1961-62

WAPDA ANNUAL REPORT

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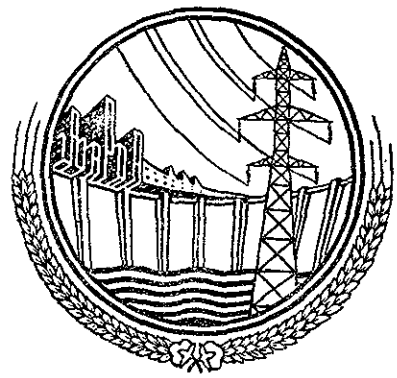
A review of the
activities of
the West Pakistan
Water and Power
Development
Authority from
1st July, 1961
to 30th June 1962

WAPDA ANNUAL REPORT



This report on the activities of the West Pakistan Water and Power Development Authority from 1st July, 1961 to 30th June, 1962 has been prepared for submission to the Government of West Pakistan as required under Section 21(1) of the WAPDA Act, 1958. Included in this review also are reports on projects under the Indus Basin Settlement Plan which the Authority is executing on behalf of the Government of Pakistan. They have been included in this review to give a complete picture of the activities of the Authority.

The Authority, availing of this occasion, wishes to place on record its appreciation of the services of all its staff and consultants who during the year under review have helped the Authority in making a substantial progress towards the fulfilment of its statutory responsibilities. The Authority is also deeply appreciative of the close cooperation and help given to it by the various departments and agencies of the Central and the West Pakistan Governments. Without this cooperation and active assistance the Authority would not have been able to achieve all that has been recorded in this report.

T. J. O'Brien

Secretary.

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INTRODUCTION

This is the fourth annual report of the West Pakistan Water and Power Development Authority. It covers the broad spectrum of Wapda's activities undertaken during 1961-62 in the fulfilment of its statutory obligations to the West Pakistan Government and as tasks specially assigned to it by the Government of Pakistan. At places this review adds to its retrospection by going beyond July, 1961, and recapitulating what Wapda has been doing in the previous years to bring into greater relief the rate and scope of progress in the period now under report. An attempt has been made to blend with progress statistics some relevant background information to give in each section of this report as complete a picture as possible of Wapda's programmes, projects and problems.

Wapda's Charter

The Authority was set up by the Government of West Pakistan by an ordinance issued in February, 1958. Shortly afterwards this ordinance was repealed and replaced by an Act of the provincial legislature. This Act was first published in the Gazette of West Pakistan on 24th April, 1958. It was amended by a West Pakistan Government notification on 27th March, 1959, to enable the Government to transfer the Electricity Department to Wapda. There have been no further amendments to the Act.

Under the Act, which serves the Authority as its charter, Wapda is charged with the responsibility of preparing, for the approval of the Government, a comprehensive plan for the development and utilisation of the water and power resources of West Pakistan on a unified and multipurpose basis. Its charter covers the framing of schemes for all or any of the following:

i) irrigation, water-supply and drainage; and recreational use of water resources;

ii) the generation, transmission and distribution of power; and the construction, maintenance and operation of power houses and grids;

iii) flood control;

iv) the prevention of waterlogging and reclamation of waterlogged and salted lands;

v) inland navigation; and

vi) the prevention of any ill-effects on public health resulting from the operations of the Authority.

The Wapda Act provides that the Government shall have the power to direct the Authority to hand over any scheme other than a power scheme or the power

part of a multipurpose scheme carried out by it to any agency of the Government or a local body. In such a case the Authority shall be entitled to receive credit to the extent of the audited expenditure incurred by it on that scheme.

Land and Water Resources

The setting up of Wapda with a measure of autonomy wide enough to match the scope of its activities was in recognition of the important part that the development of water and power resources played in the building of an infra-structure of a nation's economy. In 1951 the population of West Pakistan was 33 million and on the basis of the 1961 census the present population is about 43 million. It is estimated that by 1970 this population will be approximately 50 million and by 2000 A.D. it will exceed 80 million. At present the 43 million people in West Pakistan depend on 39 million cropped acres for food, and the bulk of this population depends on agriculture for its livelihood. To improve agricultural production and to provide additional employment opportunities Wapda is working towards making a more efficient use of the water and power resources of West Pakistan. A preliminary inventory (to be firmed up in 1962-63) of our water and land resources shows that of West Pakistan's total area of 198 million acres the Indus Basin covers 130 million acres and the remaining 68 million areas lie in the Baluchistan region which is drained by coastal tributaries and desert streams. Each of these two regions has its own specific characteristics and internally related hydrological systems and special problems of water resources development. According to the Planning Commission, of the 130 million acres in the Indus Basin 75 million acres are good culturable land. At present about 39 million acres are cropped to some degree, 33 million acres are commanded by our irrigation network and the annual average irrigated area is just over 24 million acres. To irrigate these 24 million acres West Pakistan is presently using 72 million acre feet of water out of the total supplies of 168 million acre feet for the entire Indus Basin.

