

**FUNDING REQUIREMENTS**  
**For**  
**ADEQUATE IRRIGATION SYSTEM**  
**OPERATION AND MAINTENANCE**  
**PAKISTAN**

**May 1984**

**Report for**  
**UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT**  
**Mission To Pakistan**

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**FUNDING REQUIREMENTS  
For  
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OPERATION AND MAINTENANCE**

**INTRODUCTION**

Historically, funding for irrigation system operations and maintenance (O&M) has not been adequate to maintain and operate Pakistan's irrigation systems in good working order. As a result, systems have deteriorated and irrigation operations are adversely affected. Pursuant to agreements reached between the Government of Pakistan (GOP), the Provincial Governments, USAID, and the World Bank for the Irrigation Systems Rehabilitation Project (ISRP), the provinces agreed to provide annual increases in O&M for canals, surface drains and flood protection bunds at levels at least equal to those targeted in the World Bank Staff Appraisal Report (SAR), number 3717-PAK, dated April 9, 1982.

Since then, provincial funding for O&M has generally exceeded the targets set by the World Bank. What has not been known is whether those targets are adequate or whether expenditures by the Provincial Irrigation Departments (PIDs) are sufficient to maintain the systems in a safe and sound operating condition.

A consulting team<sup>1</sup> was employed by USAID to assess both target and PID funding adequacy, to review the management and work of

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<sup>1</sup> Wm. L. McAnlis, Irrigation System Management Consultant, Hermosillo, Sonora, Mexico; Willard H. Rusk, PE, Consulting Operation and Maintenance Engineer, Burlington, Kentucky, USA; and Dr. James M. Wolf, Irrigation Management Specialist, Development Alternatives, Inc, Sacramento, California, and Washington D.C..

the PID's, to propose cost estimates for new targets as dictated by an accelerated maintenance program and changes in PID staffing and equipment, and to make recommendations as appropriate. The team worked closely with USAID and representatives of the World Bank, and visited PID's in all provinces during the period January 30 to April 7, 1984. We are grateful for the support received from all of these groups.

This report responds to the question of what should be appropriate provincial O&M expenditure levels to keep the irrigation system in good working order. PID's give major day-to-day emphasis to maintenance as opposed to operations. Functioning with but a few water control and flow measurement devices, there is no attempt to regulate and control the water in the main system. Thus, the costs associated with PID functions are mostly on the maintenance side of O&M.

The report is divided into seven sections: one on general background, including historical, organizational, and operational; one on methods and terminology, which includes SAR targets; a separate chapter on each of the four provinces; and a final section which focuses on revised target figures, and which contains recommendations and conclusions.

## I GENERAL BACKGROUND

### INTRODUCTION

1.01 Many aspects of the organization, administration and operation of the irrigation systems in the four provinces of Pakistan are essentially the same. Common factors are set out in this section, with individual differences detailed in the provincial sections.

### HISTORICAL BACKGROUND ABOUT PAKISTAN'S IRRIGATION SYSTEM

1.02 Although irrigation had been practiced along the rivers and streams of the country for centuries, prior to the mid-1800s it was confined to over-land flooding and to lands served by inundation canal systems diverting directly from rivers without controls or weirs. The inundation systems carried water only during high river stages. With the advent of British rule, about 1850, a larger-scale, perennial irrigation network began to take shape. The canal systems were all run-of-the-river, and were designed to meet the following objectives:

- o To maximize area commanded, thus providing some water to a large number of families for purposes of famine prevention.
- o To match the canal and its culturable command area (CCA) to the normal supply from the river.
- o To maximize the area irrigated with a minimum consumption of water.
- o To insure water availability at critical periods of crop growth.
- o To keep administrative and operational staff requirements as low as possible.

Moreover, the systems were intended to provide "equitable distribution (of water) without any interference by the canal establishment--which is an important advantage to the irrigation community."<sup>1</sup>

1.03 Other objectives were resettlement of farmers into the many areas which were largely uninhabited, and the realization of substantial revenues from the sale of Crown lands. The end result was a system of irrigation works generally well designed and constructed so as to be able to supply about 2.5 to 3.3 cfs per 1000 acres. (This amounts to about 300-400 acres per cfs.)

1.04 Most of the canals were unlined, and remain so. They were designed with slopes and sections in regime so there would be neither scour nor silt deposition in the bed, and no shoaling or erosion of the banks. The number of control structures was kept to a bare minimum; cross-regulators (checks) were installed only where necessary to control operating water levels for the headworks of offtaking channels.<sup>2</sup>

1.05 Gates were not installed at the turnouts, called moghas; rather, these structures were designed to pass the

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1. J. Clibborne, Irrigation Work in India, rev. G.T. Anthony (Roorkee: Thomason College, 1924), p.146. This work formed a part of the "Roorkee Treatise on Civil Engineering" of the Thomason College, which largely influenced the development of 'modern' canal irrigation development under the Canal and Drainage Act of 1873. This legislation still applies and is followed to some extent today, particularly in sanctions and revenue matters.

2. For example, in Sind the distance between regulators on main canals averages about 15 miles, about 10 miles on branch canals, and 20 miles on distributaries and minors.

desired quantity of water at the normal full-supply level. Moghas act as proportional flow dividers, each taking proportionately less when the canal level is lower than normal, and more when the supply level is high. The theory is that the entire system, from the main canal headworks down to the last outlet on the last minor, will operate in balance, provided the head inflow is close to normal full supply and the moghas are in good condition. The design obviates the need for operational changes common in a modern irrigation system, and in essence the canal system functions much like a drain.

1.06 Climatological and geographical factors also played an important part in shaping the layout of the irrigation system:

- o Pakistan lies at the western end of the South Asia monsoon belt. The climate is mostly arid, with an average annual precipitation in the southwest of only 4 inches. Precipitation increases to about 20 inches in the piedmont areas, and sometimes exceeds 30 inches in the northern foothills.
- o The Indus is the largest of the major rivers that originate in the high mountains of the Himalayan chain. They are fed in late spring and summer by melt from the snowfields and glaciers of the world's highest mountains.
- o Rainfall comes principally during the monsoon season, June-July through September-October, with July and August usually the wettest months.

The flows in the rivers, and hence the supplies for the canals, were subject to wide variations; water supplies were low in the winter and floods were common in July and August. Many of the canals, therefore, were "non-perennial" and operated only from mid-April through mid-October.

1.07 The creation of the new independent nations of Pakistan and India from what had been British India brought very serious

problems for the irrigation systems. The boundary between the two nations cut directly across the rivers that served most of the irrigated lands in Pakistan. The head areas in India took the water they needed, and the tail areas in Pakistan got what was left. The resulting water dispute was finally resolved in September 1960 with the Indus Water Treaty. Broadly speaking, the treaty gave the supplies of the three eastern rivers (Sutlej, Beas, and Ravi) to India, and the supplies of the northern rivers (Chenab, Jhelum, and Indus) to Pakistan.

1.08 The problem of water supply replacement and augmentation in Pakistan's Punjab was solved by the construction of two major storage dams and a series of link canals. Mangla Dam, on the upper Jhelum River, was completed in 1967. The reservoir has an active capacity of 5.9 maf. Link canals, mostly in the capacity range of 10,000 to 20,000 cfs, were completed about the same time to carry substitute water to the three cut-off rivers. Tarbela Dam is located on the Indus in NWFP near the Punjab-NWFP line, and impounds 9.3 maf of active storage.<sup>1</sup> It was substantially completed in 1975, and commenced some irrigation storage and deliveries in that year. These major sources of stored water made irrigation supplies available in Rabi (the dry season, from mid-October to mid-April) to many canals that had been non-perennial until then.

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1. The major storage dams, Mangla and Tarbela, are operated and maintained for both irrigation storage and power production purposes by the federal Water and Power Development Authority (WAPDA), as are several other smaller dams. Costs of O&M are covered at the federal level, and are not charged to the PID's. Therefore, storage dams and associated costs of O&M are not included in the PID O&M costs estimates of this report.

During the period that the large dams were being built, major barrages and associated main and link canals were constructed on the middle reach of the Indus River and on the lower reaches of the Jhelum, Chenab, Ravi and Sutlej Rivers. Kotri and Guddu Barrages on the lower Indus and three associated link canals were built to improve the effectiveness of the system in the southern part of the country. Starting in 1975, the availability of new water through these channels from Tarbela storage made possible the irrigation of areas which until then had been served only by inundation canals. Substantially improved flexibility in basin-wide operation of the system also became possible because of Tarbela storage.

1.09 About ten years ago, the PID's began to shift emphasis from construction of new irrigation facilities to rehabilitation and improved water management on lands already served by the irrigation system. An effort to increase cropping intensities required the PID's to increase the flows through the system to deliver more water to the farms. The effect of this response is most apparent in Sind, where many of the major canals often carry 120% of design capacity, and where several of the largest canals have been run up to 140% of design for short periods. The impacts of this kind of operation are: accelerated wear on the canals and structures, higher-than-normal maintenance and repair costs, and increased danger of overtopping or breaching of the canal banks.

## CHARACTERISTICS OF THE IRRIGATION SYSTEM

1.10 Characteristics of the canal irrigation system in each of the provinces are detailed in Table 1.1. Also given is a summation of area commanded, now totaling almost 35.5 million acres. Additional detail is furnished in each of the provincial sections.

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TABLE 1.1  
CANAL IRRIGATION, ALL PROVINCES

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<u>Province</u>	<u>Total Length of Canals</u> (miles)	<u>Design Q</u> (cfs)	<u>CCA</u> (M acres)
Punjab	22,659	151,538	20.802
Sind	13,163	125,230	12.752
NWFP	1,723	6,231	1.115
Baluchistan	<u>510</u>	<u>4,770</u>	<u>0.750</u>
	38,055	287,769	35.419

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1.11 A great many other water supply and conveyance schemes have been built since independence which have added substantially to the nation's water supplies. Notable among these have been the salinity control and reclamation projects (SCARP's) undertaken by the federal Water and Power Development Authority (WAPDA). The first SCARP project was started in 1959 and involved installation of 2,069 tubewells (TW's) of 1-5 cfs capacity. Within a few years, it became apparent that wells in the fresh groundwater (FGW) zones should be considered as sources of irrigation water, rather than merely water-table control

facilities. Almost all wells in FGW zones are now located adjacent to and discharge into surface irrigation channels, usually near the Mogha. Public tubewells number almost 13,000, about 10% of which are in saline groundwater zones. A summary of the numbers and discharge of public tubewells, by province, is shown in Table 1.2.

TABLE 1.2  
PUBLIC TUBEWELLS, ALL PROVINCES

<u>Province</u>	<u>Number of Tubewells</u>	<u>Discharge (maf/yr)</u>
Punjab	8,523	6.214
Sind	3,782	1.240
NWFP	688	0.273
Total	<u>12,993</u>	<u>7.727</u>

Source: 1982 and 1983 data from the PID's.

Public TW's produce an estimated 7.7 maf/yr. Private TW's located within the canal command areas, (about 90,000), pump an estimated 25.3 maf/yr, for a total of approximately 33 maf/yr. (This total figure is from IBRD, SAR 3717, 1982, Plate I.) Other pumping schemes outside the CCA's, many of them very small and using animal power, number about 110,000 and produce an additional two maf/yr.

1.12 The PID's are responsible for the operation and maintenance of drainage and flood control works. Summaries of the characteristics of these facilities are given in Table 1.3, surface drains, and Table 1.4, flood control.

TABLE 1.3  
SURFACE DRAINS--CAPACITIES, CATCHMENT AREAS, AND LENGTHS  
ALL PROVINCES

<u>Province</u>	<u>Design Capacity</u> (cfs)	<u>Catchment Area</u> (sq.miles)	<u>Total Length of Drains</u> (miles)
Punjab	35,000	12,970	3,769
Sind	9,870	6,870	4,147
NWFP	3,700	1,070	1,350
Baluchistan	<u>390</u>	<u>140</u>	<u>100</u>
Total	48,960	21,050	9,366

TABLE 1.4  
FLOOD PROTECTION WORKS (miles)  
ALL PROVINCES

Punjab	1,510
Sind	1,457
NWFP	143
Baluchistan	<u>154</u>
Total	3,264

Several tile drainage projects are in place, and more are planned and under construction. Even though tile lines are usually less expensive to maintain than surface drains, these buried drainage systems will require special care in operation to insure reasonable life and effectiveness.

## THE IRRIGATION ORGANIZATION

1.13 PID's are the only organizations involved in public irrigation functions in the provinces. There are no smaller or local public agencies in this field. The federal government involves itself in water resource matters, but usually only in the planning, research, design, and construction of major projects beyond the capabilities of the provinces. Power is exclusively a federal responsibility, and the federal government is also involved in flood control and flood flow forecasting, and in the allocation of both stored and "free" flows among the provinces.

1.14 The PID's follow the organizational structure inherited from the British, with position titles and responsibilities similar to those in colonial times. The chief executive officer of the Irrigation Department is the Secretary, who is assisted by a secretariat staff. Next in line are one or more Chief Engineers (CE), depending on the size of the department. Each CE usually supervises three to six Superintending Engineers (SE), each with their supporting staff. The organization under the command of an SE together with the area served is called a Circle. The circle is divided into Divisions (usually 3-5), with each division under the authority of an Executive Engineer (XEN). Reporting to XEN's are Sub-Divisional Officers (SDO's), positions normally held by Assistant Engineers. The day-to-day field work is carried out at the divisional level and below; all levels above the division are administrative or support staff in nature.

