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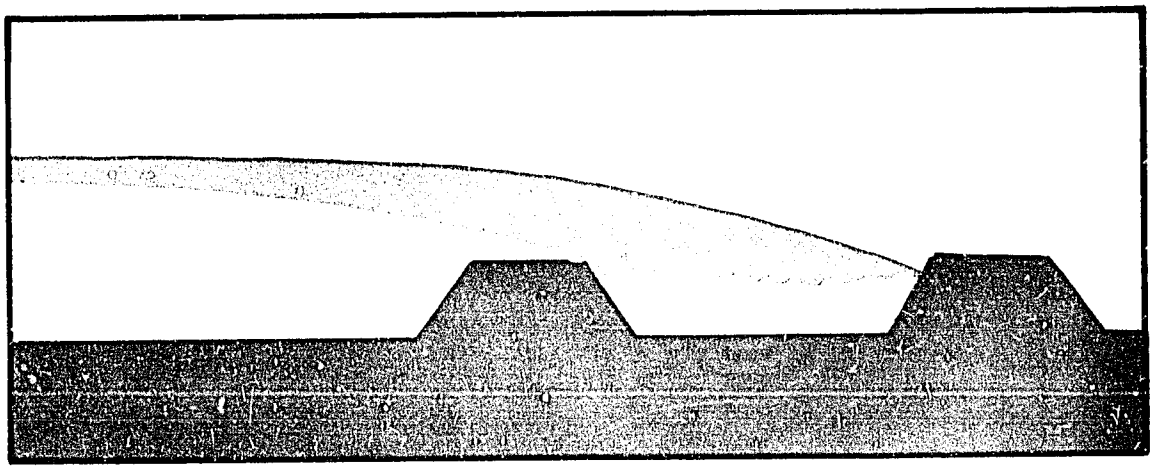
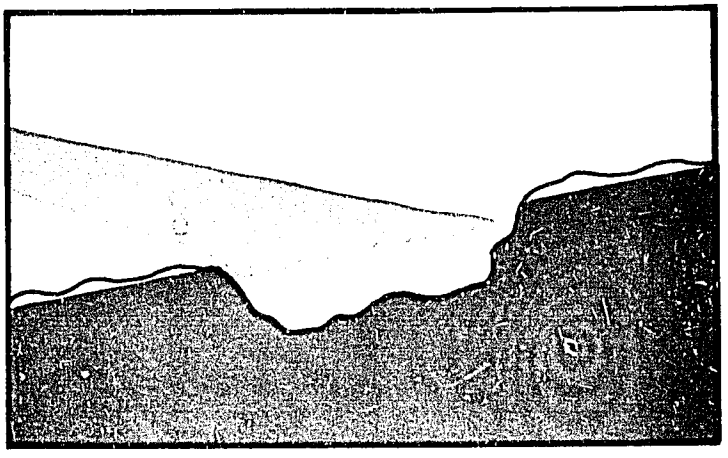
Recommendations For Improved Operation and Maintenance of Rehabilitated Canal Systems

February 1986.



Full Funding Budgets
Yardsticks
Management
Inspections
Equipment
Training
Transport
Communications



CONSULTANTS FOR O&M ACTIVITIES, USAID.

Recommendations
For
Improved Operation and Maintenance
Of
Rehabilited Canal Systems

Executive Summary

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   - General
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RECOMMENDATIONS
FOR
IMPROVED OPERATION AND MAINTENANCE
OF
REHABILITATED CANAL SYSTEMS

* * * EXECUTIVE SUMMARY * * *

PRC/Checchi

February 1986

EXECUTIVE SUMMARY

Increased cost of construction in many parts of the World has caused a renewed emphasis upon improved operation and maintenance of existing systems. The emphasis is directed toward timely maintenance in order to avoid the much larger capital costs of extensive rehabilitation at a later date. Improved operation and maintenance can be achieved through selected application of modern technology and use of practices that have proven successful in other parts of the World. Modern equipment, adequate funding, well trained staff and careful management are generally key ingredients of well maintained irrigation systems in other countries.

The Irrigation Systems Management (ISM) Project sponsored by the Government of Pakistan and USAID and the companion World Bank funded Irrigation System Rehabilitation (ISR) Project involves several major long-term efforts aimed towards increased agricultural production in Pakistan. These efforts are directed primarily toward improvement of more than forty irrigation systems which serve nearly 35 million acres.

Many of the canals that serve these extensive irrigation systems will be rehabilitated as a part of the overall program. The responsibility for the operation and maintenance of these irrigation systems rests with the Provincial Irrigation Department in each of the four Provinces.

One of the primary tasks of the USAID sponsored PRC/Checchi advisory team is that of "strengthened operation and maintenance procedures for these rehabilitated canal systems". The purpose of this report is to present a number of recommendations which are designed to meet this objective.

These recommendations for improved operation and maintenance are herein presented for review by the Provincial Governments, the Government of Pakistan and the donor agencies. The recommendations are the result of an extensive examination of current practices of the Provincial Irrigation Departments in the fields of management, operation and maintenance.

During the study eight functional areas were identified as a part of an overall operation and maintenance improvement program. The resulting recommendations are for each of these eight functional areas:

- Full Funding Budgets
- Maintenance Yardsticks
- Management Systems
- Inspection Systems
- Equipment Management
- Training
- Transport Systems
- Tele-communication Systems

A very brief description of each area of recommendation is given in the following sections. It is important to note that these recommendations focus upon the management and maintenance functions for rehabilitated canal systems.

Full Funding Budgets

Spending on water projects in Pakistan currently ranks third among all capital spending sectors. With great competition for Federal and Provincial funds, the Provincial Irrigation Departments are confronted with severe financial constraints. In the case of operation and maintenance, full funding of budget requirements is needed on an annual basis to avoid the much greater long-term cost that results from deferred maintenance.

Maintenance Yardsticks

Budget estimates for various Government spending activities are commonly made by use of "yardsticks". New and updated maintenance yardsticks need to be developed in order to secure the funds necessary to properly operate and maintain the rehabilitated canal systems. Maintenance standards have been proposed for these rehabilitated canal systems along with appropriate yardsticks.

Management Systems

Operation and maintenance of the rehabilitated canal systems in an as-built condition will also require improvement in a number of related management

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and administrative support activities. Several general yet critical areas of needed improvement are delegation of authority, better utilization of work-force and discipline. Specific measures of performance need to be identified and utilized in periodic performance evaluations at all levels.

Certain administrative functions of the field working Divisions and Sub-Divisions need to be moved upward in the organization to the administrative Circle and Zone levels. With this administrative relief and given full responsibility and authority, the field working units could devote full attention to improved operation and maintenance. Unskilled field personnel should report directly to a first level of field supervision which has authority to hire, fire and discipline. Additional specialists are needed at the Division levels to deal with the many legal matters and public relations.

Inspection Systems

To ensure that the rehabilitated canal systems are properly operated and maintained, an independent inspection system is recommended at the Secretary level within each Province. This unit would conduct independent on-site inspections of the canal systems and equipment on a regular schedule. Maintenance deficiencies would be identified, the cost of repairs estimated and the items categorized and prioritized for remedial action. Progress on remedial actions would be continually monitored. Lack of action in correcting major deficiencies would be reported directly to the Secretary. Incentives to ensure success of the program would be provided through annual performance evaluation at each supervisory level.

Equipment Management

The canal operating units need additional equipment such as farm-type tractors, small trucks and hand tools in order to continually perform the

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routine day to day maintenance. The Mechanical Circles need additional heavy equipment in order to perform the larger recurring maintenance work of the canal operating units. Improvements are needed in the funding and cost recovery procedures associated with this additional heavy equipment. A modern management information system, which is needed in many areas, would be especially useful in the equipment management area. The Mechanical Circles also need improved management systems in the areas of stores, workshops, repair, overhaul, etc. to effectively support the increased equipment fleets. Adopting the concept of preventive maintenance is also central to this whole equipment effort.

Training

Most of the foregoing recommendations for improved operation and maintenance would also require appropriate training programs. Training is generally needed for technical and management skills improvement and manpower development. The primary thrust of required training would be toward implementation of these O&M recommendations.

Transport Systems

An improved transport system needs to be established for all levels of field supervision. This system is critical to effective operation, maintenance and inspection and could also provide considerable savings in the recurring costs of field housing and inspection bungalows. A study is needed in each province to determine the best means of providing such systems and the most appropriate vehicle configurations. A field test in each Province is proposed for this study and evaluation.

Tele-Communication Systems

Improved tele-communication systems are also needed in each Province to ensure proper operation and maintenance of the rehabilitated canal systems. This need is especially critical for canal operations during flood periods and emergencies. In many cases, the present antiquated systems are totally unreliable during these periods. Careful study and consideration will be necessary to maintain continuity of service and to supplement the existing systems with new/improved systems.

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Implementation

All of the foregoing recommendations for improved operation and maintenance of rehabilitated canal systems are contingent upon full funding of these programs in each Province. In view of the competition for funds, an on-going study of concern to full funding is that of "water charges and recovery". The PRC/Checchi advisory team is currently working on studies aimed at establishing equitable, reliable and productive ways to increase revenues including farmers ability to pay any increase in water charges.

The schedule for implementation of the operation and maintenance recommendations would be keyed to the canal system rehabilitation work to be undertaken in Phases I and II of Irrigation System Rehabilitation Project. The ISR schedule proposes completion of an average of 600 miles of main and branch canals and 3000 miles of distributaries and minors per year over the next 6-7 years. This rate of construction would allow gradual implementation of full funding of budgets, procurement of additional equipment and adoption of associated inspection, management and training programs necessary to support improved operation and maintenance of the rehabilitated systems. This overall schedule would also allow for a gradual increase in funding to implement improved operation and maintenance.

Chapter-I INTRODUCTION

General

The ISM Project sponsored by the Government of Pakistan and USAID, and the companion World Bank funded ISR Project consists of several components targeted towards the increased agricultural production on the more than forty irrigation systems in Pakistan. The primary tasks addressed by the PRC/Checchi team, among others, include:

- Improved methodology for redesign of canals.
- Rehabilitation of deteriorated canal systems.
- Equipment procurement and utilization.
- Strengthened operation and maintenance procedures for the rehabilitated systems.
- Upgraded training and management of the Provincial Irrigation Department staff.

This report addresses in particular the fourth task listed; however, there are such strong inter-relationships between all of the mentioned work items that any recommendation concerned with improving existing O&M procedures requires consideration of all other work items as well. It should be noted that ensuring that the various ISM components, such as Command Water Management and Research, are properly interfaced with the PRC/Checchi tasks is a part of the on-going coordination process. The important subject of tubewells is not covered in this report, since the subject is fully addressed in the SCARP transition project.

The purpose of this report is to present the findings of PRC/Checchi's multidisciplinary teams in the study of current O&M practices in Pakistan, in a set of recommendations designed to bring about improvement over existing methods. Appropriate action on these recommendations will come after their review by the Provincial Irrigation Departments,

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the Federal Government, and the donor agencies. Consequently, appropriate follow-on steps will be necessary to carry out the recommendations as approved.

The scope of the report is limited to making the recommendations, justifying the need for such actions, discussing the impacts and proposing an implementation schedule. In the context that these are feasibility study recommendations, a more complete and detailed program will have to be developed for each recommendation once it is accepted in principle.

It may be noted that most of the recommendations in this report focus on the subject of maintenance. This is because the configuration of the existing irrigation system in Pakistan has considerable constraints on options available for flexibility in operations, and thus improvements in maintenance would appear to give more beneficial results on a priority basis than limited operational improvements.

The implementation of the recommendations is phased. Since one of the objectives of the current ISR/ISM program is that the rehabilitated canals stay in good condition to avoid costly capital expenditures in the future, it is logical that improved practices be introduced on these particular canals, which automatically defines the rate at which the recommendations are implemented. In this connection, it should be pointed out that a "systems" approach to the rehabilitation of canals is proposed as it provides for an integrated and comprehensive canal design (remodelling) process. More important, in terms of maintenance, a system is identified with a Canal Circle, a convenient unit into which procedural, organizational and management changes can be introduced.

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O&M Universals

All irrigation systems in the world to sustain their effectivity must be properly operated and maintained. There are common aspects or 'universals' of good operations and maintenance which are present in all effective irrigation systems. Basically, these 'universals' can be categorized by disciplines and activities, and displayed in a matrix, as follows:

Disciplines	Activities			
	Planning	Implementation	Inspection/Review	Report
Operations	x	x	x	x
Maintenance	x	x	x	x
Equipment Management	x	x	x	x
Management/ Training	x	x	x	x

Figure - I-1 contains as illustrative chart, which shows in detail the various activities in each discipline as a project passes from the rehabilitation phase through the transition phase to the annual O&M phase. The more than one hundred items listed should be carefully considered in the context of the degree of their applicability to the specific system, and to the extent that these have been implemented so as to assess the current status of the system.

The Discipline-Activity matrix has been examined for the existing irrigation systems in Pakistan by the PRC/Checchi team. The results have been compared with the 'universals' in order to answer three questions about the four Disciplines and many detailed functions which comprise the Activities

contained within the above general matrix:

- Are the Disciplines and Activities all present in O&M practice in Pakistan ?

- If they are present, what is the relative stage of their actual development, modernization and/or implementation ?

- Assuming that redesigned/rehabilitated canals are to have considerably improved O&M practices, are the actual current Discipline and Activities sufficiently developed and modernized to support appropriate O&M practices ?

The conclusions drawn from the study are that all the Disciplines are present; but that detailed functions among the Activities in each of these are sometimes non-existent or very obsolete. Examples of these findings include:

1. The Discipline of Operations has extensive degrees of obsolescence scattered through its Activities. The Activities requiring attention in Operations are: criteria/standards; adequate water measurement devices and methods of measurement; Benchmark network and chainage markers (R.D.) up-dating; adequate and up-dated maps, files, inventory of facilities and longitudinal sections; introduction of participative systems to coordinate conveyance, delivery and drainage of water with farmer needs; improved coordination of inter-departmental policies and activities regarding priority of irrigation operations.

2. The Discipline of Maintenance is outdated in many instances. The Activities requiring attention in Maintenance are: modernization of criteria/standards; appropriate physical and financial yardsticks; right-of-way; adequate scheduling of maintenance; up-dated Schedule

of Rates; slow-moving, fractionated, small-scale contracting; lack of equipment at Sub-Divisional and Divisional levels; improved participative systems to coordinate maintenance with farmer support/needs; expanded coordination of inter-departmental policies and activities regarding priority of proper maintenance and enforcement of laws and regulations.

3. The Discipline of Equipment Management is very weakly equipped, staffed, organized, programmed and supported for action on O&M matters in each Province.

4. The Discipline of Management/Training for O&M is obsolete in many instances; and, in a number of cases, appropriate processes have never been developed for O&M.

   Examples of items needing up-dating include: authority and discipline; personnel planning and management; work unit responsibilities; job task load specifications; supervisory transport and communications; and control systems including budgeting and inspection.

   Examples of detailed functions that need to be instituted include: manpower development and training programs and effective programs for public relations, liaison, and participation among farmers and government agencies.

5. The Activity of Planning is currently not well-staffed or organized among the four Disciplines except for the annual budget planning and, in that case, analyses and presentation techniques could be improved.

6. The Activity of Implementation needs considerable concentrated effort to improve or activate actual performance of procedures

which are even currently prescribed: there are many good standing rules and regulations which would improve system O&M if these were only properly applied.

7. The activity of Inspection/Review needs more systemization in its organization and application among the four Disciplines. It is most developed with reference to certain budget controls prescribed by the Department of Finance and expenditure controls prescribed by the Auditor General. Basically, it needs strengthening in all other Disciplines.

8. The Activity of Reports is outdated in many cases. Modern management information systems could simplify and speed analyses of needed reporting.

A screening of these conclusions was made by the PRC/Checchi team to determine the priority needs for the newly redesigned/rehabilitated canals to be properly operated and maintained. An inter-related 'package' of eight general sets of Activities stretching across all four Disciplines has been developed. These are assessed as the more important, first priority undertakings needed for the long-term support of improved O&M practices for the redesigned/rehabilitated canals. The recommended undertakings in order of relative importance are:

- Full Funding Budgets
- Maintenance Yardsticks
- Management Systems
- Inspection Systems
- Equipment Management
- Training
- Transport Systems
- Tele-Communication Systems

Each one of these eight activities is discussed in considerable detail in the following Chapters.

CONSTRUCTION/REHABILITATION PHASE

TRANSITION PHA

Transfer to O&M

Planning/Design

PRODUCTS FROM CONSTRUCTION/ REHABILITATION PHASE CONCERNING O & M

CIVIL ENGINEERING

As-built Layout Drawings
Schematic Layout Drawings
Design Criteria
O&M Manuals (General)
Cadagtral Survey Maps
Inventory of Irrigation, Drainage, Tubewell, Small Dam, River Training Facilities Drill Hole Logs

MECHANICAL ENGINEERING

Appropriate Plan and Equipment

Performance Criteria

Plan and Equipment

MANAGEMENT/TRAINING

Inter-departmental controls and relationships

Organizational/management systems developed for rehabilitation work.

Objective-setting procedures

Land Title Register (Lal Kitab)

Communications

OPERATIONS

Design Standards/Criteria for Operations

Design Water Measurement Programs

Design Bench-mark Network

Design Cropping Pattern

Plan Cropping Calendar

Plan Safety Program

Design Offices and other required equipment

Plan Performance Indicators

Design plans to coordinate conveyance system operations with farmer distributary needs

MAINTENANCE

Develop Standards/Criteria for Maintenance of Irrigation, Drainage systems/structures, Tubewells, Small Dams, and River Training Works
Develop Tech. Performance Specifications and Conditions of Contract
Review Schedule of Rates
Review Cost Estimating Procedures 'Yardsticks'
Review O&M Manuals (General)
Plan Design Capabilities

EQUIPMENT MANAGEMENT

Select Plant and Equipment
Select Vehicle Fleet
Prepare Operation Schedule for Plant, Equipment, Vehicles
Prepare Maintenance Schedule for Plant, Equipment, Vehicles
Design Workshops and Stores
Develop Operational Procedures for Workshops and Stores
Develop Costing Criteria for Equipment.
Develop Economic Parameters for Equipment Use (Manual/ Mechanical)

MANAGEMENT ADMINISTRATION/ TRAINING

Plan Organization and Mgmt. Systems for O&M activities.
Design Job Specifications and work Units.
Develop systems of employment planning, compensation, performance appraisal, incentives, and discipline.
Develop criteria for recruitment, selection, orientation of personnel.
Design control systems of management including administrative procedures.
Design effective communications for mgmt. including physical systems.
Design liaison and participative systems for coordination in government and work with farmers.
Review legislative/litigation matters related to O&M
Design information and Public Relations programs re O&M
Design institutionalising of on-the-job, non-formal, and formal training programs in O&M

Note:

The Nodes are not time-related and are used only to define the inter-faces of the principal parts of each phase. However, the O&M work is an annual activity.

TRANSITION PHASE

Implementation — Start of Annual O&M Programme — Planning — Approval o

ions with

Install Water Measurement Devices
Install Bench Mark Network
Install Chaingage Markers (R.D.)
Install Headgate, Barrage, Structural and Tubewell operating procedures
Construct, equip offices, supervisory field quarters.
Install procedures relating water delivery to water charge assessment operations
Install programme performance indicators
Introduce safety measures
Install participative systems to coordinate conveyance system operations with farmer needs

Review/amend Cropping Pattern and Cropping Calendar
Prepare Operations Programme including Inspection a Schedule
Prepare Operations Reporting/Monitoring Programme
Prepare Cost Estimates
Prepare Plans for participation with farmers in re operat
Programme inter-departmental coordination on policie related work.
Prepare staff transport schedules
Schedule Operational staff conferences.
Develop contingency plans for emergencies

Drainage
Training
itions of

Establish design capabilities
Install O&M Manuals (Specific)
Introduce procedures for applying standards and criteria
Introduce a programme for prior tizing maintenance.
Install systems and procedures for maintenance work by contract and direct labor (Force Account)
Establish an interface between maintenance on the conveyance system and maintenance done by farmers on the distributary system.

Prepare Maintenance programmes, including Inspection schedules for canals, drains, tubewells, small dams, and river training works by (contract, direct labor ount)
Prepare staff transport schedules
Update Schedules of Rates, and cost estimating 'Yard sticks'
Prepare Cost Estimates
Prepare schedules to participated with farmers in revie tenance issues.
Schedule maintenance staff conferences
Review Training plans

icles
(Manual/

Position plant, equipment, vehicles and machinery and supplies
Equip Workshops and Stockpile Stores
Install equipment preventive maintenance programme
Install operational procedures for Workshops and Stores
Establish procedures for costing equipment operations

Test economic parameters for maintenance (manual and mechanical)

Introduce safety measures.

Fix Annual Schedules for Operation and Maintenanc Equipment, Vehicles.
Plan logistics to support Plant, Equpt. Vehicles.
Review procurement schedules for replacement of equp plant.
Prepare cost estimates
Prepare equipment maintenance reporting programme.
Review plans for equipment utilization (eg. rental o contractors,proportional use of equpt. to labor and tion; direct labor (Force Account)
Review training plans

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Activate and staff O&M organizations and planning/management systems.
Install personnel management procedures
Introduce management control procedures including management information systems, administrative systems, budgeting, external auditing, reporting.
Introduce procurement and logistics management systems
Install communications systems, including physical facilities.
Introduce intensive liaison with all levels of relevant government departments and irrigation-related programmes.
Install participative planning/monitoring procedures designed to coordinate conveyance system O&M with the needs/problems of farmer-operated distributaries.
Introduce proceduses for special handling litigation/legislate
Introduce in-house and external on-the-job, non-formal, and formal training programmes.
Introduce public relations and information programmes

Review, update all management systems, plans, and from transition phase.
Prepare and submit budget for O&M
Plan targets against which to measure budget performan
Plan schedules for participative planning/monitoring of ivities.
Plan monitoring/reporting activities
Plan legislative liaison and litigation-review activities.
Prepare communication schedules
Schedule/monitor inter-departmental Coordination on p substance
Schedule/monitor internal staff Corridination and confe
Prepare Public Relations and information activities.
Plan annual training activities for Civil Engineering, Engineering and Management as on-the-job, non-fo formal.

O & M PHASE – ANNUAL

rt of Annual | O&M Programme | Planning | Approval of Budget | Implementation

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stem

Review/amend Cropping Pattern and Cropping Calendar
Prepare Operations Programme including Inspection and Review Schedule
Prepare Operations Reporting/Monitoring Programme
Prepare Cost Estimates
Prepare Plans for participation with farmers in re operations
Programme inter-departmental coordination on policies, irrigated-related work.
Prepare staff transport schedules
Schedule Operational staff conferences.
Develop contingency plans for emergencies

Schedule/monitor hydrological data and operations (eg. wate livery, measure water delivery, water quality.)
Measure Canal Water Losses and Water storage
Record hydromet data
Monitor Water Table levels
Measure Drainage discharges
Monitor salinity levels
Execute plans for participation with farmers re operations
Coordinate inter-departmental policies, and substantive acth re operations.
Hold Operational Staff Conferences
Implement Emergency Procedures
Implement training programmes.

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Prepare Maintenance programmes, including inspection and review schedules for canals, drains, tubewells, small dams, structures, and river training works by (contract, direct labor Force Account)
Prepare staff transport schedules
Update Schedules of Rates, and cost estimating procedures, 'Yard sticks'
Prepare Cost Estimates
Prepare schedules to participated with farmers in reviewing maintenance issues.
Schedule maintenance staff conferences
Review Training plans

Preserve Rights-of-Way
Manual/Mechanical Maintenance of canals, drains, tube structures, small dams, access roads, river training works.
Provide Design Support Services
Award Contracts/supervise contractors, direct-labor (Forc count).
Monitor expenditures; and do reporting
Participate with farmers.
Coordinate inter-departmental activities
Hold Maintenance Staff conferences
Implement training programmes

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Fix Annual Schedules for Operation and Maintenance of Plant, Equipment, Vehicles.
Plan logistics to support Plant, Equpt. Vehicles.
Review procurement schedules for replacement of equpt., vehicles, plant.
Prepare cost estimates
Prepare equipment maintenance reporting programme.
Review plans for equipment utilization (eg. rental of equpt. to contractors, proportional use of equpt. to labor and animal traction; direct labor (Force Account)
Review training plans

Plant, Equipment, Vehicles Servicing and Overhaul
Provide logistics for Plant, Equpt., Vehicles.
Implement equipment use schedules
Monitor expenditures; and do reporting
Rent equipment for use by contractors
Comply with equipment use schedules for direct-labor (Forc count), contractor, and special 'mixes' of equipment, li animal power
Implement training programs

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Review, update all management systems, plans, and procedures from transition phase.
Prepare and submit budget for O&M
Plan targets against which to measure budget performance.
Plan schedules for participative planning/monitoring of O&M activities.
Plan monitoring/reporting activities
Plan legislative liaison and litigation-review activities.
Prepare communication schedules
Schedule/monitor inter-departmental Coordination on policies and substance
Schedule/monitor internal staff Corridination and conferences.
Prepare Public Relations and information activities.
Plan annual training activities for Civil Engineering, Mechanical Engineering and Management as on-the-job, non-formal, and formal.

Operate all relevant management procedures and systems.
Review budget expenditures
Monitor budget performance indicators
Monitor contractor performance
Operate communications
Monitor reporting activities and report on management
Monitor/support inter-departmental coordinator on poli substance.
Operate legislative liaison and litigation review activities.
Operate and monitor participative planning/review activities.
Operate and monitor participative planning/review activities.
Operate internal staff conferences/and coordination
Operate Public Relations and information activities.
Implement training plans.

