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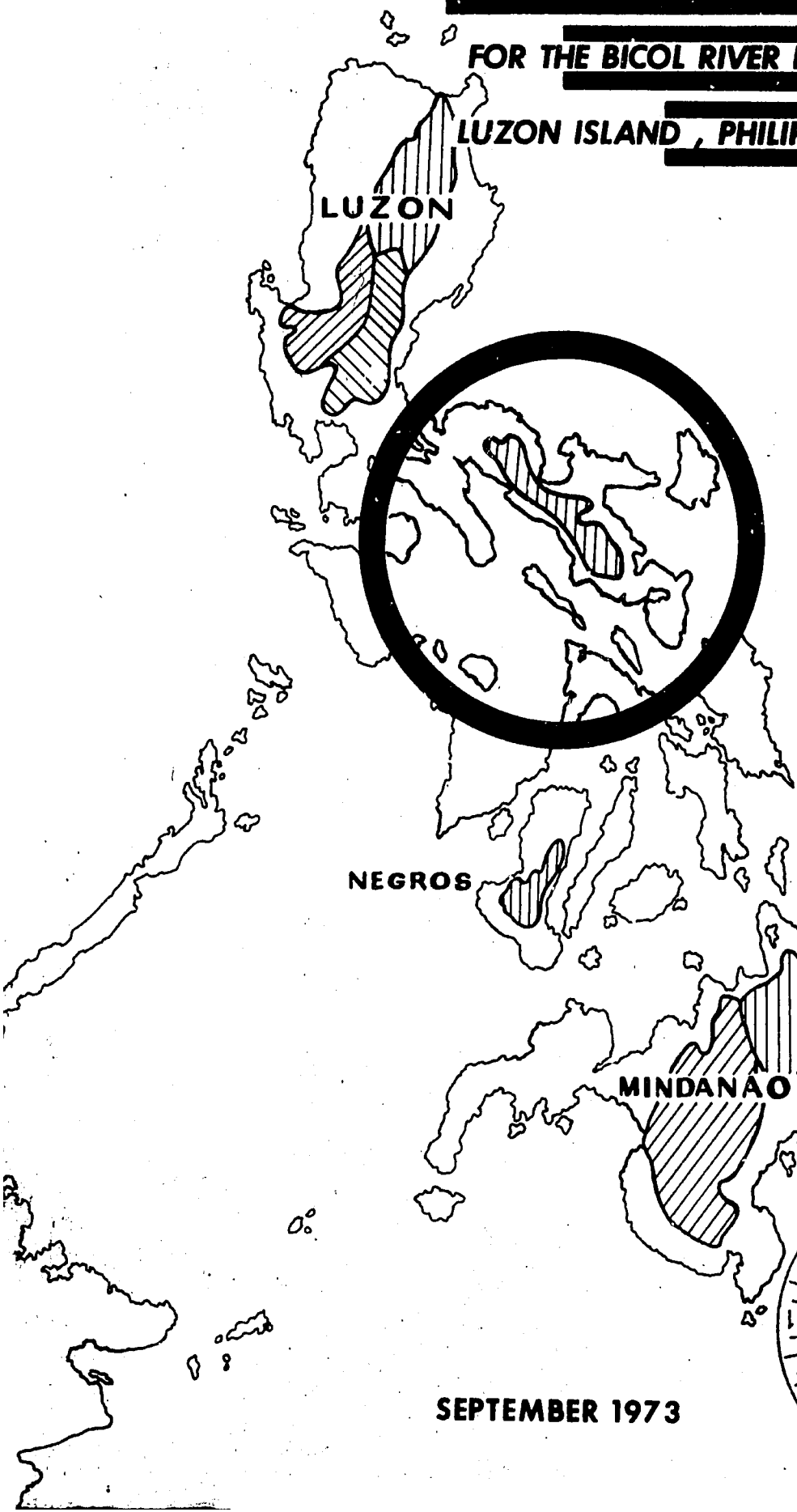

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WATER MANAGEMENT TEAM REPORT

for the

BICOL RIVER BASIN, LUZON ISLAND, PHILIPPINES

Prepared by

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CUSUSWASH STUDY TEAM

For the

U.S. AGENCY FOR INTERNATIONAL DEVELOPMENT/PHILIPPINES

September 1973

September 21, 1973

Dr. Frank W. Sheppard, Jr.
Assistant Director for Agricultural Development
U.S. Agency for International Development/Phil.
APO San Francisco 96528

Dear Dr. Sheppard:

Pursuant to the provisions of the Task Order, dated August 24, 1973, between the U.S. Agency for International Development and CUSUSWASH to provide a three-man water management team to work with the Bicol River Basin Council staff in the selection and development of three irrigation pilot project areas as a component of the Bicol River Program, we are transmitting this draft report to you for your review.

We will be happy to consider any suggested changes or additions in the report that you and your staff may present.

Sincerely yours,

Sol D. Resnick

Sol D. Resnick, Team Leader
Water Resources Engineer
University of Arizona

Willard Schmehl

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SUMMARY

A three-man CUSUSWASH Water Management Consulting Team was requested by USAID/Manila to study the on-farm water management problems in the Philippines and more specifically in the Bicol River Basin, to recommend three pilot areas in the Basin for water management demonstration and training and to develop the technical requirements and job descriptions of the personnel needed for the project.

After visiting irrigation systems in the Bicol River Basin and at Angat, the consultant team concluded that improved on-farm water management practices are badly needed. NFAC has estimated that if good on-farm water management practices were included in the present technology package for rice, yields would be increased 30 to 50%.

To assist in building the development and training programs required to bring about good water management practices, an interdisciplinary group including the consulting team selected the following irrigation systems in the Bicol River Basin for pilot projects: 1) National Irrigation Association Barit River Irrigation System, 2) Malogon Communal Irrigation System and 3) the Ombao Pump Irrigation System.

The Consulting Team recommended a 4-man Advisory Team be assigned to the on-farm water management project, the team consisting of: 1) an Irrigation Engineer, 2) an Agricultural Extension Specialist, 3) an Irrigation Agronomist and 4) an Agricultural Economist.

The Advisory Team should be directly involved in all aspects of training and demonstration programs of the Pilot Projects and in the Bicol River Basin and with the extension of the on-farm water management program to the entire nation. The Advisory Team also should be made available for advisory services to all national agencies concerned with irrigated agriculture.

CHAPTER I

INTRODUCTION

A statement of the assignment for the CUSUSWASH Water Management Team from AID/Washington, and acknowledgement of the excellent cooperation and assistance received during the assignment are presented below.

Statement of Assignment

The team should study the ADB pilot project results, the particular problems of the Bicol River Development Project, and develop the most feasible plan for water management training. research and other activities set forth in the PROP. The team would also develop the technical requirements and job descriptions for the personnel needed over the life of the project.

In developing the plan for the pilot projects for demonstration and training, the team should give consideration to the potentials and limitations of the physical system of the Bicol River area including the watershed producing the water supply, the proposed dams and reservoirs, the delivery system, the disposal system (drainage), the terminal laterals including the farm turnouts and measuring structure and the on-farm water application system. The team could also give some guidance regarding the research to determine the crop water requirements and water deliveries using different methods of delivery or various scheduling procedures.

The institutional aspect of water management will also be an important item of concern for the team. The role of the farmer organizations, the compact farms and the NIA will have to be spelled out so that all will understand how the system is to work and the joint responsibilities involved to insure utilization of the water in the most efficient manner.

It is expected that the team's guidance regarding the many considerations involved in on-farm water management will assist in selecting personnel for the long-term assignments in developing the project. However, modifications in plans are certain to be needed as research data and operation experience produce new information on which to base decisions.

Cooperation and Acknowledgements

Pursuant to the provisions of the Task Order, the water management team was responsible to Dr. Frank W. Sheppard, Jr., Assistant Director for Agricultural Development, USAID/Philippines.

Technical assistance and data were received from the following agencies of the Government of the Philippines:

Office of the President

National Irrigation Administration
National Economic and Development Authority
Philippine Council for Agricultural Research

Department of Public Works, Transportation and Communications

Bureau of Public Works

Department of Commerce and Industry

Weather Bureau

Department of Agriculture and Natural Resources

Bureau of Soils
Bureau of Plant Industry

Department of Agrarian Reform

Department of Local Government and Community Development

Bureau of Cooperatives

Educational Institutions

University of the Philippines, Los Banos

International Institutions

International Rice Research Institute, Los Banos

We are especially grateful for the assistance and cooperation given by Atty. Oscar Ravanera, Executive Director, and of course, for the considerable time and effort kindly given by Engr. Crisanto Gimpaya, Deputy Director for Programs, Bicol River Basin Council.

Greatly appreciated was the advice given in his absence by the staff of Mr. Felix Alfelor, Sr., Provincial Governor of Camarines Sur.

Lastly, from among the many helpful persons, we wish to especially thank for their interest and assistance: Engr. Sebastian Julian; Regional DAR Representative Salvador Pejo; Provincial Agriculturist Nicanor S. Clasio; the NIA-UNDP/FAO Groundwater Development Project staff; and the USAID/Philippines Agricultural Development staff and secretaries, and the Capital Development Assistant Director William C. Larson and staff.

CHAPTER II

GENERAL

From Pastir (1970), "The Bicol River Basin, see Figures 1 and 2, covers an area of about 312,000 hectares approximately 130 kilometers long with a maximum width of about 35 kilometers. It extends in a northwest-southeast direction bordered on the east by a chain of volcanoes and on the west by highlands and low hills. In the center lies a flat elongated flood plain of some 65,000 hectares. About 80 percent of the Basin area is said to be cultivated with the remaining 20 percent being forest and open lands.

The climate of the Basin is characterized by generally uniform temperatures averaging about 27°C, an average relative humidity of 85 percent and a mean annual rainfall of about 260 centimeters. The Basin is exposed to the northeast monsoon during the months of November through February and to the southwest monsoon which generally begins in June. An average of about two tropical cyclones pass through the basin annually. Although generally some rain falls in each month of the year, about 70 percent occurs in the July through December period.

The Basin is drained by two main river systems, the Bicol and the Sipocot, which join together about seven kilometers before discharging into San Miguel Bay. The Sipocot drainage, on the north, covers about 20 percent of the Basin area but provides about 35 to 40 percent of the Basin runoff. The Bicol arm of the Basin has about 73 percent of the area and 55 to 60 percent of the flow, while the estuary lands make up about 7 percent of the area and produce about 5 percent of the flow. About 75 percent of the Basin runoff occurs in the six-month period August through January. The average annual natural runoff of the Basin has been estimated to be about 5,500 million cubic meters. Recent additional data suggest that the estimate may be too high."