1.15 Without exception, all grades Assistant Engineer and above require an engineering degree. Even the position of Secretary, which is primarily a political appointment, carries the same requirement, and all of the Secretaries are men who have come up through the engineering ranks. Expertise and degree training in management, finance, or economics, for example, are no substitute for the engineering degree if one is to occupy any position of authority in the PID.

1.16 It is possible for some exceptionally capable non-degreed sub-engineers to be appointed to the position of SDO. In these cases, however, the grade and pay are not raised to subdivisional level, and such opportunities are limited to fewer than 20% of the openings available. There appears to be a feeling, particularly in Punjab, that non-degreed persons should be excluded from officer ranks, and that the existing appointments should be rescinded to make room for new graduates.

1.17 Most of the officer positions are held by civil engineers, although there are a few mechanical and electrical engineers assigned to specialized functions such as SCARP tube-well projects, lift schemes, and major workshops. A newly appointed engineer usually spends his first year working with an Assistant Engineer (SDO). With satisfactory performance, he is then posted to another subdivision as the responsible officer. It is the policy in all provinces to rotate all officers, up to and often including CE's, every two or three years. Although this relocation policy has drawbacks for the families involved,

it has advantages in broadening the experience and background of the engineer. The basic purpose, however, as stated by top management and by many field engineers, is to avoid the formation of friendly relationships with local farmers and people of influence and thus to reduce opportunities for gratuities.

#### O&M PLANNING AND BUDGETING

1.18 Planning for the coming year's work normally starts in September at the subdivisional level, sometimes at the prompting of civil authorities acting on behalf of constituents. Recommendations are forwarded from the divisions in September, the circles in October, and the CE's office in November, and then from the Secretary's office to the Finance Department in early January. The PID's budget request is called a "demand", a term also used to denote individual line items in the provincial budget. The Finance Department considers the proposed budget together with requests from other agencies, taking into account the funds expected to become available for Non-Development Budget (NDB) purposes and the priorities of the government. Appropriations are made by the Finance Department, after approval by the government, in July-August, and funds are allocated shortly thereafter. PID's are administered on a fiscal year which runs from July 1 through June 30.

1.19 Planning the maintenance and repair work to be undertaken in the coming year must take into consideration the probable accomplishments of the current year. Since that work depends on available finances, the cycle of planning generally begins in August, after fund allocations have been made by the Finance

Department. Field surveys and office work are done in October, and detailed plans for the work to be done during the canal closure period are submitted to the CE by late November. The CE approves the work plans for each circle and the SE approves for each division. Overall expenditure limits are set for the circles and divisions, but if sufficient funds are not provided for all of the schemes originally proposed, the responsible officers have considerable latitude in the selection of which items are to be cut. In November and December tender notices are issued, contracts negotiated and let, and preparations otherwise made for the January repair and maintenance program.

1.20 The items mentioned in paragraphs 1.18 and 1.19 relate essentially to budget categories generally termed "Extension and Improvement" (E&I) and "Repairs and Maintenance" (R&M). E&I is generally synonymous with rehabilitation; R&M refers to maintenance of a more routine, but still critical, nature. Segregation of E&I and R&M allocations by jobs and functions is generally not possible on the basis of the NDB. In addition to E&I and R&M, other categories of the NDB are administration, establishment, utilities, supplies, and several functional categories detailed in the provincial sections of this report.

1.21 No such special planning is involved with Administration, Establishment, Utilities, and other staff-associated budget items. Levels of pay, established at the federal level, and staffing strength determine the personnel costs in the budget. Permanent staff requirements, and costs of supplies and equipment

for maintenance of building and offices, structures, and channels are based on formulas and "yardsticks", most of which were developed decades ago. Such budget items are rather rigidly fixed, with occasional increases being made to reflect cost increases.

#### THE O&M WORK CYCLE

1.22 System O&M must accommodate itself to weather, cropping patterns and crop water demands, availability of water supplies, and flood conditions. The practice in all of the provinces is to close down perennial canals for two to three weeks in January and early February for purposes of silt removal and bank shaping. Non-perennial canals are normally operated from mid-April to mid-October so scheduling of silt clearance and general maintenance is more flexible than for perennial canals.

1.23 Even though the irrigation systems were intended to carry a substantial silt load through the channels for discharge through the moghas and deposition on the irrigated lands, the general experience has been that major silt cleaning efforts have been required each year. About 20% of the canals are scheduled for cleaning each year, but lack of funds often brings this percentage down. Silt removal and other critical forms of R&M are generally done by contractors using hand labor, animals and carts. In cases where silt removal cannot be deferred, the Executive Engineer can request the help of farmers and, in fact, can require their assistance. Many examples of such cleaning efforts were observed, particularly in Sind.

1.24 Silt accumulation reduces channel cross-sectional area, which means that operating water levels must be raised to maintain design flows. A higher operating level leads to reduced freeboard, more bank overtopping and breaching, and generally increased operation and maintenance costs. It also increases the flow through moghas at upstream locations, depriving farmers in the lower portions of the system of their fair share of the water, which amplifies equity problems in water allocation between top-end users and bottom-end users in the irrigation system.

1.25 Silt and rubbish clearance is particularly difficult and expensive where cities have built up next to and, in some cases, over the canals. Encroachments by walls and buildings and the use of canal banks as public thoroughfares make maintenance difficult and costly. Faisalabad, Hyderabad, and particularly Peshawar, have these problems. Punjab has relatively fewer problems of this type, apparently due to good right-of-way management by the PID and provision of alternative roadways by the province.

1.26 Early in February water is turned back into the perennial canals and the water levels are brought to normal levels. Even though demands are often low at this time of year, the system is usually run at close to full supply flow. Given the system design, this means that each mogha discharges close to its normal flow to the watercourse. As in most irrigation systems throughout the world, those in Pakistan have water levels and flows controlled at the upstream side of regulating structures;

here, however, there are relatively long distances between regulation structures. As a result, when flows are less than about 80% of normal the water surface level downstream of the regulator is lowered and erosion can occur in the bed and sides of the canal downstream of the structure. For this and other reasons (discussed in par. 1.05), the canals are normally run between 80-110% of capacity. Regulation is rarely required by variation in demand; it is required at the canal headworks to assure a relatively constant discharge despite variations in river supply and level. During periods of high demand, allocations are almost always insufficient and farmers take and beneficially use all of the water provided.

1.27 It is apparent that very little "operation" of the system is required, and the major work effort is directed toward maintenance of the canal banks. During periods of high flows and reduced freeboard, additional patrolling and maintenance is done to guard against overtopping or breaching of the banks. Where canals lie along or close to hillsides, slides and washouts caused by flash floods are common. Emergency repairs often involve farmers and small contractors, as well as PID forces.

#### WATER CHARGES

1.28 In the early development of the perennial irrigation network, lands benefited by the canals were expected to pay for the costs of operating, maintaining, and repairing the system. A District Collector had responsibility for levying and collecting

taxes, duties, and assessments. A Deputy Collector was assigned to each canal division. He was assisted by Zilladars, and the actual field work of recording land ownerships, land boundaries, crops and acreages, was carried out by Patwaris. Although the Zilladars and the Patwaris were under the technical command of the Deputy Collectors, they were under the administrative authority of the DCO and SDO's.

1.29 Water charges were assessed by the Patwaris against the cropped acreage of each field at the beginning of each growing season. At the end of the season, adjustments were made as required to reflect crop failures or other non-use of water. After the water charge records had been carefully reviewed and cross-checked, the lists were approved and signed by the DCO. These lists were final, and changes were not permitted even by the DCO himself; however, "remissions" could be authorized by the revenue department. Collection was done by the Department of Revenue, a separate civil unit. Collection costs were not charged to the irrigation accounts, but the costs of assessment, including those of the Collector and his staff, were included in the costs of the Irrigation Department.

1.30 Water revenue policies and procedures still reflect the Northern India Canal and Drainage Act VIII of 1873, in Punjab and NWFP, and the Sind Irrigation Act of 1879. In Punjab and NWFP the Collector and his staff are under the administrative control of PID officers and their costs are charged to PID; in Sind and Baluchistan these functions are the responsibility of the Revenue

Department and the costs are not charged to the PID's. In all cases, collection of water charges is done by officials of the Revenue Departments.

1.31 Revenue related to the irrigation system O&M is termed abiana. These are water charges based on cropped acreage and, indirectly, on crop water requirements, since abiana is based in part on the type of crop. For example, water charges for sugarcane and other high-use crops are about double those for grains and pulses that use less water. The rate for water delivered from tubewells and lift schemes is double that for flow canals.

1.32 At the present time, cost recovery through abiana does not pay for all O&M costs incurred by the PID's. Details on the cost recovery situation in each of the provinces is covered in those respective sections of this report.

1.33 Tubewell divestiture is one of the frequently-mentioned strategies to close the gap between expenditures for O&M and cost recovery. This subject has been addressed in other reports and is a topic of continuing study. Costs in this report assume no divestiture has taken place.

## II METHODS, SAR TARGETS, TERMINOLOGY

### METHODS

2.01 The basic thrust of this report is to determine the appropriate level of O&M funding to keep the systems in good condition, assuming that the systems are already in that condition. If current and planned rehabilitation programs are not carried forward, such work will need to be done to bring the systems up to standard. In that case, the costs of accomplishing the deferred maintenance would need to be added to the costs indicated by this study.

2.02 The costs reported in this study cover a major portion, but not all, of the costs normally associated with O&M of an irrigation system. Costs cover only those items for which the PIDs have responsibility, ie., main system O&M. In Pakistan, responsibility for O&M of dams and major power generation headworks rests with WAPDA. The outlet (mogha) serving the chak, is the terminus of PID responsibility, and below the outlet O&M is the responsibility of the water users. However, the PID's and the On-Farm Water Management Cells have limited responsibility for watercourse alignment and construction, formation of water-user groups, and establishment of a warabandi schedule. The costs detailed in this study are strictly those associated with operations of the PID's, and exclude O&M for main dams and for areas downstream of the mogha.

2.03 The funding conclusions of the report are based on the assumption that the organizational style and staffing prevailing

in the provincial irrigation departments will continue with little modification at least until 1990. Although minor changes may occur over time, perhaps in connection with the Irrigation Systems Management (ISM) and Command Water Management (CWM) Projects, we believe that such changes will not be of the type or magnitude that would result in significant changes in provincial O&M expenditures or funding requirements.

2.04 The availability and probable degree of utilization of the equipment being furnished to the PIDs under the joint USAID/IBRD-sponsored rehabilitation project are considered in determining the costs of equipment and staff.

2.05 This report includes tubewell (TW) O&M costs as a separate item, so that irrigation O&M totals with and without TW's can be examined for comparison and other purposes.

2.06 Except as noted in the text, the consultants have inferred that costs for O&M are equal to the allocations PID's receive from the NDB. This is based on two assumptions. First, that expenditures equal allocations, and this is generally the case. However, the second assumption, that the NDB provides the only source of funds for recurrent O&M expenses, is not exactly true. The NDB is the the major source of O&M funding for the PID's, but a small portion of NDB funding goes for irrigation system "extension and improvements" that in the strictest sense should not be classified as O&M. On the other hand, the PID receives funding for development projects through the Annual Development Plan (ADP), a very small proportion of which is used

to support O&M activities. (The Finance Department in Peshawar estimated that 5% of the ADP budget, or approximately Rs. 3.0 million, was used for this purpose in 1983/84.) For this report, the consultants have assumed that O&M costs are synonymous with figures presented in the provincial NDB's.

2.07 Primary sources of data for this report were records from the PID's and information from the Provincial Finance Departments, specifically information contained in the NDB presentations. Additional information was taken from other reports and records as available, and those additional sources are cited herein.

#### SAR TARGETS

2.08 The target levels of O&M expenditures required to keep the irrigation systems in good working condition were expressed (in terms of 1981 prices) in the Staff Appraisal Report (SAR) for the Irrigation Systems Rehabilitation Project (ISRP), dated April 9, 1982. O&M of public tubewells was excluded; O&M of canals and other channels, drains, and flood-control works was included.

2.09 Throughout this report, costs are given in rupees (Rs.). Table 2.1 shows SAR targets expressed in 1981 Rs. and also the "real" Rs. equivalent for each province for fiscal years 1981-1982 to 1988-1989. The conversion from 1981 Rs. to "real" Rs. equivalents was made using inflation rate percentages published by the State Bank of Pakistan. The consultants used an average of three price indices (wholesale prices, consumer

prices, and GNP deflator) to determine the average officially reported inflation rate for each year. These are as follows:

<u>YEAR</u>	<u>INFLATION RATE (%)</u>
1980/81	12.9
1981/82	10.6
1982/83	6.0
1983/84	10.1 (March 1983 to March 1984)
1984/85 and beyond	10.0 (assumed).