REHABILITATION

UPGRADING/MODERNIZATION

NEW WORKS

HASE – ANNUAL

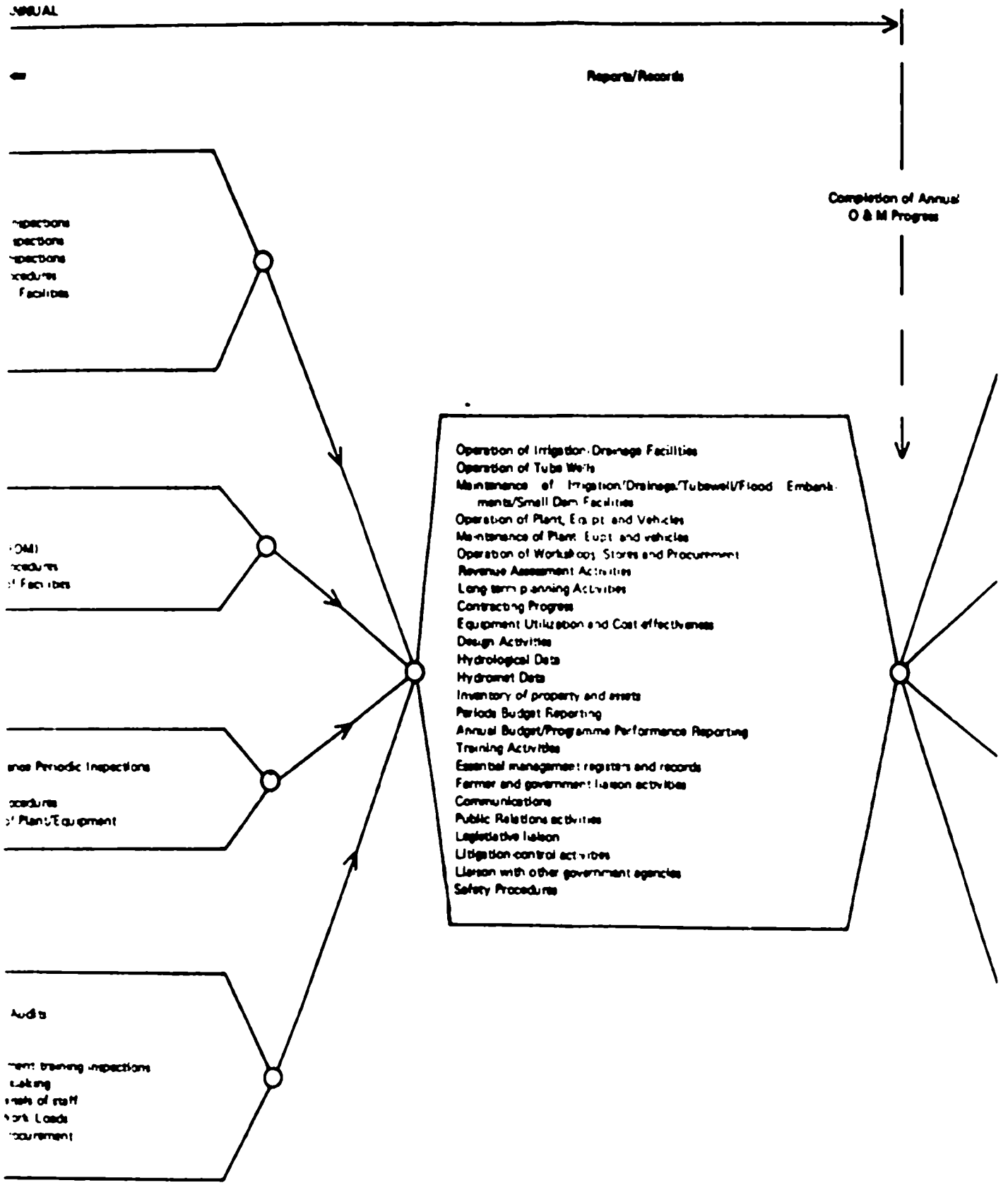
O&M PHASE – ANNUAL

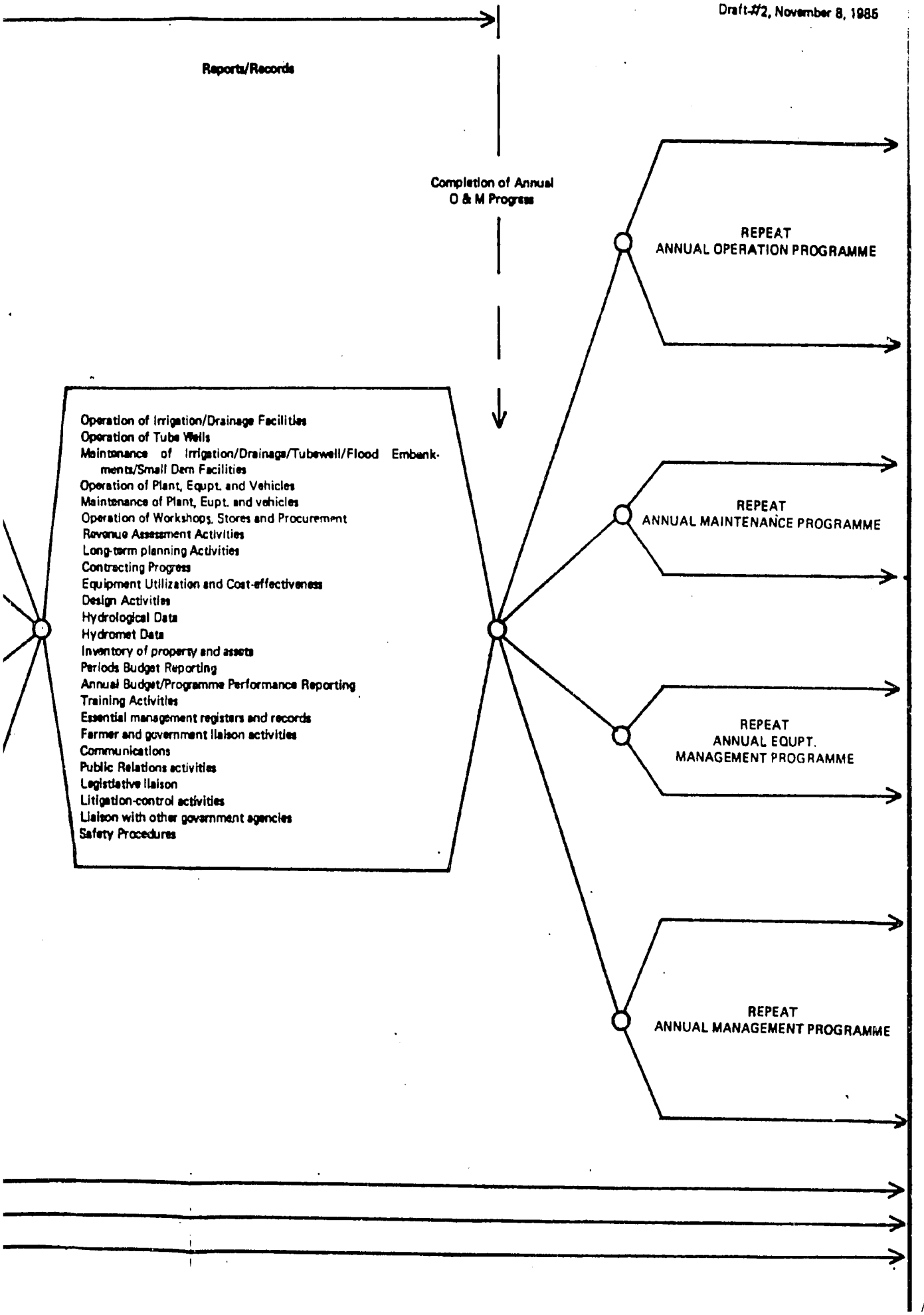
Implementation	Audit/Review
Schedule/monitor hydrological data and operations (eg. water delivery, measure water delivery, water quality.) Measure Canal Water Losses and Water storage Record hydromet data Monitor Water Table levels Measure Drainage discharges Monitor salinity levels Execute plans for participation with farmers re operations Coordinate inter-departmental policies, and substantive activities re operations. Hold Operational Staff Conferences Implement Emergency Procedures Implement training programmes.	Routine Technical Inspections Special Technical Inspections Annual Technical Inspections Check on Safety Procedures Annual Inventory of Facilities
Preserve Rights-of-Way Manual/Mechanical Maintenance of canals, drains, tubewells structures, small dams, access roads, river training works. Provide Design Support Services Award Contracts/supervise contractors, direct labor (Force Account). Monitor expenditures; and do reporting Participate with farmers. Coordinate inter-departmental activities Hold Maintenance Staff conferences Implement training programmes	Daily Inspections Special Inspections Technical Audits (ROM) Check on Safety Procedures Annual Inventory of Facilities
Plant, Equipment, Vehicles Servicing and Overhaul Provide logistics for Plant, Equpt., Vehicles. Implement equipment use schedules Monitor expenditures; and do reporting Rent equipment for use by contractors Comply with equipment use schedules for direct-labor (Force Account), contractor, and special 'mixes' of equipment, labor animal power Implement training programs	Daily Inspections Preventive Maintenance Periodic Inspections Special Inspections Check on Safety Procedures Annual Inventory of Plant/Equipment
Operate all relevant management procedures and systems. Review budget expenditures Monitor budget performance indicators Monitor contractor performance Operate communications Monitor reporting activities and report on management Monitor/support inter-departmental coordinator on policies/substance. Operate legislative liaison and litigation review activities. Operate and monitor participative planning/review activities. Operate and monitor participative planning/review activities. Operate internal staff conferences/and coordination Operate Public Relations and information activities. Implement training plans.	Work Performance Audits Budget Audits Audit Contracts Manpower development training inspections Annual Stores Stocktaking Performance Appraisals of staff Annual review of Work Loads Annual review of procurement

EHABILITATION

PGRADING/MODERNIZATION

EW WORKS


Reports/Records
Completion of Annual O & M Progress
Operation of Irrigation/Drainage Facilities
Operation of Tube Wells
Maintenance of Irrigation/Drainage/Tubewell/Flood Embankments/Small Dam Facilities
Operation of Plant, Equipment and Vehicles
Maintenance of Plant Equipment and vehicles
Operation of Workshops, Stores and Procurement
Revenue Assessment Activities
Long term planning Activities
Contracting Progress
Equipment Utilization and Cost effectiveness
Design Activities
Hydrological Data
Hydromet Data
Inventory of property and assets
Periodic Budget Reporting
Annual Budget/Programme Performance Reporting
Training Activities
Essential management registers and records
Farmer and government liaison activities
Communications
Public Relations activities
Legislative liaison
Litigation control activities
Liaison with other government agencies
Safety Procedures
Audits


Reports/Records
Completion of Annual
O & M Progress
REPEAT
ANNUAL OPERATION PROGRAMME
REPEAT
ANNUAL MAINTENANCE PROGRAMME
REPEAT
ANNUAL EQUPT.
MANAGEMENT PROGRAMME
REPEAT
ANNUAL MANAGEMENT PROGRAMME
Operation of Irrigation/Drainage Facilities
Operation of Tube Wells
Maintenance of Irrigation/Drainage/Tubewell/Flood Embankments/Small Dam Facilities
Operation of Plant, Equpt. and Vehicles
Maintenance of Plant, Eupt. and vehicles
Operation of Workshops, Stores and Procurement
Revenue Assessment Activities
Long-term planning Activities
Contracting Progress
Equipment Utilization and Cost-effectiveness
Design Activities
Hydrological Data
Hydromet Data
Inventory of property and assets
Periods Budget Reporting
Annual Budget/Programme Performance Reporting
Training Activities
Essential management registers and records
Farmer and government liaison activities
Communications
Public Relations activities
Legistlative liaison
Litigation-control activities
Liaison with other government agencies
Safety Procedures

Chapter-II FULL FUNDING BUDGETS

Introduction

Historically, in Pakistan spending on water projects has ranked second or third largest of all capital spending sectors. In the Sixth Plan (1983-88) capital spending on water projects at Rs. 32,000,000,000 (over the 5 years) stands at 10% of the national public capital investment. It now ranks as third after power, transport and communications.

Recurrent costs of Non-Development Budgets in each Provincial Irrigation Department are largest in the Punjab as exemplified by the 1985/86 NDB (see Table II-I) for that Province at Rs. 1,469,000,000 (U.S. $ 92,000,000). The total NDB for all four Provincial Irrigation Departments for Operations and Maintenance approximate Rs. 2,400,000,000 (U.S. $ 150,000,000) annually.

These large recurrent annual costs are charged against Provincial Government financial resources. Formerly, the irrigation systems produced enough revenues through water charges to farmers to equal the Operations and Maintenance costs. Today, this is not true so there is need for subsidization of these costs. In the Punjab, for example, subsidies have risen from Rs. 270,100,000 in 1980-81 to Rs. 564,500,000 in 1984-85 or an increase of 109% in four years. At the same time, despite the rising expenditures and subsidies the amount of deferred maintenance of the irrigation systems is increasing.

Budgetary policy, planning, control, monitoring, and management issues are each involved in this situation. As indicated in the section on "universals" for O&M, the existing budget systems in Pakistan are well-developed and reflect fixed policies and management practices. The PRC/Checchi advisory team has been tasked to look at these matters from four perspectives:

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Table II - I

1985/86 Non Development Budget
Punjab Irrigation & Power Department 4/

Facility		(Million Rupees) Operations 1/	Maintenance	Total
Canal Irrigation		274 3/	291	565
Flood Control & Drainage		37	43	80
Irrigation Dams		4	2	6
Tubewells		128	595	723
Equipment & Stores		18	1	19
	Subtotal	461	932	1393
Administration 2/		72	4	76
	Total NDB	533	936	1469

1/ Includes establishment; commodity & services and transfers-establishment is about 93% of the total.

2/ Includes medical services, research, training, land reclamation and cost of Chief Engineers, Superintending Engineers and certain other support organizations (54% of the total Administration cost).

3/ 33% of this expenditure is for collection of Special Revenue .

4/ Internal Table prepared from Grant No. 9, Punjab Irrigation Department.

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- Evaluation of the present yardsticks for estimating annual Operation and Maintenance budgets.

- Analysis of the Non-Development Budgets as policy instruments reflecting decision-making about Operations and Maintenance in each Provincial Irrigation Department.

- Determination of suitable applications of micro-computers to improve budget preparation planning and monitoring.

- Analysis of revenue sources particularly increased water charges, necessary to adequately support the operation and maintenance costs of rehabilitated canals. This is the subject of a separate series of policy studies organized and prepared by the PRC/Checchi advisory team.

Present Practice

Detailed procedures and proforma for preparing Non-Development Budgets concerning Operations and Maintenance exist in each Province. Budget preparation starts with the Executive Engineer at the Division level. Budget estimates under various headings for Operations and Maintenance are prepared and moved upwards in the system until a consolidated budget is prepared by the central authorities in the Department.

Detailed procedures, forms and restrictions are specified at each level by the Finance Department. These include a Budget Calendar, and numerous subject matter headings as well as specialised headings within subject matter fields. Some of the subject matter headings include: tubewells; canal irrigation; irrigation dams; flood control and drainage; etc.

Specialised headings include such matters as: repair and maintenance of durable goods, establishment, purchase of durable goods, commodities and services, extension and improvement, etc. In some provinces such as the Punjab 'Maintenance Yardsticks' have been developed by the Provincial

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Irrigation Department and sanctioned by the Department of Finance. These are used against the existing inventory of irrigation facilities and act as a base line for estimating proposed Operations and Maintenance budgets. These estimates include ordinary maintenance and special maintenance.

After completion of the budget returns by the staff, consolidation takes place at the level of the Secretary of the Provincial Irrigation Department. The Department of Finance then further consolidates the departmental budget returns, compares budget requests with estimated provincial revenue (the Provincial Irrigation Department staff must estimate anticipated revenues from water charges and other sources of income) and prepares a Demand for Grant that is submitted to the Governor and Assembly for approval.

Two significant aspects of this entire procedure are the unusual prominence of the Finance Department in the budgeting and final appropriation process and the great reliance placed upon budget and expenditure data of previous years.

Other aspects noted during the PRC/Checchi analysis of this entire process include:

- The different Provincial Irrigation Departments vary a great deal in how they assign Maintenance and Repair (M&R) costs as between Annual Development Programme (ADP) budgets and Non-Development Budgets (NDB) of provincial governments. Significant ADP sums are often assigned to 'deferred' O&M costs. Alternatively, numerous minor 'development' projects are funded through the NDB's.

- As contrasted to the ADP budget preparation process, where preparation of PC-1 disciplines exists, there appears to be a general lack of discipline in the preparation of annual NDB budgets.

- The Extension and Improvement NDB budget heading is often used

to avoid ADP-like planning discipline, e.g., as a means to start large and fairly long-term projects without adequate detailed review. It is also often used as a budgeting mechanism to meet numerous relatively minor demands for improvements from local landowners. These apply to the construction of small canal structures with little improvement in overall operation.

- Tubewells under Salinity Control and Reclamation Program (SCARP) are taking almost 50% of the annual O&M expenditures for Operations and Maintenance in Punjab and Sind. When combined with O&M expenditures on Reclamation in the Sind, the remaining funds for canals, barrages, and dams is less than 50%.

- Budget planning and procedures do not discriminate between what are major and minor areas of budget need and allocation. Hence, because of all the sub-headings of various items and the lack of relative importance among headings, it is difficult for executives to make judgements on budget issues.

- There is no capability to analyze alternative budgets. It requires too much effort to re-calculate the effects of re-allocation strategies or required cuts in some items.

- There are no simplified and rapid ways by which NDB budget monitoring and performance is done. Hence, monitoring and performance for NDB budgets lacks the precision and attention apparent in the ADP budget process.

Requirements

Full funding of improved O&M of rehabilitated canal systems will require specific changes in the present budgeting and monitoring procedure:

- Maintenance yardsticks should be reviewed and revised annually to reflect changes in construction methods and escalation of unit costs.

- Maintenance yardsticks, budget preparation procedures and monitoring of budget expenditures should be computerized to provide the capability for study of alternative budget strategy, rapid access to budget data, better budget presentation and better control of O&M expenditure.

- The initial PID budget presentation to the Finance Department should include alternative budgets which evaluate the future effects of less than full funding of budget demands.

- Monitoring of budget expenditures will require a combination of manual and automated data acquisition and retrieval systems which make current and projected expenditures available to decision makers in time for corrective action to be taken.

In addition to the immediate budget changes required, there are several long-term budget policies that require additional study. These are:

- Evaluation of revenue sources from direct and indirect beneficiaries of irrigation facilities such as public use of inspection roads, cattle water and bathing and domestic water supply.

- Revision of account heads to more nearly reflect proposed O&M procedures for rehabilitated canals (e.g., combining excavators, stores, machinery circle, workshops and durable goods heads into one major equipment account head).

- Separation of tubewell O&M costs from Irrigation Department NDB budget.

- Transfer of some present responsibilities for budget preparation and monitoring from the Division XENs to the Circle SEs.

- Separation of revenue assessment and reporting functions from Irrigation Departments.

Recommendations

Recommended actions to be taken by each Provincial Irrigation Department are:

1. Develop and update maintenance yardsticks applicable to rehabilitated canal systems. If no yardsticks exist as in NWFP and Baluchistan, a 3-man technical committee should be formed to develop appropriate maintenance yardsticks.

2. Complete computerization of maintenance yardsticks and budget preparation and monitoring procedures by the end of the 1985/86 fiscal year.

3. Adopt a budget strategy which ensures full funding for all rehabilitated canal systems over a 5-year period regardless of annual appropriation variations. Where full funding cuts cannot be avoided in a particular year, special deferred maintenance yardsticks should be used to calculate the deferred maintenance penalties for the following year.

Technical Discussion

The development of new maintenance yardsticks for rehabilitated canal systems is discussed in Chapter III of this report and examples presented. Although Punjab and Sind Provinces have been using yardsticks for budgeting for many years, none of the provinces have developed appropriate bases for estimating costs of improved O&M of rehabilitated canals systems.

Recommendation 2 can be implemented immediately. Since September 1985 the PRC/Checchi advisory team has completed elementary micro-computer based models of the Non-Development Budgets for NWFP, Punjab and Sind.

These are ready for adoption to IBM-PC equipment and very early use by each Provincial Irrigation Department.

Work has gone the furthest in the NWFP where abstracted NDB models plus a summary analysis spreadsheet and graphics package were developed. These were discussed with key Provincial Irrigation Department, Planning and Development Department, and Finance Department staff. They were demonstrated to budget office staff (including some orientation training on micro-computers). A similar modelling effort was completed in Sind, with very positive initial responses from PID officials.

Punjab modelling work was recently completed and is now ready for presentation to that Provincial Irrigation Department. No budget modelling work has been done in Baluchistan.

Attached is one example (focused upon M&R for irrigation canals) of the use of a micro-computer to assist in overall and task specific (O&M planning and monitoring) Budget Management. The attached was developed with basic "spreadsheet" software, which is the first and simplest technique used anywhere for Budget Planning and Management purposes. Sophisticated training is not required to build or use these models - only basic familiarity with computer generated spreadsheets.

Implementation of Recommendation 3 is dependent on the availability of computerized yardsticks and budget preparation procedures. With computerized budget models available, Irrigation Department executives can rapidly modify basic maintenance programs and prepare alternative budgets which show the cost effectiveness of various budget strategies.

The PRC/Checchi studies supporting Recommendations 1, 2 and 3 are identified as Task III of the 1985-86 Work Plan. Additional aspects of Task III are also discussed in Chapters III, IV and VI of this report.

Implementation

The schedule for implementation of Recommendation 1 is given in Chapter III.

Implementation of Recommendation 2 will be organized to take advantage of the work already completed in the Punjab, Sind and NWFP Provinces. Conversion of the present budget spreadsheets to Lotus 1,2,3 software and the IBM XT computer will require about 2 man-months of effort. Training a person in each Province in the use of spreadsheet programs will require 1 man-month for each PID. For Baluchistan, complete budget analyses will be required and an elapsed time of about 6 months is necessary.

Procuring and installing micro-computers for administrative uses such as budgeting,statistical analyses and monitoring has been scheduled for Sind but not the other provinces. Therefore, except for Sind, the lack of equipment may delay implementation of computerized budgeting to about July 1986.

Implementing Recommendation 3 depends only on implementation of Recommendation 1 and 2 and can be implemented by gradually improving the alternative assumptions upon which the budget is based.

Work Program

Activities should be organised in order to take advantage of what has already been started by the PRC/Checchi team. In this connection, the following is suggested:

- Each Provincial Coordinator should be authorised to organize work among selected Provincial Irrigation Department personnel and related department of finance personnel so that the micro-computerized 'spread sheet' techniques and useages can be introduced into the budgeting, planning and presentation

processes for FY 87/88. This means that the processes must be installed and operating not later than October 1, 1986.

Each Secretary of each Provincial Irrigation Department, assisted by the Provincial Coordinators where appropriate, should organize the departmental and inter-departmental committees essential to participating in the recommended actions. First priority should be given to the work already in hand by the PRC/Checchi team with reference to 'water charges' and 'farm repayment capabilities'. Participation in the review and further development of these studies should take place by such committees during the March-June 1986 interval.

At this point the primary requirement is continued concentration of Provincial Irrigation Department attention and resources to support completion of the above items. This means organization support where indicated and adherence to a schedule of activities.

Schedule

1986

February	Review of Report and Recommendations by Provinces.
March/April	Adoption of Recommendations.
March/April	Even as Recommendations are under review PRC/Checchi proceeds with the initiatives already started in

the NWFP and Sind to introduce micro-computerized spreadsheet budgeting for improved decision-making.

May/September and beyond

If the Recommendations are adopted the micro-computerized spreadsheet technique would be introduced in all four provinces according to the following general stages:

Stage 1 — 12 Weeks

PRC/Checchi advisor will work with the Provincial Coordinator and senior PID budget officers to review work done to date. They will determine the Department's preferences in terms of priorities (ADP, NDB, etc.); presentation formats; and the initial levels of analytical detail and flexibility required. The advisor will then use the Department's available budget materials to design, test, and present alternative versions of different budget and presentation models/formats.

With the assistance of the Department, the PRC/Checchi advisor will identify at least two qualified lower grade officers for training in computer operation and the use of software selected to meet the budget planning/management needs of the PID. Initial training will be arranged through a Pakistani computer/training firm.

Simultaneously, the PRC/Checchi advisor will assist in setting up a Computer Center suitably arranged, furnished and computer-equipped to perform the necessary functions.

Stage 2 — 4 Weeks

Selected PID staff sent to sub-contractor training in micro-computer use.

Reports and orientation sessions prepared to familiarize P&D and Finance Departments with PID budget plans and spreadsheet applications.

Preparation of the 1987/88 NDB budget plan and presentation using the new techniques.

Stage 3 — 4 Weeks

The PRC/Checchi advisor will work directly with the PID and the officers who have completed their training; and assist in introducing the new techniques, test, and 'debug' the initial budgeting models.

Costs

All costs of technical assistance, installation of Computer Centers, equipping of same, and intensive training of PID staff are covered in existing PRC/Checchi contract and USAID support arrangements.

Extensive training of PID staff could be carried on for a period of 6 months after completion of the intensive training - under USAID support through the PRC/Checchi contract. At the end of that time, each PID must be prepared to assume the recurrent costs of staff salaries, per diem, and other expenses that may be involved.

The same observation is true for the studies on water rates and farm repayment capabilities. All costs can be met from existing PRC/Checchi man-months and funds for the scope of work currently undertaken.

Management Impacts

Adoption of appropriate procedures associated with the micro-computer techniques described in this Chapter can ease and speed budget planning and monitoring in each Provincial Irrigation Department. Only two PID officers need to be trained in the techniques in each Province. Systems of coordination would have to be established with the Department of Finance and perhaps some training of their personnel would also be required. Overall, the management benefits to be realised are quite high and the required investment in altered procedures and training of staff is low.

Adopting the full-funding budget strategy that is also recommended does have major management implications as presented in Chapter IV on 'Management Systems'. However, these can be eased through phasing the application of the strategy over time and adopting procedures which confine management alterations to the redesigned/rehabilitated canals only as they are completed. Suggested budget-related management procedures for those canals include:

- Review the proposed engineering standards and revised maintenance yardsticks to establish realistic costs in establishing sustainable annual budgets for each canal.

- Establish performance indicators for budget monitoring against annually planned maintenance for each canal.