West Pakistan will be losing 33 million acre feet to India as a result of the Indus Waters Treaty, leaving us with an annual average of 135 million acre feet. A decade from now when the Tarbela and Mangla dams have been built and the irrigation projects of Ghulam Mohammad, Gudu, Taunsa, Thal and Panjnad barrages have reached full development we shall be using 95 million acre feet of water and the area under irrigation will have increased from 24 million acres to 27 million acres. West Pakistan will be left with a balance of 40 million acre feet of average flow supplies and of this about 17 million acre feet is estimated as the loss in conveyance through river channels leaving West Pakistan with an available supply of 23 million acre feet to develop the remaining 48 million acre of culturable land in the Indus Basin. The available river flows can be augmented by the exploitation of ground water resources tentatively estimated at 16 million acre feet and the flow from the western tributaries of the Indus to give us approximately 50 million acre feet of water. All these sources will have to be harnessed and judicially used for only about 50 million acre feet of water will be available for the development of 48 million acre of land. It is evident that large areas equal to almost

half of the culturable land under irrigation, will have to go without irrigation supplies even with the complete exploitation of the water resources of the Indus Basin, assuming that such complete exploitation is technically and financially feasible.

The position in Baluchistan is no better. In a year of good precipitation the discharge in the desert streams and coastal tributaries may be about 5 million acre feet and this is not sufficient for a potential culturable area of 10 million acres. Because of the lack of adequate data relating to the hydrology of surface and ground water in this region a large scale programme of water development is not possible in the immediate future. Wapda has, however, started collection of the required data in a systematic way for the first time in the history of the Baluchistan area.

The overall position for West Pakistan is that with the fuller exploitation of its water resources, and with an integrated use of the surface and ground water supplies —which incidentally will help in solving the problem of waterlogging and salinity—and with modern farming practices it will be possible to increase very substantially the agricultural production in the irrigated areas.

Power Development

The problem of developing power facilities is also a challenging one. Government records show that in 1950 there were about 78,000 consumers of electricity in the area served by Wapda—that is, almost the whole of West Pakistan excluding Karachi and some areas where private companies were or are operating. During 1961-62 alone the number of new consumers connected to the system was over 82,000. At the end of the period under review the total number of consumers was nearly 442,000 in an area having a population of approximately 40 million. This represents more than 90 persons for each electric service connection whereas in the highly industrialised countries the number of persons per service connection is about 3 or 4. This and the present per capita consumption of power of 23 units as compared to thousands of units per capita in the more developed countries should give some idea of the backlog of the power programme in West Pakistan.

Allocation of Funds

The urgency of speeding up measures for the development of water and power resources on which depends the growth in our agricultural and industrial sectors was realised by the Government in the early years after independece. At the time when the First Five Year Plan was formulated the cost of water and power development schemes being implemented in West Pakistan was Rs 2294 million and an expenditure of approximately Rs 900 million had been actually incurred upto March, 1955. Keeping in view the importance of the sector the number of such schemes was increased and the total cost of the water and power projects approved in the First Plan was estimated at Rs 4296 million, out of which the expenditure proposed for the First Plan period was approximately Rs 1791 million. The water development programme fell considerably behind schedule and the First Plan targets in the key sector of agriculture were not reached.

One of the reasons was that the traditional departmental methods of implementing development projects were neither speedy nor flexible enough to permit the acceleration required. In the recent past the maximum spending rate of the Irrigation Department and the Electricity Department combined was about Rs 180 million annually, that is, about half of the spending rate required for the water and power sector in West Pakistan for the First Plan and just over one-third of the estimated rate for the Second Plan.