TABLE 2.1

SAR FUNDING TARGETS  
(Rs. millions)

<u>Fiscal year</u>	<u>81/82</u>	<u>82/83</u>	<u>83/84</u>	<u>84/85</u>	<u>85/86</u>	<u>86/87</u>	<u>87/88</u>	<u>88/89</u>
<b>PUNJAB</b>								
SAR 81Rs.	355	415	475	535	595	-->	-->	-->
Real Rs.	355	459	557	691	845	929	1,022	1,125
<b>SIND</b>								
SAR 81Rs.	254	276	298	320	-->	-->	-->	-->
Real Rs.	254	305	349	413	454	500	550	605
<b>NWFP</b>								
SAR 81Rs.	68	72	76	80	-->	-->	-->	-->
Real Rs.	68	80	89	103	114	125	137	151
<b>BALUCHISTAN</b>								
SAR 81Rs.	27.5	30.5	33.5	36.5	39.5	42.5	45.5	-->
Real Rs.	27.5	33.7	39.3	47.1	56.1	66.4	78.2	86.0

At the time this report was prepared, April 1984, the exchange rate was \$1(US) = Rs. 13.4 (Pak).

TERMINOLOGY

2.10 Some differences have been evident in the irrigation terminology used in the documents and reports consulted. This report generally uses the terminology and groupings employed by

the PID's, as defined below. Even when the same definition is used by all provinces, the characteristics of the works may vary dramatically. In Punjab, for example, main canals vary in capacity (and size) from 450 cfs to 16,500 cfs; in NWFP, they vary from 250 cfs to 1800 cfs.

CANAL  
SYSTEM

Main Canal A channel which takes its supply directly from headworks on a river (or reservoir). No direct deliveries are made from main canals.

Link Canals (Feeders) A channel constructed primarily to convey water from one source to another. Normally used for transfers between river basins, or to serve existing canals from a new upstream headworks.

Branch Canal or Branch A canal taking off from a Main Canal or, occasionally, from another Branch (in which case the smaller channel is usually called a Sub-branch).

Distributary A channel taking its supply from a main or branch and furnishing water to minors or directly to outlets (moghas) serving farmer's watercourses. (The area served by a mogha is called a chak. The farmer-maintained watercourse conveys water within the chak to the fields.)

Minor A channel taking its supply from a distributary and supplying water to moghas.

Inundation Canal A canal without headworks control that fills and provides water for irrigation only when river stage is high.

Civil Canal A canal built through private initiative. The PID's have O&M responsibility for these canals, but administrative control is with the civil authorities. Common in NWFP and Baluchistan.

Perennial Canal A canal that has year-round access to water (except during the canal closure period).

Non-Perennial Canal A canal that has limited water availability, generally only from mid-April until mid-October.

## DRAINS

Main Drain A drain channel outletting to a river, or, occasionally, to a 'salt sink' or to a pump discharging into the canal system.

Branch Drain A drain channel discharging into a main drain. In large drainage systems, the term 'sub-drain' is sometimes used to designate smaller channels discharging into a branch.

## FLOOD CONTROL WORKS

Training Bund An earthen embankment, usually armored with rock and stone (pitching) placed to train river flows to provide protection to structures.

Protection Bund, sometimes referred to as "marginal bund". A bund constructed along the margin of a river to prevent inundation of the area behind the embankment.

Spur (Sometimes called "groyne" or "jetty".) Spurs are constructed to train river flow at critical points, and are usually built in the same manner as bunds. 'Temporary' spurs are often used to induce silting. These are normally made of stakes or pilings and brush tied in place.

## TUBE-WELLS

Private Tubewells Farmer-owned tubewells for irrigation purposes. In canal command areas, TW's provide supplemental water supplies, along with the major advantage that the operation is controlled by the farmer. More than 200,000 private TW's have been installed, and provide 27 M ac-ft/yr; About 91% of the private TWs are located in Punjab, which has by far the largest body of fresh ground water. Sind has about 4%, NWFP 2% and Baluchistan 3%.

Public Tubewells TW's that are operated and maintained by the PID's. These can be grouped into three main types: a) wells installed by the PID's, usually for full (non-supplemental) water supplies (located mostly in NWFP); b) SCARP TW's pumping fresh ground water; and c) SCARP TW's pumping saline ground water.

### III PUNJAB

#### IRRIGATION FACILITIES

3.01 Two sources were used to obtain data on the irrigation facilities in Punjab. The main source was the PID, but data about link canals comes from the ACE report of 1982.

3.02 Most canals run water 95% of the year; of 27 canal systems in Punjab, 14 are classified as perennial, six are non-perennial, and seven have areas of each type. There is a 15 to 20-day closure period in January and February for maintenance. Closure dates are established in December and published in the newspapers to inform the public.

3.03 The design capacity of individual main and branch canals extends to 16,500 cfs. In aggregate, the 22,083 miles of canals in Punjab (excluding link canals) were designed to carry 151,500 cfs. Present discharge capacity was estimated by the PID at 135,400 cfs. Using this figure, a CCA of 20,802,000 acres, and a utilization factor of 95%, canals can supply 4.51 ac-ft/ac/yr. If water supplies from SCARP tubewells are taken into account, supply amounts to an average of 4.82 ac-ft/ac/year. The design "water duty" (the average number of acres served by one cusec) is 137 ac/cfs; the water duty based upon actual carrying capacity is 154 ac/cfs. Canals serve 49,332 watercourses; average chak size is calculated to be 422 acres.

3.04 The PID has O&M responsibilities for 10 link canals with an aggregate length of 576 miles and combined capacity of 144,000 cfs. When link canals are added to main, branch, major, and minor canals described above, the result is a 22,600-mile canal system with a carrying capacity of 280,000 cfs. This immense network is operated and maintained by the PID.

3.05 The PID has O&M responsibilities for 17 small dams, access and patrol roads; colonies and buildings; 11 barrages and headworks; 2 major syphons (Ravi and Mailsi); 9 lift irrigation schemes; and 160 miles of railroad track.

3.06 The PID has maintenance responsibility for 1,510 miles of flood control works (bunds and spurs). It also is charged with maintenance of 3,769 miles of surface drains for a catchment area of 8.3 million acres. Estimated capacity of the drainage system is 35,000 cfs, based on PID data. The World Bank SAR (citing earlier NESPAK data) and the ACE Report cite a capacity figure of 15,000 cfs.

3.07 Punjab has a total of 13 SCARP's operated and maintained by the PID. Three additional SCARP's, Mona, Shahpur I, and SCARP-II Saline Zone, are operated by WAPDA. In 1982/83, the PID operated 8,523 wells that pumped an estimated 6,213,800 ac-ft (1982 Kharif plus 1982/83 Rabi). SCARP's provided drainage, and irrigation water on a supplemental basis, to an estimated 5,127,000 ac.

TABLE 3.1  
Irrigation Statistics - Punjab

	<u>CCA</u> (acres)	<u>Q</u> (cfs)	<u>Length</u> (miles)
Canals	20,802,000	151,538 (design) 135,387 (present)	22,083
Link Canals		144,082	576
Operational Tubewells (8,523)		8,750	
Drains		35,000	3,769
Flood Protec- tion Bunds			1,510

SOURCE: Data provided by the PID in 1984. Link canal data from the ACE Report of 1982.

## ORGANIZATION AND STAFFING

3.08 The PID is organized into six regions, Central, Bahawajpur, Multan, Lahore, Faisalabad, and Sargodha; and five functional offices: flood control and drainage, water treaty, water allocation, irrigation research institute, and design. Each is headed by a Chief Engineer who reports directly to the Secretary. Each region is divided into five circles which are each headed by a Superintending Engineer, and the circles are further broken into divisions. All units below the category of region are separated into designations based on either location or functional category, such as mechanical (tubewell), SCARP, drainage, small dams, hydrology, and floods.

3.09 By any standards, the size of the irrigation bureaucracy in Punjab is enormous. More than 50,000 individuals were employed by the PID in 1983/84 (see Table 3.2). In contrast, the U. S. Bureau of Reclamation currently has about 7500 employees. Punjab has a ratio of one employee per 414 acres irrigated. Salaries and allowances for these individuals came to Rs. 374 million, or 30.8% of the allocated NDB budget. Almost 40% of the total workforce comes under the category of canal irrigation-executive engineer, followed by 26% in the tubewells category, 15% in the special revenue grouping, and 6% under drainage. The rest of the workforce is assigned to administration, or to a number of functional categories such as dams, flood control, hydrology, hill torrents, land reclamation, water logging and salinity, workshops (Moghalpura and Bhalwal), research, design, stores, water treaty, and water allocation.

3.10 In Pakistan, where labor costs are low, the fact that an agency has such a large number of employees is not in itself inimical to good management. More important than the large number of employees is the fact that in Punjab responsibility for irrigation delivery is concentrated in a single water agency, the Punjab PID. By way of contrast, Punjab irrigates 20.8 million acres, California 9.5 million. However, 244 separate and distinct water districts<sup>1</sup> make irrigation water deliveries in California. Given current trends in many countries toward increased farmer involvement as a partial substitute for centralized decision-making, one can reason that decentralized farmer-based control of certain O&M functions may also offer opportunity for cost savings. But even if sought after, decentralized control is not easily attainable given that Punjab's irrigation system is a contiguous network.

3.11 The special revenue group in charge of assessments for abiana consists of 7,967 staff, almost half of whom are patwaris. In 1983/84, the budget allocation for the special revenue group amounted to Rs. 76.0 million.

3.12 The irrigation design section consists of 10 officers and 48 other staff. As a function, design is generally performed at the field level by executive engineers and their staff. However, the small size of the design section is indicative of the relative importance of design to other functions such as O&M.

1. Statewide Alpha Listing of Water Service Agencies, Department of Water Resources for the State of California, June 1983.

TABLE 3.2

## Staffing Levels - Punjab

<u>Position or Pay Equivalent</u>	<u>Pay Level</u>	<u>Numbers</u>
Secretary	20	2
Chief Engineer	20	12
Superintending Engineer	19	47
Executive Engineer	18	145
Sub-Divisional Engineer	17	574
Sub-Engineer	11 & 16	<u>2,312</u>
Sub Total Officers and Sub-Engineers		<u>3,092</u>
Other Staff		<u>47,185</u>
Total		50,277

SOURCE: PID and NDB figures for 1983/84

FUNDING FOR O&M

3.13 Demand No. 9 in the provincial NDB provides funding for the PID. Allocations have increased by 65%, from Rs. 735 million in 1980/81 to Rs. 1,211 million in 1983/84. This represents an average increase of 18% per year, which is significant since inflation during the same period averaged 9.9%. Allocations have varied from 85 to 103% of demand during this four-year period, but on the average the PID has received 93% of the amount requested. The PID states that expenditures were essentially equal to allocations.

3.14 The PID's budget allocation for repairs and maintenance is based upon the physical characteristics and inventory of the

irrigation facilities against which are applied "yardsticks" developed by the PID and sanctioned by the Finance Department. For example, the PID receives Rs. 13,000 per year for each mile of main and branch canals with discharges greater than 10,000 cfs. Payments for other categories of canals also depend upon length and discharge capacity. Tubewell schemes merit reimbursement on the basis of number of wells, discharge, and pumping lift. Flood control and drainage works are rated on the basis of mileage and bed width, barrages and headworks on discharge capacity, dams per individual facility, buildings per criteria established by the Buildings Department, and railway track at Rs. 7,000 per mile.

3.15 For the period 1980/81 through 83/84, allocations for all PID activities were, in Rs. millions, 734.5, 931.5, 1007.3, and 1210.6. Details of the allocations are shown in Table 3.3. Financial data furnished by the PID were broken into five categories for percentage-wise analysis: canal irrigation, tubewells, flood control and drainage, establishment, and other. Establishment costs are those associated with administration of the headquarters unit or units, and include salaries and allowances for staff, buildings, transport, telephone, and utilities. The "other" is a minor cost category that includes small dams, research<sup>1</sup>, design, and land reclamation. For the four-year period of analysis, more than 45% of the budget has been allocated to tubewell repair and maintenance (R&M), 16% to canal R&M, 2.5% to

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1. Even though expenditures for research are not large (see Table 3.3), Punjab and Sind are the only provinces where the PID's have a research component.

to flood control and drainage R&M, 36% to establishment (included under establishment is 6% of the total budget that is allocated to revenue collection), and the remaining 0.3% to all other functions. Table 3.4 shows this breakdown, as well as the percentages for 1983/84.

TABLE 3.3

Summary of Punjab PID Allocations (Rs. M)

	<u>1980/81</u>	<u>1981/82</u>	<u>1982/83</u>	<u>1983/84</u>
Canals	88.3	213.9	158.0	162.1
Tubewells	362.9	392.9	424.3	588.7
Establishment	280.9	321.2	373.3	407.8
Flood Control and Drainage	0.2	0.6	46.5	48.3
Dams	0.9	1.1	1.7	1.6
Research & Design	0.1	0.1	0.8	0.1
Land Reclamation	0.8	1.0	1.0	1.1
Equipment & Machinery	0.4	0.4	0.4	0.4
Other	0.1	0.3	1.3	0.4
	<hr/>	<hr/>	<hr/>	<hr/>
Total	734.5	931.5	1,007.3	1,210.6
Canals, FC&D, etc.	309.2	461.9	494.3	532.1
Tubewells	425.3	469.6	513.0	678.5

Source: NDB figures

TABLE 3.4

## A Percentage Breakdown of Punjab PID Allocations

Allocation to the PID for	Average Percentage 1980/81 to 1983/84
Canal Irrigation	16.0
Tubewells	45.5
Flood Control and Drainage*	2.5
Other	0.4
Establishment Total	<u>36.0</u> 100.0

\* The allocation for flood control and drainage, and associated establishment costs has increased greatly in the four years from Rs. 19 M in 80/81 to Rs. 75 M in 83/84. In 1983/84, the allocation for flood control and drainage (including establishment costs) was 6% of the budget.