EXAMPLE OF MICRO-COMPUTER SPREAD SHEET-SIND

	1	2	3	4
1	SIND NDB - DEMAND 37			PAGE 8
2	CANAL IRRIGATION 6-523			
3	IRRIGATION WORKS			
4		Rupees	Percent	References
5	MAINTENANCE & REPAIRS	138710000	64%	PAGE 8
6	EXTENSION & IMPROVEMENT	76090000	35%	PAGE 12
7	MACHINERY & EQUIPMENT	3589000	2%	PAGE 14
8	TOTAL - CANAL IRRIGATION	218389000	100%	
9				
10	MAINTENANCE & REPAIRS 523-450		Percent	Percent
11			Subheading	TOTAL
12	IRRIGATION WORKS - MAIN CANALS			
13	SHAH AWAIS CANAL	2350000	8.51%	
14	KOTRI BARRAGE	4450000	16.12%	
15	DESERT CANAL	2400000	8.70%	
16	UNHAR WAH CANAL	1300000	4.71%	
17	BEGARI CANAL	2600000	9.42%	
18	SIND CANAL & BRANCHES	1000000	3.62%	
19	RAJIB CHATTI & GARANG CANAL	300000	1.09%	
20	LINED CHANNELS	2800000	10.14%	
21	THATTA SUJAWAL ROAD BRIDGE	750000	2.72%	
22	GUDDU BARRAGE - HEAD WORK	4850000	17.57%	
23	MAHI WAH	4800000	17.39%	
24				
25	SUB TOTAL MAIN CANALS	27600000	100.00%	20%
26				
27	IRRIGATION WORKS - FEEDER CANALS			
28	PAT FEEDER	275000	1.18%	
29	WEST FEEDER	2900000	12.47%	
30	EAST FEEDER	3200000	13.75%	
31	K.B. FEEDER	4900000	21.06%	
32	PINYARI FEEDER	4340000	18.65%	
33	FULELI FEEDER	4850000	20.85%	
34	BEGARI SIND FEEDER	2800000	12.04%	
35				
36	SUB TOTAL FEEDER CANALS	23265000	100.00%	17%
37				
38	Continued on page 6			
39				

28

	1	2	3	4
40	CANAL IRRIGATION 6-523			PAGE 9
41	IRRIGATION WORKS, Cont from page 8		Subtotal	Percentage
42			Percentage	TOTAL
43	OTHERS			
44	REPAIR GATES SUKKUR BARRAGE	67700000		49%
45	PUMPING SCHEMES			
46	SHADA BAHAR STATION	1750000	15.70%	
47	MAKHDOOM SAHAR STATION	1750000	15.70%	
48	LAKI SHAH SADAR STATION	775000	6.95%	
49	CHACHER SCHEME	1350000	12.11%	
50	NARA CANAL - MILE 1 to 44	1650000	14.80%	
51	NARA SCHEME D/S RDs 156,220,300	2550000	22.88%	
52	MALIR WEIR	170000	1.53%	
53	PANDHI WAH CHANNEL	750000	6.73%	
54	HYDERABAD GREEN BELT	300000	2.69%	
55	FASADI WAH	100000	0.90%	
56	SUB TOTAL PUMPING SCHEMES	11145000	100.00%	8%
57	MISC.OTHER			
58	MD. KHAN DISTY TAIL	200000	2.22%	
59	KOTRI SURFACE DRAINAGE	5500000	61.11%	
60	MAKHI DHAND DRAINAGE	1600000	17.78%	
61	MATLI BRANCH	100000	1.11%	
62	SERI FAZAL LINK CANAL	300000	3.33%	
63	LINK CANAL D/S KB FEEDER BYPASS	300000	3.33%	
64	R&M DADU-MORO BRIDGE	1000000	11.11%	
65	SUB TOTAL "MISC." OTHER	9000000	100.00%	6%
66				
67	SUB TOTAL OTHERS 523-459	87845000		63%
68				
69	SUMMARY M & R			Percent of
70				Total
71	MAIN CANALS	27600000		20%
72	FEEDER CANALS	23265000		17%
73	OTHER	87845000		63%
74	Sukkur Barrage Gates	Percent >	49%	
75	Pumping Schemes	of >	8%	
76	Miscellaneous	"Other" >	6%	
77				
78	TOTAL - IRRIGATION 6-520 - M&R	138710000		100%

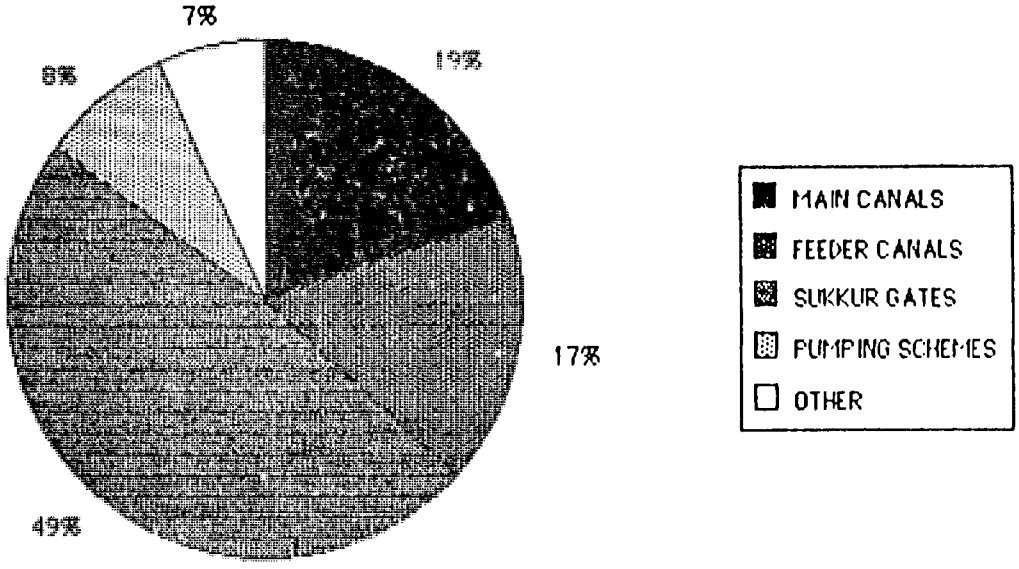
29

	1	2	3	4
79	MAINTENANCE & REPAIRS 525-400			PAGE 10
80				
81	OTHER IRRIGATION	Rupees	Percent	
82	EMBANKMENT & DRAINAGE - BUND	17540000	87.83%	
83	IRRIGATION WORKS	500000	2.50%	
84	MACHINERY AND EQUIPMENT	30000	0.15%	
85	OTHER CHARGES	1900000	9.51%	
86				
87	TOTAL OTHER IRRIGATION	19970000	100.00%	
88			Percent	Percent
89	EMBANKMENT & DRAINAGE 525-460		Subheading	Total
90	SUKKUR BARRAGE	8500000	51.52%	
91	KOTRI BARRAGE	3400000	20.61%	
92	GUDDU BARRAGE	4600000	27.88%	
93	SUB TOTAL BARRAGES	16500000	100.00%	83%
94	OTHER EMBANKMENT & DRAINAGE			
95	M&R - S.M.H.L.	160000	15.38%	
96	M&R KINJHER LAKE	401000	38.56%	
97	MACHINERY & EQUIPMENT - SUPPLIES	470000	45.19%	
98	" " - CARRIAGE	9000	0.87%	
99	SUB TOTAL OTHER	1040000	100.00%	5%
100	SUB TOTAL EMBANKMENT & DRAINAGE	17540000		
101	IRRIGATION WORKS - MAIN CANALS			
102	RAILS FOR DEMARCATION OF			
103	INDUS BOUNDARIES	500000	100.00%	3%
104	OTHER MACHINERY AND EQUIPMENT			
105	RESEARCH DIVISION	30000	100.00%	0.2%
106	OTHER M&R CHARGES			
107	INUNDATION INSPECTION BUNGALOW	200000	10.53%	
108	M&R RESEARCH DIVISION	1310000	68.95%	
109	DISCHARGE OBSERVATION CELL	55000	2.89%	
110	LAHORE REST HOUSE	35000	1.84%	
111	SOIL MECH & HYDRAULICS LAB	300000	15.79%	
112	SUB TOTAL - OTHER	1900000	100.00%	10%
113				
114	TOTAL M&R OTHER IRRIGATION	19970000		100%
115				
116				
117				

DEMAND 37 - MAINTENANCE AND REPAIR BUDGETS
DETAILS FOR CANALS AND "OTHER" HEADINGS

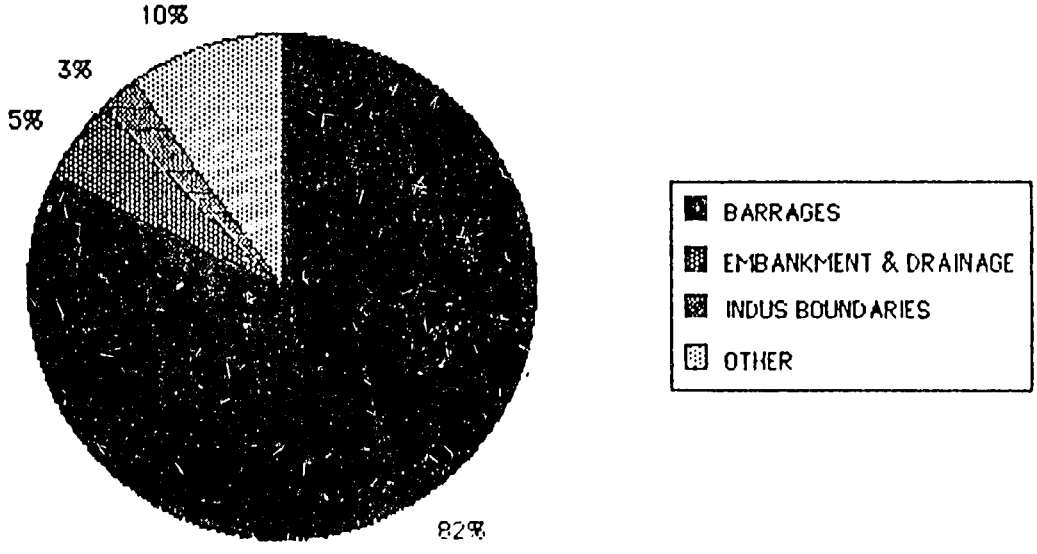
D.37 - M&R - CANALS

RS 138,710,000



D. 37 -M&R - OTHER

RS 19,970,000



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Chapter III MAINTENANCE YARDSTICKS

Introduction

The use of standardized estimates of the cost of carrying out various components of maintenance work simplifies the preparation of the departmental budgets discussed in Chapter II and expedites their approval by other affected organizations. This standardized estimate has been called a "yardstick" and takes the following form:

$$C = Q \times U$$

Where C = budget cost in Rupees

Q = quantity of work in any unit

U = cost per unit quantity of work

The quantity of work must be estimated from an engineering analysis using specified maintenance standards for that component or facility. The unit cost is taken from an analysis of the cost of recent completed work of the same or similar type.

This chapter reviews the canal system maintenance yardsticks now in use in Punjab Province, recommends changes in maintenance standards and construction methods and evaluates the impacts of the recommended changes on overall budgets. The analyses presented are based on data obtained for the Punjab Province only, althoug similar data are available from other Provinces. Similar analyses and recommended yardsticks will be presented in the near future for Sind, Baluchistan and NWFP Provinces. A review of yardsticks is also proposed for drains, barrages and flood control embankments.

The Punjab PID is required to maintain 13 barrages, 12 link canals, 23 canal systems serving over 20 million acres with over 20,000 miles of channels, 4000 miles of surface drains, 1500 miles of flood embankments, about 10,000 tubewells and 20 small dams. A list of these facilities is given in Table III-1.

Present Practice

Maintenance yardsticks were first introduced in the West Pakistan Irrigation Department in 1937. The basis for the quantities used in these early yardsticks is not known but the unit costs (rates) used were those approved for Work Order contracts. Since Work Order contracts involved mostly labor items, the 1937 Yardstick was primarily a measure of labor costs for various maintenance activities. It was used in all Provinces for budgeting purposes by applying a new multiplier each year.

The 1937 Yardstick was not revised until after the Provinces became autonomous in 1970. In 1981 when the Punjab Province revised the Yardsticks, the 1937 multiplier had reached about 16 and is now about 20. The 1981 Yardstick improved the quantity estimates by using typical values from actual expenditures on the Upper Jhelum and Lower Bari Doab Canal systems. It also used the 1979 Composite Schedule of Rates which was based on more realistic construction methods than used in the 1937 Yardstick.

The 1981 Punjab Yardstick is now being updated by the PID and will be used in preparation of the 1986-87 budgets. A summary of the updated yardsticks is given in Table III-2.

The present practice of maintaining canal cross sections in all PID canal systems relies heavily on the use of contractors who use labor intensive methods to accomplish the required earthwork. The quality and quantity of work of labor dependent contractors is limited, resulting in many contracts and extra administrative burdens on PID field staffs. The limited financial powers of XEN's (Rs.15,000 per contract) also tends to restrict the size of contracts and further attract labor dependent contractors. Labor contractors are also limited in the type of earthwork they can do effectively. For example, canal embankment compaction, road surface grading and excavation and placement of materials with long leads are beyond their capabilities. These operations can only be done with specialized equipment which only large contractors now have. However, large contractors are not interested in the small contracts available from PID sources. The experience gained in Phase I of the ISR Project has improved contractors performance and the quality of constructed works.

Requirements

Modern O&M practices cannot be put into practice unless adequate funds are available. These funds must be secured from other organizations such as financial and political bodies which evaluate competing claims for limited resources.

To secure adequate funds, the PIDs need a consistent and reliable method of calculating and supporting budget requests. Maintenance yardsticks are readily understood by non-engineers, can be easily computerized and have been in use in Punjab for almost 50 years. They only require updating to keep pace with escalation of construction costs and modern O&M practices.

The past practice of updating maintenance yardsticks by applying a multiplier to past yardsticks should be discontinued in favor of a more rational approach. The yardstick quantity should be updated separately and only when it is found to be inconsistent with desired standards while the unit cost should be updated annually to reflect general escalation of construction costs. Hence, yardstick values would require an annual modification of their unit costs before use in preparing the annual budget demand.

The yardsticks should be developed in a manner that allows their updating to be done by a computer program. Such a method could use the Construction Cost Index prepared quarterly by NESPAK to update the yardstick unit cost. Infrequent changes in maintenance standards could be easily made by minor revision of the computer program.

When yardsticks have an engineering basis and this basis has been agreed upon prior to preparation of the budget, they become the policy for allocating maintenance funds.

Recommendations

Recommended actions to be taken by:

1. The Punjab Provincial Irrigation Department:

   - Adopt the maintenance standards shown in Table III-3.

- Procure the types and quantities of equipment as shown in Tables III-4 and 5 on a schedule consistent with the implementation of canal rehabilitation programs.

- Perform annual maintenance work using both centralized and distributed equipment and reduce the present practice of labor contracting to specialized conditions only.

- Adopt the revised maintenance yardsticks shown in Table III-6 for budgeting the maintenance of rehabilitated canal systems (supporting yardsticks are shown in Tables III-2 and 7).

- Review and if necessary revise the 1985-86 yardsticks for maintenance of barrages, drains, flood embankments and small dams.

- Complete the application of computer based techniques to Maintenance Yardsticks.

2. Sind, NWFP and Baluchistan Provincial Irrigation Departments:

- Establish 3-man technical committees in each Province for developing maintenance yardsticks similar to those recommended for Punjab.

- Adopt a formal procedure for updating the yardstick quantities and unit costs annually.

- Apply computer based techniques such as spreadsheet analyses (i.e., Lotus 1, 2, 3 and Multi Plan) to expedite budget preparation.

Technical Discussion

The recommended actions given in the preceeding section for each PID have been followed in developing revised maintenance yardsticks for Punjab Province canal systems to demonstrate their suitability. A portion of the Rakh Branch of the Upper Depalpur Canal System in Punjab was rehabilitated in early 1984 under the World Bank program. It was inspected in November 1985 to assess the requirement for maintenance after about 24 months of operation. The Tando Adam Branch and the Shahdadpur Distributary of the Rohri Canal System in Sind were inspected in December 1985 for the same purpose. The results of these inspections were used to establish annual maintenance standards and requirements for canal embankments given in Table III-3.

The proposed Hydraulic Design Criteria requires continual removal of deposited sediment (silt removal) from various locations in the rehabilitated canal systems. The use of dredging will allow the work to be done over the entire year, eliminate the need for a closure period and provide for refilling of borrow areas.

The technique adopted for the removal of silt is dredging a trench 8-10 feet wide down the centerline of the channel. The length and depth of the trench will be selected to remove a designed quantity of material annually. Where the propose channel bottom width is 8 feet or less the channel will be widened sufficiently to accommodate a minimum size dredge. The quantity of material to be removed annuall from all Punjab canals (300 million cuft.) was estimated on the basis of available ACOP and PID measurements of sediment concentrations at major headworks and is shown in Table III-8. The unit cost of dredging in canals has been estimated to b Rs. 137 per 1000 cuft. of dry material (which does not include any cost of disposa or an average of Rs. 1760 per mile of distributary and minor channel.

Implementation

Canal System Maintenance

A summary of the proposed increase in canal system maintenance budget after all Punjab canals are rehabilitated is given in Table III-9.

Enhancement of the departmental O&M budget according to the proposed increase in maintenance yardsticks can take place gradually and in concert with

implementation of the rehabilitated systems. Although individual yardsticks are substantially increased, their combined effect on the Canal Irrigation portion of the Punjab Non-Development Budget will be about 10% (exclusive of inflation). The actual scheduling of budget increases required will be proposed after completion of analyses of yardsticks for the barrages, drains, flood embankments, small dams and tubewells.

The major implementation effort is scheduling the heavy capital expenditure required for procurement of additional equipment for the Punjab Mechanical Circle and the Canal Operating Circles. In terms of funding, the Mechanical Circle already has equipment which is equal to 15% of the total expenditure requirements for operation and maintenance of canals, drains and flood control embankments. Capital expenditures to procure the additional 85% and the new equipment to be utilized in the Canal Operating Circles can be scheduled according to the probable schedule for completing rehabilitation of the canal systems included in the ISR Project.

The present schedules and cost estimates for completion of Phase I and II of the ISR Project indicate an expenditure of Rs. 2.0 million spread over a period of about 7 years (July 1985 to July 1992).

	Phase I (1985-87)		Phase II (1987-92)		Total	
Province	Cost 1/ (Rs.M)	Circles Rehab. 3/	Cost 2/ (Rs.M)	Circles Rehab.	Cost (Rs.M)	Circles Rehab.
Punjab	563	-	600	10	1163	10
Sind	333	-	260	7	593	7
NWFP	67	-	85	2	152	2
Baluchistan	66	-	65	1	131	1
Total:	1029	-	1010	20	2039	20

An average circle contains about 200 miles of main and branch canals which costs about Rs.200,000 per mile to rehabilitate and 1200 miles of distributaries and minors which cost Rs.60,000 per mile giving a total cost of Rs. 112 M per canal circle.

1/ From ISM Work Plan, NESPAK, October 1985, p 15. plus foreign exchange windfall.

2/ Total estimated and distributed according to Phase I costs.

3/ Although no complete systems are rehabilitated in Phase I, work completed within the systems will allow greater progress in Phase II.

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Neglecting drains and other prior project components, the country-wide average annual rate of rehabilitations over the 7-year period is 600 miles of main and branch canals and 3000 miles of distributaries and minors. Hence, Phases I and II will complete about 60% of all canal systems.

The schedule for increasing the canal system maintenance budget and for procurement of O&M equipment items listed in Table III-4 and III-5 would be consistent with the above rehabilitation schedule. The average annual increase in the Punjab maintenance budget would be Rs. 15.2 M[1/] or about 1.0% of the total NDB for the Province. A 1.0% per year increase in the maintenance budgets (in real terms) of the other Provinces will probably be required to implement the revised yardsticks. Equipment procurement would require a capital expenditure of about Rs. 52 M per year over the next 6-7 years to supply the Canal Circles and Sub-Divisions in all Provinces (see Table III-4). The capital expenditure for additional equipment in the Punjab Mechanical Circle is estimated to be Rs. 62 M per year (see Table III-5) over the same period. Additional studies will be required to determine this cost for the Mechanical Circles in the other three Provinces.

Yardstick Study Schedules (PRC/Checchi Team)

Barrages

Select four of the fourteen barrages (Punjab) and inspect the condition of each to determine if the level of maintenance is adequate. If the level of maintenance is adequate, assume that the present yardstick are acceptable.

If the maintenance is not adequate, review existing standards, improve or develop as needed and estimate the annual work necessary to meet the revised/ new standards. Convert the work into unit costs to obtain a yardstick for each maintenance activity. Unit costs will be based on the Composite Schedule of Rates or other approved source of costs.

Completion of yardsticks for barrages for all Provinces will require 109 working days, and will be completed about July 01, 1986.

1/ [(187.9 - 81.5) ÷ 7] See Table III-9

Flood Embankments

In parallel with field inspection of barrages, inspect three to four flood embankments at each barrage site and evaluate present level of maintenance.

The Provincial flood embankment yardsticks will be completed July 01, 1986.

Drains

Select a range of sizes of drains that have been rehabilitated and inspect representative sections of each drain to:

1. Develop standards of maintenance that will ensure that the drain will maintain its rehabilitated sections and bed levels.

2. Estimate the annual maintenance requirements necessary to meet the standards.

3. Apply unit costs of the estimated quantities to obtain a yardstick for each maintenance activity. Unit costs will be based on the Composite Schedule of Rates or other approved source of costs.

Completion of the drain yardsticks for all Provinces will require about 60 working days and will be completed by July 01, 1986.

Management Impacts

Many management changes are required in each Provincial Irrigation Department when the recommended maintenance standards, equipment deployment, and funding levels are adopted in their entirety. These changes include: functional changes in Provincial Irrigation Department field systems; deployment, support, staffing, and use of equipment; minimizing the use of small private contractors on maintenance work; altering the tasks and developing the technical and supervisory skills of field staff, and annual updating of the recommended maintenance yardsticks. Other agencies involved in the use of recommended yardsticks include the following: Department of Finance; Department of Planning and Development; Department of General Services and Administration; Organization and Methods - Secretariat; Public Service Commission and Provincial Procurement Committee.

The gradual start-up schedule for design and construction of rehabilitated canal systems lends itself to a learn by doing management approach during the 1986-92 period. Inter-departmental study of applications of the recommended yardsticks on initial rehabilitated canal systems will produce improved management of succeeding canal systems.

TABLE III-1 - EXISTING IRRIGATION FACILITIES, PUNJAB

Facility	Source of Water	Design Capacity (1000 cfs)	Culturable Area Served (1000 acres)	Length of Main & Branch Channels (miles)	Length of Tributary Channels (miles)	Reservoir Storage Capacity (1000 Ac ft)
BARRAGES						
Islam	Sutlej River	275.0				
Sulemanki	-do-	325.0				
Balloki	Ravi River	225.0				
Sidhnai	-do-	150.0				
Marala	Chenab River	1100.0				
Khanki	-do-	810.0				
Qadirabad	-do-	900.0				
Trimmu	-do-	645.0				
Panjnad	-do-	700.0				
Rasul	-do-	850.0				
Kalabagh	Indus River	950.0				
Chashma	-do-	950.0				
Taunsa	-do-	1000.0				
LINK CANALS						
Marala Ravi(MR)	Chenab River	22.0	157.2 1/	65	190 1/	
Bombanwala Depalpur (BRBD)	-do-	4.5	414.8 1/	128	314 1/	
Upper Jhelum (UJ)	Mangla Res.	9.0		88		
Balloki-Sulemanki (BS-I)	Ravi River	18.5		54		
Balloki-Sulemanki (BS-II)	-do-	6.5		38		
Qadirabad-Balloki (QB)	Chenab River	18.6		103		
Rasul-Qadirabad (RQ)	Jhelum River	19.0		30		
Chashma-Jhelum (CJ)	Indus River	21.7		90		
Trimu-Sidhni (TS)	Chenab River	11.0		44		
Sidhnai-Mailsi-Bahawal(SMB)	Ravi River	14.0		78	20	
Taunsa-Panjnad (TP)	Indus River	12.0		38		
Pakpattan-Islam (PI)	Pakpattan Canal	1.1		24		
Sub-Link (BRBD)				2		
Sub total:			572.0	782	524	
CANAL SYSTEMS						
Central Bari Doab(CBDC)	BRBD Link	2.6	654	66	567	
Upper Depalpur (UDC)	BRBD Link	2.3	350	114	946	
Lower Depalpur (LDC)	BS Link	4.0	612			
Upper Chenab (UCC)	Chenab River	16.5	1434	115	868	
Lower Chenab (LCC)	CJ Link	12.3	3030	454	2494	
Lower Bari Doab (LBDC)	UCC & QB Links	8.7	1670	168	1355	
Haveli	CJ Link	5.7	1017	43	142	
Sidhnai Canal	TS Link	4.0		140	851	
Rangpur Canal	CJ Link	2.7	345	90	309	
Muzaffargarh Canal	Tarbela Res.	8.3	820	151	849	
D.G. Khan Canal	-do-	14.5	904	223	904	
Upper Jhelum Canal(UJC)	Mangla Res.	9.0	544	67	626	
Lower Jhelum Canal(LJC)	-do-	5.3	1518	252	1286	
Thal Canal	Tarbela Res.	7.5	1912	243	1988	
Bahawal Canal	SMB Link	2.5	731	150	790	
Qaim Canal	PI Link	0.5	42	7	53	
Mailsi Canal	SMB Link	3.7	687	70	629	
Punjnad Canal	TP Link	10.5	1351	209	1431	
Pakpattan Canal, Upper	BS Link	6.6	1269	222	1131	
Pakpattan Canal, Lower	SMB Link					
Ford Wah	BS Link	3.5	426	96	400	
Sadqia	BS Link	5.1	1040	129	780	
Abbasia	TP Link	1.4	235	44	259	
Sub total:			20591	3835	18651	
INUNDATION CANALS						
Muzaffargarh Inundation	Indus River		34.9		55	
D.G. Khan Inundation	-do-		16.0	15	5	
P.D. Khan	Jhelum River		6.3	16		
East Grey	Sutlej River		60.6		58	
Total:			117.8	3866	19293	

TABLE III-1 Contd...

Facility	Source of Water	Design Capacity (1000 cfs)	Culturable Area Served (1000 acres)	Length of Main & Branch Channels (miles)	Length of Tributary Channels (miles)	Reservoir Storage Capacity (1000 Ac f
TUBEWELL SYSTEM						
Scarp I	Ground Water	6.0				
Scarp II	-do-	8.4				
Scarp III	-do-	6.3				
Scarp IV	-do-	3.8				
Scarp Shahpur lxll	-do-	4.2				
Scarp Shorkot-Kamalia	-do-	0.2				
Scarp Ford Wah-Sadqla	-do-	0.2				
Scarp Panjnad-Abasia	-do-	1.3				
Scarp III (Saline)	2/	0.7				
Scarp II (Saline)	2/	1.1				
SURFACE DRAINS						
Sargodha Regin				1497		
Faisalabad Region				1161		
Lahore Region				1179		
Multan Region				165		
Bahawalpur Region				202		
Sub total:				4204		
FLOOD EMBANKMENTS						
Flood Bunds	Indus River			355		
Flood Bunds	Jhelum River			55		
Flood Bunds	Chenab River			672		
Flood Bunds	Ravi River			244		
Flood Bunds	Satlej River			212		
Sub total:				1538		
SMALL DAMS						
Rawai	Korang River		0.4		14.0	47.6
Misriot	Domel Kas		0.1		1.6	0.6
Sipiala	Sipiala Kas		0.1		3.0	0.6
Tanaza	Tanaza Kas		0.1			0.1
Bango	Chhabbar Kas		0.1		1.8	0.2
Gurabh	Gurabh Nala		0.5		3.0	0.6
Ratti Kassi	Nurpur Kas		0.6		4.4	1.7
Narali	Tributary of Nalisar River		0.3		1.5	0.7
Dungi	Hachiari Nallah		0.4		3.0	1.6
Dhurnal	Nikki Nallah		0.3		4.0	1.6
Dhok Tahlian	Siran River		0.8		6.0	1.4
Qibla Bandi	Tributary of Indus		0.9		3.0	1.8
Kanjoor	Kanjoor Kas		2.5		5.0	2.6
Channi Bor	Channi Bor Kas		1.5		2.0	2.0
Khokhar Zer	Bhitti Nala		1.2		5.0	3.3
Garat	Garat Kas		1.6		3.5	2.2
Walana	Narala Nala		1.2		4.0	2.2
Khasala	Khasala Nallah		2.2		2.2	2.4
Surlah	Surlah Nallah		1.6		2.0	1.9
Shahpur	Nandna River		4.5		11.7	14.4
Namal			12.1		21.0	
Sub total:			33			

Foot notes

1/ Direct offtakes from link canal

2/ Pumped to drains

Canal Miles = 5,000 feet

TABLE III-2 UPDATED YARDSTICKS PROPOSED FOR 1986-87, PUNJAB

Facility	Unit	Yardstick Rate 1/
Main Canals and Branches:		
Over 15,000 cfs.	Rs/mile/year	23,500
10,000 - 15,000 cfs.	Rs/mile/year	17,200
5,000 - 10,000 cfs.	Rs/mile/year	13,000
1,000 - 5,000 cfs.	Rs/mile/year	11,300
200 - 1,000 cfs.	Rs/mile/year	9,366
Link Canals:		
10,000 cfs. up	Rs/mile/year	26,475
10,000 cfs. down	Rs/mile/year	17,100
Lined Canals (5,000 - 10,000 cfs.)	Rs/mile/year	34,700
Distributaries and Minors	Rs/mile/year	4,000
Barrages and Headworks	Rs/cfs/year	2.60 - 6.50
Flood Embankments:		
With wetting channels	Rs/mile/year	39,800
Without wetting channels	Rs/mile/year	26,300
Drains:		
0-10 ft. bed width	Rs/mile/year	3,300
10-15 ft. bed width	Rs/mile/year	10,400
15-25 ft. bed width	Rs/mile/year	16,200
25-50 ft. bed width	Rs/mile/year	30,000
Small Dams	1000 Rs/dam/year	30-725
River Surveys 2/	Rs/mile/year	3,000
Durable Goods 3/		
Vehicles	1000 Rs/year	1,200
Equipment	1000 Rs/year	400
Furniture	1000 Rs/year	400
Gauge and Discharge:		
Rivers	Rs/station/year	11,100-68,800
Canals	Rs/station/year	7,600
Nullahs	Rs/station/year	8,355
Water stage recorders	Rs/station/year	5,000
Automatic rain gauge	Rs/station/year	5,500

1/ Does not include operation (establishment costs).