Other resources in the Bicol Basin, such as soils and crops, are discussed and referenced as needed within the context of the report. Because of lack of time and because they are described in the numerous reports listed in Annex I, still other resources and data, such as groundwater and well logs, are not discussed further.

CHAPTER III

REGIONAL WATER MANAGEMENT PROBLEMS

As discussed in the Pastir Report (1973), some of the water resource problems in the Bicol River Basin concern river flooding, sea water intrusion, and an inadequate irrigation water supply. To this list with regard to water management problems should be added: The lack of on-farm drainage facilities for irrigated lands; and the failure to use an interdisciplinary approach in the solution of these problems.

River Flooding

About 42,000 hectares are said to be subject to annual flooding, while in 1956 about 56,000 hectares of the Bicol River Basin's 312,000 hectares were under water. Hence, most of the best agricultural lands, which are in the flood plain, cannot be fully developed for improved irrigated agriculture.

Sea Water Intrusion

Pastir (1973) states: "In recent years, the brackish waters, of mixed sea and fresh water, have been reported to be intruding up the Bicol River as far as Minalabac, some 40 kilometers inland, during the low flow seasons. This growing intrusion is believed to result from the increasing river diversions upstream and the shortening of the downstream channel brought about by construction of cut-off channels #1 and #2." Moreover, the river bed elevation is below mean sea level for more than 60 kilometers upstream, and below high tide level up to Lake Bato. This limits further surface water diversions and increased pumping for irrigated agriculture from the Bicol River and its tributaries since it would induce greater sea water intrusion. Further, development of the groundwater for irrigated agriculture would become hazardous because of possible sea water intrusion into the groundwater aquifiers.

Inadequate Irrigation Water Supply

There is an inadequate irrigation water supply in the Bicol River Basin during the periods of lighter rainfall, which usually occurs within the months of February to June, for about one-third of the estimated 25,000 hectares being serviced out of the 100,000 hectares estimated to be suitable for irrigation. This is true for the most part for the following reasons:

1. The lack of flood water storage facilities.

2. Sea water intrusion which limits the amount of diversion and pumping from the rivers, and the development of groundwater for irrigated agriculture.

3. The irregular distribution of rainfall over the year.

4. Poor water management practices in the existing irrigation systems.

Lack of On-Farm Drainage Facilities

Apparently on-farm drainage facilities are not even being considered in the design of an irrigation system. Rice in lower lying fields in many cases cannot survive because of complete submergence in water due to the lack of these drainage facilities.

Lack of Interdisciplinary Approach in Solution of Problems

The trained-experienced personnel, in the areas of engineering, agronomy, soils, extension-training, geology, economics, and sociology, who are available to the Bicol River Basin are not being used as an interdisciplinary group in the solution of the above regional water resource problems. These problems are so complex that no one discipline, even if very well trained and experienced, can possibly come up with the correct solution by themselves.

CHAPTER IV

IMMEDIATE DEVELOPMENT

While a long-range program is required to completely resolve the regional water management problems and develop the water resources in a thorough manner, marked improvement is possible in the next several years with regard to improved crop yields and increased amount of irrigated areas by means of good water management practices, which include development of on-farm drainage facilities, and the use of an interdisciplinary approach to solve these water management problems.

The major emphasis in this report is with regard to developing good water management practices. The following definition of "water management" from the East-West Center Report (1973) is provided as a frame of reference for the discussions that follow:

> "Water management is the integrated process of intake, conveyance, regulation, measurement, distribution, application, and the use of irrigation water to farms, and removal of excess water from farms, in proper amounts and at the right time, for the purpose of securing maximum return from the land and water economy."
>
> Further, from the Report, "This definition indicates that 'water management' means a lot more than mere provision of adequate water to the farm, and also that it means a great deal beyond the technical engineering aspects alone. The agronomic, economic and social aspects are as important as the engineering aspects and they all link up with each other in a larger context or goal which may be termed 'agricultural development.' Reference to water management henceforth is in this broader meaning of the term."

Bench mark studies are under way for the Bicol River Basin and are being recommended in detail for the three selected pilot project areas by independent and government agencies. This is being done so as to establish a baseline from which to gauge the amount of social and economic development made possible by the Bicol River Basin Program.

Water Management

Water management is discussed below with regard to soils and crops, the on-farm distribution systems, the delivery system, and organizational aspects.

For the sake of clarity and to insure cohesiveness in terminology, each of the elements of an irrigation system will be discussed with regard to its role in water management.

Soils and Crops

Water management, as defined above, includes many facets. The ultimate goal of effective water management in the Philippines is to maximize both food production and economic returns with the supplies of irrigation water that are available for a given system. Crop production is maximized by supplying the farmer with the information needed to integrate the various inputs most effectively. Some of the soil and crop factors significant to on-farm water management in the Bicol Basin are reviewed.

Soils of the Irrigated Bicol Basin. The Pili soils (loam, clay loam, and clay soil types) predominate in the basin (Lucas, 1965). These soils are dark brown to black with two to four percent organic matter, and were formed from older alluvial deposits. They are found, largely, in the flood plain of the Bicol River and are subject to frequent flooding, and drainage both surface and internal, is poor. The clay and clay loam soils can be puddled effectively and are good soils for lowland rice production. The loam-

textured soils are more suitable for upland crops but they also are cropped extensively to lowland rice. The Pili soils are medium to low fertility, and when cropped to lowland rice give good yield responses to nitrogen fertilizer. There is some response to application of phosphate fertilizer but generally no response to potash. Because of their topographical position these soils are subject to flooding during major storms and have surface drainage problems after flooding.

Another soil of the upper irrigated basin, but of lesser importance, is the Macolod-Pili complex (Lucas, 1965), which occurs between Lake Buhi and Lake Bato along the Camarines Sur-Albay provincial boundary. The Macolod soils are light textured soils of the rolling to hilly topography and the Pili soils are found in the level areas and valleys. Rice is grown on the Pili soils of the complex.

The Bolongay clay occurs in the lower basin along San Miguel Bay. Also, the lower Bicol near the mouth of the river are tidal influenced marshy soils called hydrosols (Lucas, 1965). These soils have poor surface drainage and are under water much of the time.

Irrigated Crops in the Bicol. Because of greater economic returns as well as adaptability to the soils, rice is essentially the only crop grown on the irrigated land. When water is available, 2 to 2½ crops per year maybe grown. Corn and other food and feed crops are grown on adjacent upland soils. Yields of upland crops are poor because of the lack of high yielding varieties and poor management practices. Corn could be grown during the dry season on the irrigated land not cropped to rice when irrigation water is unavailable. It usually is not grown, however, because farmers would rather keep the land uncropped and plant rice when water does become available. It should be noted also that considerable work is required to prepare a seed-bed suitable for corn or another upland crop after paddy rice. Even with good seedbed preparation, yields of upland crops will be low unless HYV and other good management practices are followed. Research is needed to determine the feasibility of paddy rice-upland crop rotations.

Water Requirement of Rice. The water requirement of rice is the sum of E-T (evapo-transpiration or consumptive use) and soil percolation. E-T will depend upon seasonal climatic factors, such as temperature, relative himidity and wind, as well as upon the leaf area of the plant. It will be greater in the dry season and will increase with advance in stage of growth.

The contribution of soil percolation to water requirement will depend upon soil texture, pressure or lack of water table, and the effectiveness of the soil puddling. Percolation will be greater for lighter textured soils and where the water table is at a considerable depth. Soil puddling reduces the permeability to water and consequently reduces percolation. Effective puddling becomes a more significant operation during the dry season and especially on lighter textured soils.

The water requirement for rice has been determined for the San Manuel silt loam (the Cagaycay River Irrigation System) near San Jose. It was 8.6 mm per day for the November-January period (average for 2 years) and 10.5 mm for March to May (one season only). Because of climatic and soil differences between San Jose and the Bicol Basin, the water requirement should be determined for representative soils in the Basin.

Climate in the Bicol in Relation to Rice Production.

There is less than 150 mm rainfall per month in Naga City for the five months period January through May and greater than 250 mm from July through December except for August (Annex 1, World Bank Report, 1973). When rice is grown during the relatively dry season, irrigation is required and is supplied only 60 to 80% of the area served during the wet season. Since water is limited at this time of year greater emphasis needs to be placed on more efficient use of the available supply.

Rice yields during the dry season are higher than during the wet season. On the basis of measurements taken at the Bicol Rice and Corn Experiment Station at Pili, the 2-year average hours of sunshine is 7.2 during the dry season and 5.9 during the wet season. Research at IRRI has shown that rice yields are highly correlated with the amount of sunshine during the 30 days prior to harvest, and plant growth throughout the crop season is greater with more sunshine. Moreover, the wet season is a high risk period because of the greater possibility of typhoons and also because of more frequent flooding, both from local runoff and from excessive river flows.

Climate has a close relationship to the operation of an effective irrigation distribution system. Water needs to be used more efficiently on the farm during the dry season so as to attain the maximum possible hectarage of rice when yields are highest. During the wet season, the distribution system must provide water when needed but must also be designed to remove excess water from locally flooded fields.

Intensive Technology Package for Rice Production. The agronomic technology package for intensive cropping of rice under irrigation includes the use of improved varieties (HYV), fertilization, weed, insect and disease control, and good water management. There has been considerable emphasis since the introduction of HYV on fertilizer and pest control inputs but the importance of water control as an input has lagged. NFAC (Annex 6, World Bank Report, 1973) estimates that at the current level of rice production, additional inputs of improved seed, fertilizer, and pest control practices when combined could increase rice production from 35 to 45%, but improved water management as a single input could increase production approximately an equal amount, 30 to 50%.

Most of the essential information needed to assemble the intensive technology package for increasing production is available for all inputs except possibly for water. Although much is known about water management on the farm, additional research is required and an extensive education program in water

management is required. Improvements in water management for irrigated rice can give the farmer an improved technology package that has the potential to raise rice production to a new and higher level.

Farmers of the Bicol Basin are receptive to the new improved technology. It has been estimated that the use of HYV is higher in the Bicol Basin than in any other region of the Philippines (CSIS Team Report, 1972). The progressiveness of the farmers, as shown by their extensive use of HYV plus their interest and their favorable reaction to discussions on the use of water, suggest that farmer training programs in on-farm water management in the Bicol probably would be successful.

On-Farm Distribution System

The lowest level for water management is at the farm. It is here that the user must integrate his water input with all of his other inputs for productive farming. This level of water management is therefore the most important because all else is futile if the management fails at this level.

The farm distribution must be capable of delivering to each field or paddy, the correct amount of water at the time it is needed. Delivery schemes vary depending on local conditions of water supply, crops and the capacity of the physical system. The most common method in the Philippines is a continuous flow system wherein water runs continuously from the system onto the land. A continuous system requires small streams at each farm if excessive run-off is to be prevented. The total system must, however, be large enough to carry the continuous flow to all parts of the field. Continuous flow is well adapted to lowland rice production but good management is necessary to spread available supplies over the entire system, especially in the dry season.