Source: PID records

3.16 The PID classifies budget allocations by "establishment" and "repairs and maintenance" (R&M). Approximately two-thirds of the overall budget goes for R&M and one-third for establishment. Expenditures for tubewells dominate the R&M portion of the budget, accounting for 71%; canal R&M totals 25%; and flood control and drainage accounts for almost all the remaining 4% of R&M expenditures. Establishment costs can be allocated 31% to tubewells and 69% to canal irrigation, flood control, and drainage. In the period 1980/81 to 1983/84, allocations to canals, drains, flood control works, and associated establishment costs have increased relative to allocations

for tubewells and their associated establishment costs. During this period, allocations to canals, etc., grew by 72%, while those to tubewells increased by 60%. The increase in allocations for canals relative to tubewells represents a change from policies in effect during the 1970's that tended to favor expenditures for tubewells. All categories of expenditures received allocation increases in excess of inflation, which totaled 32%. The fact that O&M funding increases are on the rise is considered positive, particularly so since changes in NDB allocations have tended to closely follow inflation rates.

#### COST OF IRRIGATION SERVICES

3.17 The cost of irrigation services, including water deliveries, flood control, and drainage activities, is computed on the basis of 1983/84 NDB allocation to the PID and acreage and water delivery figures furnished by the PID. O&M costs for tubewells (SCARP's) and the portion of establishment costs associated with tubewell operations are separated from O&M costs for canals, drains, and flood control works. Table 3.5 shows the cost of irrigation services computed as Rs./ac and Rs./ac-ft for canal and tubewell deliveries, together with the method of computation.

TABLE 3.5

Cost of Irrigation Services - Punjab  
(acreage, ac-ft, and Rs. in millions)

	<u>Canals</u>	<u>Tubewells</u>	<u>Overall</u>
Rs./ac/yr	$\frac{532.12}{20.802} = 25.6$	$\frac{678.5}{5.127^*} = 123.3$	$\frac{1,211.}{20.802} = 58.2$
Rs./ac-ft	$\frac{532.12}{93.9} = 5.7$	$\frac{678.5}{6.214} = 109.2$	$\frac{1,211.}{100.114} = 12.1$

\* Area served with SCARP tubewell water on a supplemental basis.

Canal irrigation O&M was computed to cost Rs. 25.6/ac/yr or Rs. 5.7/ac-ft. O&M costs of Rs. 25.6/ac/yr are identical to updated "Revised Action Program for Irrigated Agriculture" (RAP) figures for canal O&M that in 1979 were pegged at Rs. 16/ac/yr. On a volume basis, the cost of SCARP-supplied water, Rs. 109.2/ac-ft, is almost 20 times that of canal water. Insofar as benefits are concerned, the cost of SCARP-supplied water can be allocated primarily to drainage (entirely, if groundwater is saline) and secondly to irrigation water supply. Aggregate costs to Punjab to provide irrigation services were computed at Rs. 58/ac/yr and Rs. 12/ac-ft.

3.18 Based upon 1983/84 costs for operations, maintenance, repair, and establishment of 8,523 operational tubewells in Punjab, the annual cost to operate and maintain a tubewell is

approximately Rs. 80,000, which is about twice that for NWFP and three times that for Sind. On the other hand, per ac-ft costs for tubewell-supplied water are roughly the same in the three provinces (see Table 7.8). Therefore, it can be concluded that the difference in annual costs is largely due to the number of operating hours per well and associated power costs, which are greatest in Punjab. Also, because Punjab uses tubewells for irrigation purposes the PID has a tendency to replace abandoned wells, which factors into the higher costs per well. In Sind, where tubewells are used primarily for drainage, the PID tends not to replace wells that have been abandoned.

#### O&M FUNDING TARGETS AND PROVINCIAL BUDGET ALLOCATIONS

3.19 Presented in Table 3.6 is a comparison of provincial expenditures for O&M with targets established in the 1982 World Bank SAR. Both expenditures and targets exclude allocations for tubewell O&M. In 1981/82 and 1982/83, provincial expenditures were in excess of SAR targets. In 1983/84, expenditures were four percent short of targeted levels.

TABLE 3.6

SAR Target Funding for O&M and Provincial Allocations  
Punjab

	<u>Rs. Millions</u>		
	<u>1981-82</u>	<u>1982-83</u>	<u>1983-84</u>
<u>SAR Targets*</u>			
1981 Constant Rs.	355	415	475
Real Rs.	355	459	557
<u>Provincial Allocation</u>			
NDB Actual**	462	494	532
Allocation as a Percentage of Target (%)	130	108	96

\* See Table 2.1.

\*\* Does not include tubewell O&M.

COST RECOVERY

3.20 In the period 1970-74, irrigation revenues from abiana were sufficient to exceed O&M expenditures by the PID, but expenditures have exceeded abiana revenues since 1974/75. In 1983/84, expenditures were Rs. 1211 million (Rs. 58/ac), and revenues were Rs. 749 million (Rs. 36/ac); i.e., abiana covered 62% of PID expenditures this year. If public tubewells were divested from the PID, abiana would support remaining PID expenditures.

## IV SIND

### IRRIGATION FACILITIES

4.01 Lands served by the Sind PID are irrigated through offtakes located at three barrages on the Indus, Guddu, Sukkur, and Kotri (at Hyderabad), from upstream to downstream, respectively. PID responsibility for O&M begins with the barrages, extends downstream, and terminates with water delivery to the mogha. The water users are responsible for O&M of the tertiary network, which in Sind serves 35,018 watercourses averaging 364 acres in size.

4.02 Sukkur, the oldest of the three barrages, was completed in 1932, and as a consequence of water rights obtained at that time the canals served from Sukkur are perennial. The single exception is the Rice Canal, which serves 520,000 ac. Canals served from Guddu and Kotri generally are classified as non-perennial, a reflection of inferior water rights obtained when those barrages were subsequently completed. Forty percent of the area in Sind is served by non-perennial canals and 60% by canals that have access to water year-round. However, most canals classified as non-perennial are able to make reduced water deliveries even during Rabi. The fact that certain canals run water year-round and others do not has implications for performance of canal maintenance, since silt removal from perennial canals can only be accomplished during the official January-February closure period. The area served by each of the barrages is summarized in Table 4.1. A summary of the irrigation

facilities operated and maintained by the PID is given in Table 4.2. These facilities are discussed in paragraphs 4.03 to 4.09.

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TABLE 4.1  
Culturable Command Area (CCA) Served From Each  
of the Barrages in Sind

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	CCA (ac)	
	<u>Non-Perennial</u>	<u>Perennial</u>
Guddu	2,293,000	-
Sukkur	520,000	6,926,000
Kotri	2,174,000	839,000
Totals	4,987,000	7,765,000

Grand Total 12,752,000 ac

Source: PID Data for 1983

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TABLE 4.2  
Irrigation Statistics - Sind

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	<u>CCA (acres)</u>	<u>Design Q (cfs)</u>	<u>Length (miles)</u>
Canals	12,752,000	125,230	13,163
Flood Protection Works			1,457
Drains	4,400,000	9,870	4,147
Tubewells	3,403 wells (fresh groundwater only)		

SOURCE: Information about canals and flood protection works provided by the PID in 1984. Drains and tubewell information is from the ACE Report of 1982.

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4.03 While the CCA indicated in Table 4.1 totals 12.752 M ac, less than half of this area is cultivated in any one season. This is due to limited water supplies, limitations in canal carrying capacity, and inefficiencies in water conveyance and water management. Between 1980/81 and 1982/83, cultivation during Kharif, the wet season, averaged 5,416,126 ac (42.5% of CCA); for the same period, cultivation during Rabi, the dry season, averaged 4,376,471 ac (34.3% of CCA).

4.04 There are four main canals offtaking from Guddu, seven from Sukkur, and four from Kotri. These total 1,201 miles in length. Overall, the PID has O&M responsibility for 13,163 miles of main, feeder, distributary, and minor canals, with a design discharge of 125,230 cfs. Main canal design discharge varies in capacity from 2,000 to 14,850 cfs, with maximum actual discharge often exceeding design by 20-40%.

4.05 Based upon records for 1982/83, combined water releases from the three barrages totaled 46.208 M ac-ft, 30.971 M ac-ft in Kharif and 15.237 M ac-ft in Rabi. Water release averaged 6.05 ac-ft/ac cultivated in Kharif, and 3.65 ac-ft/ac cultivated in Rabi.

4.06 The PID has O&M responsibility for 1,457 miles of flood control works including training bunds, flood protection bunds, and spurs.

4.07 Surface drainage works maintained by the PID include 4,147 miles of main, branch, and sub-branch drainage canals (ACE Report, 1982). These have a combined design discharge of 9,870

cfs, but actual discharge exceeds design by up to 60%. The area benefited by surface drains is 4.4 M ac.

4.08 The PID has O&M responsibility for SCARP'S and public tubewells having a total of 3,403 wells that pump fresh ground water and 379 wells that pump saline ground water (ACE Report of 1982). Unlike other provinces, Sind views tubewells as part of its drainage strategy and costs associated with tubewells are found in the land reclamation line item of the budget, separate from canal irrigation.

4.09 An undated copy of "Yardsticks of Maintenance and Operation of Irrigation System" indicates the PID has O&M responsibility for 692 regulators and 1,125 bridges.

#### ORGANIZATION AND STAFFING

4.10 The PID is headed by a Secretary for Irrigation and Power who is assisted by an Additional Secretary and a staff of Deputy Secretaries and Section Officers. Reporting to the Additional Secretary are four Chief Engineers, one for each of the three barrages, or regions, and one who is responsible for Development. Regional C.E.s are assisted by Superintending Engineers whose responsibility generally corresponds with main or feeder canals. Each S.E. usually supervises three or four Executive Engineers (XEN's). The C.E. for Development is in charge of a wide variety of functional categories including: Survey and Investigation, Land Reclamation, Design, Hydrology and Research, SCARP'S, Indus River Commission, Drainage, and Workshop.

4.11 Table 4.3 presents staffing levels for the PID. In 1983/84, 23,706 individuals were employed, or one employee per 538 ac of CCA. Salaries and allowances for these individuals totaled Rs. 175 million, or almost one-third of the PID budget estimate for that year.

TABLE 4.3  
Staffing Levels - Sind

<u>Position or Pay Equivalent</u>	<u>Pay Level</u>	<u>Numbers</u>
Secretary	20	3
Chief Engineer	20	5
Superintending Engineer	19	26
Executive Engineer	18	87
Sub-Divisional Engineer	17	246
Sub-Engineer	11 & 16	873
Sub Total Officers and Sub-Engineers		<u>1,240</u>
Other Staff		<u>22,466</u>
Total		<u>23,706</u>

Source: NDB figures for 1983/84

FUNDING FOR O&M

4.12 Funding for irrigation system O&M is provided in two demands or line items in the provincial NDB. Demand 37 deals primarily with canal irrigation, but includes barrages, flood control, and most surface drainage work. Demand 38, Land Reclamation, is primarily for tubewell O&M, but also provides funding for surface drainage works in SCARP's. This breakdown facilitates an analysis of canal irrigation vis-a-vis tubewells,

but it was difficult for the consultants to segregate budget categories and analyze these by functional groupings. Similarly, the PID management cannot easily use the NDB categories to analyze job costs or functional cost trends. On the other hand, the advantage of a budget that is aggregated is that it affords management the flexibility to maneuver expenditures between functional groupings.

4.13 As in the other provinces, yardsticks are used as the basis to establish budget estimates for O&M. For 1983, it was proposed that Rs. 7.95 million be allocated for desiltation of canals and Rs. 0.29 million for weeding. Other lump-sum yardsticks include an annual allocation of Rs. 3.0 million for O&M of the barrage at Guddu, Rs. 4.0 million for Sukkur, and Rs. 2.5 million for Kotri. The overall O&M yearly allocation was also based on Rs. 10,000 for maintenance and Rs. 5,000 for inspection per regulator in main canals; Rs. 2,500 maintenance and Rs. 3,000 inspection per regulator for distributary canals; and Rs. 1,500 maintenance and Rs. 2,000 inspection per regulator for minor canals. For each bridge inspected, the proposed yardstick was Rs. 1,000/year.

4.14 Between 1980/81 and 1983/84, NDB allocations to the PID increased from Rs. 303.0 million to Rs. 540.6 million, an annual increase of 21%. The annual increase for canal irrigation, including all PID expenses except tubewells and establishment costs associated with their O&M, has been 22%. The land reclamation (tubewell) portion of the budget has increased by 18% per year. A summary of PID allocations is given in Table 4.4.

4.15 For 1982/83 and 1983/84, allocations associated with tubewell O&M represented 19% of the PID budget; 81% of the budget was associated with canal irrigation. Establishment costs associated with tubewell O&M represented 11.6% of the overall establishment costs.

TABLE 4.4  
Summary of Sind PID Allocations (Rs. M)

	<u>1980/81*</u>	<u>1981/82*</u>	<u>1982/83</u>	<u>1983/84</u>
Canals	122.3	206.0	143.8	152.3
Barrages	20.5	18.0	10.1	48.2
Flood Control and Drains	16.2	17.0	15.9	45.8
Misc.	1.7	2.5	2.3	-
Electricity			53.7	54.3
Tubewell Maint. and Repair			25.8	21.0
Establishment**	<u>69.5</u>	<u>74.1</u>	<u>161.8</u>	<u>231.4</u>
Totals:	230.2	317.6***	413.4	540.6
Sub-Total Canal Irrig.	230.2	317.6	307.7	438.4
Sub-Total Tubewells	72.8	87.9	105.7	102.2

\* Does not include tubewell allocation.