2/ Includes planetable and cross section surveys.

3/ Maintenance and replacement costs.

TABLE III-3 MAINTENANCE STANDARDS FOR REHABILITATED CANALS

Item	Annual Maintenance Required
Canal embankments	
Inspection Road	Replace 5 inches of material along 20% of total length, grade 6 times per year, restrict use to inspection staff. The Highway Department must provide alternate roads on all unpaved embankments now being used by public. No dowels will be included in the design section.
Outer Slopes (includes 4 foot road shoulder)	Replace 10 inches of material along 20% of total length, repair 250 rain cuts per mile, remove all trees and brush, maintain turfing where feasible and control weed growth to facilitate inspection of seepage on outer slopes.
Inside Slopes	Provide 50 feet of killa bushing per mile to correct and prevent erosion as necessary; maintain turf on inside slopes above water surface and cut weeds as necessary to facilitate surveillance of canal prism. No berms will be included in the design section.
Silt Removal	Remove by dredging an average of about 15,000 ft^3 of material per mile of canal at selected locations. Cross-sections will be measured at downstream locations to be sure sediment concentrations remain within design limits.
Dredge Spoil Disposal	Initially the sediment removed directly from the canal will be placed along the toe of the canal. It may be necessary to purchase storage areas adjacent to the sediment trap sites. However, there is evidence that the sediment has a market value that may offset the cost of disposal. A marketing study will be made to verify this. In the meantime, as sediment is removed, a better evaluation of the potential problem can be made when the exact amounts and location are determined.
Canal Structures	
Mechanical	Inspect all gates, gate hoists and steel accessories annually and repaint, repair or replace as needed during the canal closure period. A miscellaneous cost is included for this work.
Stilling Basins	Provide 50 feet of killa bushing and 25 feet of brick pitching downstream of each structure.

TABLE III-4 O&M EQUIPMENT REQUIRED IN CANAL CIRCLES
(AT DIVISION AND SUB DIVISION)

Equipment Item	No Required Per Circle 1/	Unit Cost (Rupees)	Total Capital Cost (Million Rs)	Economic Life (Years)	Annual Replacement Cost, ea. (1000 Rs/Yr)	Annual O&M Cost		Total OM&R Cost Per Circle 2/ (1000 Rs/Yr)
						% of Unit Cost	(1000 Rs/Yr)	
Tractor trolley 2 wheeled trailer, locally made.	17	20,000	0.3	10	2.00	5	1.00	51
Rear end Dump Truck, 2 tons capacity, 4 x 4 drive.	9	320,000	2.9	15	21.00	30	96.00	1053
Farm tractor 25 HP with scraper, 3 pt. hitch, PTO, 7' lifting book, 6' bush hog, 5'mower and trailer.	17	400,000	6.8	10	40.00	30	120.00	2720
Pickup Truck, 4 x 4, 3/4 ton.	9	200,000	1.8	5	40.00	30	60.00	900
Pickup Truck, tandem seat, 1/2 ton.	8	250,000	2.0	5	50.00	30	75.00	1000
Water tank 1000 gallons self filling with spray bar with tractor tow hitch.	9	250,000	2.2	25	10.00	5	7.50	158
Chain saw, 17" bar.	27	5,000	0.1	3	1.70	10	0.50	59
Mobile flood lighting set.	1	225,000	0.2	5	45.00	10	22.00	67
Hand tools set.	9	100,000	0.9	3	33.00	-	-	297
			17.2					6305

Equipment Yardstick $= \frac{6,305,000}{1,290}$ = Rs.4,900/canal mile.
canal

1/ An average operating circle is assumed to serve 1290 miles of channel and includes 3 divisions, 1 headworks sub-division and 8 canal sub-divisions. Equipment is to be assigned to the headworks and canal sub-divisions.

2/ Annual cost to be charged against circle. OM&R cost of Mechanical Circle equipment used on O&M work in Canal Circle is included in the hourly rental rates and the unit cost of [illegible]

TABLE III

TABLE III-5 TOTAL EQUIPMENT REQUIRED IN THE MECHANICAL CIRCLES FOR MAINTENANCE OF PUNJAB CANAL SYSTEMS

Equipment Item	Units Required	Units Available	Unit Cost (million Rs.)	Usage F (Rs./hc
Dredge, 8 ft. Mud Cat	31	2	1.37	272
Dredge, 10 ft. Mud Cat	31	0	2.05	388
Tractor Dozer, Caterpillar D3 class	47	0	0.60	120
Tractor Dozer, Caterpillar D4 class	10	0	0.80	160
Backhoe, Hydraulic Caterpillar 212 class	50	0	1.50	160
Backhoe, Hydraulic Caterpillar 224 class	45	0	2.40	256
Dump Trucks, 10 tons	45	11	1.20	200
Dump Trucks, 15 tons	18	0	1.50	250
Backhoe, Hydraulic Caterpillar 245 class	4	10	4.00	700
Road Grader, Caterpillar 120 G class	3	10	1.20	176
Compactor, 1 ton S.P. Vibrating	9	15	0.06	50
Compactor, 6 tons Vibrating	3	5	0.91	100
Water Tanker, 2500 gallons	3	12	0.90	100
Pump, 2" x 2"	10	0	0.005	20
Mobile Workshops	5	2	1.80	*
Fuel Trucks, 1500 gallons	5	0	0.50	*
Mobile Crane, 15 tons (Rough Terrain)	2	0	2.40	*
Tractor Trailer, 30 tons	2	9	4.80	*
Lube Trucks	5	2	1.00	*

Equipment Procurement

- Cost of equipment required for O&M = Rs. 468,000,000
- Cost of equipment to be procured for O&M = Rs. 406,000,000
- Average procurement rate (406/6.5) = Rs. 62,000,000/year

* Rental Cost is included in rates of other equipment.

Table III-6 REVISED YARDSTICKS FOR O&M OF REHABILITATED CANAL SYSTEMS PUNJAB[1/]

(Rs. Per Canal Mile)

Item	Distributaries & Minors (30-200cfs)	Main and Branch Canals					
		200 to 1000 cfs.	1000 to 5000 cfs.	5000 to 10000 cfs.	10000 to 15000 cfs.	> 15000 cfs.	Lined Canals 5000 to 10000 cfs.
Length (Canal Miles) 23,226	19274	1091	1482	576	280	145	378
Embankment Repair	(2385)[2/] 2340	(7009) 5772	(7465) 8815	(8048) 12300	(8525) 15180	(8843) 15732	(8048) 12300
Structure Maintenance	(395) 836	(672) 2718	(672) 3186	(672) 4020	(672) 5195	(672) 5609	(672) 2148
Erosion Control [3/]	(632) 278	(632) 1426	(2094) 1650	(3860) 1872	(6870) 2616	(12872) 2616	(25410)[4/] 25410
O&M Equipment[5/]	(45) 4900	(45) 4900	(45) 4900	(45) 4900	(45) 4900	(45) 4900	(45) 4900
Vehicles [6/]	(54) 216	(264) 1056	(264) 1056	(264) 1056	(264) 1056	(264) 1056	(264) 1056
Road Maintenance [7/]	440	440	440	440	440	440	440
Silt Removal [8/]	1760	1760	1760	1760	1760	1760	1760
Canal System Yardstick	(4000) 10770	(9400) 18072	(11300) 21807	(13000) 26348	(17200) 31147	(23500) 32113	(34700) 48014

1/ Does not include establishment costs.
2/ Figures in parentheses are yardstick values proposed by Punjab PID for 1985/86.
3/ Protection of water side of embankment (50 ft of Killa Bushing per mile).
4/ Assumes replacement of 1% of the total lining.
5/ OM&R cost of maintenance equipment assigned to sub-divisions (does not include dredges).
6/ Taken as four times PID estimate to include OM&R cost for new vehicles for maintenance staff.
7/ Assumes no public use of canal bank inspection roads.
8/ Based on removal of 300 million ft^3 per year from all Punjab Canals at a cost of Rs. 41 million

TABLE III-7 STRUCTURE MAINTENANCE YARDSTICK

Channel Capacity (cfs.)	(Rs. per mile) Killa Bushing 1/	Brick Pitching 2/	Earth work 3/	Miscellaneous 4/	Structure Yardstick (Rs/mile)
Main and Branch Canal:					
100 - 1,000	1,426	778	314	200	2,718
1,000 - 5,000	1,650	906	380	250	3,186
5,000 - 10,000	1,872	1,294	604	250	4,020
10,000 - 15,000	2,616	1,556	773	250	5,195
> 15,000	2,616	1,818	925	250	5,609
Lined Canal (5,000-10,000)	-	1,294	604	250	2,148
Disty. & Minor (30-200)	278	232	126	200	836

1/ 50 feet of channel length per major structure.

2/ 25 feet of channel length per major structure.

3/ 50 feet of channel length per major structure.

4/ Painting, patching and repair.

5/ Channels average one major structure per canal mile (minor structures such as outlets and bridges are neglected).

TABLE III-8 SEDIMENTATION IN PUNJAB CANAL SYSTEMS 1/

Canal System	Average Concentration (p.p.m.)	Design Discharge (ft^3/s)	Irrigated Area (1000 acres)	Total Sediment ($10^6 x ft^3/Y$)	Sediment Per Acre (ft^3/Year)
CBDC	130	2600	655	4.4	6.7
DCC	120	6300	962	14.0	14.6
UCC	130	(16500) 2/	1436	14.4 3/	10.3 3/
LCC	130	12300	3030	30.5	10.0
LBDC	160	8700	1669	26.9	16.1
Haveli	100	(5700) 2/	1017	12.1 4/	11.9 4/
Sidhnai	120	4000			
Rangpur	100	2700	345	5.0	14.5
Muzaffargarh	160	8300	820	25.7	31.3
D.G. Khan	160	14500	903	44.9	49.7
Upper Jhelum	70	(8800) 2/	544	2.4 5/	4.4 5/
Lower Jhelum	70	5300	1518	6.6	4.3
Bahawal	110	2500	730	5.2	7.1
Thal Canal	160	7500	1912	23.2	12.1
Qaim Canal	130	500	42	1.3	31.0
Mailsi	120	3700	695	8.3	11.9
Panjnad	130	10500	1352	26.0	19.2
Pakpattan	160	(6600) 2/	1273	19.2 6/	15.1 6/
Sadqia	150	5100	1042	14.6	14.0
Abbasia	130	1400	235	3.5	14.9
Ford Wah	150	3500	424	10.0	23.6
			Total:	298.2	14.6

1/ Sedimentation is calculated as the concentration of the incoming water multiplied by the amount of water entering the system during a year. The incoming concentration of sediment that may settle in the system, and that will not go into the fields, has been estimated on the basis of very scarce information.

2/ Canal is a feeder canal (partly). Design discharge can therefore not be used for calculation of sedimentation in the system.

3/ The unit rate of sedimentation in UCC and LCC is assumed to be the same.

4/ The unit rate of sedimentation in Haveli and Sidhnai is assumed to be the same.

5/ The unit rate of sedimentation in Upper Jhelum and Lower Jhelum is assumed to be the same.

6/ The unit rate of sedimentation in Pakpattan Systems is assumed to be uniform.

$$\text{Silt Removal Yardstick} = \frac{298.2 \times 10^6 \times 137}{23,226} = \text{Rs. } 1760 \text{ / mile}$$

TABLE III - 9 COMPARISON OF BUDGETS, PUNJAB 1/

Canal Capacity (cfs)	Estimated 1992/93 Rehabilitated Length (miles)	PID 1985/86 2/ Yardstick (1000 Rs. per mile)	PID 1985/86 2/ Budget (Million Rupees)	Prop. Yardst. (1000 per mi
Main Canal & Branch				
200 - 1,000	669	9.4	6.3	18.1
1,000 - 5,000	908	11.3	10.3	21.8
5,000 - 10,000	353	13.0	4.6	26.3
10,000 - 15,000	172	17.2	3.0	31.1
· 15,000	89	23.5	2.1	32.1
Lined Channels	232	34.7	8.0	48.0
Distys & Minors	11,800	4.0	47.2	10.8
Total:	14,223	-	81.5	-

1/ From Main Canal portion of Canal Irrigation accounts (Acct. Head 6-523, Main Canals).

2/ Under consideration but not approved. Does not include M&R of durable goods.

3/ Proposed by PRC/Cheechi and assumes constant 1985 costs.

Chapter IV MANAGEMENT SYSTEMS

Introduction

The management presented in this paper concerns systems by which improved operation and maintenance for rehabilitated canals are organized, supervised, administered, staffed, and monitored.

These will be quite different than those management systems currently used in Pakistan to operate and maintain unrehabilitated canals. The differences originate in the emphasis upon establishing, funding, and enforcing the operation and maintenance standards as recommended in the Maintenance Yardsticks developed by this team.

In summary, the following illustrations contrast notable differences in management needs between those associated with present management systems in Pakistan and those essential to meeting the recommendations:

	Present		Proposed
-	Low capital and high human/animal labor intensity in maintenance work.	-	High capital and low human/animal labor intensity in maintenance work.
	Supported by management systems relying upon employment of non-specialized labor with limited supervision and high rate of use of contractors.		Requires management systems that are designed to provide carefully selected dispersed equipment; technically trained staff; logistics and preventive equipment maintenance adequate supervision; and use of few contractors.

Relatively low standards of maintenance are achievable.	Relatively high standards of maintenance are achievable.
- Non-field tested quantity/ cost estimate of maintenance requirements per unit.	- Field-tested quantity/cost estimate of maintenance requirements per unit.
Supported by limited budget management systems based on quantity/cost estimates and annual increments.	Requires dynamic budget management systems based on adequate quantity/ cost estimates and alternative budget analyses capabilities.
Under-funded and inadequate maintenance results.	Fully-funded and adequate maintenance results.
- Daily inspection of maintenance conditions without periodic review by supervisors.	- Independent inspection of canals, facilities and equipment accompanied by training in daily inspection, with deficiencies categorized and penalties for failure of timely remedy.
Management systems only partially supported because of many other assigned tasks and weakened supervision.	Management systems which are professionally staffed, operated and independently oriented to applying inspection techniques with formal procedures for categorizing, reporting and monitoring/penalizing follow-on actions or non-actions.

Lack of early identification and priortised remedy of defects results.	Defects in canals, facilities and equipment are identified and appropriate early maintenance and preventive repairs enforced.
- Combined engineering and administrative supervision of numerous functions including operation, maintenance, revenue, etc.	- Differentiated engineering and administrative supervision of specific functions related to maintenance only.
Management systems designed for operation by engineers acting as generalists in a number of subjects.	Management systems designed for operation by engineers acting as specialists on particular functions supportive of mechanized, high standard, fully-funded, adequately inspected systems.
Diffusion and dispersion of responsibility, authority, and attention to results.	Concentration and definition of responsibility, authority, and attention to results.
- Physical communications via telegraph and telephone and limited supervisory transport.	- High speed and frequent physical communications with adequate coverage by telephone, telegraph, radio tele-communications, and a network of appropriate supervisory transport.
Management systems based on movement of limited information by physical means and reduced transport facilities.	Management systems based on integrated use of reliable physical communication facilities and adequate number, types, and logistically supported supervisory transport equipment.

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- Results in limited information flows and sporadic and restricted field supervision.

- Results in full, timely, information flows and high frequency of field supervision of maintenance.

The single outstanding characteristic of present O&M management systems among the irrigation departments is that they are organized primarily to 'respond' to problems rather than 'anticipate' problems. Additionally, the prestige and professional status associated with O&M management and technical activities continues at a lower level as compared to that of personnel engaged in construction.

Problems of maintenance in physical facilities/equipment are not generally anticipated through managed programs of prevention. Instead, management either responds to actual or near-threatened crisis or responds within severely constrained budget limits.

Similarly, management is not well staffed or equipped in matters concerning operation of the canal systems. Demand for irrigation water generally exceeds supply. The basic design of continuous flow irrigation systems limits the extent to which systems can be managed in assuring the right amounts of water to farmers at the correct times. Yet, within those limits, there may be a number of operational management actions which could anticipate water distribution, waste, or loss problems. Currently these are not fully anticipated nor responded to on a managed basis among the irrigation departments.

Present Practice

Numerous maintenance management practices particular to Pakistan are outlined in the materials relevant to Inspection Systems (Chapter V). Additionally, some of the more important management systems needed in support of improved operation and maintenance include:

Centralization

Irrigation department decision-making on many kinds of maintenance activities concerning procurement, personnel, budgeting, contracting, etc. is not decentralized. Over the years, regulations and practices have moved decision-making upwards. At the same time, responsible offices such as those of the Secretary, Chief Engineer, Superintending Engineer, and Executive Engineer have not been strengthened with numbers of trained staff essential to perform all centralized assignments in maintenance.

Organizational Functions

Elements of the irrigation departments such as Sub-Divisions, Divisions Circles, and Zones are often over-tasked or under-tasked by maintenance functions.

Dispersion and Authority

Some elements of the organization are expending too much time and effort on responsibilities other than maintenance without adequate support of assigned authority by establishment and political sectors.

Diffusion and Responsibility

Staff responsibilities are often spread over many functions other than maintenance with insufficient training and inadequate discipline.

Non-specialization

The irrigation departments use engineers as the core of their technical and management strength. This staff is assigned interchangeably on a non-specialized basis with little training in any function except skills learned in schools as students in civil engineering. In the case of this cadre as

well as vocational/administrative staff, personnel are not specially trained/ assigned for particular skills in maintenance.

Field Staff Functions

Lowest level field staff have too few substantive functions concerning maintenance; and supervisory field staff have too many functions which do not concern maintenance.

Work Planning, Scheduling, and Performance Monitoring

Tasking of Beldar work assignments by periods of time is currently required; but often not practised. Maintenance work is planned and scheduled mostly with reference to budget estimates and plans. Systems of quarterly or annual work plans for ordinary maintenance are prescribed but not enforced; and periodic monitoring of performance against plans are dependent upon Executive Engineers work load and availability.

Legal and Administrative Suborning of Staff

Continued disputes over water rights, assessments, contracts, and enforcement of irrigation water regulations increasingly occupies staff and diverts them from maintenance responsibilities.

Indistinct Work Loads

Work loads are not specified in detail for maintenance by organization, unit, or job. Special skills, routines, and schedules for individual performance of each function in maintenance are not defined. Individual performance standards for maintenance functions are not identified and monitored.

Erratic Controls

Budget controls on maintenance remain operative in the irrigation departments;

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but other forms of control such as discipline, monitoring, and individual performance evaluation are generally not adequate.

Inadequate Administrative Support

Current spans of control for effective supervision of maintenance require speedy, non-redundant, and accurate administrative support staffs and systems. These do not now meet current demands.

Poor Communications

Later chapters highlight inadequacies in two aspects of physical communications for maintenance work; supervisory transport, and tele-communications. Other inadequacies concern communication in which the chain-of-command may be ignored or there is non-continuous delivery of orders and information to staff or no delivery of information at all.

Limited Liaison

The irrigation departments are becoming increasingly isolated from other departments while, at the same time, experiencing expanding demands for maintenance work on canals from farmers. This is adversely affecting morale among irrigation department maintenance-related personnel who feel increasingly isolated and subject to criticism.

Underdeveloped Personnel Management

- Recruitment and incentives policies for maintenance-related work are generally lacking.

- Procedures and programs for transfer of maintenance-related staff are often not well developed, properly published, and fully explained.

- Promotions and confirmation of new positions in maintenance work are very slow.

- Performance evaluation and annual reviews of individual performance are not focused on maintenance-related functions. Standards must be established for maintenance skills, procedures of evaluation tightened, and improved communication established with those evaluated.

Requirements

Given the management implications when fully implementing the recommended Maintenance Yardsticks as measured against the current maintenance management practices, the following appear to be new minimal management requirements:

Responsibility

Means must be developed by which maintenance-related irrigation department personnel are forced to exercise their responsibilities, protected from outside influences, and penalized severely if they do not enforce the standards established under the recommended Maintenance Yardsticks.

Authority

Designation of authority must be restructured around new functional assignments for maintenance-related work.

De-centralization

Responsibilities, and authority will require concentration at the Circle level concerning equipment pooling, deployment, and equipment back up in support of the recommended maintenance techniques applied at Sub-Divisional levels. Similarly, certain responsibilities, and authority will require concentration at the Sub-Division in order to plan, staff, budget, and manage the necessary equipment applications recommended to maintain

rehabilitated canals. Other decentralization actions will be required with reference to the responsibilities and authority of Executive Engineers, Chief Engineers, Secretaries etc. in support of the recommended maintenance standards.

Functions

Under the current organizational set-up the only technical personnel directly concerned with maintenance in the field are the Sub-Engineers. Everyone else has additional duties which distract them from either operations or maintenance work.

At the non-technician level only the Beldars, Gauge Readers, Gate Tenders, Mates, and Mistries are fully engaged with operations and maintenance in the field.

The new standards and accompanying maintenance techniques will require that all engineering, technical, and non-technical staff functions be redefined. Emphasis must be upon reliable, timely application of standards with all functions supporting this goal.

Work Planning, Scheduling, Implementation, Monitoring

Contemporary systems for planning, scheduling, monitoring all maintenance work at the field level must be installed and staff assigned/trained/monitored in the operation of same. These include work and equipment use planning, scheduling, funding, personnel assignments, and monitored performance.

Control and Staff Performance

Presently, irrigation department staff are generally held accountable for performance against assigned tasks. However, tasks need detailed requirements and specialization in maintenance with performance indicators built into them.

Current monitoring and disciplining procedures for enforcing improved maintenance performance by assigned irrigation department personnel need strengthening. Supervisors of maintenance work must have authority to quickly shift, discipline, or dismiss personnel for various degrees of non-performance. Such powers must be highly discretionary and quick-acting (with little or no appeal process) for personnel performance up to certain levels of responsibility. Supervisors, themselves, must be equally subject to very specific performance requirements concerning how they are enforcing maintenance standards and obtaining work production of acceptable quality.

Performance indicators must be established for each level of personnel assignment. These will require procedures and organization for enforcement against standards of accountability.

Absorptive Capacity

How much extra work and task assignments can Provincial Irrigation Departments accept in matters concerning maintenance and still perform effectively ? This question is pertinent when thorough introduction of the Maintenance Yardsticks is an objective and participation in the rehabilitation of the canals under the ISM/ISR project demands departmental attention. Answers are dependent upon assessment of a number of factors, particular to each department as well as the size and character of the rehabilitation to be accomplished.

Those assessments should be initiated and completed before additional maintenance duties are placed upon a system that is already over-centralized, with too many dispersed tasks assigned to untrained and inadequately supervised staff.

Liaison with Public and Other Agencies

Well organized and steadily operated public information programs directed at farmers and local village populace as a whole are a necessity if the

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maintenance standards are to obtain their support. This creates a need for an information/liaison officer at each Division who must be trained and equipped to handle not only public contacts and relationships but also organize and operate all liaison with other public agencies.

Legal and Disputes Settlement

Field and supervisory irrigation staff must be relieved of duties connected with handling legal cases, appearing in court, and dealing with disputes on a daily basis. A special staff, assigned and trained, at the Divisional levels must be created to take care of this business so that irrigation personnel can perform their critical operation and maintenance functions.

Management Training

Systems and procedures of personnel evaluation will be needed which are based upon emphasizing the importance of maintenance management training for different levels of supervisory staff.

Recommendations

Recommended actions to be taken by each Provincial Irrigation Department are:

1. Develop a program of management changes necessary to management of the rehabilitated canal systems and determine a schedule of implementation.

2. Design and install management systems fully supportive of the maintenance standards essential to keeping rehabilitated canal systems in an 'as-built' condition. Those management systems must be designed to support effective maintenance through:

- Authority and Supervision.
- Defined Responsibilities.
- De-centralization of Functions.
- Specialization.
- Work Planning, Scheduling, Funding, and Monitoring.
- Equipment Use, Control and Support.
- Controls and Management Information.
- Personnel Management for Maintenance.
- Legal and Disputes Settlement.
- Liaison with Public and Other Agencies.
- Management Training.

3. Adopt specific policies and schedules for designing detailed management systems as outlined in Recommendation 2 before the start of FY 86/87.

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4. Adopt policies for designing management systems supportive of new maintenance standards using these guidelines:

- Management systems must encompass the entire rehabilitated canal system, be linked directly to new standards for maintenance, and emphasize increased professional involvement and staffing.

- Within practical limits, management systems must be self-contained and not dependent upon major modifications or support among current management practices in Provincial Irrigation Departments.

- In order to assure emphasis upon separate and different methods of management for entire rehabilitated canal systems, Provincial Irrigation Departments must distinguish them from the beginning as 'special', 'autonomous' or 'independent' with regard to regulations, policy directives, and executive orders.

5. Design the new management systems using the technical services on management from the PRC/Checchi advisory team or expanded resources. These should be used on various tasks concerning the new management systems as defined under policies by each Provincial Irrigation Department.