Another delivery method frequently used is referred to as a rotational method. Various rotational schemes have been described, (NIA, 1970), but all variations have one thing in common, water is delivered to the land on an intermittent basis. The principal advantages of such a system, from a management point of view, are: (1) Larger quantities can be delivered to each turnout and hence provide a more rapid coverage of the area it serves; and (2) Short water supplies can be equitably distributed over a larger area.

Both continuous and rotational systems can be effectively used and good use made of available supplies, if adequate water control is provided within the system. Control is the key to good management. Water users can understand all of the principles of good water management, know how to apply those principles and be willing to apply them, but they cannot apply them unless they can control the water, unless they can put the quantities of water they need where they need them when they need them. Such control requires adequate means of water measurement, a sufficient number of well constructed and maintained structures to control the ditch grade and hence water velocities and heights, a method of catching runoff and re-using it on other areas where feasible, and a sufficient length of farm ditches to get the water to the fields as needed.

In tropical regions such as the Philippines, a good surface drainage system is equally important as a good irrigation system for good water management. In many areas, the quantity of water that must be drained during the rainy season is at least as great, if not greater than the total annual water requirement which the irrigation system must provide. Hence, adequate physical systems must be built to get the water off.

Adequate irrigation and drainage systems with their appropriate control structures, provide the opportunity for efficient use of water. Many definitions of irrigation efficiency exist, i.e. Hagen, et. al. (1967). The gist of all such definitions is that

efficiency is the ratio of the amount of water delivered or used at some downstream point in the system to the amount of water admitted at some upstream point. For example, the ratio of water actually needed on a particular paddy to the amount actually delivered to the paddy. Hence, it is a measure of the water beneficially used or, conversely, wasted. Efficient use of water requires good management.

Another facet of good water management is proper operation and maintenance. Unless a distribution system is well maintained and operated according to the design, it cannot deliver the water needed as it is designed to do.

As a result of visits to various irrigation project in the Bicol Basin and other areas of Luzon, a few general problems bear comment.

Very few farm ditches exist. This makes the water control necessary for good management difficult if not impossible. On existing ditches there is little control beyond the headgate at the beginning of the ditch, which further limits management.

The predominant delivery is by continuous flow and water is delivered to most paddies from the next paddy above. This paddy to paddy delivery imposes several problems. The user who is closest to the ditch always gets all the water he needs, and more, as long as water is available in the ditch. Once the water leaves his paddy, he is no longer concerned with where it goes, or how much goes off. It is difficult for the last farmer in the chain to convince the first farmer to cut back the discharge to prevent runoff, hence, inefficient use from excessive runoff

Paddy to paddy distribution imposes a mono-culture on the area being served. If a farmer in the middle of the paddy chain decided to grow corn, he could not. The water coming from the rice paddy above would drown out his corn and he in turn would dry up the rice paddy of the farm below. Hence it is merely an academic exercise to speak of alternating paddy rice with upland crops unless the on-farm distribution system permits water delivery to individual paddies.

Not only does paddy to paddy water distribution impose a mono-culture on a given area, it also imposes, to a more or less extent, uniformity among farmers with regard to harvesting and planting. It is impossible for a farmer to dry up his paddy for harvesting if the farmers above and below him are using water.

Very little attention, if any, is being given to adequate surface drainage. Windshield surveys of the Bicol Basin have produced many examples of flooded rice paddies. The system now existing for moving water is designed to move small quantities of water during the dry season through small cuts in the paddy dikes. These cuts are univers lly uncontrolled and hence cannot be manipulated to meet the heavy demands imposed in the rainy season. The result is drowned-out rice.

Delivery System

The next level of water management in the irrigation system is the delivery system. The sole purpose of the delivery system is to divert adequate amounts of water from the water source and deliver it to where it is needed. As is the case with on-farm distribution systems, adequate control is the key to good management. The system must provide for adequate control of water quantity, seepage losses in the canal, water lost through spillage, and the water delivered. The control structures needed to accomplish this include:

1. Inlet Works

    a. Diversion dams
    b. Head gates

2. Canals

    a. Unlined
    b. Earth lined
    c. Concrete lined
    d. Pipelines
    e. Siphons
    f. Flumes

3. Regulatory

   a. Measuring devices

      i. Weirs
      ii. Flumes
      iii. Rated sections
      iv. Constant head orifices
      v. Current meters

   b. Turnouts

   c. Checks

   d. Drops

4. Protection

   a. Trash racks
   b. Overflow spillways
   c. Debris basin
   d. Sediment traps
   e. Underpasses and overpasses
   f. Fences
   g. Escape ladders

5. Service Roads

The number of such structures is a function of system size.

Generally, on-farm distribution systems can and must be operated by farmers. When it comes to the delivery system, however, they may or may not be able to handle the work. This again is a function of size. There is a limit to the farmers' time for such maintenance work. As the system size increases, hired help must be secured. The scale of magnitude also impose problems on the system operation and maintenance. More water is handled, and complex equipment is required. Increase in complexity of distribution requires larger budgets, and with the increase of all

these factors comes the need for more highly skilled operational personnel. In order to obtain such expertise, it is usually necessary to hire full-time personnel at all levels of management, from the workers who keep the system clean up through the highly skilled professionals who manage the entire complex.

Organization

The complexity of the organization which must be set up to support an irrigation system is dependent on size. There are some elements, however, which are common to all such organizations regardless of their size, that is their function and the legal structure under which they operate.

Function. The prime function of the organization is to ensure water delivery. To carry out that mandate the following additional functions are necessary:

1. Maintain the system.

2. Recruit and train a sufficient number of administrative, office and field personnel.

3. Secure adequate financing.

4. Develop a record keeping system which accounts for financial matters such as income and expenditures, keep track of and sets water use fees, and sees that proper notification of assessments get to the farmers.

5. Other records which must be kept, include water deliveries to the farmers; analytical data, such as inflow-outflow data, which can be used to generate comparative reports on the system operation; and personnel records.

It is obvious that small systems do not need to perform all of the above functions as the complexity does not justify all of the above inputs. But the organization should be viable enough to provide these required functions.

Institutional Framework. Many types of institutional models are available upon which irrigation organizations can be built. The two most common in the Philippines are Communal Irrigation Associations and systems owned and operated by the government.

Communal Irrigation Associations are associations of farmers who have joined together for the common purpose of operating the irrigation system which serves their lands. The systems thus operated to date are usually the smaller ones which serve less than 1000 hectares. A recent World Bank Report (1973), however, suggests that all systems in the Philippines which serve less than 3000 hectares should be communal systems. All of the operation and maintenance of such systems are the responsibility of the users.

On the systems under the government organization, the National Irrigation Administration, water is delivered to each turnout by NIA and all operation and maintenance is under their control. The organizational functions listed above also are theirs.

Both of the above mentioned organizational patterns are viable institutions which can and do operate successfully. The key to success is a willingness among all concerned with the system, from users through all the ranks of the administrative organizations, to work in a unified cause.

The unifying cause of an irrigation system is the water delivery. This cause in itself imposes certain restraints on organization which must be recognized and dealt with. The overriding restraint on all gravity irrigation systems (those which operate by gravity once the water is in the main canal) is the geographic boundaries of the system. The direction and extent of the water flow is dictated by the slope of the land over which it flows. The boundaries of the system, then, are dictated by geography, and hence are not subject to arbitrary delineation by ordinary political processes. Because of this restraint, user organizations are generally confined to the geographic boundaries of the system, and rightfully so, for the organization must serve those who are benefited by the system.

The above pattern has generally been followed by both the communal and National Irrigation Systems in the Philippines. However, recent developments in governmental regulations have raised some question as to whether this pattern will continue. This change is related to the establishment of the Samahang Nayon and the Kilusang Bayan Cooperatives throughout the country. The Samahang Nayon is the stepping stone to the organization of full cooperatives, or the Kilusang Bayan, and are organized within politically set Barrio boundaries. It is anticipated by the Department of Local Governments and Community Development under whose auspices the Samahang Nayons have been organized, that the SN's will gear up to control all agricultural cooperatives, including irrigation. Under the original concept, the SN organizations would replace both the Communal Irrigation Associations and NIA in the operation of irrigation systems. Herein lies the conflict, the irrigation associations, which operate along the logical geographic boundaries, and the SN's which are barrio oriented. These conflicts must be resolved before any real consideration can be given to the operation of irrigation pilot-demonstration projects in the Bicol Basin. This conflict has already lead to doubt and confusion among the farmers of the region, so there is an urgent need for resolution of the situation. It is strongly recommended that some compromise be negotiated wherein water user institutions be permitted to organize within the natural boundaries of the system.

Assistance in Selection of Pilot Project Areas

One of the most important functions of the Water Management Study Team was to assist in the selection of three pilot project areas in the Bicol River Basin, which are to be used to determine, demonstrate, and train personnel with regard to good irrigation water management practices. Engineer Crisanto Gimpaya, and our team counterparts, an agricultural engineer, an agronomist, and a soil scientist, all of NIA; extension, soils, agronomy and agrarian reform personnel from the regional government offices; other Bicol River Basin Council personnel; and our team all joined in the discussions and the final selection of the three pilot project areas.

Considered in the selection of the areas were the following: type of water supply, water management problems, soils, cropping patterns, communication systems, organizational structure, and attitude of the farmers.

The approximately 300-hectare areas visited, and the three areas selected are discussed in detail in the following sections. The areas selected were the Barit Irrigation Project, an NIA operated system; Lologan Irrigation Project, a communal gravity system; and the Ombao Irrigation Project, a communal pump system.

No other NIA systems were considered in the selection process. Engineer Gimpaya had recommended the Barit system as being the most adaptable of the three NIA systems in the Basin. A subsequent visit to the project confirmed his recommendation.

Two communal gravity systems were considered. The Lologan, which was selected, and the Yabo River project. The major disadvantage of the Yabo system was an existing, vigorous irrigation association, which has a history extending back at least 200 years, and perhaps farther. It was felt that trying to make changes through such a well entrenched organization would be an insurmountable task.

Two pump systems, in addition to the Ombao project, were considered and rejected. The systems were at Milaor and Minalabac on the lower Bicol River.

Reasons for rejection include:

1. The pumps are now in operation under private contracts.

2. It is highly possible that part of the area, if not all, will be served by the Bicol-Ragay Diversion Canal within a few years, and the "pump" objective for the pilot area would be lost.

3. Major sections of the project area would be inundated for long periods of time by seasonal flooding of the Bicol River.

