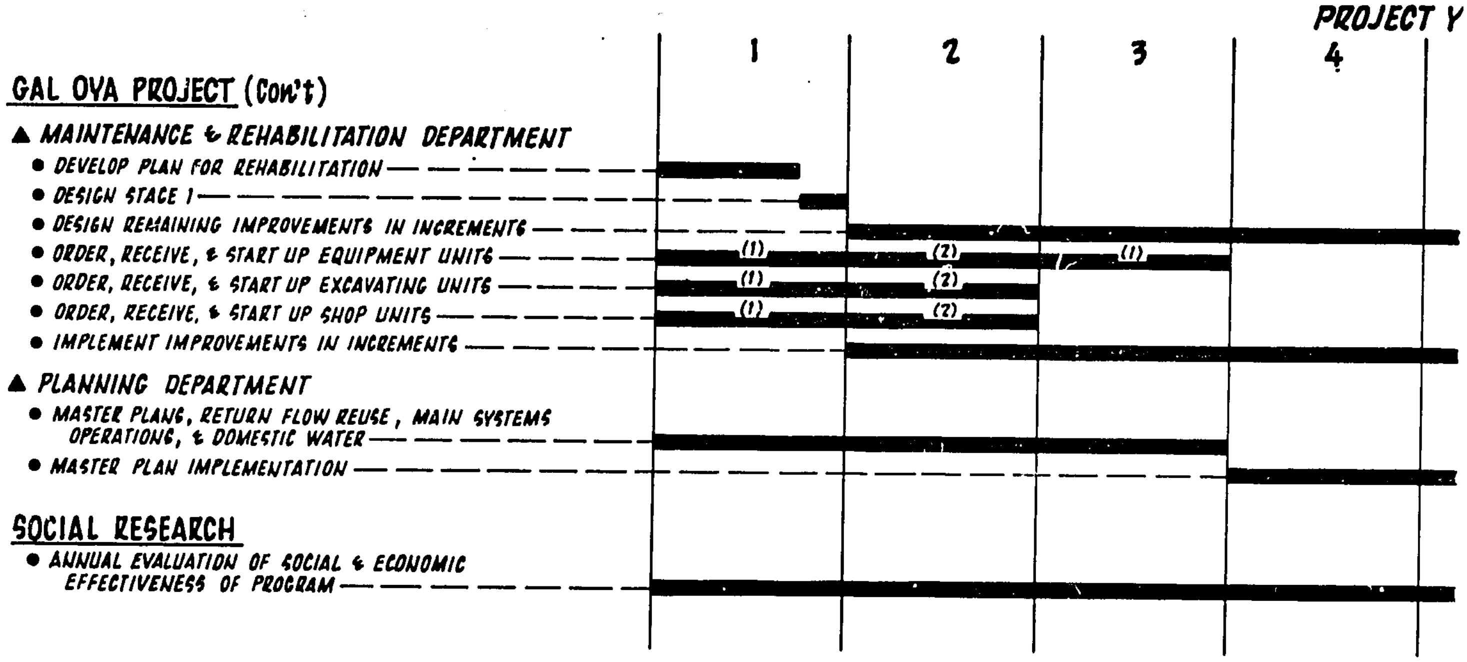
FIGURE 8-3

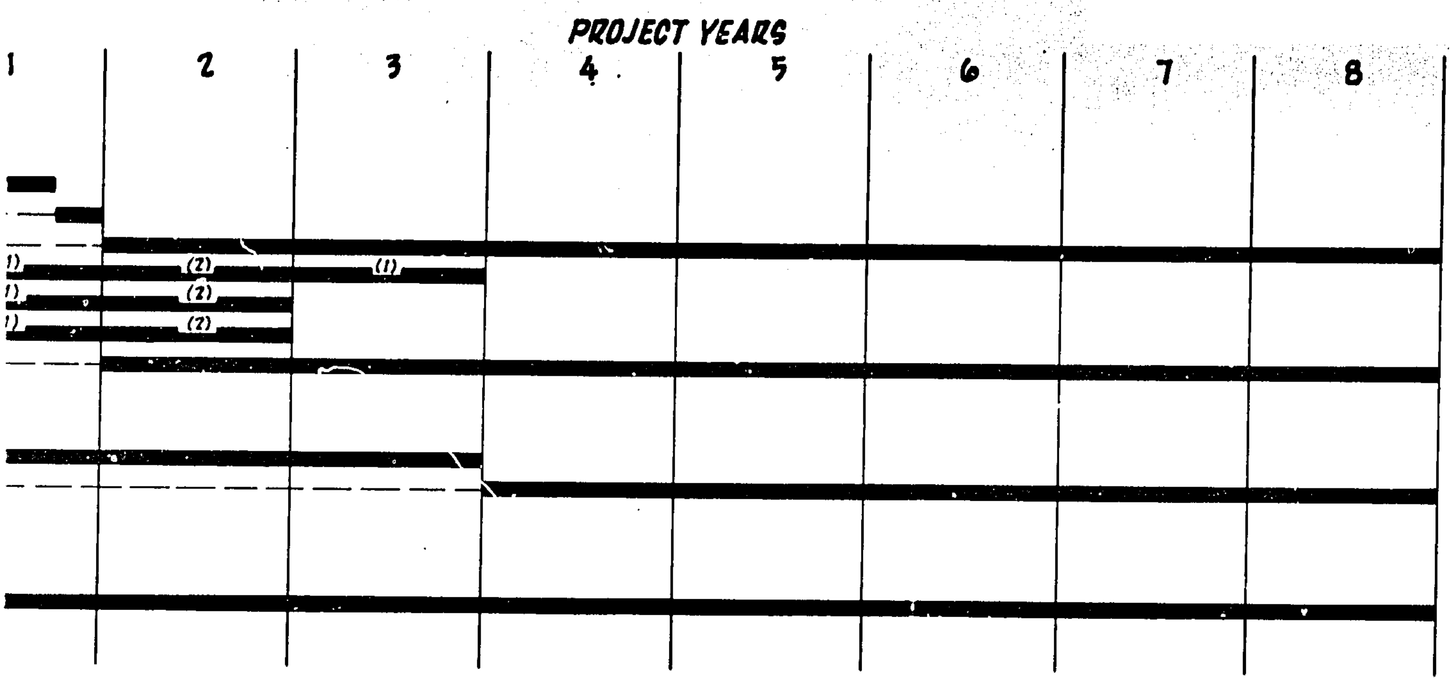
SRI LANKA WATER MANAGEMENT PRC

PROJECT IMPLEMENTATION SCH



LANKA WATER MANAGEMENT PROGRAM

CT IMPLEMENTATION SCHEDULE (Con't.)



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IMPLEMENTATION SCHEDULE (3)

FIGURE 8-3