\*\* For 1980/81 and 1981/82, establishment costs are associated only with canal irrigation. For 1982/83 and 1983/84, establishment costs for tubewells have been combined with establishment costs for canal irrigation. Approximately 11.6% of these two years' establishment costs accrue to tubewells and 88.4% to canal irrigation.

\*\*\* Included a special allocation of Rs. 50 million from the federal government.

Source: NDB and PID records

4.16 Table 4.5 is a percentage breakdown of Sind PID allocations for 1982/83 and 1983/84. Earlier years are not included because certain items in the NDB presentation could not be disaggregated into the expenditure categories presented. Thirty-five percent of the budget goes for establishment and one-third for canal irrigation; other major categories of expenditures are electricity charges, tubewell maintenance and repair,

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TABLE 4.5

A Percentage Breakdown of Sind PID Allocations  
for the Period 1982/83 - 1983/84

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Allocation to the PID for	%
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Establishment	35.0
Canal Irrigation	32.3
Barrages	5.2
Flood Control and Surface Drainage	3.7
Electricity	11.5
Tubewell Maintenance and Repair	6.1
Revenue Collection	1.5
Other Allocations (generally associated with canal irrigation)	4.7
	<u>100.0</u>

Notes: Approximately 76% of the budget goes for canal irrigation, barrages, flood control, drainage, and administration of these activities. Approximately 24% of the budget is associated with tubewell O&M and related establishment costs.

Source: NDB and PID records

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barrage maintenance, and flood control and surface drainage maintenance and improvement. Approximately Rs. 5.7 million of the establishment budget goes for revenue collection. Research merits an allocation of approximately Rs. 1 million per year, and design approximately Rs. 0.5 million per year.

COST OF IRRIGATION SERVICES

4.17 The determination of the cost of irrigation services was computed from NDB allocations shown in Table 4.4 for 1983/84, figures for CCA (1983) given in Table 4.1, and water releases at the barrages (1982/83) cited in paragraph 4.05. For tubewell supplied water, it was assumed that each well pumping fresh groundwater discharges 1 cfs and is operated 50% of the time. Table 4.6 is a summary of the cost of irrigation services.

TABLE 4.6

Cost of Irrigation Services - Sind  
(acreage, ac-ft, and Rs. in millions)

	<u>Canals</u>	<u>Tubewells</u>	<u>Overall</u>
Rs./ac/yr	$\frac{438.4}{12.752} = 34.4$		$\frac{540.6}{12.752} = 42$
Rs./ac-ft	$\frac{438.4}{46.208} = 9.5$	$\frac{102.2}{1.24} = 82.4$	$\frac{540.6}{47.45} = 11$

Canal irrigation O&M was computed to cost Rs. 34/ac/yr, or Rs. 9/ac-ft. By including the cost of tubewell O&M, overall costs

rise to Rs. 42/ac/yr, or Rs. 11/ac-ft. These costs are similar to those computed for Punjab. However, in Punjab, the SCARP programs are a much larger proportion of the budget than in Sind, which makes overall costs of irrigation services in Punjab significantly greater.

4.18 Based upon 3,782 operational public tubewells in Sind, and 1983/84 allocations for their operations, maintenance, repair and establishment, the annual cost to operate a public tubewell is Rs. 27,020. This is cheaper than for any of the other provinces (see paragraph 3.18).

#### O&M FUNDING TARGETS AND PROVINCIAL BUDGET ALLOCATIONS

4.19 Presented in Table 4.7 is a comparison of provincial allocations for O&M with targets established in the 1982 World Bank SAR. Both allocations and targets exclude tubewell O&M. Sind has equalled or exceeded the targets in each of the past three years by an average of 17%.

#### COST RECOVERY

4.20 In 1982/83, cost recovery through abiana amounted to Rs. 204 million, against an O&M allocation of Rs. 413.4 million, which is a recovery of 49.3% of costs. Expenditures for irrigation services were Rs. 42/ac and cost recovery averaged Rs. 16/ac. The PID estimated that cost recovery in 1983/84 would be Rs. 246 million.

TABLE 4.7

SAR Target Funding for O&M and Provincial Allocations  
(In Rs. Millions)  
Sind

<u>SAR Targets*</u>	<u>1981-82</u>	<u>1982-83</u>	<u>1983-84</u>
1981 Constant Rs.	254	276	298
Real Rs.	254	305	349
<u>Provincial Allocation</u>			
NDB Actual**	317.6***	307.7	438.4
Allocation as a Percentage of Target (%)	125	101	126

\* See Table 2.1.

\*\* Does not include tubewell O&M.

\*\*\* Included a special Rs. 50 million contribution from the federal government.

4.21 In the period 1970 to 1973, cost recovery exceeded O&M costs. Between 1973/74 and 1979/80, recovery increased from Rs. 61.8 million to Rs. 88.0 million, an increase of about 6% per year, while O&M costs escalated upward by almost 20% per year. This resulted in a significant gap between expenditures and recoveries; in 1979/80 expenditures climbed to Rs. 248 million against Rs. 88 million in recoveries, i.e., expenditures were 280% of receipts. Since then the annual rate of cost recovery has increased by almost 30%, which exceeds the escalation rate for expenditures, but current expenditures are still about twice the amount of recoveries.

4.22 In 1983, the Government of Sind published a law that areas benefited by drainage works in SCARP's are required to pay a drainage levy. For Khairpur, North Rohri, and Sukkur Right Bank, the rate is Rs. 16/cropped acre in each crop season, ie. Kharif and Rabi. For surface drainage, the rate is Rs. 5/cropped acre in the Larkana Shikarpur Surface Drainage Project, and Rs. 2/cropped acre in the Kotri Surface Drainage Project.

## V NORTH WEST FRONTIER PROVINCE

### IRRIGATION FACILITIES

5.01 The PID is charged with operations and maintenance of six principal categories of irrigation facilities:

- o Flow irrigation canals
- o Lift irrigation canals
- o Civil canals
- o Tubewells
- o SCARP Tubewells
- o Drains
- o Flood protection bunds.

Flow (or gravity) irrigation canals include a total of five head works and 57 schemes, the largest of which is the Upper Swat Canal with a design capacity of 1800 cfs. Seven other canals are classified as main canals with capacities in the range of 250 to 830 cfs.

5.02 Most canals are perennial, closing only when canals are cleaned in January. Thus, ~~flow~~ schemes are assumed to be utilized 92% of the year. They command 952,300 acres, giving an average designed capacity, or "water duty," of 165 ac/cfs. Average water allocation is 4.08 ac-ft/ac/yr. Based on 3,357 watercourses in the province, average chak size is 332 ac. A synopsis of data for flow irrigation and other irrigation facilities is furnished in Table 5.1.

5.03 Included in the irrigation works mentioned above and listed in Table 5.1, are a significant number of civil canals.

TABLE 5.1

Irrigation Statistics  
North West Frontier Province

	CCA (Acres)	Q (CFS)	Length (Miles)
Flow Irrigation Schemes <sup>1</sup>	952,300	5,783	1,596
Lift Irrigation Schemes <sup>1</sup>	82,500	448	127
Tubewells (191) <sup>2</sup>	80,230	210	-
SCARP Tubewells (497) <sup>3</sup>	27,710*	470	-
Paved Roads	-	-	226
Gravel or Dirt Roads	-	-	1,116
Drains	-	3,700	1,350
Flood Protection Bunds	-	-	143
Total	1,115,000		

1. Gravity irrigation schemes and lift irrigation schemes operate 330 days of the year. The average utilization factor is 92% for gravity canals. (Civil canals are included.) Utilization is estimated at 87% for lift canals assuming 5% down time for power outages and repairs. Approximately 4.17 M ac-ft are delivered each year by canals.
2. Based on a sample of 70 wells, average discharge was 1.1 cfs/well; wells operated 16 hours per day, 300 days per year. The utilization factor was estimated to be 55%. Depth of wells was 170-380 ft; pumping water level was 50-230 ft. Motor horsepower was 15-40 HP.
3. Based on the sample of 223 SCARP tubewells, average discharge was 1.1 cfs/well; wells operated 16 hours per day, 300 days per year. The utilization factor was 55%. Depth of wells was 170-380 ft; pumping water level was 50-230 ft. Motor horsepower was 15-40 HP. Approximately 273,000 ac-ft are delivered annually by SCARP and other public tubewells.

\* Acreage that is supplementally irrigated by SCARPs.

SOURCE: Data provided by PID for 1982-83.

These canals discharge about 830 cfs through a length of 362 miles, serving about 111,000 acres. Although O&M costs and services are furnished by the PID, these facilities are under the administrative control of the civil authorities, and no irrigation cost recovery is derived from water service to these lands.

5.04 The Province has 27 lift irrigation schemes commanding 82,500 acres. Twenty-one of the schemes have design capacities less than 10 cfs; five are in the range 12-55 cfs; the Warsak lift canal is designed at 200 cfs. Similar to flow schemes, lift canals operate in all months except January. Allowing for 5% downtime due to power outages and pump/motor maintenance, lift irrigation utilization is estimated at 87%.

5.05 The PID operates and maintains 191 tubewells and 497 SCARP tubewells. Utilization is estimated to be 55% for both types of wells, considering downtime for regular daily maintenance, repairs, power outages, and canal closure. SCARP wells generally discharge into watercourses. Other types of tubewells generally supplement canal sources and/or provide water for small irrigation schemes. Wells are estimated to provide water supplies to 108,000 acres, furnishing an average supply of 2.49 ac-ft/ac/year.

5.06 As a matter of provincial policy, many canal roads in NWFP are used as public thoroughfares. The PID is responsible for maintenance of 1,342 miles of paved and unpaved canal roads, and a network of 1,350 miles of open drains. The Department also

has responsibility to operate and maintain 10 small hydro facilities (five in operation and five to be commissioned in 1984), ranging in size from 100 to 300 kw and located in remote areas of NWFP. Two colonies and 34 bungalows are operated and maintained for use by PID personnel travelling to the field.

#### ORGANIZATION AND STAFFING

5.07 The NWFP Irrigation Department is headed by a Secretary who is assisted by a secretariat staff. In this province, the Secretary and some of his staff are responsible for public health engineering as well as irrigation. Responsibility for day-to-day functions of the irrigation department are under the direction of the Chief Engineer, assisted by 10 officers and 97 other staff. In total, the PID has more than 5000 employees, or one employee per 220 irrigated acres. In 1983/84, salaries and allowances for all categories of staff amounted to Rs. 40 million, or 28.4% of the PID NDB allocation. Staffing levels are shown in Table 5.2.

5.08 Although the Office of Collector is shown on the PID Organization Chart as under the C.E., the Collector and his staff (10 officers and 773 other staff) are essentially autonomous. Costs, however, are charged to the administration portion of the O&M budget.

5.09 The four Irrigation Circles in the PID are located primarily on a geographic and hydrographic basis. The Central and Southern Circles, located around Peshawar and Bannu,

respectively, comprise the two main blocks of irrigation development and serve approximately 730,000 acres. They each have four Divisions and eleven Sub-divisions. The two other Circles, Northern and Malakand, serve an irrigated area of approximately 410,000 acres with some portions scattered over very large and mountainous areas of the province. Northern has three Divisions and eight Sub-divisions; Malakand has three Divisions and seven Sub-divisions. There are two 'functional' divisions, the Tubewell Irrigation Division in the Central Irrigation Circle, Peshawar; and the Remodeling Division in the Southern Irrigation Circle, D.I. Khan.

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TABLE 5.2

Staffing Levels  
North West Frontier Province

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<u>Position or Pay Equivalent</u>	<u>Pay Level</u>	<u>Numbers</u>
Secretary	20	1
Chief Engineer	20	1
Superintending Engineer	19	7
Executive Engineer	18	20
Sub-Divisional Engineer	17	64
Sub-Engineer	11 & 16	<u>208</u>
Sub Total Officers and Sub-Engineers		301
Other Staff		<u>4,731</u>
Total		5,032

Source: NDB figures for 1983/84.

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## FUNDING FOR O&M

5.10 The Finance Department provides funding for PID operations through NDB allocations contained in Demands 8 and 9 of the NWFP NDB. Allocations (including those for tubewells) have increased from Rs. 96 million in 1980/81 to Rs. 140.9 million in 1983/84, an average annual increase of 13.6%. This represents a modest, but real, increase in funds for O&M because inflation during the same period averaged 9.9%. However, allocations as a percentage of PID requirements (demands) submitted to the Finance Department have decreased as follows during the past four years:

<u>Year</u>	<u>NDB Allocation/PID Requirement (%)</u>
1980/81	80.8
1981/82	77.4
1982/83	70.8
1983/84	67.8

5.11 It has been customary for the Finance Department to reduce the PID's budget requests by a significant amount (Rs. 31 million, or 21%, in 83/84), and to retain the amount of the reduction for targeted items. These retentions have been used to fund unforeseen and emergency work, but the funds are kept at the disposal of the Finance Department, not the PID's.