The limited capacity of the traditional government departments to undertake or execute large projects at a fast enough rate was also inhibiting the flow to Pakistan of foreign aid which is invariably linked up with a country's capacity to absorb such aid. At that time the Indus Waters Treaty was also in sight involving further capital outlays far in excess of what was envisaged in the Second Plan. It was under these circumstances, about four years ago, that the Government decided to create Wapda with enough administrative and operational flexibility to speed up the rate of development work in the water and power sector. Wapda was also appointed by the Government of Pakistan and the World Bank as their agent to implement the projects under the Indus Basin Settlement Plan. Some idea of the additional work involved may be had from the estimate that during 1959-64 the expenditure under the Indus Basin Settlement Plan will be about Rs 2430 million, that is, more than the Second Plan allocation of Rs 2260 million of public funds for the water and power sector.

The total allocation for Wapda projects during the Second Plan period (1960-65) is Rs 1801.7 million. Of this the expenditure for the first two years (1960-62) has been Rs 762.5 million. At the time of the formulation of the Second Five Year Plan it was represented both to the Planning Commission and the Government of Pakistan that, considering the objectives of the Second Plan and the targets to be achieved, Wapda would have to undertake many more water and power development schemes than had been provided for in the Second Plan, and that for this purpose the existing allocations would be totally inadequate. The additional schemes, spread all over West Pakistan, are those for the building of dams on the Hub River near Karachi, on Gomal Zam at Khajuri Kach, on the Haro near Khanpur, on Kohat Toi near Tanda, and on Khost River at Mangi in the Sibi area; salinity control and reclamation projects in the Sind and Punjab areas; and a new power station near Lyallpur, the extension of the Sukkur thermal station, and the expansion and renovation of the power distribution system.

Budget for 1961-62

Since its creation Wapda has been working on a large number of projects and schemes, several of which have been completed and brought into commission. As listed in the Wapda budget for 1961-62 thirty two schemes are being or have been financed out of the Authority Fund consisting mainly of loans from the Provincial Government and foreign agencies, receipts from its power operations and from debentures issued by it. This list does not include the Gudu Barrage Project under con-

struction by Wapda as agents to the Provincial Government but financed directly out of the provincial exchequer; the Karachi Irrigation Project financed by the Central Government; and projects under the Indus Basin Settlement Plan financed mainly from the Indus Basin Fund administered by the World Bank and partly by the Central Government (for items not covered by Indus Basih Fund Agreement). During the year under review the revised Wapda budget for the above schemes, excluding MPO and projects under the Indus Basin Settlement Plan, was Rs 551.7 million. Of this amount the expenditure actually incurred was Rs. 543.3 million. Meanwhile, work on the Indus Basin Projects has gathered momentum and the expenditure on them has gone up from Rs 62.7 million in 1960-61 to over Rs 330 million during 1961-62.

Conscious of its responsibility as the largest spender of public funds in West Pakistan, the Authority has, in addition to the statutory audit by the Auditor General of Pakistan, provided also for audit checks by its own organisation and by commercial firms. The World Bank has its own team of auditors for the Indus Basin Projects.

Highlights of Progress

Many of the tasks assigned to Wapda were completed during the year under review and a steady progress was maintained in the remaining programme. Among the highlights of 1961-62 were the completion of the Rawal dam and the Hyderabad thermal Station and their inauguration by the President of Pakistan; the diversion of the Indus at Gudu through 40 spans of the new barrage and the consequent opening of the Begari-Sind and Desert feeders, and the new canal network on the right bank; the pumping out a million acre feet of ground water in 9 months by the Central Rechna tubewells working for the first time and the general lowering of the water table by over 3 feet the in operationl area; and the increase in the annual per capita consumption of electricity from 18 to 23 units and in consumers from about 360,000 to 442,000.

Organization

As has been implied earlier in this *Introduction* an important contribution to the speeding up of the rate of development in the water and power sector has been made by the organisational posture of the main implementing agency. During 1961-62 there has been no change in the tribasic organisational pattern of the Authority—*Administration and Coordination Water* and *Power*, but internally within the Water and Power Wings there were several structural and functional changes. The Power Wing was reorganised in February, 1962, in view of its new responsibilities in the commercial and constructional spheres of its activities. Other features of the reorganization which is described in detail in the main report are that the distribution of electricity has been made a separate functional responsibility both at the departmental and regional levels, and in the regions greater autonomy has been given to the Power Wing's four zonal offices at Lahore, Multan, Peshawar and Hyderabad. The reorganization of the Water Wing followed that of the provincial departments towards the end of the financial year under review. The Water Wing now has separate Chief

Engineers for Ground Water and Reclamation Division, Water and Soils Investigations Division, Coordination and Development, Gudu Barrage Project and Tarbela Dam Project. The Indus Basin Project at the headquarters was placed under the charge of a Director-General. Both for the Water and Power Wings the Authority has created organisations to carry out a physical auditing of the works in progress.