Water Management Project

Three pilot project sites are being recommended for study and will be described in detail. There are, however, a few general recommendations that apply to the operation of the pilot projects as a whole.

Staff

The water management project should be conducted under the direction of a four-man water management Advisory Team consisting of the following persons:

1. Irrigation engineer as team leader--An agricultural engineer with extensive training in on-farm water management.

2. Agricultural extension specialist--A person experienced in soil and crop management on irrigated soils and in training methods for agricultural technicians and farmers.

3. Irrigation agronomist--A soils scientist broadly trained in soil-water-plant relations and with experience in irrigated agriculture.

4. Agricultural economist--An economist with experience in water management economics and has knowledge of the structure of water management institutions in the Philippines.

The first three members of the team should be Americans and the agricultural economist should be a Filipino. The three-man American team should have counterpart Filipino scientists. Detailed job descriptions of the individual team members are given in Annex II.

In addition to the Advisory Team, it is recommended that a three-man team of Filipino scientists be assigned to each pilot study site. The team should consist of B. Sc. level scientists, as follows: (1) agricultural engineer (water management); (2) irrigation agronomist or soils scientist; and (3) an agricultural extension specialist.

The operation of the pilot project should be an interdisciplinary effort of the advisory team, cooperating research and extension organizations and administrators. Only by such a coordinated effort can improved water management for the Bicol Basin be realized.

Project Activities

Initially some remodelling or redesign in the irrigation system may be required and water measuring devices should be installed. A weather station should be installed at each project area as well as lysimeter tanks for measuring water requirements of rice.

The training program should begin as soon as the Advisory Team is assembled. Training will be required for the scientists located on the project sites and for administrators, extension technologists, and farmers. Training methods will include seminars, conferences, field demonstrations, short courses and on-the-job training.

As soon as possible after a pilot project is initiated, the technological package for the farmer should be outlined with special emphasis given to on-farm water management. The technological package will serve a dual purpose; first, it is needed for the training programs; secondly, it will show gaps in knowledge and indicate directions for both adaptive and basic research.

As the interdisciplinary effort proceeds, the impact of the project will be observed first by improved water management in the pilot project areas. Then with more extensive training and a continued broadening of effort the improved technology will spread to other irrigation systems of the Bicol Basin and to other irrigated areas in the Philippines.

Base Line Studies

A detailed socio-economic survey of each pilot project should be conducted by an independent study

group as soon as possible after the project is approved. The survey will serve as a base for evaluating at a later date the impact of the new water management technology on the economic and social status of the farmers in the project area. The impact studies of the three sites will permit an estimate of the potential of improved water management for the Basin as a whole.

A detailed soil survey of each project area should be made. When the success of the project is evaluated at a later date, the soil surveys will supply information that will help in the selection of new irrigation projects. Mr. Feliciano Garcia, Regional Director of the Bureau of Soils for Camarines Sur, has agreed to assign surveyors to the task as soon as the project locations are submitted to him.

Selected Gravity Pilot Project--Barit River NIA Irrigation System

The Barit River Irrigation Pilot Project is located about four kilometers west of Nabua along the provincial road to the Barrio of Santo Domingo. The terrain is generally flat, with some localized areas which may rise as high as 30 to 50 centimeters above the general lay of the land. The land slopes to the north-northeast and varies from 0.2 to 0.3% throughout the pilot area.

System Description. The pilot project area consists of three hydraulically independent areas, designated in Figure 3 as Test Area A, Test Area B, and the Pilot Water Management Area. Test Area A, shown in Figure 4, is a narrow strip of rice land bounded on the north by the canal, the south by the Provincial Highway, the east by the supply ditch from the main canal and the west by a higher area where coconuts are grown. The only access of water to the area is through the inlet structure on the west end of the field, and all outflow passes under the road through two culverts, one at each end of the plot. No water crosses the higher coconut land. Thus, once a weather station is installed with a rain gage, all water inflows and outflows can be measured. There are approximately seven hectares in the area.

Test Area B, shown in Figure 5, is also a hydraulically bounded area making it possible to measure all of the water inputs. Its boundaries are the main canal on the south and west, a small farm ditch on the north and elevated coconut land on the east. It covers approximately 10 hectares. It is believed that these two test areas are real bonuses to the pilot area concept. They are in essence field lysimeters where valuable data can be collected for dissemination to the main water management pilot area. Hence, they must be developed concurrently with the pilot area.

The main water management pilot area is a 250-hectare tract of land just to the north of Test Area B. It is bounded by an abandoned road on the lateral "G", on the north, and the Barit River on the east and southeast.

Water is delivered to the entire area through the main diversion canal from the Barit River. It is distributed to the land by one main lateral, lateral "F" and a series of small farm ditches. There is adequate water, even in the dry season of drought years to provide the test area with enough water for two crops of rice per year. On down the main canal, below the test area, this is not the case and better water management in the test area would probably provide more water for downstream users.

Inadequate drainage is a major problem of the area. There is no system to handle the large quantity of water from the wet season rains. Flooding from either the Barit or Bicol Rivers is not a major problem. Only the extreme lower fields next to the Barit are flooded in heavy storms and it does not remain on the land very long.

Organization. Parts of the Barit River Project are relatively new to the NIA system. Originally, parts of the area were served by community pumps. Later, NIA rehabilitated its part of the system, extended its limits to include the pumped areas, and closed down the pumps. A complete users' organization does not exist for the area. Some laterals have a user who is designated as a

"coordinator" who sometimes has an assistant. Their work is to coordinate the distribution along the lateral. These coordinators are not designated in the pilot area. Farm ditches are maintained by the users, with each farmer cleaning the part of the ditch which crosses his farm. The canals and laterals are maintained by NIA.

Water Management Problems. One of the major water management problems has already been mentioned, that is the need for surface drainage during the rainy season. There is a good possibility that the solution of this problem can be found by integrating a surface drainage network with needed increase in irrigation farm ditch density. At the present time, farm ditches are widely scattered and water must move from paddy to paddy over long distances. If a surface drainage network can be integrated with a better irrigation ditch network, then the entire area will be benefited in both the dry as well as the rainy season. This network will require taking some land out of production to provide space for the ditches, but discussions with local officials and with two of the farmers seem to indicate a willingness to sacrifice the land in favor of the advantage of improved drainage.

Another problem which the farmers and the NIA operating personnel recognize is that of delivering water under the present system to paddies where the rice is at different growth stages. This problem would also be relaxed by an improved farm distribution system.

Field observations indicate that in some areas farm ditch maintenance presents a problem. At present, the ditches are cleaned about once a year on a community basis, with the farmers whose land the ditch crosses, being responsible for that section of the ditch.

The major canal system is in good condition and well maintained. There is some problem, however, with trash removal from the canals and aquatic plants are now starting to appear. In some areas, where the level of the rice paddy is several centimeters below the canal bottom, there is a potential, and a noticeable tendency for, washouts to occur.

Recommendations. Some general recommendations can be made to get the area ready to begin the pilot program.

1. Data Collection. The following data should be collected on the pilot area.

   a. Weather data from a field station.
   b. Water inflows and outflows from the main canal.
   c. Water diverted into the laterals and farm ditches.
   d. Water drained off from lower fields.
   e. Crop production data for yield-water stress comparative studies.
   f. Effects of water manipulation.
   g. Water requirements and evapo-transpiration measurements for rice.

2. Equipment. Measuring devices should be located on all major canals at the beginning and end of each test area and at the end of the pilot area. Care should be given to selecting staff gage locations so they may be easily read and yet not obstruct the flow regime head of the structure. Water stage recorders should be used to measure the flow through the measuring structures on the main canal.

   All headgates and ditches into the pilot areas should be checked and any leaks or unauthorized diversions closed so the water is well controlled.

   Lysimeter tanks should be installed in at least two locations in the project area for the measurement of water requirement. Tank construction is described in the NIA-ADB manual on irrigation water management (1970).

   A field weather station should be installed where at least rainfall, sunshine, humidity, evaporation and wind data can be collected.

   A more complete list of equipment for the pilot areas has been considered with NIA officials, and should it be needed, can be obtained from Engineer Crisanto Gimpaya in Naga City.

3. Practice Changes. The major changes in irrigation practice which have been considered include more attention to surface drainage, adjusting flows to meet actual plant water requirements as closely as possible, and a possible switch from continuous to rotational or intermittant delivery. Other management changes will come as experience is gained in the operation of the systems.

4. Organization. At present, there is no organization within the pilot project concerned with the on-farm water distribution. Without one, maintenance of the distribution is haphazard and not very effective. Some kind of organizational structure must be developed to cover this phase of project operation.

Selected Gravity Pilot Project - Lologon River Communal Irrigation System

The Lologon River Communal Irrigation System is located just south of the town of Buhi, and straddles the main highway from Buhi to Iriga between the Lologon and Barit Rivers.

The terrain is moderately flat alluvial valley, randomly interrupted by sharp, steep hills. The rice paddies are in the valley floors while the hilly areas are coconut, bananas and other upland crops.

System Description - The gross area of the entire project, as shown in Figure 7, is about 600 hectares. Of that, about 350 hectares will be served by the canal of the pilot project. The project area will be that covered by the main canal, and its laterals, downstream from Station 0+630 (Fig. 7).

Not all of the project area is in operation because the project is not yet complete. Part of the system was destroyed in the 1970 flood, and along with the rehabilitation, some new areas have been added. The main canal is operational throughout its length but lateral "C" has not yet been put in operation. Construction is complete except for a short section between station 0+220 and 0+460, on lateral "C". A rock formation was encountered during construction and the canal had to be re-routed.

Most of the field areas have rather short lengths from the canal to the drain and hence there are very few farm ditches. These short runs also reduce the problem of prolonged flooding due to rainfall. The river courses through the area are deeply cut into the valley floor and hence river flooding is not a serious problem.

Organization -The formal communal irrigation association has been organized for only three years. It follows the general pattern of Philippine communal systems in that the board of directors, nine in number, are elected in an open, general meeting, of the association members to serve for one year. At the first board meeting, the nine directors elect one man from among their member to be the President.

System maintenance is carried out by the farmers themselves. The areas to be maintained are decided and the work assignments are made in an open meeting of the entire membership, and is done once or twice a year as canal conditions demand. Some routine maintenance between these "events" is also done by the farmers but he is paid a token wage from the finances of the association. A water master is hired by the association to deliver the water to the farms and ensure equitable distribution. He is also paid a token wage.

Finances are raised through assessment of a share of the crop. The amount of the share is set by the directors, depending on what the needs of the association are. Some farmers pay 80% of their assessment, and others pay about 10%. The income, however, has met expenses to date.

No outside help has been solicited in the solution of disputes. When one arises, a meeting is held and the problem is solved.