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Technical Discussion

The scheduling, design, and installation of management systems supportive of new standards of maintenance will not be easy. A great deal of coordination among Provincial Government entities will be basic to attaining any degree of success. Procedural changes within the Provincial Irrigation Departments may produce behaviorial and other alterations very helpful to improved management. Identifying these first and designing/installing the necessary procedural routine may be a priority task.

However, preoccupation with these matters should not obscure the point that major personnel, authority, and functional changes will be needed. These cannot be introduced by Provincial Irrigation Departments alone. Responsibility for decision in those matters is scattered among a number of political, executive, and autonomous entities. All of them must be engaged at one stage or another in the design, adoption, and implementation of significant management changes. The entities include:

- The Chief Minister of the Province
- Provincial Assembly
- The Provincial Minister for Irrigation and Power
- Chief Secretary of the Province
- Public Service Commission
- Secretariat, Organization and Methods Division
- Planning and Development Department
- Department for General Services and Administration

- Department of Finance
- Department of Irrigation and Power

These various entities can be coordinated to design management changes in numerous instances without need for careful studies or tests. Required only, in such cases, are defined objectives and prioritized tasks to which coordinated and sustained attention among the entities must be directed.

There are a number of complex changes which cannot be arbitrarily prescribed in content, even when coordination is working well and new systems are emergent For example, the decision to place equipment in the Sub-Division with accompanying emphasis upon equipment-supported maintenance generates management complexities at various levels. A brief list would include origins and training of operators; compensation and incentives for same; discipline and control on machine time; timely funding of fuel, lubricants, essential parts and spares; preventive maintenance; scheduling and supervision of work, monitoring of quality products; and rapid deployment of equipment where needed.

Resolution of these and other complexities will require studies and tests in numerous cases. Their duration, location, content, and method of implementation will vary greatly; but their necessity cannot be minimized. Early identification of the most critical of such efforts should be a matter of high priority when endeavoring to follow the Recommendations.

A phased development of studies and tests will be needed in each Provincial Irrigation Department. These should take the form of well-defined 'Action Plans' with phases set for 'Action Plan I' having a scheduled sequence of effort, and later phases in 'Action Plans II, III', etc. This will facilitate concentration upon simpler procedural changes during the first phase with attention concentrated upon:

- Increased authority for planning, operating, and controlling maintenance at the Sub-Divisional level.
- Strengthened internal administrative, personnel, technical, and functional performance requirements with accompanying

specialized staff tasked and disciplined against reasonable indicators.

- A management information system oriented towards the measurement of staff performance against physical and financial targets.

- A revised set of functions for Circles, Divisions, and Sub-Divisions with stress upon de-centralization with flexible and quick response to local maintenance needs.

- Objective inspection of maintenance conditions in a professional and standardized manner. (See Recommendations on Inspection Systems)

- Introducing improved estimating, budget planning, and budget monitoring capabilities (See Recommendations on Full Funding Budgets)

- Systems of equipment deployment, use, logistic back-up, and equipment maintenance in support of the full-funding maintenance standards. (See Recommendations on Equipment Management)

- Staff deployment, disciplinary, incentives, and work unit tasking policies which emphasize and support specialized O&M functions. (See Recommendations on Training)

- Strengthened facilities of tele-communications and transport to support effective supervision of maintenance. (See Recommendations for Tele-communications and Transport)

- Developing formal and informal systems of liaison with farmers, and other government departments with emphasis upon education, exchange of information, and mobilization of effort.

Implementation

While the Recommendations place the burden for developing and adopting the management systems on the Provincial Irrigation Departments, the fact is that this subject involves the entire Provincial Government. In certain cases, as noted above, some management procedures can be altered within Provincial Irrigation Departments. Those changes can help in the development of appropriate management systems. Where it is possible to identify those procedural changes and design new ones that are more appropriate, Provincial Irrigation Departments should get on with that work immediately. Everything of major significance to the necessary changes is dependent upon the following decisions:

Employment of Resources

1. Adopt all six Recommendations immediately; but with the Chief Minister and Chief Secretary designating the long-term responsibilities for various committees to be associated with the effort and tasking the Minister for Irrigation and Power, and the Secretary of Irrigation and Power to chair the committees where appropriate.

2. Simultaneously, phasing of special studies and 'tests' should begin. These will be aimed at rapidly identifying procedural changes that will support the management systems required on entire rehabilitated canal systems. They would be changes that could be made by Provincial Irrigation Departments internally without having to seek authority or decisions from other departments or centers of authority in the Provincial Government.

   The Secretary, and specially assigned staff within each Provincial Irrigation Department should work with technical assistance advisors to help in designing the necessary Phase I 'Action Plan' and supporting same during implementation.

3. Each Provincial Phase I 'Action Plan' should be programmed over fourteen months. They will be operated and organized within the existing policy contexts and management characteristics of each of

the Provinces. This may mean committees and inter-departmental groups will be designated to supervise the Phase I 'Action Plans' or senior staff may be assigned to this task.

4. The Phase I 'Action Plans' will be organized and operated, as mentioned above, to identify and redesign essential procedural changes; but, at the same time, they will be producing data and insights about the larger and inter-departmental issues arising if modernization of maintenance management is to be truly achieved in each Provincial Irrigation Departme That information will affect how the Chief Minister and Chief Secretary organize and operate the broader supportive efforts on functional changes through the committees indicated as necessary in 1 above.

5. Technical assistance in designing and operating the Phase I 'Action Plans' will require technical advisory assistance external to each Province. These would be set up as "O&M Management Improvement Groups" of varying size, one for each Province. These should be comprised of technical assistance specialists with a mix of management analysis skills sufficient to assist each Province in identifying and designing essential procedural changes.

6. After ten months of Phase I 'Action Plan' operations, sufficient information and insights will have been generated to assist in formulating a Phase II 'Action Plan' of longer duration aimed at identifying and designing management of maintenance. The Phase II 'Action Plan' would probably be under the policy direction of the inter-departmental and other groups mentioned in 1 above.

Work Program

Activities under the Phase I 'Action Plan' for each Provincial Irrigation Department will be programmed according to the plans and strategies adopted by each Province. Priorities would also vary from one Province to another.

Three particular types of work programming are suggested here as possibilities for each Provincial Irrigation Department to consider. They could be applied simultaneously or one by one, as desired. They include:

- Utilization of special management consensus-building methods as developed in modern management practices. These would require technical advisory assistance. One particular method, that of Organizational Development/Performance Improvement Program (OD/PIP) has been successfully introduced in Pakistan. The present PRC/Checchi technical advisory assistance team has used it in specific applications among Provincial Irrigation Departments in NWFP, Baluchistan and Sind.

- Utilization of "O&M Management Improvement Groups" comprised of technical advisory specialists on management drawn from expatriate and Pakistani private sector sources. Such Groups, tasked against Phase I 'Action Plans' should be organized and programmed within each Province for the 14 month period specified above. The groups would resemble the same technical assistance model and 'Action Plan' currently standing before the Punjab Planning and Development Department for approval. That model, suitably adjusted to concentrate only on improved management of maintenance for the entire rehabilitated canal systems, could perform the studies and 'tests' required to implement the Recommendations stated above.

- Utilization of special Management for Maintenance Improvement 'seed funds' that should be created in each Provincial Irrigation Department. These could be supplied from ISM Project funding and used by the 'Management Improvement Groups' or alternative technical assistance sources. Provincial Irrigation Department guidance would utilize the funds to:

    * Provide stipendary support to selected personnel drawn from the Provincial Irrigation Department to work with the 'Management Improvement Groups' or other forms of technical assistance on assigned studies and tests concerning improved procedures/methods for managing maintenance.

    * Underwrite the costs of fully designed tests concerning broader functional and systems management associated

with firmly supporting the maintenance standards that are to be established and enforced.

Responsibility

There are no expatriate and Pakistani man-months in the existing PRC/ Checchi contract to support any of the Recommendations or apply any of the Resources and Work Programs suggested in the foregoing.

Given the critical importance that must be assigned to introducing improved management of maintenance of rehabilitated entire canal systems, this situation signals an early need to decide how, by whom, and in what way the necessary technical assistance will be provided. In the absence of appropriate decisions on this point, nothing can be done.

Assuming, however, that adequate technical resources can be obtained on a timely basis the Schedule and Costs outlined elsewhere below are projections related to those subjects.

Schedule

1986

February	Review of Report and Recommendations by Provinces.
March/April	Adoption of Recommendations.
May/August	Recruitment of expatriate and Pakistani technical assistance resources.
Sept./Oct.	New Technical assistance team begins process of assisting Provinces to decide how to schedule and design management improvement work.
Nov./Dec.	Bids advertised and selections made for 'Management Improvement Groups' to assist each Province.

1987

Jan./Feb.	Negotiation of contracts with Pakistani sub-contractors and mobilization of teams.
March/December	Adoption and implementation of Phase I 'Action Plans' in each Province adjusted to the schedules of construction of redesigned and rehabilitated entire canal systems.

1988

January/May	Completion of Phase I 'Action Plans' and adoption of recommended designs.
March/May	Development of proposed Phase II 'Action Plans' for each Province.

Costs

Technical Assistance (over 14-month contract)	$ 725,000
* 28 Expatriate Man-Months	
* 28 Direct-hire Pakistani Man-Months	
* 168 Pakistani Sub-contractor Man-Months	
Equipment	160,000
Supplies	50,000
Seed Funds	150,000
	US $ 1,085,000

Management Impacts

The Recommendations, when adopted and applied in their entirety, will certainly impact upon all existing management systems in Provincial Irrigation Departments. However, this will be a gradual process because only a few entirely rehabilitated canal systems will be completed per year. This provides a significant opportunity for phased development and application of appropriate management systems canal by canal.

Additionally, it is possible to concentrate upon identifying and introducing those minimal procedural changes that will facilitate early management improvements applied to entirely rehabilitated canal systems. A number of these lend themselves to an integrated introduction that would assist other aspects of management in the entire Provincial Irrigation Department even as they foster improved O&M management on the entirely rehabilitated canals. These include the following:

- Define and adopt job descriptions for specific technical and management tasks for improved O&M on rehabilitated canal systems.
- Opening opportunities to in-house staff for jobs and training in specific technical and management O&M tasks.
- Developing training courses and training opportunities for in-house staff in specific technical and management O&M tasks.
- Design and installation of performance indicators on O&M management.
- Design and installation of management information systems on O&M management.
- Design and installation of budget planning, estimating, and monitoring on O&M management.

CHAPTER V INSPECTION SYSTEMS

Introduction

Inspection of operation and maintenance of canal systems facilities (barrages, headworks, channels, drains, flood embankments, tubewells, and maintenance equipment) by an independent organization is a normal and effective management technique. It is used in many countries to avoid heavy future expenditures for extensive rehabilitation of facilities that results from poor operating practices or insufficient maintenance.

Although permanent operating personnel are usually aware of inadequate maintenance, they are not as likely to report it to superiors, and supervisors are not as likely to take effective action for correction. In some cases, it may be a matter of local personnel failing to understand proper maintenance or simply overlooking certain conditions. In other cases these same personnel may feel that identification of maintenance deficiencies may reflect adversely upon their performance, tenure etc. Inspection and reporting is also needed from officers other than those directly assigned to system works.

The scope and intensity of inspection of canal systems can be quite variable. It usually depends upon the monetary value of the service and the threat to society if the system fails. In this report, an annual inspection of 25% of the total rehabilitated canal system facilities and equipment has been taken as reasonable to ensure adequate maintenance.

Present Practice

The present inspection of maintenance conditions among irrigation systems in Pakistan is based on daily observation of facilities by the operating personnel. Under the present system for inspecting maintenance,

everything rests on the proposition that each level of establishment functions as prescribed in existing manuals (1). This means that the daily work of the gangmen (Beldars) at intervals on each canal, observations by water assessor personnel (Patwari's and Zilladar's), daily field visits by Sub-Divisional Officers, and overall inspections by Executive Engineers in charge of Divisions must identify, assess, and correct maintenance needs.

In this system the same personnel who are responsible for operations and maintenance are responsible for inspection. It is assumed that all personnel will perform their assigned functions of operations, maintenance, and inspection in an orderly manner. Supervision must be disciplined and adequate attention addressed to inspecting and correcting maintenance conditions.

Reliance upon the present system of inspection obviates the need for 'check' sheets or other forms aimed at reporting on maintenance conditions. In fact, out of the 28 monthly or annual reports expected from Irrigation Department field staff involving matters concerning operations or maintenance, only 7 touch upon maintenance conditions (2). Of these, only 2 concern a monthly report on a specific maintenance condition; the Monthly Breach Statement, and the Mogha Evaluation Statement used in some provinces.

Original Manual Requirements

Detailed field surveys are to be made every five years. These are aimed at examining all maintenance conditions. They are preparatory to developing the detailed plans for surveying and estimating when establishing a priortised 'shelf' of maintenance items for budget submissions.

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1. Manual of Irrigation Practices, PWD Code, Irrigation Manual of Orders.

2. PCC "Potential Microcomputer Application-NWFP's" June, 1985.

Gangmen (Beldars) are expected to work according to 10-day programs developed by overseers-in-charge according to the following:

" ... For each 10-daily period (1st to 10th, 11th to 20th and 21st to the last date of the month)the overseer-in-charge (now the Sub-Engineers) should prepare a program of work, noting the work to be done by every individual gangmen or pair of gangmen for each day of the 10-daily period. Such programs should be prepared in triplicate, one copy should be sent to the Sub-Divisional Officer; one should be kept with the overseer and the third should be supplied to the head gangman. These programs should be sent to all concerned three days before the commencement of the 10-daily period.

The Sub-Divisional Officer scrutinizes these programs as soon as he gets them and if he finds any change necessary he should immediately inform the overseer.

Copies of these programs should be kept on their persons by the Sub-Divisional Officers, overseers, and head gangmen during inspection and they should see that gangmen work according to the program ..." (3)

These work programs are to include attention to maintenance conditions and their repair.

Maintenance standards are contained, in the case of the Punjab Irrigation Department, in the massive Manual of Irrigation Practices. Other Provincial Irrigation Departments have either developed their own standards or rely upon those prescribed for the Punjab.

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3. Para. 8.665, Manual of Irrigation Practices, Punjab

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Each Divisional office is expected to maintain 'L-sections' on each canal in that Division, plus as built drawings for each link, major, distributary, and minor canal in the Division.

Each Executive Engineer is expected to identify the most pressing maintenance needs,prioritize these, and put them forward to Superintending Engineers for consideration and ultimate submission in the budget cycle. The types of maintenance to be budgeted for are carefully described in the Irrigation Manual of Orders.

Responsibilities for inspection of maintenance conditions starts with the field workers (Beldars, Patwaris, Zilladars's) and moves upward to Sub-Engineers and Sub-Divisional Officers. They, in turn, report to the Executive Engineer of a Division. He exercises command over what is to be inspected more intensively and decides upon maintenance programs and executes them when plans are approved and funds provided by higher authority.

The Executive Engineer and the staff which he supervises for BOTH inspection of maintenance conditions and correction of maintenance defects is subject to plans and control by higher authority for all work including operation of the system, maintenance, and new works when approved and funded. Therefore, he is not independent of superior policies and priorities when carrying out inspection of maintenance conditions.

The Executive Engineer has the authority to determine what is to be inspected and for what reasons. He also has the authority, within his budget and staffing limits, to determine what maintenance should be planned and executed by his staff.

The Executive Engineer (operating under policy directions from higher authority) is responsible for planning what is to be inspected more intensively than the routine inspection,estimating costs for proposed

maintenance, developing budgets for proposed maintenance, and executing corrective actions when funds are received. The Five-Year periodic reviews of maintenance assist in this process.

The present inspection system is based on the assumption that on-the-job training of staff by competent, conscientious, Sub-Divisional Officers and Sub-Engineers will be sufficient to ensure adequate inspection of irrigation works and canals.

Staff is deployed according to a manning and frequency-of-visit table, of which the one for the Punjab is an illustration:

Manning and Frequency of Visit Table for Punjab

Type of Staff	Area of Coverage	Frequency of Visit
Gangmer (Beldars), Mates, and Mystries	Beldars: 1 to every 2 miles main canals: 1 to every 6 miles of Distributaries-Minors	Daily
Sub-Engineer	30 to 50 miles of channels, drains, embankments, etc.	Lives in area and may travel almost daily
Sub-Divisional Officer	110 to 160 miles of channels, drains, embankments, etc.	15 over-night halts out of station monthly
Executive Engineer	350 to 900 miles channels, drains, embankments, etc.	10 over-night halts out of station monthly
Superintending Engineer	900 to 1,500 miles of channels, drains, embankments, etc.	Has discretion in scheduling field visits.
Chief Engineer	6,000 miles of channels, drains, embankments, etc.	Has discretion in scheduling field visits.

There is no annual specific budgeting to cover the costs for inspection

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of maintenance conditions. The results of inspection must be used by the Executive Engineer on schedule with the annual budget cycle preparation and planning activities.

An extensive physical support system for inspection of maintenance and operations is required. In Pakistan, a widespread network of inspection bungalows have been constructed to support field operations. These are staffed, operated and designed to provide overnite facilities for irrigation department staff on field visit assignments. Sind operates 406 and Punjab operates 710 of these at varying standards.

Transport, transport allowances, etc. are also to be provided to staff at all levels sufficient to accomplish the various tasks in a timely manner.

Deterioration in Inspection Systems

In recent years, numerous reports document the deterioration in Pakistan's irrigation systems. (4) This is said to be due to deferred maintenance arising from a lack of sufficient funds.

However, other reasons are evident. There is considerable evidence indicating that basic systemic changes have occured in the past four decades and these have adversely altered the quality of maintenance inspection by irrigation departments.

The major changes, insofar as they relate to inspection of maintenance are as follows:

- Increased number of land-holdings.
- Increased litigation over land-holdings and construction contracts.
- Expanded local participation in civil affairs.

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4. "Pakistan" Flood Rehabilitation Program Credit, Report No. 304a-Pak World Bank (Feb. 20, 1974); "Operation and Maintenance of Flood Protection Works in Pakistan", Inter-Departmental Group (June 1978)

Since Partition the number of land-holdings has at least doubled and in some areas almost tripled. This means that for a Sub-Divisional Officer responsible for a particular area the Warabandi (5) demands are increased and he must guide this matter.

This impacts directly upon the day-by-day observation system because the Sub-Divisional Officer and his staff must handle the planning for equitable distribution of water, arbitrate disputes, and assist in assessing water rates.

Interviews with Sub-Divisional Officers indicate that their effort in Warabandi and related matters has increased from 20% to 40% of their time.

The enlarged number of land-holders has resulted in more disputes and a great tendency to seek remedy in the civil courts for conflicts with Irrigation Department personnel.

Private contractor resort to the courts has also increased. This is particularly true since the arbitration clause has been removed from contracts. Disputes formerly subject to simple arbitration often go forward to civil courts.

Since court dockets are overwhelmed with cases (45,000 in the Punjab) it requires much time and many hearings before cases are settled.

Sub-Divisional Officers, Executive Engineers, and other irrigation personnel must attend these hearings. Sub-Divisional Officers and Executive Engineers indicate in some cases (notably in non-SCARP areas of the Punjab) that 10% to 20% of their time per month goes into litigation or dispute-related matters. (6)

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5. The present system of water allocation observed in most parts of Pakistan (Wara means turn and bandi means Fixation).

6. SCARP - Salinity Control and Reclamation Project.

In some cases Executive Engineers are ex-officio members of eight District committees which meet monthly. Sub-Divisional Officers and other irrigation officers are expected to attend these and other coordinating types of committees at local levels. Officers interviewed indicate that up to 5% of their time per month may be expended on such activities.

Staff has not been expanded within the Irrigation Departments to meet all of the foregoing obligations. From 40% to 60% of Sub-Divisional Officer and Executive Engineer time may now be devoted to meeting these additional burdens with the result that inspection of maintenance conditions has suffered.

Reduction in Staff Qualification and Discipline

Many of the present lower staff field personnel such as Beldars were formerly employed on a monthly work-charge basis with the Sub-Divisional Officer (SDO) hiring individuals on an as-needed basis. There were some permanent staff at this level, but, in general, discipline and qualifications were enforced through the work-charge system, i.e. the SDO had authority to hire and fire.

Since the early 1970's this system has been severely modified with most Beldars now employed as Civil Servants and responsible to the Executive Engineer rather than the Sub-Divisional Officers for control, wages, disciplining etc. The effects of this upon maintenance and operations at field levels (including inspection of maintenance conditions) are said to be damaging. Beldars are said to work less hours, get regular pay, and do not follow detailed instructions.

During the past two decades, Sub-Engineers have been drawn, increasingly, from the ranks of Diploma-holders coming from Polytechnic Institutes. Since the vocational training is of a broad and not specialised nature,

Sub-Engineers are often not well-equipped to perform their assignments when employed by Irrigation Departments. There are no special or on-the-job training programs for such personnel within the Irrigation Departments and, as a result, the quality of their performance suffers. This situation adversely affects operations and maintenance.

Obsolescence of Standards

The growing need for agricultural production has encouraged disregard of safe operation. This has been stated as follows:

".... Generally, the operating criteria of the canal system have evolved to:

(a) fit the availability of water supplies in the river:

(b) meet the objective of bringing to maturity the largest possible acreage of crops with the minimum consumption of water; and

(c) operate at a low cost and with a limited number of technical staff.

.... However, with the urgent demand to increase crop production ... flows in excess of designed capacities are now being carried in many of the canals, especially in Sind Province. This has placed greater stress on the system and has increased significantly the risk of failures..." (7)

In many areas the systems are being operated at nearly twice the design capacity. As observed by one study group in the Punjab:

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7. "Rehabilitation of Irrigation and Flood Protection Works in Pakistan" NESPAK, March 1981.

".... The irrigation channels are generally running at a high risk level, with frequent breaches and damages. The drains are poorly maintained and not cleared of silt in time... While rationing the low financial resources, main canals and large branches claim priority thus ignoring the needs of maintaining smaller irrigation channels and drains. These are the arteries of the irrigation system on the maintenance of which depends the efficiency of canal water distribution to the farms ..." (8)

Standards of operation and maintenance and design criteria do not meet these current conditions.

Reduced Administrative Support

Field offices lack typewriters, office supplies, filing facilities, and adequate administrative staff to cope with the expanded business generated by more landholders, extended irrigation systems, procedural requirements, disputes, contracting, etc.

In many cases procedures are redundant or not relevant to modern conditions. They act as a constraint upon proper use of time by relatively small administrative staffs.

The field housing facilities for inspection and supervision purposes have been described elsewhere. Daily records on usage of these facilities indicates a downward trend. This may reflect a number of changes. These include: less field travel by supervisory staff, greater use of vehicles capable of travelling long distances each day or less time spent by field supervisors examining conditions in the field.

Transportation for supervisory staff is in very short supply. Equipment

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8. Page 22. " Punjab Irrigation and Power Department Objectives, Policies, Organization, Review and Recommendations". Report of the Committee of Irrigation Engineers and Professors of the University of Engineering and Technology-Lahore, November, 1981.

owned by the Irrigation Departments is sufficient for only about one-fifth of the supervisory staff. Personnel are dependent either upon their own vehicles, borrowed rides, or public transport.

Present communication facilities consist of telephone/telegraph which are unreliable at best. They are maintained by the Telephone and Telegraph Department and operated by the Irrigation Departments. Their condition and reliability has declined steadily. Recent studies done in the Punjab indicate that the system performs at less than 50% efficiency particularly in the monsoon season when most needed. This adversely effects reporting of operating data and maintenance conditions, particularly those of an emergency nature.

All of these dificiencies adversely affect inspection of maintenance conditions in the field.

Abandonment of Reporting Systems

".... Based on a review of PID's records ... during the period July 1973 through December 1977, it was determined that an average of about 7% of the Canal Command Area (CCA) (or around 2,295,000 acres) suffered annual interruptions of canal water supplies due to canal breaks and closures for emergency repairs. However, PID officials indicated that probably no more than 40% of the breaches were reported by field staff because of a desire to keep recorded breaches to a minimum for public relations and professional considerations ... Consequently, it is estimated that about 12% of the Canal Command Area (or around 4,140,000 acres) on an annual average basis is adversely affected by breaches and canal closures..."(9)

As pointed out elsewhere past practice supplemented maintenance inspection with a detailed periodic field survey of all maintenance

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9. Page 32, "Revised Action Program (RAP) for Irrigation Agriculture," Water and Power Development Authority (May 1979)

needs. As this was done, detailed plans were developed for performing the necessary surveying and estimating work preparatory to establishing a 'shelf' of prioritized plans for maintenance repairs. Items from this 'shelf' were then submitted in the annual budget cycle.

Today, Irrigation Departments continue to develop their annual submissions on maintenance needs for budgetary purposes. However, the five-year periodic survey has been abandoned. Now, each Executive Engineer with the help of Sub-Divisional Officers is expected to identify the most pressing maintenance needs by whatever means are at hand, to prioritize these, and put them forward to Superintending Engineers for consideration and ultimate submission in the budget cycle. This is not regarded as a satisfactory practice. It is the subject of extended comment and recommendations by one study group concerning the Punjab:

"... The practice of routine periodic observations of all irrigation works should be meticulously followed by the Department in order to know its requirements of funds for proper maintenance whether or not full funding requirements are met. Recently due to frequent and heavy budgetary cuts, the Department has been content with preparing small estimates to match the funds available for repairing only the worst reaches. This practice of ad hoc repairs needs to be changed in favor of periodic field surveys to assess the total requirements and to decide the priorities in case the available funds are not matching. The regional Chief Engineers must take immediate steps to conduct periodic surveys of irrigation channels, open drains, and flood embankments in their jurisdictions, and to prepare estimates to restore them in good operating conditions. Such estimates should be kept ready in stock and should be updated periodically, Government (including all agencies) must be informed regularly of the extremely poor condition of the irrigation works. These should be based on sound supporting technical data for necessary decisions. These surveys and estimates would help the Chief Engineers and other field officers to

determine priorities of repair works and to prepare a good case for additional funds....."(10)

Requirements

Within each Provincial Irrigation Department the maintenance condition of each rehabilitated canal must be inspected on a regular schedule. The required corrective actions (including an estimate of cost) must be determined and prioritised.

Presently this is not done. Although the four Provincial Irrigation Departments do inspect maintenance conditions, it is not systematic and is in serious need of modernization. Its modernization is dependent upon improving a number of general features about Operations and Maintenance among the Provincial Irrigation Departments. These include such matters as:

- Redeployed and disciplined work force
- Modernized standards
- Improved O&M manuals
- Expanded controls and authority
- Full-funded levels of maintenance
- Low-cost, efficient, communications systems
- Divisional and Sub-Divisional equipment fleets
- Training Programs for Operations and Maintenance

Inspection in each Provincial Irrigation Department could be improved through adopting four objectives: assure independent inspection;

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10. Pages 23-24 "Punjab Irrigation and Power Department Objectives, Policies, Organization, Review and Recommendations", Report of the Committee of Irrigation Engineers and Preference of the University of Engineering and Technology - Lahore, November, 1981.