5.12 In the past, the Finance Department has determined NDB allocations for O&M using a "yardstick" of O&M as a percentage of updated capital costs. The approved "yardsticks" are as follows:

<u>Type of Facility</u>	<u>Annual O&amp;M Allotment As a Percentage of Capital Costs</u>
Canals	1.0%
Masonry	1.5%
Buildings	1.5%
Electrification	6.0%
Water Supply	6.0%
and	
Roads	
Blacktop (10 ft.)	Rs.7500/mile
Gravel	3646/mile
Earth	938/mile.

In practice, the PID has found it time-consuming and difficult to maintain updated capital costs for the entire irrigation system.

5.13 Actual NDB expenditures by the PID approximate 100% of the NDB allocations. Table 5.3 is a summary of PID expenditures and Table 5.4 gives a percentage breakdown of expenditures for the three-year period 1980/81 to 1982/83. In round numbers, one-third of the budget goes to canals, one-third to establishment, and one-third to other categories of work such as tubewells, bunds, lift irrigation, and drains. The allocation for tubewells has doubled over this three-year period, thus increasing relative to allocations for canal-associated irrigation costs.

TABLE 5.3

Summary of PID Expenditures (Rs. M)  
North West Frontier Province

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	<u>Expenditures</u>			<u>Allocation</u>
	<u>1980/81</u>	<u>1981/82</u>	<u>1982/83</u>	<u>1983/84</u>
Canals	29.3	39.9	43.0	52.8
Lift Irrigation	5.1	6.8	7.1	5.9
Tubewells	11.5	15.8	19.5	23.1
Drains	5.2	5.7	5.6	6.3
Bunds	12.1	10.4	12.2	12.7
Establishment*	<u>32.7</u>	<u>33.2</u>	<u>42.8</u>	<u>40.1</u>
Totals:	95.9	111.8	130.2	140.9

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\* Includes all establishment costs, of which an estimated 15% are devoted to tubewells and 85% to other PID activities.

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TABLE 5.4  
A Percentage Breakdown of PID Expenditures  
for the Period 1980/81 - 1982/83  
North West Frontier Province

<u>PID Expenditure</u>	<u>Demand*</u>	<u>%</u>
Government Canals	8	30.0
Civil Canals	9	<u>3.1</u>
Canals Total		33.1
Tubewells	8	13.7
Drains	9	5.0
Bunds	9	10.4
Lift Irrigation	8	5.6
Establishment	8	<u>32.2</u> 100.0
Total Demand 8	81.5	
Total Demand 9	<u>18.5</u> 100.0	

\* The PID draws its budget from two line items, Demands Number 8 & 9. Revenue-generating canals, tubewells, and establishment fall under Demand 8; drains and bunds, and canals that do not generate revenues, are charged against Demand 9.

#### COST OF IRRIGATION SERVICES

5.14 O&M allocations for canal-supplied water (including canal maintenance and repair, lift irrigation, and 85% of establishment costs) totaled Rs. 92.8 million in 1983/84. This equates to an allocation of Rs. 83/ac/year, or Rs. 22/ac-ft. If

allocations for maintenance and repair of drainage and flood control works are included under the canal irrigation category, 1983/84 allocation amounted to Rs. 111.8 million, or Rs. 100/- ac/yr, and Rs. 27/ac-ft.

5.15 The cost of tubewell O&M was derived from 1983/84 allocations for tubewell operations, maintenance and repair, plus 15% of the overall establishment costs. Tubewell O&M totalled Rs. 29.1 million, or Rs. 42,300/well/yr. Using the acreage that is supplementally supplied by water from public tubewells and SCARP's, allocations for tubewells were calculated at Rs. 269/- ac/yr, or Rs. 107/ac-ft.

5.16 Independent of NDB allocations, the PID provided their own details of certain O&M expenditures for 95 tubewells based on costs incurred in the 1982/83 fiscal year. The percentage breakdown in expenditures was as follows:

Electricity charges to WAPDA	72.3%
Repairs and transport of pumps and motors	23.7%
Living facilities for operators & guards	2.3%
Salaries for operators & guards	1.6%

This breakdown did not include other salaries and establishment costs associated with tubewell operations. These bring the cost of tubewell O&M to the figure of Rs. 42,300/well/yr cited in Paragraph 5.15. The annual cost of O&M for a typical well in NWFP was one and one-half times that for a well in Sind but half that for a well in Punjab. (See paragraph 3.18.)

5.17 Since almost three-quarters of the O&M costs for tubewells are tied up in electricity charges, it is useful to

speculate on the implications for the PID budget of a marked increase in electricity costs. Assuming the same degree of reliance on wells, a 25% increase in electricity rates would call for Rs. 4.6 million in additional expenditures, or a 3.3% increase in the 1983/84 NDB allocation. Unless additional funds were allocated by the Finance Department to cover an electricity rate increase, it is likely that the PID would transfer funds from the canals, bunds and drain maintenance portions of the O&M budget, resulting in an accumulation of deferred maintenance for non-tubewell items of the budget.

5.18 Based upon the 1983/84 NDB allocation to the PID for canal and tubewell O&M, and on 1982/83 figures for acreage, system capacity, and degree of utilization, the overall cost of providing irrigation services (including canals, tubewells, drainage and flood control) is approximately Rs. 126/acre, and Rs. 32/ac-ft. Results are summarized in Table 5.5. On a volume basis, water from public tubewells is four times as costly as canal-derived supplies. However, the utility from public tubewells, particularly SCARP's, is more than irrigation alone because the costs also reflect drainage benefits.

TABLE 5.5

Cost of Irrigation Services NWFP  
(acreaage, ac-ft, and Rs. in millions)

	<u>Canals</u>	<u>Tubewells</u>	<u>Overall</u>
Rs./ac/yr	$\frac{111.8}{1.115} = 100$	$\frac{29.1}{0.108^*} = 269$	$\frac{140.9}{1.115} = 126$
Rs./ac-ft	$\frac{111.8}{4.17} = 27$	$\frac{29.1}{0.273} = 107$	$\frac{140.9}{4.443} = 32$

\* Area served by public tubewells on a supplemental basis.

O&M FUNDING TARGETS AND PROVINCIAL BUDGET ALLOCATIONS

5.19 In SAR 3717-PAK the World Bank targeted funding levels for O&M to be provided to the PID. Targets were exclusive of tubewell O&M, but included the following categories of expenditures:

- o Canals, bunds and drains
- o Regulators
- o Headworks
- o Bungalows and colonies
- o Special repairs
- o Telephone & telegraph
- o Lift irrigation
- o Supervision and administration (establishment).

Though not explicitly mentioned, it is presumed that patrol road maintenance was included under canal expenditures. Small hydro O&M is an additional responsibility of the PID, but since it occupies less than one-half of one percent of the budget, it was ignored. WAPDA performs all O&M of power generation facilities in the Upper Swat Canal.

5.20 Table 5.6 presents targets and Provincial budget allocations, exclusive of tubewell O&M. Between 1981/82 and 1983/84, allocations averaged 130% of the SAR targets.

TABLE 5.6

SAR Target Funding for O&M and Provincial Allocations  
North West Frontier Province  
(in Rs. Millions)

	<u>1981-82</u>	<u>1982-83</u>	<u>1983-84</u>
<u>SAR Targets*</u>			
1981 Constant Rs.	68.0	72.0	76.0
Real Rs.	68.0	80.0	89.0
<u>Provincial Allocation</u>			
NDB Actual**	91.5	103.6	111.8
Allocation as a Percentage of Target (%)	135	130	126

\* See Table 2.1.

\*\* Excludes tubewell O&M and 15% of establishment costs that are associated with tubewells.

## COST RECOVERY

5.21 Water charges are assessed based upon crop acreage and type and location of water delivery scheme. Water charges are greater for crops having a higher water requirement. For example, sugarcane and tree crops are assessed at a per-acre charge that is 2-3 times that for grains or pulses. Water provided by lift irrigation or tubewell schemes is assessed at a per-acre rate that is twice that of flow irrigation schemes.

5.22 Revenue collection from abiana totals about Rs. 31 million per year versus Rs. 130.2 million in expenditures (1982/83), a recovery of 24%. The percentage cost recovery in NWFP is significantly less than in Punjab or Sind. Since cost recovery averages Rs. 28/ac and irrigation service costs are Rs. 126/ac, there is a shortfall of Rs. 98/ac between expenditures and cost recovery through abiana. If the lack of revenue from civil canal areas is taken into account, the revenue per acre would be Rs. 31. (Rs. 31 million/1.004 million acres.)

## VI BALUCHISTAN

### IRRIGATION FACILITIES

6.01 Data regarding the irrigation sector in Baluchistan were difficult to obtain. We have used secondary sources, sometimes contradictory but always cited, to provide background on the size of the irrigation sector in the province.

6.02 The overall length of the canal system was given as 510 miles (NESPAK 1981) and 1,649 miles (ACE 1982). Capacity was cited by these sources as 4,770 cfs and 8,299 cfs, respectively. Principal canals are the Kirthar Branch and the Pat Feeder Canal, both from the Indus and serving Nasirabad District; and the Nari Canal (or river), which originates in the Ziarat, Harnai and Loralai areas and serves the Sibi and Kachhi Districts.

6.03 Both sources list the Hair Din drainage system as maintained by the PID. Covering 87,000 acres, it may be the only sizeable drainage system in the province; channel length is 100 miles and capacity is rated at 390 cfs.

6.04 The PID has responsibility for maintenance of:

- o 154 miles of flood protection bunds, per NESPAK;
- o 17 small dams, per IBRD SAR 3772-PAK, Baluchistan Minor Irrigation and Agricultural Development Project, 1982;
- o 78 delay-action dams (for groundwater recharge), per SAR 3772-PAK;
- o 79 diversion structures, per SAR 3772-PAK.

6.05 The various sources give diverse figures for irrigated area (in acres):

- o 740,000, CCA, per ACE Report, 1982;
- o 760,000, CCA, per SAR 3717-PAK, 1982;
- o 1,500,000, "has some form of irrigation" per SAR 3772-PAK, 1982. This figure includes indigenous as well as PID systems. Of this area, 74% is irrigated from non-perennial canals, 16% from karezes, 10% from wells and tubewells.
- o 1,342,000, per Agricultural Statistics of Baluchistan for 1981/82. Canals irrigate 960,000 acres; wells, 42,000; tubewells, 135,000; and karezes, 205,000.

For purposes of this report, we have assumed that the PID has O&M responsibility for an irrigation system commanding 750,000 acres. Based upon 1,393 watercourses in the province, average chak size is 538 acres.

6.06 According to Agricultural Statistics of Baluchistan, 1981/82, there are 6,928 wells and 7,584 tubewells in the province. Only 131 of these are public, and all are used for domestic water supply purposes.

#### ORGANIZATION AND STAFFING

6.07 The PID is organized into four regional circles: Quetta, Sibi, Kalat, and Makran; and, within these, into 12 divisions. There is an Electrical and Mechanical Circle at Quetta, but costs associated with that circle are not included in this report since its function is mainly potable water supply.

6.08 Table 6.1 presents staffing levels for the PID. There are 240 acres irrigated for each employee of the PID. In 1983/84, salaries and allowances for the 3,114 employees amounted to RS. 24.7 million, or 29.3% of the PID budget.

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TABLE 6.1

Staffing Levels

Provincial Irrigation District - Baluchistan

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<u>Position or Pay Equivalent</u>	<u>Pay Level</u>	<u>Numbers</u>
Secretary	20	1
Chief Engineer	20	1
Superintending Engineer	19	10
Executive Engineer	18	17
Sub-Divisional Engineer	17	49
Sub-Engineer	11 & 16	<u>177</u>
Sub Total Officers and Sub-Engineers		<u>255</u>
Other Staff		<u>2,859</u>
Total		<u>3,114</u>

Source: NDB data for 1983/84.

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FUNDING FOR O&M

6.09 Funding for the PID is contained in Demand 30 of the Baluchistan NDB. Public tubewells are used almost exclusively for potable water supply purposes, and after 1983/84, allocations associated with tubewells will be budgeted in a line item that is separate from irrigation expenditures. Because public tubewells are not used for irrigation, the consultants have not included tubewell costs in the analyses that follow.

6.10 Total NDB allocations to the PID have been as follows:

<u>Year</u>	<u>Rs. Millions</u>
1980/81	71.5
81/82	78.2
82/83	80.9
83/84	84.1
84/85	95.1

Between 1980 and 1984, the annual allocation increase averaged less than 6%. Unless revised it appears that the 1984/85 allocation increase will be significant, Rs. 11 million, making a better than 7% average annual increase for the period 1980-1985. While these increases do not keep pace with inflation, the allocation amounts are well in excess of 1982 Bank targets (see paragraph 6.12).

6.11 Expenditures were broken down into the following categories: establishment, canal maintenance and repair, drainage and flood control, and workshop and supplies. Based upon data for 1983/84, the percentage breakdown was as follows:

establishment	39%
canal maintenance and repair	54%
drainage and flood control	4%
workshop and supplies	3%.

#### O&M FUNDING TARGETS AND PROVINCIAL BUDGET ALLOCATIONS

6.12 Table 6.2 is a comparison of provincial expenditures for O&M with targets established in the 1982 World Bank SAR. O&M allocations to the PID have been more than twice Bank targets. The major discrepancy was that the SAR greatly underestimated staff salaries and allowances. Also, targets were considerably short of actual spending levels for canal maintenance and repair.