Authority

There was no change in the personnel of the Authority. Mr Ghulam Ishaq continued as Chairman, and Mr A. M. Sial and Mr N. H. Jafarey as Members. Mr A. M. Sial whose term of office was due to end on 16th September, 1961, has been given an extension for another term of three years.

PROJECTS UNDER THE INDUS BASIN SETTLEMENT PLAN

This section of the annual report describes the progress made on the various projects under the Indus Basin Settlement Plan. The purpose of this introductory chapter is to give some background to the Settlement Plan which is being implemented by Wapda as agents to the Government of Pakistan. The Settlement Plan is the outcome of the Indus Waters Treaty with the formal ratification of which on September 19,1960, ended the 13 year old dispute with India on the distribution of waters of the Indus river system. This multiproject plan is being financed under the Indus Basin Development Fund Agreement which too was concluded on September 19, 1960, between Pakistan and the Indus Club countries.

The Treaty

The Indus Waters Treaty is based on the principle of division of rivers—the three eastern rivers, the Ravi, the Beas and the Sutlej going to India and the three western rivers, the Indus, the Chenab, and the Jhelum, save for some uses by India in the upper reaches, being reserved for the exclusive use of Pakistan. The Treaty provides for a transition period of 10 years during which Pakistan is expected to complete the system of works required to replace from the western rivers the supplies so far received from the eastern rivers. The transition period can be extended at Pakistan's request, but on payment of penalties to India, by another three years. Meanwhile the Treaty contemplates that Pakistan will continue to receive from the eastern rivers progressively diminishing quantities of water linked up with the completion of its own replacement works.

Development Fund

To finance the cost of the replacement works, an Indus Basin Development Fund has been set up with contributions from USA, UK, West Germany, Canada, Australia and New Zealand and loans from the International Bank for Reconstruction and Development and the former Development Loan Fund (now part of the United States Agency for International Development). India has to make her contribution to the Fund without deduction or set-off on account of any other financial claims of India on Pakistan. A permanent Indus Commission consisting of one representative each of India and Pakistan has been set up to supervise the implementation of the Treaty. There are provisions for the settlement of differences of a technical nature by a neutral expert, and of differences over the interpretation of the Treaty by a court of arbitration.

The Fund is being administered by the World Bank as Administrator under the Fund Agreement and in this it is assisted by Sir Alexander Gibb and Partners, as consulting engineers, and by Cooper and Lybrand as auditors and accounting consultants. Within Wapda, the Indus Basin Projects Division headed by a Chief Engineer

is responsible for the execution of the works. Assisting Wapda are several consulting engineers of repute.

Indus River System

The Indus river system consists of the Indus main and five of its major tributaries -the Jhelum, the Chenab, the Ravi, the Beas and the Sutlej. This system drains a total area of about 348,000 square miles, out of which 204,000 square miles lie in West Pakistan, 29,000 square miles in India, 52,000 square miles in Jammu and Kashmir, and the remaining 63,000 square miles in Afghanistan and Tibet. The total average annual flow of the system entering Pakistan is about 168 million acre feet, the flow of the Indus main, the Jhelum, the Chenab, the Ravi, the Beas and the Sutlej being 87, 24, 23, 7, 13, and 14 million acre feet respectively.