An informal back-up organization has been very helpful to the farmers. The Good Shepherd Sisters Convent in Buhi maintains an active social work program in the rural areas and have been very helpful in maintaining interest in the success of the association. They promise to maintain that support. The BAE extension man in Buhi, Tiotima Gonzaga, is doing an excellent job with the farmers in his district. Also Mayor Jaime Claveria of Buhi is interested in the project and willing to support it.

Irrigation Problems - Insufficient water is a problem and will be until the new canal is finished. That, however, should be finished by the end of October 1973.

The shortage of distribution ditches, with the subsequent imposition of paddy to paddy delivery and all its associated restrictions is a problem, but not as serious as on the Barit project.

Farm ditch maintenance appears to be neglected, and access trails along the canal banks are non-existent. Some consideration should be given to overflow protection for the inverted siphon at station 0+460 on lateral "C" to

insure that if overtopping of the canal above the siphon occurs, due to heavy rain or clogging of the siphon with trash, the earth fill above the siphon is not washed out.

Recommendations - Recommendations with regard to data collection, equipment and practice changes are in conformity with those given for the Barit project. The organizational structure should be made fully active by holding the prescribed elections (none for the last three years) and more attention given to insure more equitable fee collection.

Selected Pumping Pilot Project - Ombao Communal Irrigation System

The Ombao project covers an area of about 300 hectares of gently sloping land adjacent to the Bicol River at the Barrio of Ombao. The project area is bounded by the Bicol River on the south and west, Polpog Creek on the east, and a small natural drainage channel on the north. The general slope of the land is to the northeast away from the river.

System Description - The water source for the project is a 16 inch diameter pump, which lifts water from the Bicol River into a canal system. At the present time, the pump is not operating because of poor management. However, the original system was well built and can be put back in operation by cleaning and reshaping the canals, checking the structures and repairing any minor damage which may have occurred and reactivating the turnout and control structures. It appears that the diesel engine merely needs servicing to be put back in operation. The pump did not have any serious problems when last used, but may need a routine servicing to put back in operation.

The water users indicate that a fairly dense network of farm ditches exists, with water delivered to at least every land owner, independently from any other paddy, and as, in some cases, delivered from the ditch to individual paddies. This being the case, the project will afford an excellent opportunity to verify the value of a dense farm ditch network.

As in the case on the other projects, internal surface drainage is a problem. The dense farm ditch network may be worked into doing double duty as a drainage system as well.

The entire area is flooded during high flood flows of the Bicol River. Because the project area is relatively high on the river, however, the water does not stay on the land for extended periods of time.

Organization - At the present time, there is no irrigation association active on the project. Hence it will be necessary to start again and reactivate the organization.

Irrigation Problems - The major problems have already been alluded to: i.e. no water because the pump is not operational; the system needs rehabilitation; surface drainage; and no organizational structure under which to operate the system.

Recommendation - Recommendations for data collection, equipment and practice changes remain consistent with those of the two previous projects. It has also been stated that the farmers must be reorganized, and a viable working group created and sustained by an equitable assessment structure.

Summary Regarding Use of Pilot Project Areas

A summary regarding the use of the three pilot project areas is the following: To field determine good water management practices; to demonstrate these practices; to provide on-farm training with regard to good water management practices to farmers, technicians, professionals, and administrators; and to provide the impetus by means of the above inputs for expanding these good water management practices throughout the Bicol River Basin and the Philippines.

It should be emphasized that the recommended Advisory Team should be directly involved in all aspects of the training and demonstration program, and extension of the water management program to the entire Bicol River Basin. To function efficiently, the Advisory Team should probably report directly to Executive Director Oscar Ravanera, Bicol River Basin Council. Lastly, the Advisory Team should be made available on a national level for advisory services to all the agencies which are required for the interdisciplinary approach needed for efficient irrigation and drainage practices in the Philippines.

Research Needs

One of the early tasks of the Advisory Team will be to assemble a technological package for the farmers. This package will be developed with an interdisciplinary group consisting of the best informed research and extension scientists available from the Bicol Basin and from organizations outside the Bicol Basin. Although emphasis will be placed on water management, other contributory inputs must be inserted. When the technological package is developed, gaps in information will appear. One of the activities of the Advisory Team will be to assist in the design and conduct of research needed to provide information that can be used to improve and revise a more effective technological package. Both adaptive and basic research probably will be required.

The adaptive (applied) research can be conducted in the pilot areas, with farmers outside the project areas, and on the local experimental stations of BPI, Bureau of Soils and/or in cooperation with the Pili Agricultural College. The purpose of adaptive research is to translate the results of closely controlled experiment station results to farmer conditions. This research gives the verification for finalizing the technology package.

Basic research will be required, also, to give additional data and new knowledge where it is needed to improve the technology package. For example, research may be required to give a better definition of the effect of moisture stress on the yield of lowland rice, to evaluate the possibility of alternate crops with lowland rice, to obtain more accurate water requirement data for rice, to determine water-use efficiency for rice, etc. The Pili Experiment Station, Bureau of Soils, UPLB, IRRI, and NIA have expressed an interest in a coordinated research effort on water management research in the Bicol Basin. Other agencies may be interested also.

In addition to obtaining the information for the technology package, the research will be an educational experience in demonstrating the interdisciplinary approach to the solution of common water management problems that cut cross agency boundaries.

Training in Water Management

Water management training should constitute a large and important part of the pilot project activities. Highly qualified people will be required to staff the three pilot areas and similarly trained people will be needed for other irrigation systems in the Bicol Basin as the program expands as well as for other irrigation projects in the Philippines. Instructors will be needed for schools to train BAE technicians and for schools for farmers. Special conferences and seminars should be held as the need arises for administrators and interested staff of the various Basin organizations. Training in on-farm water management has many forms and ranges from extensive on-the-job training, to short courses, to formal training. There is unlimited opportunity for the innovative mind. Among the various training mechanisms are the following:

1) On-the-job training
2) BAE technician schools
3) Short courses at the project level
4) Short courses at the Angat Station
5) Short courses at the UPLB College of Agriculture and other colleges.
6) Seminars, conferences, workshops
7) Foreign study

Subject matter areas in water management are:

1) On-farm water management for maximized production
2) Water control, measurement, and delivery
3) Irrigation system management
4) Organizational structure and administration
5) Operation and maintenance of irrigation systems
6) Farm surface drainage

The people to be trained include:

1) Irrigation engineers
2) Irrigation agronomists
3) On-farm water management technicians
4) Water users (farmers)
5) Ditch tenders and gate keepers
6) Water masters
7) Administrators

The training staff for water management include:

1) Filipino experts
2) Foreign experts
3) Extension personnel

There may also be a training opportunity at the proposed Pili Agricultural College-NIA Water Management Training Center. The Advisory Team should investigate the possibility of a cooperative venture with the Center.

Need for Interdisciplinary Approach

Traditionally, irrigation systems have failed throughout the world because of lack of understanding of on-farm water use and drainage practices. Successful water management practices requires a knowledge of soil-water-plant relationships, which are extremely complex.

For an irrigation and drainage system to function properly, the following is required: A water delivery and drainage system constructed by the engineers, which can provide or remove the required water at the proper time as specified by the soil-water-plant scientists. Also required are extension workers and others to bring the message to the farmers; managers-economists to organize the farmers in an irrigation unit so as to enable the system to function; and credit, marketing, infrastructure as road and river communication systems, etc. inputs as necessary.

These ingredients are available or can be made available to the Bicol River Basin. We strongly urge that they be used.

Other Suggested Studies

While this reports is essentially concerned with the need for improved on-farm water management practices, other studies, of course, are required in parallel for the pilot project areas to determine the effectiveness of these practices. For example, required are economic analysis to determine costs and benefits. What effects an improved infrastructure or the availability of electric power would have on increasing the effectiveness of the water management practices would need to be determined.

The nature and scope of these studies would need to be determined by the Bicol River Basin Council staff and the recommended Advisory Team.

CHAPTER V

ASSOCIATED LONG-RANGE DEVELOPMENT STUDIES

While proper water management practices can assist greatly with regard to the immediate solution of water supply and on-farm drainage problems for irrigated agriculture, the complete logical long-range development of irrigated agriculture in the Bicol River Basin requires the solution of the regional water resource problems discussed in Chapter III.

Control of River Flooding

The Pastir Report (1973) discussed the methods being considered for the control of the serious river flooding problem in the Bicol River Basin. While complete control of the flooding does not seem economically feasible at this point of time, the problem would be alleviated to the point wherein improvements to the water management systems on the 42,000 hectares which are annually flooded, could be undertaken.

The Pulantuna Reservoir, besides serving as a flood control structure, would provide a source of water for irrigated agriculture during periods of inadequate rainfall. Further, the proposed Bicol-Ragay Flood Flow Diversion Channel would also be used to continuously irrigate about 13,000 hectares, which are now being serviced by pumping water from the Bicol River during the wet season only as sea water intrudes during the periods of low flow.

Control of Sea Water Intrusion

The Pastir Report (1973) also discusses the control of sea water intrusion by construction of a tidal barrier at the entrance of San Miguel Bay. This would make river water available from storage behind the tidal barrier for irrigation during periods of inadequate rainfall, and pumping from the rivers would be possible even at low flow.

Most important though, the groundwater resources could be developed for irrigated agriculture and other uses without fear of sea water intrusion into the fresh water bearing aquifiers. The development of groundwater is necessary to balance the low-river flows to furnish the water needed to service the irrigated areas during the periods of inadequate rainfall.

Collection of Data for Hydrologic Studies

Long-term hydrologic and climatological data are necessary to complete the essential water balance study and for accurate design of the hydraulic structures needed to develop the water resources of the Bicol River Basin. The cost of collecting the data is justified by the considerable savings generally obtained in construction costs of the hydraulic structures when the designs are based on adequate data. Collection of the necessary data should be an immediate consideration.

The solution of the above associated long-range development studies would enable proper on-farm water management practices to be extended over the entire 100,000 hectares of irrigated area in the Bicol River Basin.

CHAPTER VI

CONCLUSIONS AND RECOMMENDATIONS

From the intensive visits to irrigation projects in the Bicol River Basin, in a one-day visit to the Angat Irrigation Project in Central Luzon, from many discussions with Filipino national and local officials, and from water users themselves, it can be concluded that:

1. Proper on-farm water management practices are badly needed. Some areas which appear too short of water in dry seasons may in reality have sufficient water if available supplies are properly used.

2. The basic knowledge for good on-farm water management already exists in published Filipino literature. Some success has already been achieved on several pilot projects, but the experience gained has not spread to the rest of the country.

3. The critical need to expand the existing knowledge and make good on-farm water management a reality is more adequately trained people.

4. At the present time, there appears to be some unresolved procedural problems between the various governmental entities having jurisdiction over water and other agricultural policies and procedures which makes irrigation system operation uncertain.