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professionalize inspection; link independent professional inspection to training of existing staff; and directly connect Independent Inspection results to the decision-making of the Secretary and Chief Engineers of each Provincial Irrigation Department.

Adoption of an Independent Inspection System will not, of itself, improve a number of Operations and Maintenance practices which must be modernized. However, if improvements are started in those matters the action-oriented presence of an Independent Inspection System can help speed modernization of Operations and Maintenance practices in all four Provincial Irrigation Departments.

Recommendations

Recommended actions to be taken by each Provincial Irrigation Department are:

1. Establish, staff, and equip an Independent Inspection Organization. The objectives and functions are:

   - Initially staffed by a two-man team of professional engineers with specialised training in modern inspection techniques.
   - Reports major deficiencies and required corrective action directly to the Secretary of the Department.
   - Inspects the maintenance conditions on 25% of all rehabilitated canal systems and all associated facilities each year.

2. Task the Independent Inspection Organization additionally to:

   - Check the maintenance and use of all equipment.
   - Operate a regular reporting system on required action including estimates of costs of remedial actions and the assignment of priorities for remedy.

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- Monitor the completion of maintenance items identified in the reports and periodically advise the Secretary of the progress/lack of action.

- Install and manage Inspection Centers (Rooms) for coordinating and presenting the results of objective inspections together with recommendations to the Secretary of the Department. If feasible, similar centers might be established at chief engineer levels.

- Review selected field operating procedures and compare statistical data with approved operating plans.

- Field train regular staff in daily inspection techniques.

3. Enforce compliance with Independent Inspection reports and recommendations by:

   - Utilizing the reports as a means of identifying continued poor/non-performance of personnel.

   - Establishing status of corrective action on inspection findings as a part of Annual Performance evaluations of each supervisor responsible for maintenance.

   - Periodically reporting Independent Inspection findings to the Additional Secretary for Planning and Development, and to the responsible Minister.

Technical Discussion

Each proposed Independent Inspection Organization will require the following in order to operate effectively:

- Technical data such as previous and reconstruction 'L' sections, right-of-way maps, operating and maintenance

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manuals, standards for each system, staffing charts, equipment lists and records, and maintenance expenditure and budget data.

- Appropriate equipment for conducting inspections such as vehicles, cameras, tape recorders, and supporting staff, supplies and office equipment.
- A phased introduction (to progress in concert with rehabilitation schedule) of the Independent Inspection Organization to ensure that:
  - A professional staffing and incentives plan which will attract and hold qualified Civil and Mechanical engineers as inspectors.
  - Efficient, timely, and objective reporting and presentation methods are established in order to meet the needs of the Secretary and Chief Engineers.
  - A truly independent and objective inspection and reporting system which is free of influence by the operating organizations of the Irrigation Departments.
  - Appropriate field training methods are developed so that Independent Inspection staff can improve the quality of daily inspection of maintenance by regular staff.
  - A shared or staged costing will be needed in the initial stages of establishing and equipping an Independent Inspection Organization (Perhaps up to 4 years). This is because the necessary modification, staffing organization, support and reporting procedures all require adaptation to local conditions.

Provincial Irrigation Departments should not be asked to bear initial development costs other than providing support staff.

Implementation

As described in the Technical Discussion section the development and establishment of an Independent Inspection Organization must be a phased program. This can be done when the following actions have been completed in each Province:

Employment of Resources

1. Adopt the Recommendations.
2. Establish departmental and inter-departmental committees essential to guiding policies on the phasing and development of an Independent Inspection Organization.
3. Task an external technical advisory team to assist in developing policies under (2) above, and in:
   - Defining appropriate equipment.
   - Defining staff to assist in developing the Independent Inspection Organization.

Ultimate Parameters of Inspection

Assuming that Recommendation 1 is adopted, the ultimate mileage of rehabilitated canals, etc. that would comprise the overall area subject to annual inspection would approximate the following:

Baluchistan	350 Miles
NWFP	650 Miles
Punjab	23,000 Miles
Sind	8,000 Miles

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In accordance with Recommendation, the mileage actually inspected each year would be 25% of the above or approximately:

Baluchistan	100	Miles
NWFP	200	Miles
Punjab	5,700	Miles
Sind	2,000	Miles

Work Program

The phased approach would be used to work towards development by each Province of capability for annual Independent Inspection of the total mileages under 25% target listed above. In planning the dimensions of the Independent Inspection Organization the following general assumptions were made:

1. Detailed field inspection by each two-man team would be conducted at the rate of approximately 10-20 mile (foot/vehicle) per day including some training of field staff. It is assumed that the team would devote about one-third of their total time to such field inspection and training.

2. It is also assumed that each team would devote about 50% of their total time per year in preparing reports, making presentations, etc.

3. The remaining time would be used for travel, administration, and other tasks.

4. One team of two engineers along with supporting staff, would be more than sufficient to perform Independent Inspection, certain training and reporting in Baluchistan and NWFP.

5. As rehabilitation proceeds, additional engineers would be required in the Independent Inspection units in Sind and Punjab.

Responsibility

There are insufficient expatriate and Pakistani man/months in the existing PRC/Checchi contract to support the development and implementation of the Independent Inspection systems in each PID. Additional external technical assistance would be needed in establishing, training and equipping the initial two-man teams in each PID. Policy-making and control over the Independent Inspection teams would be by each Secretary supported by the departmental and inter-departmental committees suggested under Employment of Resources above.

Schedule

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February	Review of Report and Recommendations by provinces.
March-April	Adoption of Recommendations.
May-July	Plans to be developed by the PIDs with external assistance for organizing and implementing Independent Inspection Organizations.
Aug.-Onwards	PIDs establish necessary policy and other departmental and inter-departmental committees.
Aug.-Onwards	External assistance team will begin to order equipment[1/] essential to organizing and operating the Independent Inspection Organizations.
Aug.-Oct	PIDs will each select highly qualified Civil and Mechanical engineers for assignment to the Independent Inspection Organization.

1/ Including vehicles.

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Nov.-Dec.	Mobilization of the teams will take place and provincial staff together with external technical assistance personnel will plan the first phase of inspection program.

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Jan - June	Because ordered equipment may be slow in arriving, external assistance team will be funded so that rented equipment can be used if necessary.
Jan - March	First Quarter of operation in actual field inspection.
March - April	External assistance team orders second round of necessary equipment based upon experience in the Jan-Feb 1987 period.
April - June	Development of Inspection Center and reporting systems in support of Independent Inspection in each PID.
July - Aug	Second round of field work by the inspection team.
Sept - Oct	Second round of testing and developing the reporting and inspection center systems.
Oct	Review of progress and experience and formation of future work plans.

Costs

The estimated cost for a 12-month period for start up of one team in each Province is:

Technical assistance.	Rs. 5,600,000 or	US $ 350,000
Equipment: (Vehicles,etc.)[1/]	Rs. 3,600,000	225,000
Supplies.	Rs. 600,000	36,000
Inspection Center Development.	Rs. 700,000	45,000
	Rs.10,500,000	US $ 656,000

Neither the equipment nor the technical assistance would come from the current PRC/Checchi contract.

Management Impacts

In the initial stage of introducing the Independent Inspection system, phased use of the technical advisory team resources will minimise the start-up management problems among the Provincial Irrigation Departments. However, as the system develops under the recommended design a number of major management changes will be required which are quite specific to this proposal. These are in parallel or perhaps preceed those suggested in Chapter IV on 'Management Systems'. They include the following:

- Restructuring of the functions of the Office of Secretary to include supervision, management, reporting, and monitoring of Independent Inspection.

- Establishing positions, job descriptions, and salary levels for Independent Inspection staff.

1/ An advance period of at least 12 months is required to procure and deliver equipment.

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- Developing a line item budget allocation for annual funding of the Independent Inspection staff and activities.

- Defining the authority, relationships, and procedures of Independent Inspection in relation to regular Sub-Division, Division, Circle and Zone organizations.

Chapter VI EQUIPMENT MANAGEMENT

Introduction

The use of mechanized equipment in the Provincial Irrigation Departments of Pakistan began in the early 1920's. At that time various headworks, barrages and canal systems were being constructed in Punjab and Sind Provinces.

Mechanization has slowly evolved over the years from that early specialized use of equipment towards limited utilization of additional equipment where manual and or animal labor is not practical. Today, the need for accelerated rehabilitation schedules, improved quantity and quality of work and a growing scarcity of manual labor has speeded up mechanization. Similarly, to ensure proper operation and maintenance of irrigation facilities, more equipment utilization will be needed for these activities.

Recent World Bank and USAID-supported studies of this subject confirm this trend. As a result, considerable equipment has been imported, more is on the way, and workshops are being up-graded so that equipment can be properly and efficiently maintained.

As a part of this report PRC/Checchi has determined the amount and type of equipment needed to properly maintain the newly rehabilitated canals. A considerable number of personnel is already available in the PID establishments to operate and manage the new equipment. All that is needed in this regard is re-definition of authority, re-deployment of staff, and training of staff. Present equipment use and equipment maintenance practices have been reviewed, requirements delineated and recommendations of needed programs formulated.

Areas where improvements are needed in equipment use, management, and maintenance have been examined. This was done in the field and also in the context of the 'Universals' of Disciplines and Activities as described at

the beginning of this report. The specific functions examined include:

- Equipment Funding
- Equipment Management Information Systems
- Maintenance and Repair Program
- Overhaul and Recommissioning
- Equipment Deployment and Utilization
- Standards and Procedures
- Acquirement of Additional Equipment
- Training

Present Practice

The four Provincial Irrigation Departments are responsible for the organization and operation of equipment support for ordinary, special and emergency O&M activities, as well as for rehabilitation works. A discussion of present practices found in the PIDs follows:

Equipment Funding

In early days, mass earthwork was accomplished through the use of dragline excavators. The operation of these new machines was regulated under a set of principles called 'Rules for Maintenance of Depreciation Account for Excavators'. These rules fixed recovery of depreciation and repair costs as follows:

".... The depreciation account will be cleared by crediting it with the following:

a) Rs. 1.50 per thousand cubic feet of earthwork booked against earthwork estimate. This is for writing off the initial cost of excavators.

b) Rs. 0.50 per thousand cubic feet of earthwork booked against earthwork

estimate. This is to meet the cost of overhauls and replacement....".

The above scheme of accounting remained in use until 1949 when large numbers of draglines and earthmoving machinery began to arrive in Pakistan. The existing accounting rules were inadequate and the irrigation department at that time began to charge for equipment usage on a cost basis involving no profit or loss. Life of plant was fixed and recoveries were made from the charges for work done for depreciation and repairs.

According to current rules in the Punjab these accounts have to be closed at the end of a financial year. The amount accumulated under the recoveries is then surrendered by the operating divisions of the PID to the Revenue Department. There is no pooling of funds to meet future expenditure for replacement of the plant and for major overhauls. Thus, in spite of huge earnings by the plant, the Punjab PID has no money left at the end of the year to finance replacement and repairs. All money recovered goes to the Provincial Treasury.

By contrast, the Sind PID is crediting all recoveries, under heads of depreciation and repairs, to a pool. This has been created as a result of an order by the Auditor General, Government of Pakistan, vide his memorandum # 202-A/C-1/18-78, dated 03 May 1978, addressed to all Provinces and designated "P-Deposits and Advances-Part 1(A) Reserve Funds". In addition to these two recoveries the residual value of the plant recovered after auctioning and disposal is also credited to this pool out of which the replacement and repairs of the plant are financed.

Accounting of this type is not being maintained in the NWFP and Baluchistan Provinces where available equipment is operated against job-estimates using direct expenditures only.

In summary, accounting for equipment operations in the Punjab and Sind is in an advanced stage compared to NWFP and Baluchistan. The former two

Provinces are maintaining accounts of each piece of equipment while the latter two are running job-estimates for each individual assignment of work. In the Sind and Punjab expenditure ledgers have two pages assigned for each individual machine on which expenditure under operation and recoveries are posted monthly. The account is adjusted at the end of each month and closed at the end of the financial year.

Equipment Management Information System

At the present time there is no equipment management information system. Draft equipment inventories for all four Provinces have been prepared by the PRC/Checchi Team through field visits and discussions with PID officials. Copies of these inventories have been circulated to all the PIDs requesting changes, amendments or additions. Some information has been received and incorporated but the inventories are not yet complete.

Currently, varying methods for numbering of equipment are used and in some cases no method is in use. As a result, it is impossible to develop management information programs concerning equipment population, rentals, depreciatio recoveries, costs of repairs, replacements, etc. When information is needed by management it is laboriously compiled and prepared each time a new request is received.

In addition, none of the Provincial Irrigation Departments has any system for keeping detailed records on equipment; however, field supervisors do keep a nominal record of field equipment in a 'Tools and Plant Register' but it does not give details of models, serial numbers, major assemblies, sub-assemblies and structural changes in the machines.

Maintenance of essential records is now done manually by clerks through posted ledgers, bin-cards, shelving, etc. In some Provinces these systems are not kept up-to-date. Balances shown in warehouses seldom represent actual count.

Maintenance and Repair Program

At present the PIDs do not follow established procedures for the maintenance and repair of their equipment. The operation and maintenance of the equipment in the PIDs is being left mainly to the judgement of poorly trained lower staff. Supervisors do not have enough time to supervise site operation. Little training and orientation is given to operators and mechanics when a new machine is introduced. Field crews seldom consult or refer to maintenance and service manuals. They rely entirely upon past experience gained from repairing other equipment or merely depend on intuition. Manuals are lost soon after a new machine goes into operation and thereafter the machine is maintained and repaired erratically.

Logistics Management, in terms of Preventive Maintenance, Repair and Supplies, does not exist in the PIDs. Systems are not in place for ensuring proper lubrication, scheduling timely preventive maintenance services and scheduling and controlling maintenance. In the same way stockage and supply systems are either non-existent or require modernization.

Overhaul and Recommissioning

Presently, the PIDs do not operate realistic overhaul and recommissioning programs for existing equipment. Repairable equipment often lies scattered in unprotected dumps. Some of the units have been cannibalized extensively or the vital assemblies such as engines, transmissions, etc. are missing. While it is difficult to arrive at an exact amount required for rehabilitating equipment, initial estimates indicate a range of Rs. 40 to 80 million (US$3-5 million) for Punjab alone. A list of the Punjab units requiring overhaul is given below:

Equipment list	Number requiring overhaul
Motorized Scrapers WABCO 229 G&H model	52
Cat D8K Dozers	26
Motor Grader Galion, Model T-500	4
Tank Truck International	8
Cat 824 Wheel-Type Tractor	2
Compactor Ingersoll Rand	4
Tractor Trailer Mach (70 Tons)	1
P&H Dragline Excavator 255 ALC 3/4 cyd.	15
American Dragline Excavator 3/4 cyd.	2
Garwood Dragline Excavator	1
P&H 655 BLC Dragline Excavator 1 cyd.	2
Ruston Bucyrus Dragline Excavator 1 cyd.	3
P&H 1055 ALC Dragline Excavator 2½ cyd.	2
Motor Grader Cat 16 G	2
Miscellaneous Compressors, Generator Sets, Welding Sets	20
Total:	144

The lists for Sind, NWFP and Baluchistan have not been completed. It may be noted that because of methods in Sind, the number of units of equipment requiring overhaul is being reduced, whereas the number of units in Punjab, Baluchistan and NWFP is increasing.

Equipment Deployment and Utilization

The amount and configuration of construction equipment needed for ordinary maintenance and emergencies have not been determined by the Provincial Irrigation Department. The equipment now utilized by the Provincial Irrigation Departments is organized and deployed primarily by Circles or Divisions with machinery subject to indenting by Civil Divisions. Types of

equipment include:

- Excavators (dragline, backhoe and dredge type).
- Earthmoving equipment of all types.
- Material haulers.
- Workshops (machine tools).
- Steel fabrication plants.
- Concrete plants.
- Quarrying equipment
- Rolling stock, locomotives with both narrow and broad gauge tracks.

At present the following work is being done exclusively by equipment deployed by the machinery organization of the Provincial Irrigation Departments:

- Canal silt clearance during closure periods.
- Cleaning of drains.
- Repairs to steel structures and gate hoisting machinery.
- Major earthmoving jobs on river protection works and embankments.
- Emergency repairs.

The work done by private contractors is accomplished largely through manual or animal labor because the following factors inhibit major mechanization in the private sector:

- Contractors are too small.
- Contractors can earn more profit with manual labor which can be disbanded quickly, while the cost of idle equipment and operating staff continues to drain resources after contract work is completed.
- A continuous flow of contract work is not planned or available at all times.
- Permanent facilities have to be created for equipment with regard to service and spare parts or the contractor must rely upon the private sector repair sources which are often inadequate.

- Heavy initial investments are required in equipment.

- Approved schedules of rates have not yet been developed for use of machinery by private contractors for work available to the public sector. Because of this, bids covering use of equipment are not entertained by the irrigation departments.

At the same time private contractors are facing difficulties for the following reasons:

- The supply of manual labor is decreasing because of migration to larger towns and cities where wage rates are better.

- Contractors are tending to seek contracts in the larger cities where private development is accelerating and more profitable contracts are available to the private sector.

- Improper supervision and disputes with the irrigation department inspectors on specifications and performance are increasing and tend to reduce profits.

Standards and Procedures

In general standards and procedures related to equipment and stores management are either non-existent or out of date. No regular security, fire-fighting or safety procedures are being followed and no codes exist. Accounting and funding procedures are antiquated and in general, repairs are accomplished dependent on management and usually change when a new supervisor is posted. Codes and manuals which are available have numerous changes which, in effect, nullify effective use.

Acquirement of Additional Equipment

The Provincial Irrigation Departments have recently received many pieces of new construction equipment. In many cases, these are sized for rehabilitation works. In terms of an expanded maintenance program, more equipment will be needed at the Sub-Divisional level, which responds better to the routine maintenance activity.

Training

The extent of training taking place at present is limited to short and periodic on-the-job experience in workshops and for equipment operators. In other words, limited attention is diverted to upgrading some vocational skills. The systematic upgrading of the skills of gazetted and non-gazetted professional personnel, either in equipment management or workshops operations does not occur. None of the PIDs have a core of trained trainers around which a comprehensive program can be organized.

Requirements

A modern system of funding and accounting is needed which will provide for and encourage proper operation, maintenance, repair and overhaul or replacement of equipment.

Good equipment management requires a system which continually provides current information upon which to make good decisions for optimizing the use of the mechanized plant available. This system should include data on the number and types of equipment, spare parts and level of stores required. Computers are ultimately required but compilation and updating of data at timely intervals would be a logical initial step to facilitate later computerization.

A state of the art equipment maintenance and repair program is mandatory

for proper maintenance of equipment assigned to O&M functions. A specific immediate need is the repair and overhaul of the presently deadlined equipment. Many units of construction equipment are in need of major overhaul and recommissioning. A conservative estimate of the value of the deadlined construction equipment of the four PIDs is Rs. 2400 million (US$ 150 million). Using a nominal 10% investment return, Pakistan suffers an annual loss of Rs. 240 million if that equipment is not available for use because of maintenance. In addition the value of Rs. 2400 million further erodes by 7-8% per year as equipment deteriorates when it stands idle. This does not include any value of equipment which is operational now but will become deadlined unless maintained.

A complete equipment deployment and utilization plan is required including the staffing, organizational and logistic configurations necessary for proper deployment and utilization of PID equipment. This includes the types and numbers of equipment assigned to mechanical circles, headworks and canal sub-divisions, drainage divisions and flood protection organizations. The plan must also include a method for maintenance and inspection of the equipment at the deployed locations. A study is also required to determine what support the private sector could appropriately render in the overall O&M program for irrigation facilities and for equipment.

New and updated manuals are required for the use of personnel in those organizations managing the equipment. The manuals should include the standards and procedures necessary for adequate funding, management, maintenance and repair of all equipment. A listing of 18 required manuals has been identified.

It will be necessary to acquire considerable additional equipment in order to maintain the rehabilitated canal systems in accordance with the

proposed higher maintenance standards shown in Table III-3 on Maintenance Yardsticks. A list of the additional equipment required in the Sub-Divisions is shown in Table III-4 and a list of the additional equipment required in the Mechanical Circles is shown in Table III-5.

Operators of both new construction equipment and workshop machinery as well as supervisory personnel will require training. Stores personnel will also require training in rationalization of stores and ware-house operations with accompanying installation of cardex, controls, inventory, and micro-computer systems. Additional complementary equipment is required to provide for an effective mechanized maintenance organization.

The beginning of a more formalized program for training in the professional and vocational skills related to equipment use, management and maintenance in an improved O&M process are outlined in the Training chapter. Ultimately, this program must address the machinery and equipment management practices and workshop/maintenance operations and associated stores activities.

Recommendations

Recommended actions to be taken by each Provincial Irrigation Department are:

1. Establish realistic costs for equipment use and adopt a funding procedure which adequately covers ownership and operation.

2. Institute a management information system, which will provide useful up-to-date data on stores inventories and equipment status with operational, maintenance, and performance statistics.

3. Undertake a comprehensive preventive maintenance and repair program.

4. Organize, schedule and fund an overhaul and recommissioning program

for existing deadlined equipment.

5. Acquire the additional equipment shown in Tables III-4 and III-5; the former shows the additional equipment required in the Sub-Divisions and the latter shows additional equipment required in the Mechanical Circle.

6. Assign the above equipment to the Sub-Divisions and the Mechanical Circles. After an appropriate study, provide the necessary staffing, organization and funding to effectively support and utilize the assigned equipment.

7. Implement a comprehensive training program for PID personnel associat with the stores, workshops and construction equipment.

Technical Discussion

Cost for equipment use should be based on manufacturers norms for ownershi and operations costs which consider local conditions and are modified from time to time based on actual field data. The equipment funding procedure should recover sufficient revenue to fully cover operation, maintenance, repair, overhaul and replacement costs.

A good management information system (MIS) will facilitate any operation but is essential to the efficient functioning of a large organization. The basic requirements for an equipment MIS are good inventories, a numbering system, history of equipment, stores requirements and usage data, and an ability to provide information to the manager on short notice.

Draft inventories of equipment have been provided to the PIDs and a numbering procedure has been proposed. A machinery history jacket has been furnished which will provide data about the equipment and help deter-

mine repair costs, life expectancy, replacement needs, stores requirements, etc. Many computer programs are available off the shelf and could be utilized with little or no modification. There has been considerable discussion with the PIDs who have shown considerable interest in having an Equipment M.I.S.

Management principles have been discussed with the Punjab PID and discussions with the other PIDs are being planned. A maintenance report format has been provided to the PID which when utilized will ensure that preventive maintenance in accomplished. The following procedures should be incorporated in the program:

- Repair parts should be issued by workshops only.
- Manuals, Parts Catalogues, etc., should be transferred to Workshop libraries for safe custody and reference.
- The existing field maintenance staff located with the Operation Divisions should come under Administration Control of Workshops thereby ensuring that mechanics are kept abreast of maintenance practices.
- All preventive maintenance and minor and major overhauls, to be done by workshops.
- Base workshops as a starter should take over all mobile workshops units and organize field repair parties under experienced Sub-Divisional Officers.
- The maintenance teams should use the proposed forms to carry out the 50-hour-interval work-over on every machine.

An overhaul program is essential to any good equipment management program. As indicated above deadlined equipment is currently costing Pakistan Rs. 240 million annually and will increase unless corrective action is taken.

A report on proposed rules of maintenance has been provided to the PIDs which would protect their investment in equipment and ensure maintenance of their irrigation facilities. These rules could be utilized by the PIDs in adopting a scheme of operation and is recommended for their use. These

rules would place the responsibilities for economic operation of the equipment on the managers of the equipment, which is most desirable.

An initial review has indicated a need for deployment of additional maintenance equipment to civil divisions but a study is needed to delineate specific staffing needs, organizational changes etc. to support the deployed equipment. A simultaneous review should be undertaken to determine public sector capabilities and participation in the long term maintenance program. Private contractors presently have very little equipment capability but might be encouraged to acquire more if the incentives were improved. This recommendation will require gathering of additional data and further study. A preliminary report will be completed by 31 March, 1986, however, it is not feasible to do a comprehensive study in the next three months and will probably require specific study of some of the recommendations after discussions with USAID and the PIDs.

A list of additional equipment has been compiled which is needed to accompli maintenance of the rehabilitated facilities. This list can be modified as experience indicates additional needs and/or changes in operation.

A formalized on the Job Training Program has been developed and when implemented further discussion with the PIDs will be needed to work out details.

Implementation

These recommendations should be implemented as quickly as feasible; many actions can be initiated immediately in anticipation of approval by the Provincial Governments. PRC/Checchi will assist the PIDs in review of the recommendations and through discussion help develop and finalize procedures with due consideration for individual provincial requirements but try to standardize throughout all provinces where possible. After approval of procedures, monitor the implementation and assist the PIDs in accommodatin on site and local conditions. Tasks required are as follows:

- Seminars will be held with constructive criticism invited and recommendations updated to incorporate suggestions for improvement.
- Initiate pilot implementation and invite participants for on site studies.
- Study financial implications and funding arrangements.
- Collect feed back and incorporate improvements into the final recommendations.
- Study work programs in the PIDs and set priorities.
- Develop pattern of equipment deployment.
- Assist the PIDs in preparing job estimates.
- Monitor field operation.
- Plan surveys of equipment requiring overhaul.
- Assist in preparing lists of and obtaining spare parts.
- Develop a phased shop overhaul program.
- Monitor and advise on repairs and train skilled labor.
- Finalize requirement for additional equipment.
- Plan procurement.
- Monitor budgeting, accounting procedures and economics of equipment operation.

An Implementation Plan for each recommendation is shown on Table VI-1.

Costs

There are sufficient funds available in the PRC/Checchi Contract to provide for direct hire Pakistani technical assistance through October 1987 and expatriate assistance through June 1987.

Management Impacts

Most of the Recommendations made within this Chapter indicate a need for procedural changes in management only. This is particularly so if careful use is made of technical advisory team services in planning and executing the various studies and tests involved. The advisory team can also identify and design many of the procedural changes required.

By contrast, major management changes of a structural as well as procedural nature are involved in assigning equipment to the Sub-Divisions and Mechanical Circles. These are generally described in Chapter IV 'Management Systems' and they may require much time to plan and introduce. However, there are a number of immediate procedural changes that can be introduced even as the long-term structural issues are under study and development. These can be introduced on a phased basis as the equipment is slowly assigned to each redesigned and rehabilitated canal system. They include:

- Work planning and scheduling for each piece of new equipment.
- Work charge employment of operators and support staff against approved work plans.
- Costing equipment use and budgeting for same against full operation, maintenance, repair, overhaul, and replacement figures.
- Introduction of preventive maintenance procedures on field-assigned equipment.