The Settlement Plan

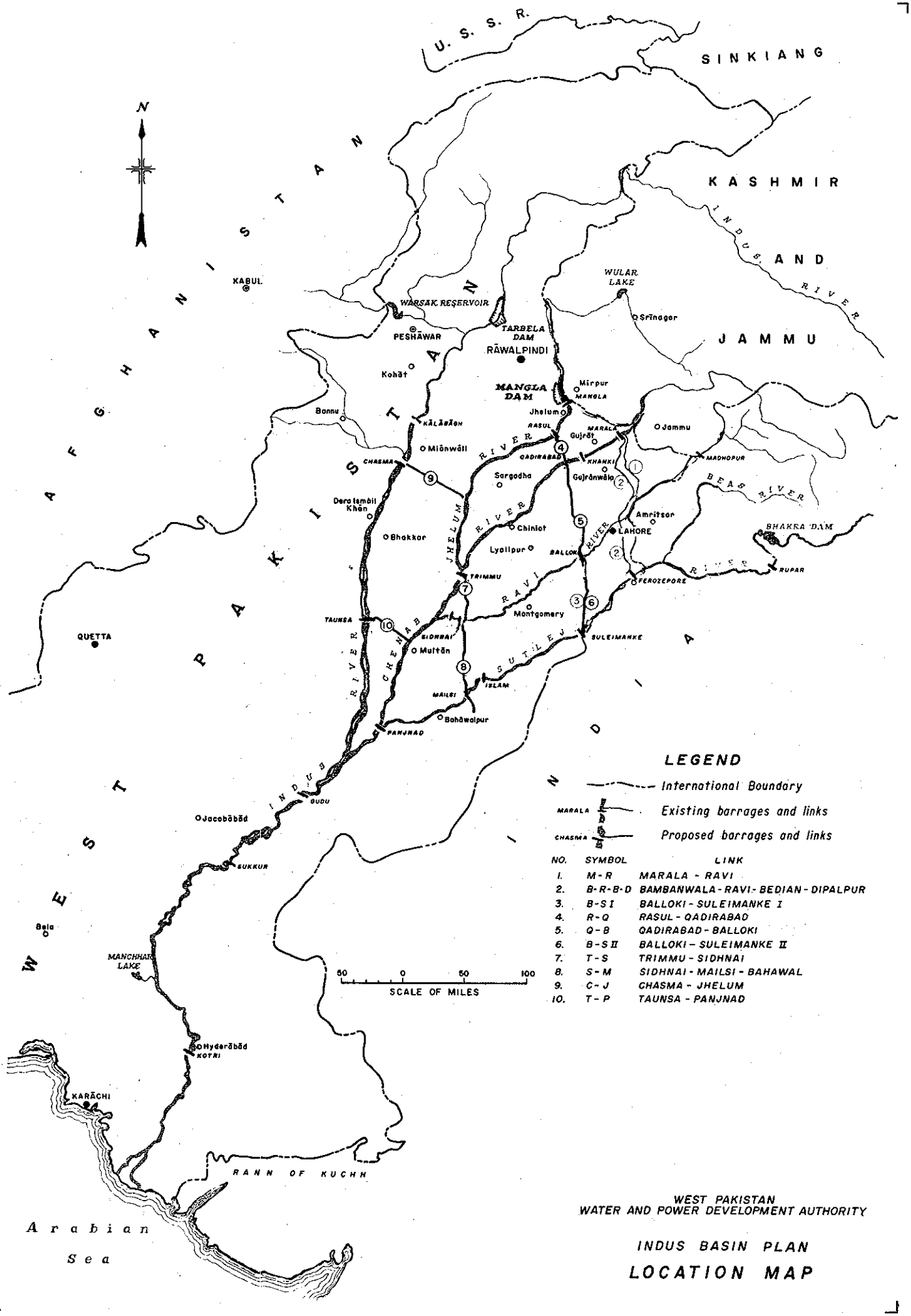
Under the Indus Waters Treaty, India will be entitled to the exclusive use of the waters of the eastern rivers—the Ravi, the Beas, and the Sutlej, while Pakistan will be entitled to the use of the waters of the western rivers—the Indus, the Jhelum and the Chenab, except for certain uses, specified in the Treaty, for areas lying in India and in Jammu and Kashmir. The system of works to be constructed in West Pakistan consists of 2 dams, 8 inter-river link canals, 4 barrages, one gated syphon, remodelling of 3 existing inter-river link canals and some existing irrigation systems severed by the new construction, and a set of tubewells and drainage wroks.

The primary object of the Settlement Plan Works is to provide for the replacement both in time and place of the supplies lost to India. On completion, these works however will serve a secondary purpose also and that is that apart from providing a small element of direct development they will lay the foundation for and facilitate the fuller development in future of West Pakistan's waters.