To help in the resolution of these major problems and the minor ones which result therefrom, it is recommended that:

1. Three pilot water management projects be established in the Bicol River Basin; one on the NIA's Barit River Gravity Irrigation System; a second in the cooperation with the Communal Irrigation Association of the Lologon River Gravity Irrigation System, and the third on the pumped irrigation system at Ombao on the Bicol River, which was a Communal System at one time.

2. The pilot projects demonstrate the use of effective on-farm water management practices.

3. The pilot projects be used for training personnel at all levels of irrigation system management and for demonstration and field research purposes.

4. The thrust of the training program be focused on giving operational field experience to the trainees in such a way that correct management principles and concepts can be transferred to actual operational experience.

5. The training program be an interdisciplinary and an interagency effort, recognizing that no single scientific discipline nor single government agency can adequately accomplish the task. To that end, tighter cross ties and more open communication lines must be created between all disciplines and agencies.

6. In the management program, special emphasis should be given to surface drainage during the rainy season.

7. That top-level government officials sit down together in the immediate future to clarify what now appears to be interagency conflicts. Once clarification is made, an active information dissemination program should be launched for clarification at all operational levels.

8. The recommended Advisory Team should be directly involved in all aspects of the training and demonstration program in the Bicol River Basin, and with the extension of the on-farm water management program to the entire country. Further, they should be made available for advisory services to all the national agencies concerned with irrigated agriculture.

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ANNEX I

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2. Planting calendar for Camarines Sur

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4. Rainfall: NIA-ADB Water Management Project

   R-1 San Jose, 1961-1973
   R-2 Inarihan, 1969-1973
   R-3 Legaspi City, 1952-1972
   R-4 Daet, Camarines Norte, 1952-1972
   R-5 Naga City, 1956-1967

5. Stream Flow

Anayan River	1955-1965
Aslong River	1955-1965
Barit River	1952-1965
Bicol River	1947-1965
Pawili River	1952-1965
Yabo River	1955-1965
Pawili River, San Vicente, Ocampo	1967-1970
Pawili River, San Roque, Bula	1968-1971
Bicol River, Sto. Domingo, Nabua	1967-1971
Bicol River, Ombao, Bula	1968-1972
Bicol River, Baliwag Nuevo, Minalabac	1968-1972
Bicol River, Mabulo, Naga City	1968-1970
Anayan River, San Roque, Pili	1967-1972
Yabo River, San Isidro, Naga City	1967-1970

6. Surface Water Quality Analysis

Pulantuna River, Napulidan, Lupi, Camarines Sur	1966-1969
Talisay River, Paulba, Ligao, Albay	1965-1969
Culaling River, Del Rosario, Camarines Sur	1965-1969
Agus River, Pulangi, Albay	1964-1969
Yabo River, Sipocot, Camarines Sur	1964
Bicol River, Plancha, Libmanan, Camarines Sur	1968-1971
Bicol River, Sto. Domingo, Nabua, Camarines Norte	1968-1969

7. Surface Meteorological Observations--Bicol Rice and Corn Experiment Station, Pili

Temperature, rainfall, hours of sunshine, relative humidity, and wind velocity for the years 1966-1973; relative humidity, and wind velocity missing for 1966.

8. Well, log and water analysis--BPW

Libon Community School, Libon, Albay
Iriga Central School, Iriga
Naga Central School, Naga City
Sipocot Central School, Sipocot (no water analysis)
Bagumbayan Community School, Bula

9a. Maps, Topographic, Philippine Islands, Bicol Region

Legaspi City	Philippine Geologic Survey
Naga City	do
Bulan	do
Pandan	do
Northwestern Bicol	U.S. Army Topographic
Camarines Norte	U.S. Army Topographic

9b. Well Logs--NIA-UNDP Groundwater Development Project

Well No. P18--Bicol
Well No. P26--Bicol

ANNEX II

QUALIFICATIONS OF ADVISORY TEAM PERSONNEL

Irrigation Engineer

He should be an on-farm water management specialist with at least an M.S. degree in agricultural engineering. He should have at least 15 years of experience in field adaptive research, training on all levels with regard to irrigation and drainage principles, and with improving on-farm water management practices.

Agriculture Extension Specialist

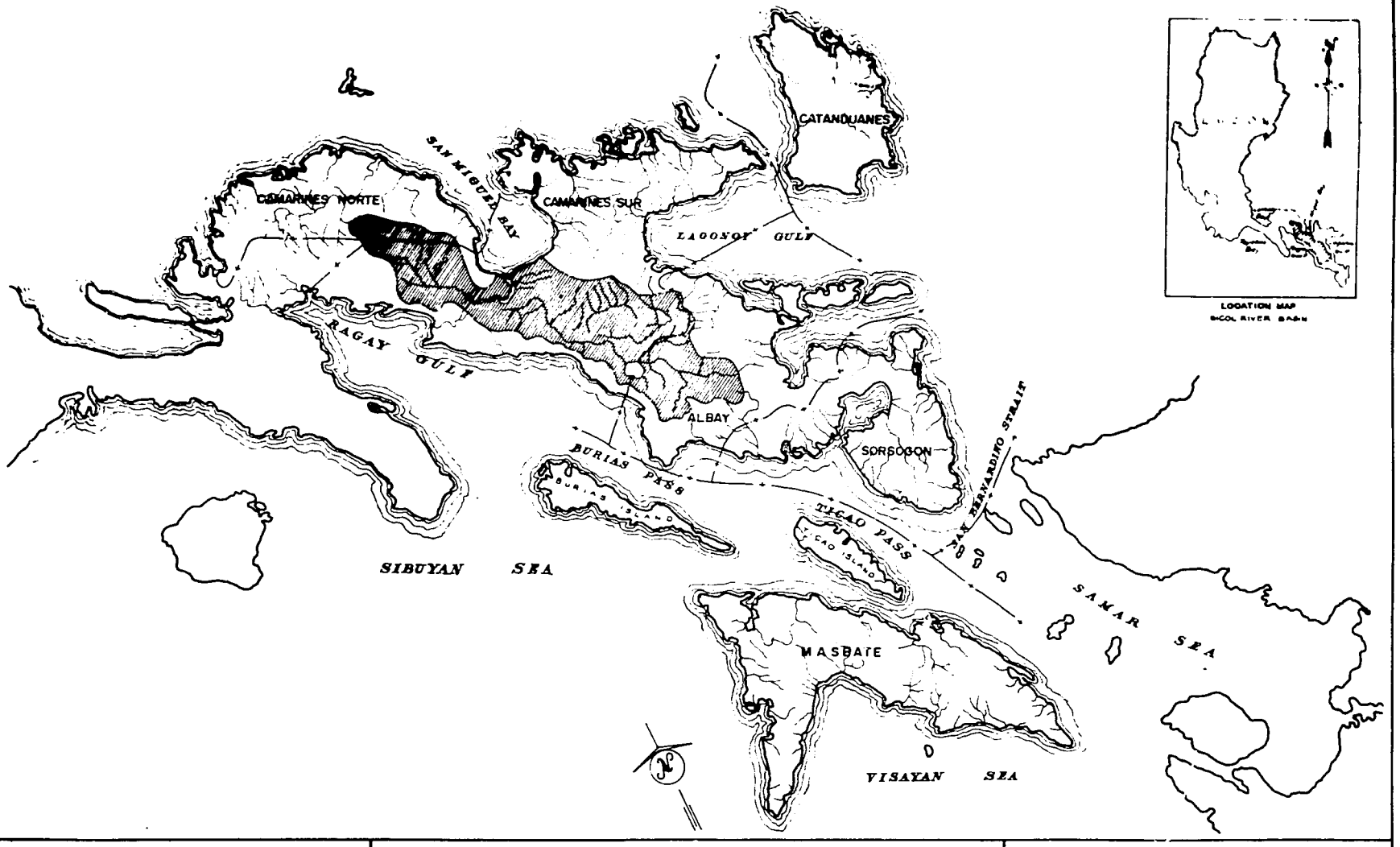
The Agricultural Extension Specialist should have at least an M.S. degree with broad training in crops and soils. He should be trained in on-farm water management and have at least 15 years experience in training and demonstration-type research at the farm level.

Irrigation Agronomist

He should have a Ph.D. degree in soil physics with emphasis on oil-water-plant relations. He should have at least 10 years field experience in research and training in on-farm water management and be proficient in instrumentation and field-plot technique. He must understand the principles of crop production in irrigated soils, and experience in rice production is desirable.

Agricultural Economist

He should have a Ph.D. degree in agricultural economics with minor areas of study in sociology and political science. He should have experience in the economic analysis of on-farm water management. He should be familiar with the organization of Philippine institutions that are involved in research, training, and administration of irrigation agriculture.