Table VI - I IMPLEMENTATION SCHEDULE FOR EQUIPMENT MANAGEMENT RECOMMENDATIONS

Activity	1986 J	F	M	A	M	J	J	A	S	O	N	D	1987 J	F	M	A	M	J	J	A	S	O	N	D
1. Establish Realistic Cost & Adopt Equipment Funding Procedure	----	----	----	----	----	----	xxx	xxx	xxx	xxx														
2. Institute Equipment MIS.	----	----	----	----	----	----	xxx	xxx	xxx	xxx	xxx	xxx												
3. Undertake a comprehensive Maintenance Program.	----	----	----	----	----	xxx	xxx	xxx	xxx	xxx	xxx	xxx												
4. Organize & Schedule and Equipment Overhaul Program.	----	----	----	----	----	----	----	xxx	xxx	xxx	xxx	xxx												
5. Acquire additional equipment for Civil & Mechanical Divisions.	----	----	----	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx					
					Preparation of specification and bidding.																			
																			Procurement					
6. Assign above equipment & Complete Equipment Management Study.	----	----	----	----	----	----	xxx	xxx	xxx	xxx	xxx	xxx												
7. Implement Comprehensive Training Program.	----	----	----	----	----	----	xxx	xxx	xxx	xxx	xxx													

Discussion and assistance in preparation of procedure -------

Modification and adoption xxxxxxx

Implementation, monitoring and refinement _____

Chapter VII TRAINING

Introduction

The 'universals' of Operations and Maintenance concerning training are not met among any of the Provincial Irrigation Departments (PIDs) of Pakistan. Organized training for O&M does not exist either by Discipline or Activities (Processes).

Federal and Provincial officials responsible for planning, operation, maintenance, and research for the world's largest irrigation system are dedicated professionals. Their effectiveness is being seriously constrained. This is due, in part, to the continued existence of a training institutional environment established early in the 20th century. At that time, on-the-job training and learning-by-doing in the traditional engineering style of apprentice or under-study learning was sufficient. But in 1985, conditions have changed dramatically.

There is need today for PID staff to constantly update technical knowledge and improve skills. Expansion of the irrigation systems, new designs, and improved O&M practices all require upgraded technical and management skills. The need is even greater when it is understood that among lower management levels, both gazetted and non-gazetted professionals lack depth and quality of basic trained skills because of lowered standards in pre-entry academic-vocational preparation. The focus of all training activities must be in support of the priority objectives of O&M of rehabilitated systems as outlined in the preceeding five chapters.

Present Practice

Currently, the Provincial Irrigation Departments do not operate manpower development/training systems. Additionally, the training courses essential to providing staff with skills needed to perform effective operations and maintenance are not defined. There are no organised means by which these skills are defined by each Provincial Irrigation Department.

This condition exists both in relation to training of PID staff within Pakistan or training abroad (either long-term or short-term).

Incentives for training within Pakistan are not a part of PID personnel policies. Individual accomplishments in training courses are not tangibly rewarded. Training has little or no bearing on post-training assignments. Disincentives to training are many and varied. These include loss of perquisites by PID officers assigned to field positions, the likelihood that training will lead to undesirable headquarters assignments and to the inability of PIDs to ensure that skills learned in training will be used.

Concerning training abroad, the situation is equally bleak. Pakistan's elaborate and slow-moving bureaucratic structure for controlling the selection process is a great constraint. Erected to ensure fairness in choice and achieve minimization of special influence, the system assures bureaucratic and often inappropriate selections and an extremely slow, multi-staged, processing schedule. In many cases, delays of two years from date of announcing a foreign training opportunity for PID personnel to selection of a candidate are the rule rather than the exception. This circumstance is additional to the same dis-incentives to training abroad as exist for training within Pakistan.

Only a few special incentives exist for long-term training abroad and these are not offered by all Provinces. The Sind PID provides six pay increments for a foreign Ph.D. and four for a M.S. Baluchistan and Punjab provide four increments for a foreign Ph.D. and two for a M.S. The NWFP does not provide any increments for advanced foreign degrees. Promotion prospects, in all of the PIDs, are not enhanced through advanced academic training abroad. The primary requirements for promotion are time in grade (seniority) and good annual performance ratings.

None of the PID Non-Development budgets provide resources specifically for manpower development and training. The PID's financial investment in training abroad is limited to continuation of the participant's salary while the individual is abroad. Several sections of each Non-Development

budget can be used to fund some costs associated with training inside Pakistan. For example, payments from the overall funds of travel and daily allowances can be and occasionally are authorized for staff members attending training. The budget allocation for establishment costs can also be used for training programs at the discretion of each Secretary. Also, PID Secretaries have small discretionary funds which, in theory, can be applied to costs of training.

At present, PIDs have an opportunity to encourage training of staff through utilizing the resources made available to them through the Irrigation Systems Management Project sponsored by the United States Agency for International Development. The PRC/Checchi advisory team is responsible for developing training opportunities both in country and abroad under the ISM Project.

To date, the PIDs have made very poor use of the foreign training opportunities provided under the ISM Project. A total of 36 degree and 130 non-degree foreign training opportunities have been offered since the inception of the program in April 1984. So far, less than 20% of the opportunities offered have actually resulted in PID personnel going abroad. The intricate and slow-moving selection process earlier mentioned is the principal cause of the poor use to date. Another cause is the dis-incentives to training, particularly long-term, mentioned earlier. This situation shows no signs of altering; and its probable continuation signals a need to diminish foreign training opportunities in favor of more in-country training.

The record on in-country training to date under the ISM Project is promising; but far from developed to the scale and range of skills training needed by PID personnel. Formal short courses may combine classroom work and lectures with field visits or demonstration. Another technique is on-the-job experience where training is given by a supervisor, skilled operator or technician. So far, 882 PID employees have been trained: 253 in formal programs and 629 in on-the-job milieus with PRC/Checchi technical personnel. None were trained, however, in an institutionalized arrangement that will continue once the ISM Project is ended.

Reasons for this situation abound. Probably the most important is that each Provincial Irrigation Department lacks institutionalized manpower/ training policies and programs. A slight trend towards such a development is discernible in the Sind. There, with PRC/Checchi advice, the PID has organized and operated its own 'in-house' training courses in recent months. The formal Sind Training Plan, which focuses on developing and teaching technical and managerial courses by improving the institutional capabilities of the Mehran Engineering and Technical University, receives continuing attention. The Sind Provincial Coordinator is actively engaged with the University and PRC/Checchi in conforming the program to Ministry of Water and Power guidelines.

The Punjab Training Plan outlines nine technical and managerial courses for PID engineers to be given at the Punjab Engineering Academy, a Punjab PID institution. Furthermore, the plan envisions selected staff and faculty development, upgrading of library facilities and teaching materials/ equipment and supporting course development with local and expatriate consultants. The Punjab PID has not shown interest similar to the Sind's in developing an 'in-house' training capacity

Baluchistan and NWFP rely, at this time, on training assistance provided through PRC/Checchi and the use of Pakistani sub-contractors. The absence of any baccaulaureate institution in Baluchistan offering engineering training makes a Sind or Punjab approach problematic. Working with Quetta's Polytechnic may offer some limited possibilities for upgrading current and future sub-engineers skills. The NWFP is a different case because there, the NWFP University is showing interest in assisting the PID in meeting training needs along lines foreseen in the Sind and Punjab proposals.

New entrant sub-divisional officers in the Sind and Punjab are required to undergo formal training. The Sind program provides for nine months of rotation training. The Punjab program covers four months of classroom training at the Punjab Engineering Academy and two months of on-the-job

training in the PIDs most important sections. The Baluchistan and NWFP PIDs each have a requirement for new entrants rotation, but because only four to five SDOs are employed each year, the program is not now followed. None of the PIDs have a new entrant's program of training for sub-engineers and other non-gazetted employees.

Specific in-country kinds of training needs are being identified by the PRC/Checchi advisory team. Training Needs Assessments directed at sub-engineers in Baluchistan and NWFP show that this level of personnel, so important in some aspects of O&M work in the field, require much training. Table VII-1 shows low degrees of capability in certain skills as reflected in the Baluchistan assessment; the NWFP data will be similar. Table VII-2 lists the curriculum for an upcoming eight-week course in general O&M subjects scheduled for NWFP sub-engineers.

Table VII-1

Sub-Engineer Disciplines in Which Training Required
(Drawn from Baluchistan Training Needs Assessment)

Sample: 34% - Under 2 years service
37% - Under 3-6 years service
29% - Under 8-16 years service

	Discipline	Degree of Capability % (Self-Evaluated) Good	Average	Poor
1.	Surveying and Use of Survey Instruments.	24	30	46
2.	Plotting of Surveys: L-Sections; X-Sections; Contouring; Estimation of Quantities.	30	18	52
3.	Standard Specifications of Materials and Works.	3	30	67
4.	Layout of Irrigation Works and Foundations; Excavation and Construction of Works.	24	19	57
5.	Design of Irrigation Works: Channels, Weirs, Spillways, D-Action/Storage Dams, Aquaducts, Super Passages, Canal X-ings, RCC Slabs, Columns, Beams.	8	8	84

6.	Discharge Measurements of Canals, Distributaries, Minors, Outlets and Tubewells.	5	5	90
7.	River Surveys, Flood Protections and River/Nullah Training Works: Construction and Design.	13	13	74
8.	Water Supply and Tubewells Machinery: Maintenance and Operation.	13	24	63
9.	Measurement Book and Accounts.	39	22	39

Table VII-2

General Engineering O&M Training
North West Frontier Province

Total Curriculum
(8 Week Program)

1. Documentation - Desk Work.

   Mensuration - Basic Formulae
   Estimating & Quantity Survey
   Field Book Maintenance
   Level Book Maintenance
   Forms & Reports
   Measurement Book

2. Canal Roads.

   Layout, Road Geometry
   Curves, Grades
   Drainage
   Culverts
   Bridges
   Standard Sub-Bases
   Wearing Surfaces
   Repair & Maintenance

3. Hydraulic Structures

   Dams
   Barrages
   Regulators
   Weirs
   Canals
   Drains
   Outlets
   Lift Irrigation
   Embankments, Spurs, Canal Bank
   Earthwork & Compaction
   Soil Testing & Classification

4. Hydraulics & Irrigation

   Flow Thru Open Channels
   Flow Measurement
   Pumps & Prime Movers
   Flow Thru Notches & Weirs
   Canal Operations
   Canal Maintenance
   Canal Outlets
   Flow Regulators
   Weir & Regulator Operations
   Tubewells
   Seepage Calculations

5. Survey

Levels & Leveling
Instrument Adjustments
Preparation of L- & X-Sections
Transits & Theodolites
Instruments Adjustments
Principles of Traversing
Preparation of Open and Close Traverses - Tacheometry
Modern Survey Instruments
Introduction to Electronic Survey Instruments and Direct Digital Computations - Use, Adjustments, Applications.
Field Exercises - Computations & Plotting.

6. Buildings

Layouts & Foundations
Brick Masonry
Stone Masonry
Plain Cement-Concrete
Reinforced Cement-Concrete
Estimating
Measurements
Reading Blueprints

7. Consumptive Uses of Water.

8. Tile Drainage.

The combined curricula in the Sind and Punjab Plans contain 23 subject matter areas, 15 technical and 8 management, proposed for training at levels from Chief to Sub-Engineer. A PRC/Checchi program described below lists 16 such areas, 8 technical, 5 managerial and 4 on associated agricultural topics. Duplication is very slight between the two lists, which appear in Tables VII-3 and VII-4.

PRC/Checchi has recently identified the main categories of technical and vocational skills required in the O&M process. The 21 skills range from automotive mechanic to well driller; see Table VII-5. Training in mechanical-machinery professional and vocational skills may follow two complementary paths. The first stresses machinery management from circle through sub-division levels, while the second addresses workshops, associated stores and warehousing. Some on-the-job courses have already been designed by PRC/Checchi technicians and more are to come. The availability of professional training facilities outside the PIDs is also being investigated. The National Logistics Cell, for example, trains automotive (diesel and gas, wheeled and tracked) mechanics, machinists and electricians as well as ancillary shop trades such as welding and blacksmithing.

Table VII-3

Illustrative Training Requirements for PID Professionals
(Punjab and Sind Training Plan)

Correlated to Nature of PID Assignment

* Surface Irrigation-Drainage Works
* Pumped Irrigation-Drainage Works
* Mechanized Equipment Works
* River Works and Flood Control
* Small Dams

Requirements	Surface	Pumped	Mech.	River	Dams
Computer Orientation	X	X	X	X	X
Survey Refresher	X	X	X	X	X
Contract Administration and Project Planning Management	X	X	X	X	X
Canal and Drain Maintenance & Repair	X				
Surface Drain Maintenance & Repair	X	X			
Construction Supervision/Inspection	X	X	X	X	X
Irrigation Design Refresher	X	X	X		
Senior SDO Skills	X	X	X	X	X
PC-1 Writing	X	X	X	X	X
Hydrometry: Water Supply/Consumption	X	X		X	X
Regulator Design	X		X		
Channel Design	X				
Channel Operation	X				
Dredging	X		X		
Pump Operation & Maintenance		X			
Surveying Supervision/Inspection	X			X	
Supervision/Review of Design Works	X		X		
Design of Gates, Seals and Operating Gear	X		X		
Personnel Supervision	X	X	X	X	X
Budgeting Refresher	X	X	X	X	X
Accounting Refresher	X	X	X	X	X
Labor Law	X	X	X	X	X
Logistics and Scheduling	X	X	X	X	X

Table VII-4

Illustrative Training Requirements for PID Professionals
(PRC/Checchi Developed Training Schedule)

Correlated to Nature of PID Assignment
(See previous table for key)

Requirements	Surface	Pumped	Mech.	River	Dams
Technical					
Protective Coatings	X	X	X	X	X
Earth & Concrete Construction	X	X	X	X	X
Weed Control	X	X		X	X
Tubewell Maintenance		X			
Small Dam Design					X
Cavitation and its control	X			X	X
Water Measurement	X			X	X
Erosion Control Measures	X			X	X
Managerial					
Supervisory Training	X	X	X	X	X
Management Techniques	X	X	X	X	X
Labor Unions	X	X	X	X	X
Computer Training	X	X	X	X	X
PC-1 Preparation	X	X	X	X	X
Associated Agricultural Topics					
Estimating Crop-Water Requirements	X	X		X	X
Parameters of Agricultural Production	X	X		X	X
Forestry Practices	X	X		X	X
Agronomics	X	X		X	X

Table VII-5

Illustrative Skills Training Requirements for PID Technicians

Correlated to Nature of PID Assignment

* Surface Irrigation Drainage Works
* Pumped Irrigation Drainage Works
* Mechanized Equipment Works
* River Works and Flood Control
* Small Dams

Specific Skills	Surface	Pumped	Mech.	River	Dams
Automotive Mechanic		X	X		X
Diesel Mechanic		X	X		X
Construction Equipment Mechanic (including Hydraulics).			X		
Refrigeration Mechanic			X		
Automotive Electrician		X	X		X
Construction Equipment Electrician			X		
Building Electrician	X		X		
Communication/Instrument Mechanic	X	X	X		X
Machinist			X		
Welder			X		
Painter	X		X		
Carpenter	X		X		
Blacksmith			X		
Tin & Copper Smith			X		
Storeman, Technical	X	X	X	X	X
Operators (Mech. Transport, and Construction Equipment).			X		
Permanent Plant Operators	X	X			X
Surveyor	X		X	X	X
Bricklayer/Mason	X				X
Plumber/Pipefitter	X	X	X		
Well Driller		X	X		

PRC/Checchi teams have also prepared an on-the-job rotation program for new-hire professional engineers, i.e., gazetted Sub-Division Officers. This program may serve as a basis for suggesting changes in the Sind and Punjab new-entrant training programs. The program might also be considered for adoption by NWFP and Baluchistan.

Finally, in recognition of the growing complexity of an improved O&M process and the training required to sustain it, PRC/Checchi has formulated for further study a proposal suggesting five areas for PID professional and vocational specialization:

- surface irrigation and drainage
- pumped irrigation and drainage
- machinery-mechanical works
- river works and flood control
- small dams.

Rather than pursue a program of rotation through all work categories to produce jacks-of-all-trades, this program would encourage specialization and offer particular patterns with requisite training, incentives and advancement opportunities. The training activities listed in Tables VII-3, VII-4 and VII-5 above have been illustratively organized according to the five suggested areas of specialization.

Other specialized training in planning, management, and the technical aspects of Operations and Maintenance have yet to be developed.

Requirements

If improved Operations and Maintenance for the rehabilitated canals is to be rooted in sound training practices there are a number of basic requirements which must be met. These include:

Inventorying skills situation

This comprises a number of needs:

- Assessing the present skills levels and past training, if any, of all gazetted and non-gazetted employees in each PID.

- Determining the kinds and duration of training required for various professional and non-professional categories.

- Assessing the specific skills needs for organizing, managing, and technically performing improved O&M activities.

- Grouping professional and vocational training within areas of specialization.

Inventorying the training resources situation

At least two issues are involved here:

- Ascertaining how and what local universities, polytechnic schools, PID institutes and workshops and private sector facilities are best suited to satisfy identified training needs.

- Determining how such institutions can be linked over a long period of time to the budgeted training needs of each Provincial Irrigation Department.

Institutionalizing O&M Training

This involves selective curriculum improvements, provision of library and teaching materials and equipment, staff training for selected educational institutions with the focus on specialized O&M training for both gazetted and non-gazetted employees of PIDs.

Re-directing training abroad

A number of actions are required here:

- Organize and implement training opportunities abroad in support of institutionalizing O&M training within Pakistan.

- Train trainers abroad so that they can provide the institutionalized training within Pakistan.

- Expose teaching faculty in selected PID related educational institutions in Pakistan to state-of-the-art developments in their fields as these pertain to O&M and teaching techniques.

- Encourage the development of relationships between U.S. and local educational institutions involved in O&M training.

Recommendations

1. Recommended actions to be taken by each Provincial Irrigation Department are:

   Develop, administer, budget, and coordinate an integrated program of manpower planning and training concerning O&M practices, in particular, for PID employees. This policy should encompass three functions:

   - Personal manpower development planning and action:

     Manpower needs linked to promotional ladders, incentives, and training requirements/performance annually. Areas of specialization to be developed for professional and vocational ranks.

- Training Management:

  Programming and budgeting in-country and training abroad activities as required under manpower development plans.

- Integrated use of the educational sector:

  Improving institutional capabilities among selected academic/ training institutions to provide specialized training for PID personnel as defined in manpower development plans.

2. Improve personnel performance standards and relate these to training programs. This may be accomplished by:

   - Implementing Job Rotation programs with built-in training activities concerning O&M for Sub-Division Officers.

   - Revising the rules of the annual ACR's to allow out-of-turn promotions and other incentives for staff members receiving exceptional evaluations based on training participation and performance in O&M.

   - Revising and expanding the Professional and Revenue Examinations for relevant staff members to include modernized O&M technical and management subjects.

   - Establishing personnel management systems, staffed, equipped, and tasked to maintain evaluated updated training histories concerning O&M on all gazetted and non-gazetted officers.

   - Utilizing all possible means to expand vocational, engineering, and management training opportunities in modernized O&M practices for all PID personnel.

- Filling continuing and persistent vacancies by offering appointments to agricultural engineers with skills appropriate to water management activities and to women Civil engineering graduates.

- Providing incentives to staff members who complete formal long-term and short-term training which improves their O&M job performance.

- Designating and implementing on-the-job training programs in O&M practices for skilled staff.

3. Make maximum use of available PRC/Checchi team advisory technical assistance in planning, management, training, engineering, O&M, and construction equipment to support Recommendations 1 and 2. Specific tasks would include:

   - Design and introduction of organizational, management, budgeting and reporting systems directed at full scale implementation of manpower development and training activities for O&M in each PID.

   - Inventory and assessment of numbers, types, and locations of potential trainees and their O&M skills training requirements.

   - Development, where appropriate, of PID 'in-house' training capacities geared to meet selected O&M training needs.

   - Assessment, selection, development, and funding of academic/training facilities external to the PIDs as venues for the organization and operation of O&M training programs.

   - Development of a U.S. University-based contractual relationship to upgrade selected local academic/training institution's design and conduct training activities keyed more directly to O&M requirements in the PIDs and re-direct (as discussed below) the composition and objectives of the ISM-supported Overseas Training Program. This contractor would also assist in the institutionalization of a formal

manpower development and training function into the PID Organization and in the formulation and implementation of training activities to enhance the managerial skills of upper, middle and lower level O&M administrators and executives.

- Limited training abroad for PID staff with emphasis upon:

  - Four to six weeks programs designed to acquaint PID senior officials with current management concepts and techniques; project planning, development, implementation and evaluation techniques; and observation of O&M requirements/activities in their countries.

  - Four to six months training in O&M technical fields in combined classroom/on-the-job programs designed to update participants on modern techniques and equipment.

  - M.S. degree programs limited to faculty of those chosen Pakistani academic/training institutions, external to the PIDs, who are to provide improved training about O&M to PID personnel. Such degree training for PID staff would be limited to specific requests made by the Secretary or Provincial Coordinator defining the degree objective and ultimate assignment of the trainee.

  - Discontinuing training for Ph. D. degrees for PID personnel.

- Establishment of a technical library in each PID to assure continuing availability of current state-of-the-art reference books, manuals and periodicals.

4. That the Ministry of Water and Power support the development, administration, budgeting, and coordination of integrated manpower planning and training programs concerning O&M in particular by each Provincial Irrigation Department. In addition to supporting the three functions as described in Recommendation 1 above, the Ministry:

- Coordinate these developments with concerned central ministries.

- Ensure that maximum and expeditious concentration of external sources of funding, training opportunities, and available technical assistance occurs. The concentration will be aimed at supporting the policies contained in Recommendation 1.

- Assume an active, enlightened attitude toward allocation of funding to local academic institutions actively engaged in collaborative education/training relationships with the PIDs.

Technical Discussion

The Recommendation are designed to help the PIDs meet their short-term training needs for modernized O&M practices at the vocational/technical level. This include: draftsmen, equipment operator, welders, automotive mechanics, construction equipment mechanics, workshop personnel, clerical staff, etc. Similarly, they are designed to assist on long-term training for professional and sub-professional staff through promoting institution-building centered around several key local academic/training entities.

All Recommendations rest upon five critically important assumptions:

- The PIDs will, in fact, adopt and implement policies designed to promote manpower development of staff for O&M work at all levels.

- PID supervisory staff and establishment ranks can be motivated to take the necessary time required for improved skills training in modernized O&M practices.

- Courses and lengths of training in O&M can be crganized and scheduled such that personnel are not long removed from their job responsibilities.

- Pakistani academic/training institutions can be motivated and developed to effectively assist in meeting certain types of long-term and short O&M training needs of PID personnel.

- In a number of instances, PIDs can develop 'in-house' training facilities and programs best suited to meeting certain short-term O&M training needs.

Recommendation 4 is already partially implemented by the PRC/Checchi training team. Training Needs Assessments have been completed for sub-engineers in Baluchistan and NWFP. Similar work should be done in the Punjab and Sind. Assessments should also be made for other levels such as Sub-Divisional Officers and Executive Engineers with both technical and management training needs investigated. Through the approved staffing network for the PRC/Checchi training personnel in each Province it may be possible to speed inventories of staff as well as assessment of training needs.

Similarly, the PRC/Checchi team has developed in-country training programs which are just now entering implementation stages in Baluchistan and NWFP. These can yield useful information about how to institutionalize training for various types of needs, especially in the private sector.

Concerning redirection of training abroad, the PRC/Checchi advisory team has already initiated plans to engage a selected U.S. institution for the upgrading of training facilities in Pakistan. At the same time, the team is continuing to focus on effectively engaging institutions such as Mehran University, the Punjab Engineering Academy, and NWFP University in a mutually beneficial training relationship with appropriate PIDs. Meanwhile, the advisory team continues to implement the PRC/Checchi Interim Training Plan for Financial Year 1985-86 as a guideline document pending resolution of the policy issues stated in Recommendation 3.

Recommendations 1, 2 and 3 require early action by the agencies concerned. Continued failure to seriously address those matters will result in PID inability to organize and operate essential training required for improved O&M.

Implementation

As described in the Technical Discussion section there are a number of initiatives in training which are already started and they will continue. However, their content and ultimate worth are very much dependent upon the following actions by the Provincial Government:

Employment of Resources

1. Adopt the Recommendations.

2. Each PID begin tasking the PRC/Checchi advisory team to accomplish the details of Recommendation 4 and organize themselves in order to facilitate completion of the tasks by the advisory team.

3. Provincial Government organize special inter-departmental committees to assist in the introduction of and budgetary support for O&M related manpower development and training programs in each PID.

Work Program

In order to sustain the on-going work of the PRC/Checchi training team as well as thoroughly engage all elements of each PID in manpower development and training activities, the following is suggested:

- Designation of a senior level PID Secretariat Manager as the temporary Training Officer for each PID would help to facilitate institutionalization of manpower development capability concerning O&M practices within each PID. Ultimately, following completion of necessary organizational and management studies this activity might be upgraded and staffed as a Training Cell under the direction of a Deputy Secretary.

- An inter-organizational O&M practices training committee within the PID should be established under the chairmanship of the Provincial Coordinator with the temporary Training Officer acting as the executive secretary of the committee. The inter-organizational committee would be comprised of the Chief Engineers and Deputy Secretaries.

- The PRC/Checchi training staff for each PID should be located and operated as a temporary secretariat for the temporary Training Officer and the inter-organizational training committee.

Responsibility

There are insufficient expatriate man/months in the existing PRC/Checchi contract to permit completion of all actions contained in the Recommendations. This mandates need to assess which tasks assigned by the PIDs should be performed by the advisory team.

Similarly, organizing and staffing Recommendations 1, 2 and 3 will require much time and attention within each PID. Priorities are, therefore, required concerning how those Recommendations will be addressed over what period of time and how the advisory team, limited in staff time, can assist in this process.

Schedule

1986

February	Review of Report and Recommendations by Provinces.
February	Re-direct resources allocated to cancelled 1984-85 overseas training offers.
March/April	Adoption of Recommendations.
February-onward	PRC/Checchi team continues to implement 1985-86 'interim' training plan and other initiatives already started, including institutionalization.
May/June	Based on Recommendations, PRC/Checchi team will draft a 1986-87 'interim' training plan incorporating essential stress on institutionalization of training in modernized O&M practices.
May/June	PIDs and PRC/Checchi advisory team will begin setting up necessary committees and secretariats in support of the Recommendations.
July/December	PRC/Checchi team will work with PID's in developing budgets and manpower training plans aimed at O&M for Financial Year 1987-88.
September	Re-direct resources allocated to cancelled 1985-86 overseas training offers.
October/December	PID's and PRC/Checchi team will begin implementation of 1986-87 'interim' training plan.
October	Limit all 1986-87 overseas training offers to specially designed and requested programs.

1987

January/June	Continue implementing 1986-87 'interim' training plan.
January/April	Complete budgets and O&M training plans for each PID NDB budget for Financial Year 1987-88.
January/Sept.	PIDs and PRC/Checchi advisory team continue to operate committees and supporting secretariats.