TABLE 6.2

SAR Target Funding for O&M and Provincial Allocations  
Baluchistan  
(In Rs. Millions)

	<u>1981/82</u>	<u>1982/83</u>	<u>1983/84</u>	<u>1984/85</u>
<u>SAR Targets*</u>				
1981 Constant Rs.	27.5	30.5	33.5	36.5
Real Rs.	27.5	33.7	39.3	47.1
<u>Provincial Allocation</u>				
NDB Actual**	78.2	80.9	84.1	95.1
Allocation as a Percentage of Target (%)	284	240	214	202

\* See Table 2.1.

\*\* Does not include tubewell O&M.

COST OF IRRIGATION SERVICES

6.13 Based upon 1983/84 expenditures, O&M costs were computed at Rs. 112/ac. Since there are no public tubewells used for irrigation in Baluchistan, these are costs associated entirely with canal irrigation. As such, these costs are more than four times those for canal irrigation in Punjab, and greater than costs in the other provinces. This is because irrigation facilities are not large, and must serve relatively small and scattered locations.

## VII NEW TARGETS, CONCLUSIONS AND RECOMMENDATIONS

### NEW TARGETS

7.01 This report builds on data in various reports, on information graciously furnished in writing by the PID's and through conversations with many of their staff at all levels, and on the experience and judgment of the consulting team members. The results of this combination of data, viewpoints, comments, and judgment are new target figures for O&M funding considered adequate to maintain the irrigation systems.

7.02 "Yardsticks" are frequently used to estimate costs of materials and labor for new construction, and they also have a place in estimating O&M expenses for new facilities. Alternatively, accurate cost records are usually the best basis for estimating future O&M costs for existing works. This was the approach used to establish the new targets.

7.03 The complement of accurate cost records is good supervision and close, frequent inspection of the system to insure that the works are being properly maintained and that the operation is responsive to changing demands and conditions. Accordingly, supervision and management were observed in both office and field. O&M activities and the physical system itself were inspected. The most common statement heard, at all levels, was that funds are inadequate to maintain the system in good condition. Bank deterioration and uncleared silt deposition were the problems most often mentioned. Our observations confirmed

that bank maintenance had been deferred on some major canals and on many distributaries and minors, often to a dangerous level. Major works and structures were, with a few exceptions, in good to excellent condition. No significant problems were observed in system operation, except those associated with flows in excess of about 110% of design.

7.04 The evaluation of appropriate funding levels required for good system O&M was based on the following:

- a) Analysis of NDB funding and PID expenditure records, plus discussions with staff to assure common understanding of terminology and application.
- b) Discussions with staff at all levels as to organization objectives and policies, responsibilities, authority, job satisfaction, support from higher levels, and the perception of their own job and its role in meeting PID objectives.
- c) Field inspection (limited by time constraints to 3 - 6 days in each province) of the channels, structures and other facilities that are operated and maintained by the PID's. Particular note was made of deferred maintenance and trends in that direction, so that targets would reflect whatever additional funding might be required to avoid deterioration.

7.05 For convenient reference, the O&M targets established in the World Bank SAR, 1982, are set out in Table 7.1.

TABLE 7.1  
SAR FUNDING TARGETS  
(Rs. millions)

Fiscal year	<u>81/82</u>	<u>82/83</u>	<u>83/84</u>	<u>84/85</u>	<u>85/86</u>	<u>86/87</u>	<u>87/88</u>	<u>88/89</u>
<b>PUNJAB</b>								
SAR 81Rs.	355	415	475	535	595	-->	-->	-->
Real Rs.	355	459	557	691	845	929	1,022	1,125
<b>SIND</b>								
SAR 81Rs.	254	276	298	320	-->	-->	-->	-->
Real Rs.	254	305	349	413	454	500	550	605
<b>NWFP</b>								
SAR 81Rs.	68	72	76	80	-->	-->	-->	-->
Real Rs.	68	80	89	103	114	125	137	151
<b>BALUCHISTAN</b>								
SAR 81Rs.	27.5	30.5	33.5	36.5	39.5	42.5	45.5	-->
Real Rs.	27.5	33.7	39.3	47.1	56.1	66.4	78.2	86.0

At the time this report was prepared, April 1984, the exchange rate was \$1(US) = Rs. 13.4 (Pak).

7.07 PID allocations (expenditures) are compared with the World Bank targets for O&M in Table 7.2. Tubewell costs are excluded in each case.

TABLE 7.2  
Comparison of SAR Targets and PID Funding for O&M,  
Excluding Tubewell Costs  
(Real Rs. Millions)

Fiscal Year	80/81	81/82	82/83	83/84	84/85**
<b>PUNJAB</b>					
Target	-	355	459	557	691
Funding	309	462*	494	532	616
<b>SIND</b>					
Target	-	254	305	349	413
Funding	230	318*	308	438	468
<b>NWFP</b>					
Target	-	68	80	89	103
Funding	79	91	104	112	123
<b>BALUCHISTAN</b>					
Target	-	27.5	33.7	39.3	47.1
Funding	71.5	78.2	80.9	84.1	95.1

\*These figures reflect federal grants in the amount of Rs. 100 million to Punjab, and Rs. 50 million to Sind.

\*\*Funding figures in this column have been estimated from the PID budget requests to reflect average ratios of requests/allocations.

From these data, it is evident that:

- a) Punjab exceeded Bank targets in FY's 82 and 83; funding for O&M fell short of targets in FY's 84 and 85;
- b) Sind and NWFP have met or exceeded targets each year;
- c) Baluchistan has greatly exceeded the targets.

7.07 The new targets developed by this study are tabulated in Table 7.3. These are based on the physical works now in

place. Should significant additions be made to or major components be deleted from the systems, appropriate changes would need to be made. It is suggested that if additions/deletions occur, the best approach is to modify cost estimates through an analysis of current cost records for similar functions and works.

TABLE 7.3

New Funding Targets for Adequate Irrigation O&M  
(Real Rs. Millions)

Fiscal Year	83/84	84/85	85/86	86/87	87/88	88/89
<b>PUNJAB</b>						
w/o tubewells	615	677	745	819	901	991
with tubewells	1384	1522	1674	1842	2026	2228
<b>SIND</b>						
w/o tubewells	527	580	638	702	772	849
with tubewells	628	691	760	836	920	1012
<b>NWFP</b>						
w/o tubewells	125	138	152	167	184	202
with tubewells	159	175	192	212	233	256
<b>BALUCHISTAN</b> No tubewells	87	96	106	116	128	141

NOTE: Base year is FY 85. Projections escalated and de-escalated at 10% per year.

7.08 The assumed inflation rate has a large influence upon the projection of new targets beyond the base year. For example, if 12% annual inflation were assumed instead of 10%, the Punjab new target with tubewells for 1988/89 would be Rs. 2,395 million rather than Rs. 2,228 million, an increase of Rs. 167 million or 7.5% of the new target shown in Table 7.3. Since projected targets are clearly inflation-rate sensitive, it is recommended that rates be monitored and new targets adjusted each year.

7.09 Table 7.4 compares PID funding (excluding tubewells) and the new target figures.

TABLE 7.4

Comparison of New Targets\* and PID Funding for O&M,  
Excluding Tubewell Costs  
(Real Rs. Millions)

Fiscal Year	83/84	84/85**
<b>PUNJAB</b>		
New Target	615	677
PID Funding	532	616
<b>SIND</b>		
New Target	527	580
PID Funding	438	468
<b>NWFP</b>		
New Target	125	138
PID Funding	112	123
<b>BALUCHISTAN</b>		
New Target	87	96
PID Funding	84	95

\*New target figures determined for 1984/85, then de-escalated at 10%.

\*\*PID funding was estimated from PID demands for FY85 to reflect average ratios of requests/allocations.

Expressed as a percentage of new targets, funding levels were: Punjab - 89%, Sind - 82%, NWFP - 89%, and Baluchistan - 98%. This is for all PID operations except tubewells.

7.10 Although the question of divesting public tubewells to the private sector has been under study for several years, the consultants believe that such action probably will not happen for some time. Accordingly, the new targets have been developed to

include tubewell O&M as a part of the PIDs' responsibilities. The comparison of the new targets with actual and projected funding by the PID's, both including tubewell O&M, is shown in Table 7.5.

TABLE 7.5

Comparison of New Targets\* and PID Funding for O&M,  
Including Tubewell Costs  
(Real Rs. Millions)

Fiscal Year	83/84	84/85**
<b>PUNJAB</b>		
New Target	1,384	1,522
PID Funding	1,211	1,362
<b>SIND</b>		
New Target	628	691
PID Funding	541	583
<b>NWFP</b>		
New Target	159	175
PID Funding	141	162

\*New Target figures determined for 1984/85, then de-escalated at 10%.

\*\*PID funding was estimated from PID demands for FY85 to reflect average ratios of requests/allocations.

For all functions including tubewells, average yearly increases in funding were 18% for Punjab, and 21%, 14%, and 7% for Sind, NWFP, and Baluchistan, respectively. Expressed as percentages of new targets, funding-level percentages were 88% for Punjab, 85% for Sind, and 91% for NWFP. Thus, PID's will have to receive additional increases in allocations to meet new targets.

7.11 A summary breakdown by NDB category and by function for the new provincial funding targets is given in Tables 7.6 and 7.7.

TABLE 7.6

New Target Breakdown by NDB Category  
(Rs. Millions)

All Categories Except Tubewells	PUNJAB	SIND	NWFP	BALUCHISTAN
Salaries and Allowances	292.9	223.2	8.8	5.3
Commodities and Services	29.2	6.2	6.4	6.0
Purchases - Durable Goods	29.1	25.9	2.5	1.5
Extension & Improvement	-	59.0	7.5	22.0
Repairs and Maintenance	<u>326.3</u>	<u>265.3</u>	<u>112.8</u>	<u>60.9</u>
Subtotal:	677.5	579.6	138.0	95.7
<u>Tubewell Categories</u>				
Salaries and Allowances	131.7	29.4	3.8	
Commodities and Services	10.0	0.7	0.5	
Purchases - Durable Goods	38.0	3.6	-	
Extension & Improvement	-	6.1	-	
Repairs and Maintenance*	<u>64.5</u>	<u>71.8</u>	<u>32.3</u>	
Sub-Total	844.2	111.6	36.6	
PID Total	1,521.7	691.2	174.6	

\*Includes electricity costs.

TABLE 7.7

New Target Breakdown by Function  
(Rs. Millions)

FUNCTION	PUNJAB	SIND	NWFP	BALUCHISTAN
Administration <sup>1</sup>	145.8	259.5 <sup>7</sup>	10.9	8.2
Dams <sup>2</sup>	6.7	-	3.8	-
Canal System <sup>3</sup>	420.5	248.3	87.1	63.1
Flood Control <sup>4</sup>	60.1	21.7	20.0	3.6
Drainage <sup>5</sup>	49.2	35.4	16.2	9.0
Work Shops	11.4	1.6	-	3.2
Land Reclamation	20.3	-	-	-
Other <sup>6</sup>	8.6	48.1 <sup>7</sup>	-	8.6
Tubewells	<u>799.0</u>	<u>76.1</u>	<u>36.6</u>	<u>-</u>
Totals	1,521.6	691.2	174.6	95.7

1. Administration, sometimes called Direction, includes all costs associated with the Secretariat and the offices of C.E., S.E., and other posts of equivalent grade. Costs for Research and Design and for Special Revenue are also included in full.

2. Dams refers to the smaller irrigation dams operated and maintained by some of the PID's, in contrast to the multi-purpose irrigation and power dams operated by WAPDA. Barrages are included under canals, rather than dams.

3. Canal System includes irrigation channels of all kinds and size, barrages and headworks, syphons and all other structures, and lift schemes.

4. Flood Control refers to flood control embankments and to hydrology and flood forecasting activities.

5. Drainage includes all surface and tile drainage; it does not include drainage tubewells.

6. The composition of this category varies from province to province. Medical and Hill Torrent functions are usually in this group. In Baluchistan, this includes buildings.

7. All Sind establishment costs are included here, because the NDB provides no breakdown by function. Also, the "Other" category for Sind includes costs of R&M; E&I; Replacement of Vehicles, Heavy Trucks and Equipment; and Office Buildings.

## CONCLUSIONS AND RECOMMENDATIONS

### Costs

1. In Punjab and Sind, the costs associated with provision of canal irrigation water are low, Rs. 6 and 9/ac-ft, respectively (see Table 7.8). In part, this is because PID responsibility for water delivery terminates at the mogha, the outlet serving blocks from 200 to 900 acres in size, with an average of 398 acres. Also contributing to keeping costs low is the fact that operationally the irrigation system requires few water measurements or adjustments in flows, and maintenance activities can be classified as largely "caretaker" or "fireman" in nature.

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TABLE 7.8

Cost of Irrigation Services  
Based on 1983/84 Expenditures  
All Provinces

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	<u>** Rs./Ac/Yr **</u>		
<u>Province</u>	<u>Canals</u>	<u>Tubewells</u>	<u>Overall</u>
Punjab	26	123	58
Sind	34	---	42
NWFP	100	269	126
Baluchistan	112	---	112

  

	<u>** Rs./Ac-ft **</u>		
Punjab	6	109	12
Sind	9	82	11
NWFP	27	107	32

---

2. The cost of public tubewell-supplied water is significantly greater than canal-supplied irrigation water. On a volume

basis, tubewell water is four times the cost of canal water in NWFP, nine times the cost in Sind, and 18 times the cost in Punjab. However, in most locations public tubewells have a dual purpose: drainage plus water supply for irrigation. Thus, it is not strictly correct to compare canal water costs with public tubewell water costs for irrigation supply alone.