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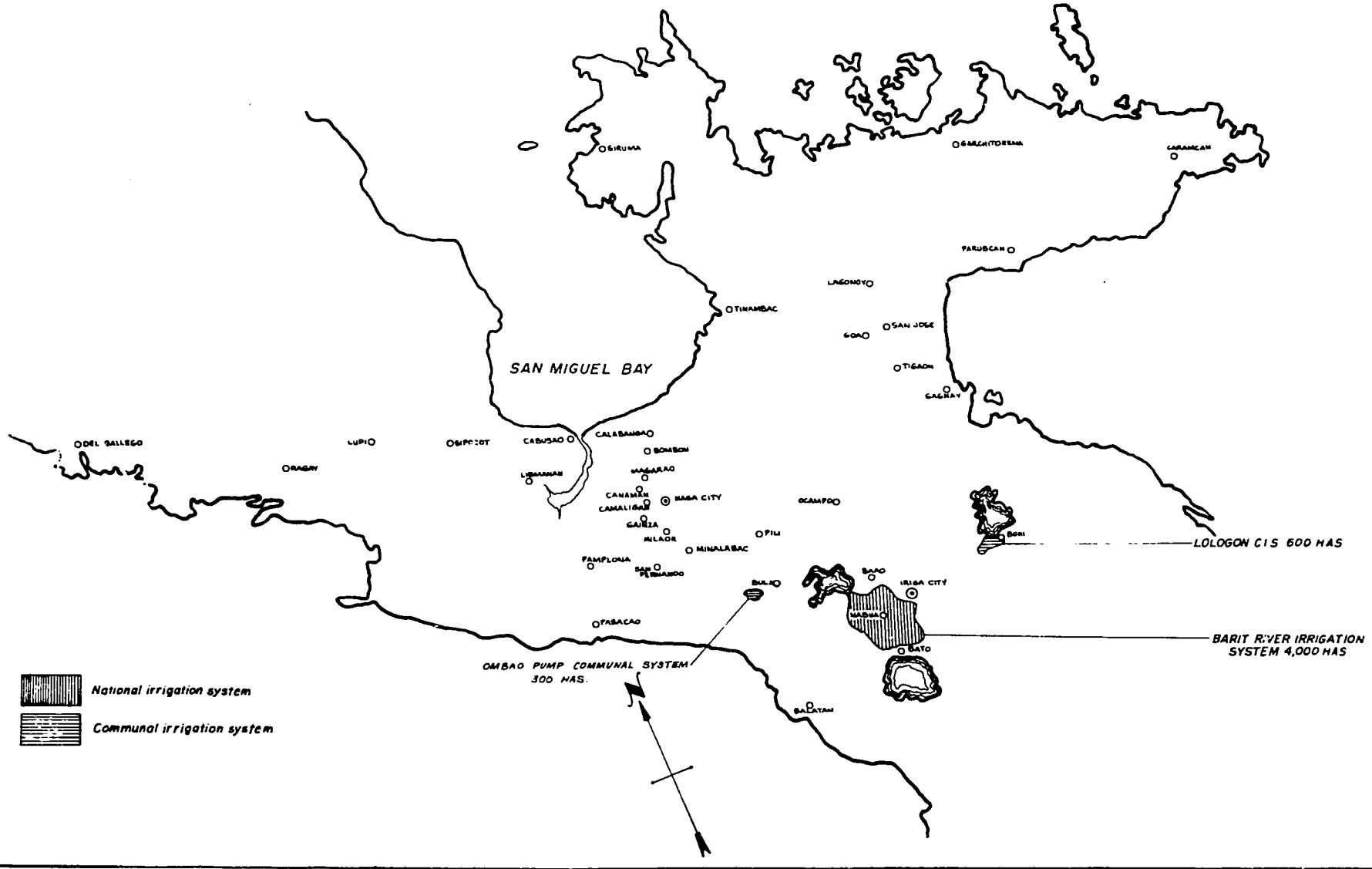
PACIFIC CO ECONOMIC DEVELOPMENT ATLAS

BICOL REGION
SCALE 1:1,000,000
KILOMETER

Fig. No 1
THE BICOL REGION PROVINCES
CUSUSWASH WATER MANAGEMENT REPORT
SEPT. 1978



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NATIONAL IRRIGATION ADMINISTRATION