Costs

All costs of training can be met within the resources in the PRC/Checchi contract, including the start-up costs of a U.S. University-based contract; resources will have to be added to cover the full costs of such a sub-contract whose financial dimensions will be known around March 1986 as an outcome of dialogue and negotiation currently underway.

Management Impacts

A major structural management change concerning training is comprised of upgrading and linking personnel performance standards to training in each PID. Presently, the PIDs lack manpower development and incentives policies related to training. The design, acceptance, and implementation of relevant policies will require much effort. Major agency involvement in such changes are outlined in Chapter IV, 'Management Systems'.

However, there are a number of immediate procedural management changes which can be introduced by each PID in support of the general training and manpower development requirements. These include the following:

- Annual budgeting in each Non-Development Budget for selected training programs.

- Designation in each PID of a responsible office and officer for managing training programs.
- Creation in each PID of a policy-making committee on training.
- Tasking the technical advisory team to identify and develop proposals for specific training programs concerning O&M skills.

Chapter IX TELE-COMMUNICATION SYSTEMS

Introduction

The 'universals' of sound Operations and Maintenance Systems outlined at the beginning of this Chapter include the planning and implementation of tele-communications appropriate to the management requirements. These vary greatly with the size, type, and local of a particular irrigation system. A system suitable for tele-communications in operating or maintaining a run-of-the-river irrigation system serving only 200,000 acres might be most unsuitable for a system serving 3,000,000 acres.

Similarly, an irrigation system using Constant Head Orifices (CHO's) off each minor would require a very rapid and reliable system of tele-communications. This would insure that CHO's are properly set for changes in supply levels. By contrast, a continuous flow system with supply outlets fixed to serve specific areas would require a different tele-communications systems.

Systems extending over long distances and in differing terrain also have special tele-communications requirements. In all cases, seasons of high water flow and maximum irrigation demand generate special demands for tele-communications.

Attainment of effective management of Operations and Maintenance very much depends upon the installation and correct use of those tele-communication systems most appropriate to the varying needs as sketched above. In that context the tele-communications systems of irrigation departments in Pakistan appear to need special dimensions and characteristics to meet the varied demands.

Present Practice

The most extensive network of tele-communication facilities among Provincial Irrigation Departments exists in the Punjab. Other Provinces have similar systems which, in recent years, have been improved for certain purposes by High-Frequency radio transmissions during flood seasons.

The system was established starting in 1905 and comprises a network of telephone and telegraph lines used to manage vitally needed information about irrigation water. Through making information readily available regarding the state of river and canal water supplies it is used to assist operations and maintenance personnel in securing equitable distribution of supplies and to prevent damage by floods in rivers and from breaches in canal banks.

The canal telegraph and telephone lines are thousands of miles in length. They run along all main canals and branches and many distributaries. Important regulation points are also equipped with telegraph stations. These operate a land-line ground return type of system comprising a single G.I. wire, insulated with common porcelain telephone pin insulators and strung on 20 foot poles at about 500 ft. intervals. Each station is equipped with a single-current Morse-key and sounder in a signal box connected to a line D.C. power supply and earth. This is called the Simplex Sounder Circuit and provides facilities for station A to communicate with station B or vice versa but not simultaneously.

Originally, all stations both telephone and telegraph were fitted with batteries; but in most systems, converters have been installed so that 220 Volt A.C. is altered to 24 Volt D.C. All stations are manned and operated by irrigation department-employed signalers (Tar Babus). The entire system is owned and maintained by Posts and Telegraph with the irrigation departments operating these systems under licence from that Department and paying monthly charges for use.

Signalers are under the control of Executive Engineers in the Divisions in which they are employed. Telephones are attended by gauge readers with those units linked into Sub-Divisional or Divisional offices depending upon location and area serviced.

Major emphasis is given to transmission and reception of readings from gauge stations. Gauge readings of canal level and discharges are taken manually and recorded. Sub-Divisions and Divisions are notified at least twice a day and sometimes with much more frequency (every two hours in some cases) through telephone and telegraphic transmissions. During flood

seasons gauge readings are much more frequent. The transmission networks are then heavily used.

Another principal usage of the system is to transmit management and administrative directives and information between the offices of Provincial Irrigation Departments at various levels. It is said that in some irrigation departments more than 50% of the usage is in transmitting information of this character because of the pressure of business and the non-availability of any other means to rapidly move information and directives to concerned staff.

Requirements

Effective tele-communications among the Provincial Irrigation Departments should deal with the following:

Reliability

All personnel interviewed at all levels in the irrigation departments insist that tele-communications should be free of the following hindrances:

- Electric power failures and load-shedding:

  While telephone systems usually continue to function during power failures or load-shedding, that is not so for most telegraph systems. If they are not equipped with emergency generators or battery-powered systems the telegraphic links shut down.

- Frequent line breaks and slow repairs:

  The present aged system receives minimal maintenance annually because the irrigation departments are not allowed to budget much for that purpose. The result has been a steady deterioration in poles, lines, and instruments over time and increasing frequency of breakdown during time of stress such as storms, monsoon, and flood. Repairs by Posts and Telegraph are often slow.

Ease of Operation

Transmission by Morse code requires trained signalers. Only those persons can transmit and receive messages. If they are not available, no communications can take place from or to that station.

Similarly, in the present network, contact is established by the signaler listening for the required stations name code. In this method, all stations have to be alert at all times since the signal is received by all stations and only the called station is required to receive.

These and other like conditions are regarded by irrigation department personnel as tolerable for some types of operation; but they believe that improved telephone and modern radio tele-communications could be important supplements to the existing system.

Quick Response

Getting messages quickly to a single station, or a group of stations, and overriding normal communications traffic with priority messages are all desired by interviewed irrigation department personnel. Present telephone and telegraph systems do not permit this.

Monitoring field supervision

The current systems are not suited as monitoring devices by which higher levels of supervision can communicate instantly with lower levels of supervisors in field locations such as minors and distributaries. If thorou monitoring of field work is to be accomplished in O&M then communications systems must be equipped and adopted to facilitate this activity.

Continuity

Major replacement or substitution of existing tele-communication systems among the Provincial Irrigation Departments is probably not required. It would be expensive and disruptive. Optimum improvements should stress continuity so that what now exists can be incorporated with appropriate modern technologies such as radio-telecommunications.

Control

At present, the Provincial Irrigation Departments operate but do not totally control the telephone and telegraph systems. Maintenance responsibilities are located elsewhere. However, introductions of improved technologies such as radio-communications should be controlled in their entirety by the irrigation departments.

Authority

Improved tele-communications will require clearer designations of authority as well as assignment of specialized staff than exists at present. This should encompass responsibility for maintenance, procurement/ installation of equipment, supplies of spare parts, etc. In some Provincial Irrigation Departments it may be possible to achieve this by designating a single and interested officer to assume the necessary tasks.In others, like the Punjab and Sind, it is probable that a separate section (technical) will be required.

Alternative tele-communication choices

As indicated earlier, it should be assumed that some or all of the components of the existing systems will be retained. A range of choices will have to be established, Province by Province, based upon distances, geographic features, and magnitudes of the existing systems. For example:

- Existing systems may need upgrading by sections or in their entirety.
- Long-haul voice communications may be required with consequent demand for a High Frequency radio network which is inter-linked among main stations.
- Tele-printer links may be required at critical points.
- Short-haul voice communication may be required with a consequent demand for Very High Frequency line-of-sight stations linked into the net.

- All or portions of the above (if proven to be necessary) must be interlinked in order to meet the demands of improved O&M supervision.

Recommendations

1. Each Provincial Irrigation Department should adopt a policy of modernising and rationalising its tele-communications system for each of the canal systems that are to be redesigned and rehabilitated. This policy will be aimed at providing tele-communications which are quick, reliable, and have priority over-ride features in support of improved O&M activities on all of the rehabilitated canals.

2. Gate tenders, gauge readers, maintenance supervisors, and equipment managers must be linked by effective tele-communications.

3. Management of tele-communications systems for supporting improved Operations and Maintenance must be specially organised, technically staffed, and authorized to operate/maintain the systems.

4. Training in the scheduling, operation, and management of tele-communications systems must be a part of the manpower development planning for improved Operations and Maintenance of rehabilitated irrigation systems in each Provincial Irrigation Department.

5. Budgets and budget procedures for supporting staff, management, and maintenance of tele-communications systems for improved O&M must be adequate and permit analysis capabilities relative to alterations in budgets supporting tele-communications.

6. Each Province must adopt an O&M tele-communications improvement plan geared to obtain facts and costs on alternative ways of upgrading and augmenting tele-communications in support of <u>each</u> redesigned and rehabilitated irrigation system, Division by Division, as the systems become operational. This plan will require:

- Assessment of current systems technical characteristics, management, staffing, and usages in relation to current O&M activities.

- Evaluate the defects and operational/management problems in the existing tele-communications systems; and develop estimates of what needs improvement and how this could be done along the redesigned/rehabilitated canals.

- Examine the existing and potential applications of High Frequency and Very High Frequency radio-telecommunications including tele-printer nets in relation to the redesigned/ rehabilitated canals and future expansions.

- Develop alternative combinations and usages of the systems together with accompanying estimates on best types of equipment, costs of procurement, installation, and operation in relation to the redesigned/rehabilitated canals and anticipated future expansions.

Technical Discussion

Recommendations 1 through 5 cannot be implemented relying only upon the existing tele-communication systems, style of management, and staffing. However, their adoption by each Provincial Irrigation Department as policy can lay the basis for implementation at a later data AFTER Recommendation 6 is adopted and completed.

Recommendation 6 is based on the fact that major investments and organizational changes in tele-communications should not occur until a series of investigations are completed.These are pre-feasibility level in nature; but with sufficient depth that only a limited amount of costing studies would be required to convert them into feasibility content.

The investigations require careful structuring in accordance with the situations and needs existant in each Provincial Irrigation Department. These vary considerably since some Provinces, notably the Sind have

already established radio tele-communications systems for flood control purposes. The NWFP has planned a system for the areas of Peshawar, Mardan, Malakand, and Swabi (High Frequency) and a Very High Frequency network for the Bannu, Kurram Garhi, Tall, Spin Wam, Jani Khel and Tajori areas. Punjab has also done preliminary work on establishing a 31 station High Frequency network for that Province.

All of these efforts require special assessment in the context of how their introduction could be aligned with preservation and upgrading of existing tele-communications. Also, there is need to relate all of the proposed improvements to supervision of O&M activities along the redesigned/rehabilitated canals.

Additionally, because Posts and Telegraphs and Finance are involved it is probable that some of the investigations must engage their input and participation. These circumstances suggest that each investigation be steadily reviewed by designated Provincial Irrigation Department personnel and that each Secretary make special efforts to involve all concerned departments.

Implementation

There are a number of actions that can be initiated almost immediately which would have early impact upon present practices and requirements concerning tele-communications systems. These include the following actions by the Provincial Irrigation Departments:

Employment of Resources

1. Adopt the Recommendations.

2. Review existing plans for improved tele-communications systems in order to determine if all or part of these could be usefully acquired with USAID assistance and draft requests accordingly.

3. Utilize existing PRC/Checchi technical advisory assistance to do two things:

   - Assist in reviewing (2) above.
   - Developing the Terms of Reference for a study designed to implement Recommendation 6 above.

Work Program

Activities should be programmed in ways designed to cbtain broad perspective on the operation of the existing tele-communication systems and how current proposed improvements in facilities would assist those systems. In this connection, the following approach is suggested:

- Utilization, where feasible, of all qualified and interested PID personnel involved in making the existing systems function.

- Engagement of PID personnel who have shown interest in introducing radio tele-communication systems.

- Involvement of personnel drawn from other departments /agencies which are already using radio tele-communications, eg. WAPDA, etc.

The special study in Recommendation 6, sub-divided into various investigations, should require about 8 months of effort. A small, steadily engaged, Pakistani sub-contracting team could do this working in conjunction with a selected expatriate contract team. Technical inputs on special needs could be met through employment of short-term Pakistani or expatriate skills as required.

Responsibility

Unless PRC/Checchi team assignments are altered there is now insufficient man/months for that team to assume responsibility for designing and completing the necessary study.

There are sufficient man/months available to permit assignment of 1 Man/Month to prepare the terms of reference for a study and also to assist the

interested provincial governments in performing item (2) under 'Employment of Resources' above. This would be at no cost, beyond the existing PRC/Checchi contract.

The study and accompanying costs would be additional in time and funds to existing USAID-approved work and the PRC/Checchi contract.

Schedule

1986

February	Review of Report and Recommendations by Provinces.
March/April	Adoption of Recommendations.
May/Oct.	Provincial Irrigation Departments reviews of existing plans/proposals for improving tele-communication networks, and development of budgets to submit to the ADP/USAID budget process for FY 1988/89. Inclusion of .50 man/month of PRC/Checchi time in this effort.
May/to whatever date is selected -	Provincial Government approvals of Terms of Reference for 8-month study. Inclusion of .50 man/month of PRC/Checchi time to draft the Terms of Reference.
8-Month Study -	Whatever start date is selected after choosing contractor and beginning study.
1987 -	Implementation of findings from study should begin as canals are redesigned/rehabilitated.

Costs

(8 Month Study)

1	Expatriate including support costs:		$ 110,000
	Direct-hire Pakistani including support costs:	= Rs. 320,000	
	Sub-Contractor (Pakistani):		
1	Tele-communications Analyist		
	Base: Rs. 14,000/Mo. plus Contractor Mark-up of Rs. 9,440/Mo. or Rs. 23,440/Mo. X 8 Months	= Rs. 187,520	
1	Economist/Mgmt. Specialist		
	Base: Rs. 12,000/Mo. plus Contractor Mark up of Rs. 8,160/Mo. or Rs.20,160/Mo. X 8 Months	= Rs. 161,280	
12	M/M Short-term Specialists and Supervision:		
	Base: Rs. 9,000/Mo. each plus Contractor Mark-up of Rs. 6,120/Mo. or Rs.15,120/Mo. X 12 Months	= Rs. 181,440	
1	Clerical Staff		
	Base: Rs. 4,000/Mo. No Contractor Mark-up Rs. 4,000/Mo. X 8/Mo	= Rs. 32,000	

Logistic Support

Funds for transport rental, office equipment supplies, contingencies:

Rs. 64,000/Mo. X 8/Mo. = Rs. 512,000

Rs.	1,394,240	U.S. $ 110,000

Combined Total

U.S. $ 197,140

Management Impacts

The tele-communication changes recommended will require structural and policy changes in each PID. Ultimately, these will concern organization, staffing, and budgeting as well as deployment of varying types of specialised equipment. Changes of this kind should be incorporated into the O&M tele-communications improvement plan adopted by each PID. A critical management consideration will be that of getting various studies and assessments completed as quickly as possible. Meanwhile, introduction of certain types and amounts of equipment can be accompanied by procedural changes that will support immediate use of new systems of limited range and restricted useages. This will not require major management changes.

Chapter X ON-GOING PROGRAMS

Introduction

Presently, there are a number of priority O&M-related activities which are continuing actions by the PRC/Checchi team. They were approved by the Provinces when the Integrated Work Plan of September 1985 was reviewed in detail and acted upon favorably by each Province.

Each of these activities carry with them their already-assigned expatriate, Pakistani direct-hire, and Pakistani sub-contractor personnel commitments. Specific needs for equipment or supplies may be generated by these activities and upon request from the concerned Provincial Irrigation Department, may be approved by the Federal authorities and USAID.

They are each presented in the following sections together with Recommendations for consideration by each Provincial Irrigation Department. It is probable that some of the activities will require further expansion and prioritizing in the next six months in support of improved O&M activities. In that case, separate and expanded budgets and staffing formats would then have to be developed.

Certain on-going activities related to O&M have already been mentioned in the earlier chapters of this report. These activities are listed below with reference to the appropriate chapter and also to the approved 1985-86 Work Plan:

(a)	Chapter II	FULL FUNDING BUDGETS	(Task III)
(b)	Chapter III	MAINTENANCE YARDSTICKS	(Tasks II b, III b)
(c)	Chapter IV	MANAGEMENT SYSTEMS	(Tasks II a, II A b, III c, VIII a, IX)
(d)	Chapter V	INSPECTION SYSTEMS	(Task II A a)
(e)	Chapter VI	EQUIPMENT MANAGEMENT	(Tasks VI, VII, VIII)
(f)	Chapter VII	TRAINING	(Tasks II c, VII e, VIII f, VIII g, IX, X)

(g) Chapter VIII TRANSPORT SYSTEMS (Task II a)

(h) Chapter IX TELE-COMMUNICATION SYSTEMS (Task II a)

Other on-going activities, also related to O&M include the following:

1. Micro-computer Applications (Task IX).
2. Hydraulic Design Criteria (Task I).
3. Specialized Hydraulic Design Offices (Task I).
4. On-Going Survey and Questionnaire Program (Task II).
5. Standards and Manuals (Task V).
6. Water Charges and Recovery Studies (Task IV).

The Purpose, Recommendations and Status of each of these continuing activities are presented in the sections that follow.

Micro-computer Applications

Purpose

Introduction of computer technology into any organization can be costly. It can also often clash with currently used data processing and managerial methods. Finally, it may be mistakenly introduced to activities which may not require application of such technology.

Accordingly, the PRC/Checchi team fosters preliminary studies of potential micro-computer applications in each Provincial Irrigation Department. After review by the authorities, particular applications may be selected and installed with PRC/Checchi team technical assistance, equipment, and training.

Recommendations

Individual Provincial Irrigation Departments should continue to work with the PRC/Checchi team, (and its supervised Pakistani sub-contractors) in

prudently introducing micro-computer applications within each department during 1986/87. These applications may be directly or indirectly related to O&M activities

Status

As of January 01, 1986, the PRC/Checchi advisory team has received formal requests for 'preliminary studies' from three Provincial Irrigation Departments. These are NWFP, Baluchistan, and Sind. The Punjab Irrigation Department is also preparing a request.

A 'preliminary study' has been completed for NWFP. Contents and recommendations have been discussed with the Secretary and his staff. Selected applications of micro-computer technology will soon begin in that Irrigation Department. Two similar studies are scheduled for Baluchistan and Sind by a selected Pakistani sub-contractor in January-February, 1986.

An "assessment study" is also underway in the Sind, on micro-computer applications in irrigation water distribution.

Comments

The efforts described above may indicate a number of areas in which use of micro-computers would be feasible in improved O&M. It currently appears that the initial applications will be largely in the areas of yardsticks, budget preparation and monitoring, equipment management and inspection reporting.

Hydraulic Design Criteria

Purpose

For many canals in Pakistan the 'in-regime' stability sought through

existing design criteria has not been achieved. The criteria are not adequately adjusted to deal with the very high and continuous sedimentation conditions. Also they do not adequately deal with cases of scouring and continuous degradation.

New design criteria must be developed which includes sediment input as one of the determining factors in achieving 'in-regime' conditions. An iteractive procedure is required in design work to assure that sediment input equals sediment transport capacity or an optimum means of sediment extraction is utilized.

Recommendations

Individual Provincial Irrigation Departments should speed the adoption, staff training, and application of hydraulic design criteria best suited to achieve stable canal conditions in Pakistan's rehabilitated canals.

Attainment of these stable conditions will in most cases materially reduce operations and maintenance problems associated with siltation and scouring of canals.

Status

Working with data provided by the Alluvial Channels Observation Project (ACOP) of the Water and Power Development Authority (WAPDA), the Delft Hydraulics Laboratory component of the PRC/Checchi team has developed new hydraulic design criteria for alluvial channels. A Computer-Aided Design for Irrigation Systems (CADIS) integrated program incorporates these criteria. CADIS has been applied to the MBL canal in the Punjab. It is now being applied to the Upper Gugera System in the Punjab and the Almani System in the Sind.

The integrated program offers alternative design choices, all subject to

validation and final approval by the concerned Provincial Irrigation Department.

Comments

Adoption and application of the CADIS-program designs to rehabilitated canals will permit maintenance activities to be rationalized. Present design criteria do not facilitate prediction of where, on each canal reach, siltation or scouring will occur. The CADIS-program designs allow annual detailed prediction of where siltation and scouring conditions would arise in each canal reach. This will assist in planning and justification of maintenance budgets.

Specialized Hydraulic Design Offices

Purpose

Present Provincial Irrigation Department design offices do not have staff trained or deployed to apply the CADIS integrated program. There is need to establish such staff and see to it that they are deployed, trained, and equipped to do this design work.

Recommendations

Each Provincial Irrigation Department intensify efforts to establish hydraulic design staff capabilities at appropriate locations within each Province.

Such trained staff can speed the application of CADIS-program designs to systems on which remodelling is to be undertaken and make modifications where required. This will permit rapid identification of maintenance requirements where such design methodology is used.

Status

Development of such centers with trained staff capabilities is a continuing part of the PRC/Checchi Work Plan of September, 1985. The individual Provincial Irrigation Departments were slow in developing these skills during 1985.

The best performance has been the Sind where extra staff have been assigned to work at Hyderabad in collaboration with PRC/Checchi assigned staff. While discussions have been going on since June 1985, nothing definitive has happened in the Punjab. The NWFP is not yet doing anything about the specialized staff training. Baluchistan has forwarded plans to the Planning and Development Department of that Province for establishment of a Design Center.

During 1986, all the Provincial Irrigation Departments and PRC/Checchi should establish very well-defined targets aimed at actually staffing, training, and implementing these essential centers.

The Provincial Irrigation Departments should concentrate for the next four years on establishing and staffing CADIS-program design capabilities within the Design Centers of each Province through special attention to:

- Organizing CADIS-program design work as a separate and distinct function within each Design Center.
- Staffing each provincial Design Center with required mix of design specialists and providing necessary training in use of computer models for design. The required staffing is as follows:

	Non-PID (1)	PID
Baluchistan (Quetta)	3	3
NWFP (Peshawar)	3	3
Punjab (Lahore)	3	3
Sind (Hyderabad)	3	3
Total:	12*	12*

* Does not include sub professionals and clerical.

1/ Sub-contractors employed by PRC/Checchi

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- Remodelling and equiping Design Centers.
- Collecting basic design data on Provincial canal systems.
- Improving and expanding computer models to facilitate design work.
- Establishing support facilities which will attract and hold well qualified and highly trained staff.

PRC/Checchi assistance to Design Centers will be provided through Task I of the 1985/86 Work Plan.

On-Going Survey and Questionnaire Program

Purpose

Perceptions about operations and maintenance management or technical problems differ among varying levels of personnel and functions in Irrigation Departments. It is important to know the content of these views and how widely they are held. Similarly, physical data inventories about canals, structures, L-sections, RD pegs, benchmarks, etc. are not well established and kept up to date in all four Provincial Irrigation Departments. It is essential to know this information when adopting policies and procedures for improved operations and maintenance activities.

Recommendations

Provincial Irrigation Departments should continue to work with the PRC/Checchi advisory team as it strives to obtain varying facts and perceptions concerning Operations and Maintenance problems in each Province.

This information would assist in making informed judgements on improved policies and O&M procedures.

Status

The PRC/Checchi team has developed and performed preliminary pre-tests on a 26-page questionnaire to "assess the current status of selected O&M practices and procedures". This has been used in the NWFP, Sind, and Punjab among 100 Provincial Irrigation Department personnel of varying levels. Some initial findings are reported under comments below. The questionnaire needs to be revised and used on a broader scale during 1986. Other types of physical surveys are also needed and will be designed/adopted by the PRC/Checchi team. This is a continuing task that can be funded through sources currently available to the team.

Comments

Some preliminary findings from the questionnaire used to date:

- Personnel devote 60 - 70% of their weekly time with operations of the systems; 20 - 25% with administration, reports and contractors; and 5 - 20% with maintenance.
- Complete inventories of facilities are not done.
- Over 50% of the RD pegs are not in place.
- Over 75% of respondents indicate that Standards must be updated.
- Schedules of Construction Rates are out of date.
- Reliable transport and tele-communications are lacking.
- Appropriate maintenance equipment is needed at the sub-divisional level.
- Additional staff and discretionary authority is needed at lower levels.

Standards and Manuals

Purpose

A number of design and maintenance standards still being used for canals

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are no longer appropriate. Other standards need to be redefined and still others require definition. In management, standards are often not applicable to the specific personnel, administration, and communication needs of the Provincial Irrigation Department. Widespread availability of engineering or management standards in the form of manuals does not exist. While personnel are short of manuals everywhere in the system, most know where to obtain relevant information.

Irrigation Department personnel interviewed in the field concerning this subject placed priority upon the creation or up-dating of standards and the need for training of staff in applying same. The availability of up-dated manuals was also of concern.

Recommendations

Operation, maintenance and management standards and manuals should be created or up-dated.

Status

Presently, there are no well-organized initiatives on this subject within the Provincial Irrigation Departments. The PRC/Checchi team has started the collection and compilation of existing material including a cursory review. A great deal more remains to be done, especially in terms of updating, which is programmed for 1986/87.

Comments

Specialized standards for O&M in Civil engineering and management which are appropriate to current conditions in Pakistan do not now exist. They urgently need development and application.

Task V 'a' of the PRC/Checchi 1985/86 Work Plan specifies completion of a separate O&M manual for each newly rehabilitated canal system. This manual would include pertinent design data, specific operating instructions, equipment deployment, maintenance yardsticks and budgeting requirements specific to that canal system. It will also include general maintenance guidelines.

Water Charges and Recovery Studies

Purpose

A vital factor in the proper operation and maintenance of an irrigation system is that adequate funding is provided on a continuous basis. This is to a large degree dependent on revenue collections from end users, or in other words, water charges. A much related subject is farmers' ability to pay water charges. Studies are needed to establish linkage between the proposed improved O&M activity on Pakistan's rehabilitated irrigation systems and its associated recurrent costs with a reviewed policy on water charges and farmer repayment capability.

Recommendations

Based upon the findings of the on-going studies, for the PID's and other provincial and federal agencies to update and/or modify the current policies on water charges.

Status

A report entitled "An Evaluation of Existing Irrigation Water Pricing Policy in Pakistan" was issued in November 1985, which is an updated compilation of the subject matter in Pakistan.

Presently, work continues by the PRC/Checchi team on studies related to establishing equitable, reliable, and productive ways to raise revenues towards paying for current and increased levels of O&M spending in each Province. The advisory team is examining farmers' ability to pay any increase in water charges (abiana).

To date, much effort has gone into the collection, improving and updating of available farm-level cost and revenue data, in order to study the

content of farm budgets by crop and area. A corollary effort is to ensure representativeness in the farming samples acquired. These studies are aimed at laying the basis for two levels of financial analysis. One is the delineation of all costs and revenues at market prices, and the other is a cash flow analysis.

These studies, for each Province, will be completed by mid-1986. Their content will then have to be examined in the context of several policy issues concerning the water charges.

Comments

The findings of all the studies under this heading will not be geared towards providing any one single solution; rather these will be arranged in such a fashion as to present policy makers with an array of reasonable alternatives, with a discussion on the consequences in each particular case.