3. The fact that many private individuals are investing in tubewells is an indicator that farmers realize additional benefits and thus can incur additional costs from being able to operate and control deliveries from their own wells.

4. Power charges are estimated to be 50 - 75% of the component costs associated with operation of public tubewells. If one assumes that the power rates for tubewells are the same to the public and private sectors (or less costly to the public sector), establishment and R&M must account for the differential in costs between public and private sector tubewells. However, expenditures for electricity and R&M are intimately linked, and improved operating efficiency and a reduction in power demands can be achieved through improved tubewell performance monitoring. In all the provinces, the standard practice is to have each tubewell watched over by a resident "operator". It is recommended that this system be abandoned, and replaced by one in which a roving specialist would monitor performance, maintain and operate a battery of tubewells. Performance monitoring should consist of measurements of discharge, drawdown, and horsepower load. This should be done on a quarterly basis, with records

kept and presented regularly to the mechanical engineer, who would make decisions as to which pumps to pull and repair.

5. The annual costs of operation of a tubewell in Punjab is 2-3 times that of a tubewell in the other provinces. This is because in Punjab tubewells are used primarily for irrigation, not drainage, and they are operated for more hours than wells in Sind or NWFP. Expenditures for tubewells consume 21% of the PID budget in NWFP, 19% in Sind, and 56% in Punjab. There may be significant opportunities for cost savings on the tubewell side of PID operations, particularly in Punjab, but also in the other two provinces.

#### Funding

6. The NDB is the principal source of funding to the PID's for recurrent-type O&M expenditures. While the format of the NDB varies by province, NDB's are not in any way structured to permit job cost accounting. Items in the NDB are grouped into broad categories, such as "machinery and equipment", "extension and improvement", and "maintenance and repairs", and provide only limited clarity as to what the budgeted item is for. Instead, a breakdown by function is recommended, such as canals, barrages, flood control works, drainage, electricity charges, etc. Further, the NDB presentation uses vague and/or archaic terminology; for example, irrigation works classified by the categories "productive" and "un-productive", or "Lloyd Barrage Unified System" (in Sind) instead of Sukkur Barrage. It is recommended that changes be made in the format of the NDB presentation to

provide a breakdown by functional category and by major jobs. This will facilitate internal management objectives for the PID by providing decision-makers with data on costs, so they can decide where to place emphasis to improve operations.

7. In the period 1980/81 to 1983/84, NDB allocations to the PID's for irrigation system O&M have increased at rates significantly greater than the prevailing inflation, which for the same period was officially reported at 32%. Allocations increased in Punjab by 65%, in Sind by 78%, and in NWFP by 47%. Allocation increases for Baluchistan were 18%, less than inflation, but more than double 1982 SAR targets. Normally, NDB allocation increases closely parallel inflation. The fact that funding increases for O&M are significantly greater than inflation indicates that the Finance Department and the PID's are committed to upgrading maintenance of the irrigation systems.

8. Between 1980/81 and 1983/84, Punjab and Sind PID funding for canals has increased at a more rapid pace than has funding for tubewells. In Punjab canal funding increased by 72% compared to 60% for tubewells; in Sind canals received increases of 90% and tubewells 40%. In NWFP the reverse is true, with expenditures for tubewells doubling while expenditures for other categories of O&M increased by 47%.

9. Increases in electricity charge rates were made in 1979, 1980 and 1981, but rates have not increased since 1981. Taken over the period 1978 to 1984 the average annual increase in electricity charge rates to the PID's was 17.1%, which equates to

a three-year increase of 60%. Thus, it would appear that increases in funding allocations for tubewells between 1980/81 and 1983/84 are related to earlier increases in electricity charge rates.

#### PID Management

10. O&M of the irrigation systems is the primary function of the PID's. Good O&M requires training and experience in management as well as background in engineering. Meeting the objectives of improved O&M may require changing promotional rules under which only engineers have positions of authority in the PID's, to recognize the importance of both engineering qualifications and training and experience in all areas of management.

11. With the provincial government providing funding, PID accountability is upward (to the governor), and not downward to the farmers. Further, PID responsibilities are to deliver water to the mogha, and not to the water user. Lack of accountability and responsibility to the farmer water-user affects the perceived quality of service, since the PID's can be fully accountable and responsible without interaction with the farmers who, in turn, can perceive the service they receive as less than satisfactory.

12. The PID's are large public water agencies (see sections 3.09 and 3.10) each with irrigation water delivery and other responsibilities for vast areas of the country. Several ways are being tested to improve services or lower costs through decentralization; for example, by function, the SCARP Transition Project, and by area, the Command Water Management Project.

These projects, or changes suggested by these projects, may affect costs incurred by the PID's, thus affecting O&M targets recommended in this report.

13. Certain figures presented in this report can be used by PID management as indicators of department performance. For example, PID's could establish criteria such as the number of irrigated (or better, cropped) acres per employee, or the cost of tubewell-supplied water, to monitor and test against with time. This is termed "management by objectives", a technique used to upgrade aspects of performance.

14. Before "management by objectives" can be implemented, better information needs to be made available to PID staff. This remains a problem area, given communication difficulties in upward information transfer and a budgeting system that cannot easily be broken into functional categories of utility to managers. While a quick recommendation might be to computerize PID record-keeping it must be acknowledged that most of the accounting functions presently are all done by hand. Thus, a jump from the mechanics of present record keeping to a computerized system may be too abrupt. What is needed is a thorough revamping of accounting procedures with a focus directed to job-cost and functional accounting.

#### Cost Recovery

15. As a percentage of PID expenditures, cost recovery through water charges is 62% in Punjab, 49% in Sind, and 24% in NWFP. Efforts should be made to increase revenue collection from lands

served by the PID's. Sind has recently adopted charges for drainage services and other provinces should be encouraged to follow suit. In NWFP, water charges should be collected from lands served by deliveries through civil canals. Revenue collection goes hand in glove with accountability. If money for PID operations comes from the province, accountability is upward; if the money comes from the farmers, accountability (and responsibility) becomes farmer-based.

16. The proper timing for an increase in water charges is important. We would recommend that it be soon, in concert with implementation of the major rehabilitation effort sponsored by USAID and IBRD.

17. Attention is frequently focused on the bases for assessment of water charges. In Pakistan, assessment is made differentially by crop and water source, not by volume. Water is a mobile input and is difficult to measure and control. A volumetric system is applicable only where water deliveries can be controlled and measured and where the irrigation department can administratively account for all the water that it manages. These conditions are not met in Pakistan, nor are they met in most developing countries. An effort to impose them would be costly in an engineering/water control sense, and costly in additional staff requirements. Further, it would divert PID attention from other O&M concerns. Therefore, it is not recommended that volumetric water charge assessments be instituted.

18. Since water revenues are not collected and retained by the PID's, the cost of their assessment and collection, presently borne by the PID's, should be charged to the revenue department. Conversely, should water charges be collected and retained by the PID's for system O&M, the PID should then be responsible for associated costs of revenue assessment and collection.

#### SAR Targets

19. Generally, expenditures for O&M have exceeded targets set by the 1982 IBRD SAR. In Sind and NWFP, expenditures ran 100-135% of targets; Baluchistan has been spending in excess of 200% of targets. Punjab exceeded targets in 1981/82 and 1982/83, and narrowly missed it in 1983/84. Expenditures are still considered too low to support adequate O&M and recommended new target levels have been proposed that are in the range of 102% to 120% of current expenditures.

20. Because of the fact that targets are inflation-rate sensitive, it is recommended that rates be monitored by USAID and IBRD, that targets be adjusted each year, and that those new figures be communicated to the PID's as references against which to judge O&M allocation adequacy.

Appendix

Persons Interviewed

Punjab

Irrigation Department

Mohammad Ashraf Khan	Under Secretary
M.M. Yunis	Provincial Coordinator ISRP
Mohammad Zarif	Dep. Sec. Operations
Mohammad Dilpazir	Dep. Sec. Development
M.M. Khan	Dep. Sec. General
Mian Mohammad Safdar	C.E. Bahawalpur Region
Shafique Ahmad	S.E. Rahimyar Khan Circle
Mohammad Afzal	S.E. Drainage Circle Sargodha
Malik Nasir Ahmed	S.E. Drainage Circle Faisalabad
Mohammad Aslam	XEN Drainage Div. Faisalabad
Anwar W. Din	XEN " " "
S. Mansoob Ali Zaidi	XEN Kwairwala Drainage Project
Sajjad Hussain Nasim	XEN Khanki Headworks Div.
Abbas Raza	SEN " " "
Abdul Majeed	SDO Lower Chenab Canal East Faisalabad
Manzur Qayaum	SDO Ali Pur Multan
Mohammad Iqbal	S.E. Depal Pur Canal Circle
Abdul Quddus	XEN Lahore Division
Allah Nawaz Khan	Assist. Professor, Punjab Engineering Academy, Niazbeg
Mazhar ul Islam	Deputy Collector
Mohammad Sadiq Khan	Divisional Accountant
G.R. Firdausi	S.E. Upper Chenab Circle Lahore
Ch. Abdul Majid	S.E. Link Canal Circle Lahore

Khurshid Mohammed Khan	XEN Gujranwala Division
S.K. Bhatti	S.E. Mechanical Circle Central
Haroon Rasid Toosy	XEN Central Store Div.
M. Khalid Ahmad	XEN Irrigation Workshop Lahore
Saleem ud Din	S.E. Lower Chenab Canal (West) Circle Faisalabad
Manzur Hussain	XEN Lower Chenab Canal (West) Circle Faisalabad
Mohammad Akram Qureshi	XEN Lower Chenab Canal (West) Circle Faisalabad
Zafar Ahmad Khan	S.E. Lower Chenab Canal (East) Circle Faisalabad
Abdul Latif	XEN Lower Chenab Canal (East) Gugera
Ali Akbar	Regional Accounts Officer (ISRP)
Asrar ul Haq	Assist. Design Engr. Lahore

Sind

Irrigation Department

Muzammil H. Qureshi	Additional Secretary
Zafar Shaikh	Deputy Secretary, Development, (S.E.), Karachi
A. L. Quadri	Provincial Coordinator (C.E.), Rehabilitation Project, Karachi
Abdul Rashad A. Memon	Deputy Secretary (S.E.), Operations, Karachi
Abdul Rahim Siddiqui	XEN Kotri Barrage
Ali Memon	Assistant XEN
Shamsuddin Memon	XEN, Nasrat Division, Nawabshah
N. M. Mathrani	XEN, Mechanical Division, Jamshoro
Zamir A. R. Memon	Assistant XEN Workshop Subdivision

A. Ghaffar Memon	Assistant XEN Stores Division, Jamshoro
G. Mustafa	Assistant XEN Tractor Subdivision (Machinery)
Abdul Rahman Memon	XEN
Muttaqi Hasan Rizui	Assistant Engineer, Mechanical, Jamshoro
Muhammad Zaffar Laghari	Assistant XEN, Khadro
Amanullah A. Qureshi	Assistant Engineer
S. A. Moghul	XEN, Irrigation Division
Agha Irayatullah	AEN Irrigation, Nawabshah
A. Noor Muhammad Shaw	Assistant XEN
Ali Gohar Tunio	XEN Irrigation, Hala Division
A. W. Channa	Assistant XEN, Civil Works
Shuja Junejo	Section Officer, Development
Abdul Hamid Shaikh	S.E. Inundation Circle, Hyderabad
Durga Shankar	XEN, Pinyari Division

**NWFP**

**Irrigation Department**

Abdul Rauf Khan	Secretary PID
Abdul Aziz Khan	Chief Engineer
Rab Nawaz Khan	Director Planning, Design & Hydrology, Peshawar.
Amir Haider	Section Officer (Construction) (Sec. of Irrigation)
Aslam Saleem	Assist. Director Design & Hydrology.
M. Hashim Khan	Section Officer Operations
Nisar Mohammad Khan	S.E. Power, Irrigation Dept.

Farouk Gilani	Power
Gulzar Khan	Tech. Officer Irrigation (Chief Engineers Office)
M. Shafi Shah	Chief Draftsman
Hassan Qadri	Budget Office
Wahab Ali	Assist. Accounts Officer
Akhtar Ali Ismaeli	S.E. Central Irrig. Circle
A. B. Balouch	XEN (Tubewell Irrig. Div.) Mech. Irrig. Div. Peshawar
Saleem Ullah Khan	S. E. Northern Irrigation Circle Mardan.
Aman Gul Khattak	XEN Mardan Division
Mohammad Raqib Khan	XEN Swabi Division
Nawab Khan	XEN Malakand Division

Other Persons

Ikbar Ullah Khan	Farmer, Mardan District
R. D. Williams	Planning & Development Dept
Zainullah Khan	Finance Department
M. Ihtesham Khan	Dep. Secretary Finance Dept.

Baluchistan

Irrigation Department

Fazal Din Khan	Technical Advisor to Secretary
Shereen Khan	S.E. Electrical & Mechanical Circle
Arbab M. Yousaf	XEN Water Supply Workshop, Quetta ISRP Deputy Coordinator
M. Azam Baluch	S.E. Sibi Circle
Dewan Budhar Das	Assistant Engr. Sibi Division
Sarwar Khan	Sub-Engineer Sibi Division