BICOL RIVER BASIN

SCALE 1:375,000

KILOMETER

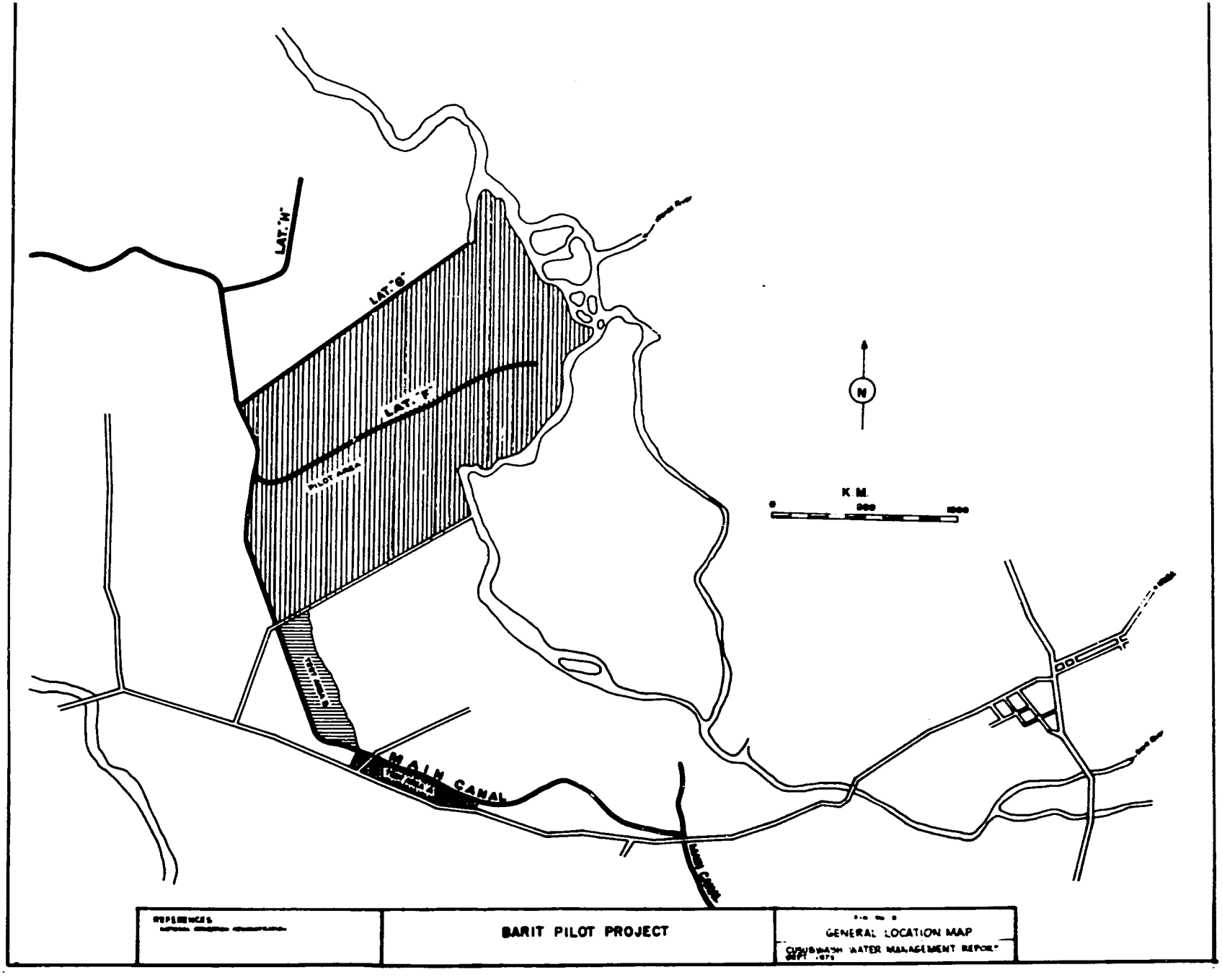
10 7.5 5 2.5 0 10 20 30

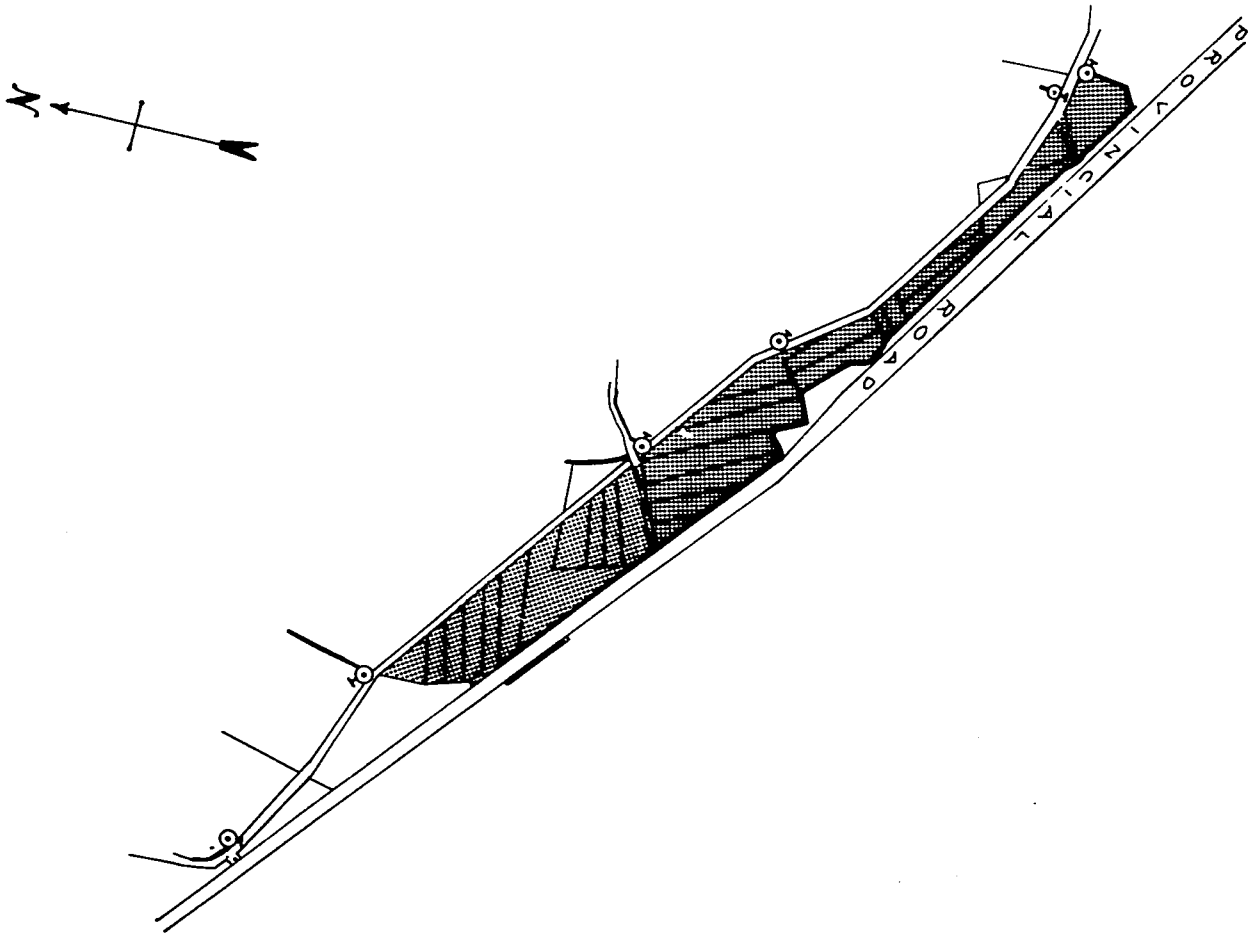
FIG No. 2

WATER MANAGEMENT PILOT AREAS

CUSUSWASH WATER MANAGEMENT REPORT

SEPT. 1973


LAT. "W"
LAT. "G"
LAT. "F"
PILOT AREA
MAIN CANAL
N
K M.
0
200
400
BARIT PILOT PROJECT
GENERAL LOCATION MAP



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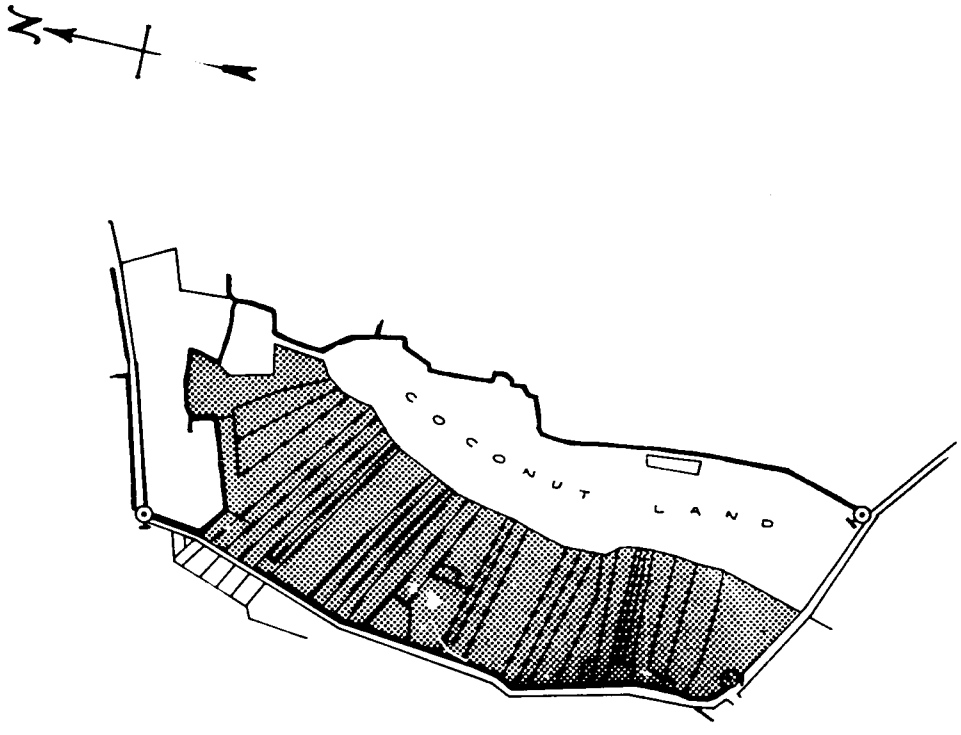
BARIT PILOT PROJECT

FIG. No. 4
TEST AREA A

CUSUSWASH WATER MANAGEMENT REPORT
SEPT. 1975



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BARIT PILOT PROJECT

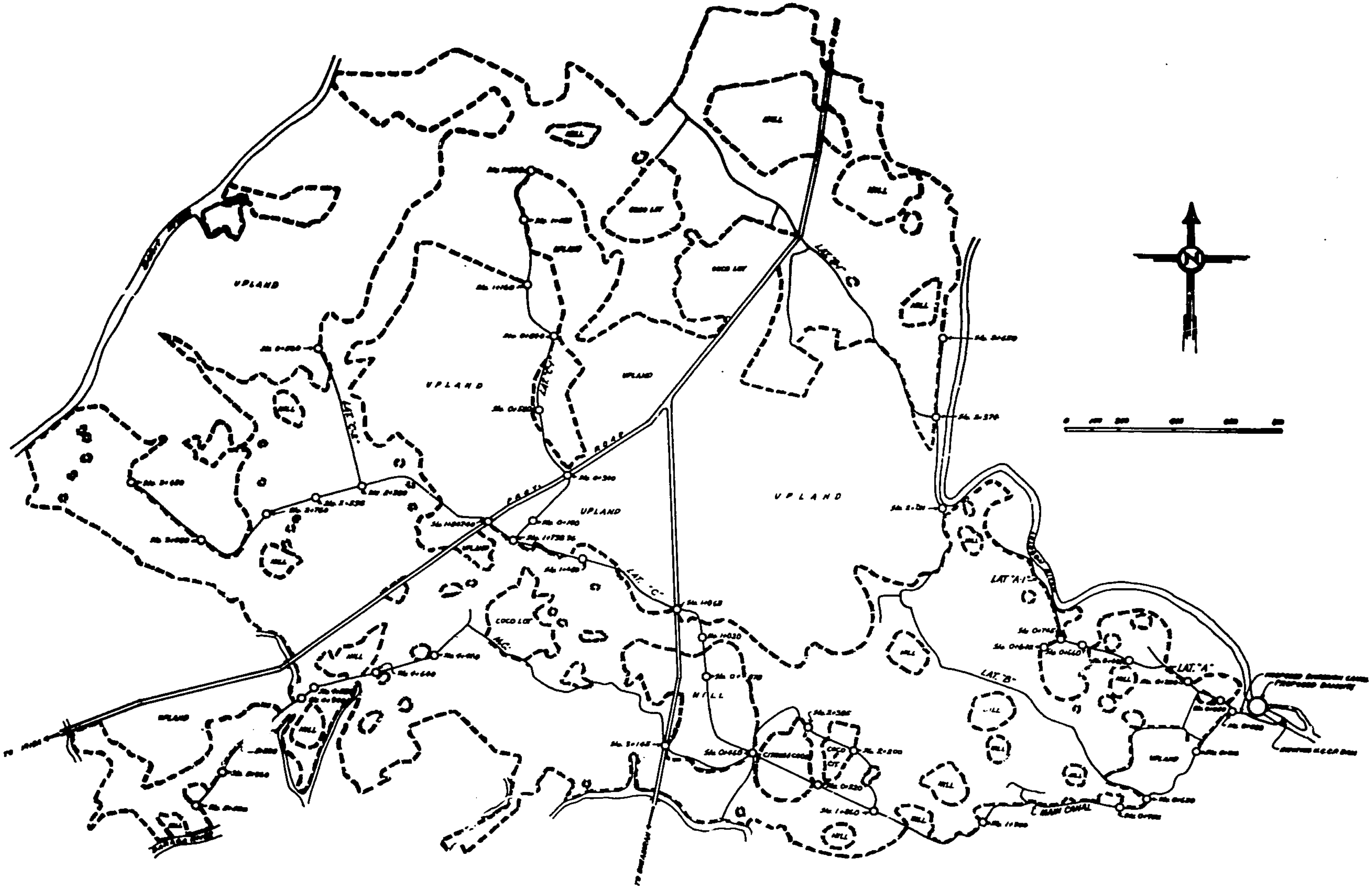
FIG. No. 5
TEST AREA B

CUSUSWASH WATER MANAGEMENT REPORT
SEPT. 1973

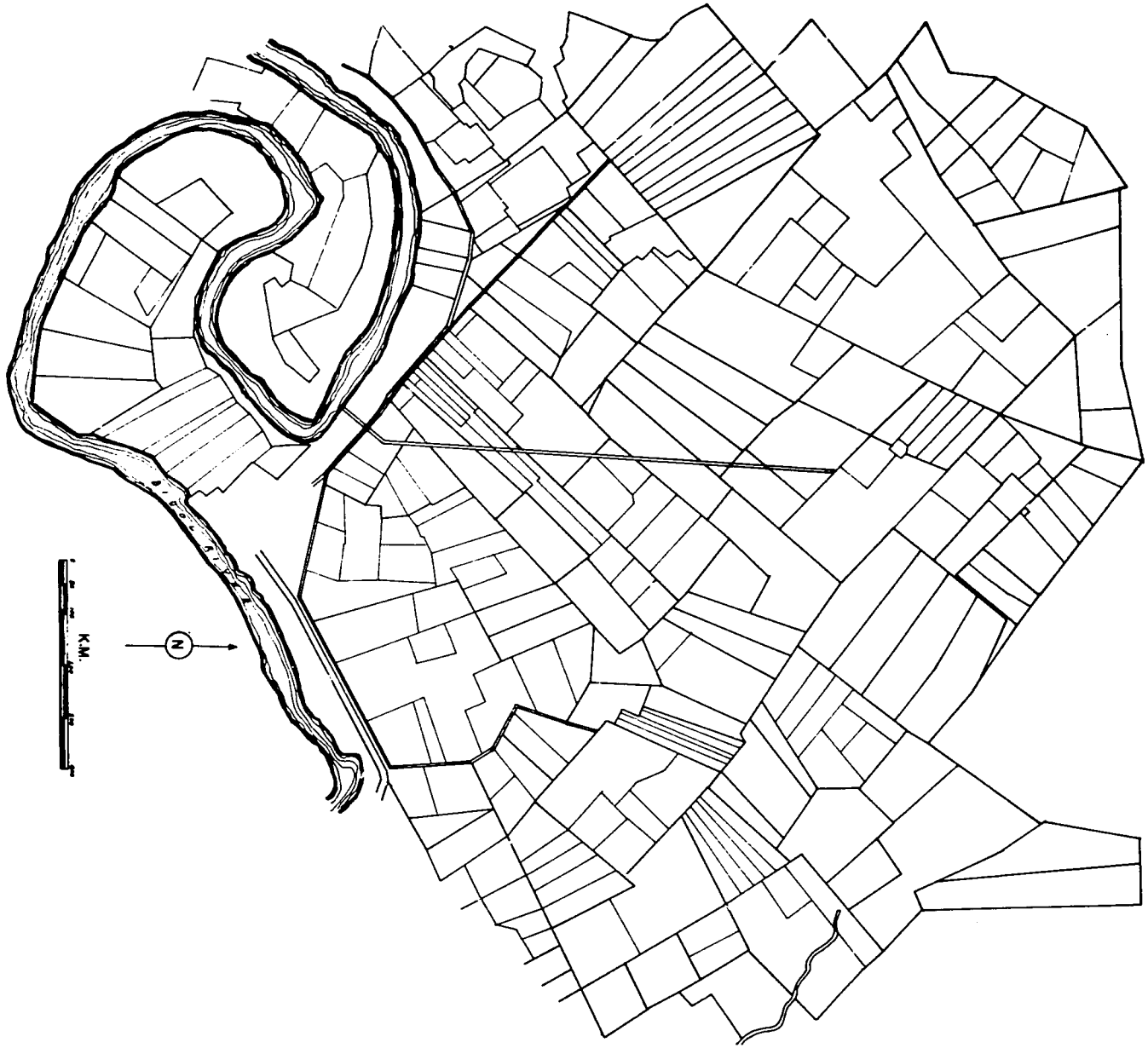
REFERENCES:
NATIONAL IRRIGATION ADMINISTRATION

BARIT PILOT PROJECT

FIG. No 8
PILOT MANAGEMENT AREA
CUSUSWASH WATER MANAGEMENT REPORT
SEPT. 1973



REFERENCES: BUREAU OF LANDS	LOLOGON RIVER COMMUNAL IRRIGATION PROJECT	FIG No-7 LOLOGON PILOT PROJECT
		CUSUSWASH WATER MANAGEMENT REPORT SEPT 1975



REFERENCE

OMBAO PUMP COMMUNAL IRRIGATION PROJECT

FIG-No-8

OMBAO PILOT PROJECT

CUSUSWASH. WATER MANAGEMENT REPORT
SEPT. 1973