While each of these works like the parts of a complicated machine is essential for the proper and efficient operation of the system as a whole, the two storage reservoirs are by far the most important components of the plan. Much of the water dispute centred round the inadequacy of the flow supplies of the western rivers to meet the replacement needs of the canal system of the eastern rivers during rabi (winter) and during the critical periods of April and May when the kharif (summer) crops mature and the rabi crops are sown. These storages by conserving the summer flood water will provide the most precious rabi supplies and the supplies that will be required during the other two critical periods. They will also provide the key and lay the foundation for future developments.

Development Features

Thee Sttlement Plan has been so prepared as to give West Pakistan a structure on which it can base its future development and which in some cases will give the province a handsome immediate start. The Mangla Dam will have a gross storage capacity of 5.55 million acre feet under the Settlement Plan but it can be raised later by another



WEST PAKISTAN
WATER AND POWER DEVELOPMENT AUTHORITY

INDUS BASIN PLAN

LOCATION MAP

40 feet. This raising will have to be done at Pakistan's own cost but by a relatively small investment the national economy will reap proportionately much greater benefits, for while the 380 feet high dam built out of the Indus Basin Fund will give us a usable storage of 4.75 million acre feet, the raising of the dam by another 40 feet at a quarter of the cost of the original dam will give Pakistan another 4 million acre feet of water. Also for the Mangla Dam, the Settlement Plan will provide funds for a power house with a capacity of 300,000 kilowatts. With proportionately less expenditure in future the capacity of this station can be increased to about 800,000 kilowatts. The margin for development uses at Tarbela is even more marked than in the case of the Mangla project. Besides making possible the development of 1.5 million kilowatts of power the Tarbela Dam will also open the way for creating a number of storages on the tributaries of the Indus and Jhelum in the districts of Campbellpur, Rawalpindi and Jhelum. The creation of these off-channel storages will make available valuable water supplies for the future development of West Pakistan. Similarly, the barrage at Chasma on the Indus will make it possible to irrigate a large fertile tract on the right bank of the river.

Settlement Plan Works

The Settlement Plan in West Pakistan includes the following projects—

1. Mangla Dam Project
2. Tarbela Dam Project
3. Link Canals Project, comprising the following link canals:

   i) Trimmu-Sidhnai
   ii) Sidhnai-Mailsi
   iii) Mailsi-Bahawal
   iv) Rasul-Qadirabad
   v) Qadirabad-Balloki, including Lower Chenab Canal Feeder
   vi) Balloki-Suleimanki II
   vii) Chasma-Jhelum
   viii) Taunsa-Panjnad

Previously the Sidhnai-Mailsi and Mailsi-Bahawal canals were treated as one unit.

4. Barrages Project, comprising the following:

   i) Mailsi Gated Syphon on the Sutlej
   ii) New Sidhnai Barrage on the Ravi
   iii) Qadirabad Barrage on the Chenab
   iv) Rasul Barrage on the Jhelum
   v) Chasma Barrage on the Indus

5. Remodelling of existing links, Headworks and Canal Systems:

   i) Balloki-Suleimanki Link
   ii) Marala-Ravi Link
   iii) B.R.B.D. (Bombanwala-Ravi-Bedian-Dipalpur) Link
   iv) Marala Headworks
   v) Balloki Headworks
   vi) Trimmu Headworks

vii) Upper Jhelum Canal
viii) Dipalpur Canal System
ix) Fordwah Canal System
x) Mailsi Canal System
xi) Bahawal Canal System
xii) Canals near Sidhnai

6. Tubewells and drainage schemes planned to solve the additional drainage problems created as a result of the construction of the large system of link canals.

The first phase of the Settlement Plan, consisting of the Mangla Dam, Trimmu-Sidhnai Link, Sidhnai Barrage, Sidhnai-Mailsi Link, Mailsi Syphon and Mailsi-Bahawal Link is set for completion by April 1, 1965, excepting the Mangla Dam which is scheduled for completion by July 1968. The remaining works are to be completed by 1970, except the Tarbela Dam which will be completed by 1973.

Cost

The total cost of all these works presently estimated as per the Consultants Cost Estimates revised in March, 1962, is Rs 8,539.53 million of which Rs 4,564.07 million will be in foreign currency and Rs 3,975.46 million in Pakistan currency.

Progress

Progress on individual projects is detailed in the subsequent chapters of this report. The following table gives the schedule of tenders, award of contracts and approximate completion dates for the first phase works.

Name of Contract	Dates			
	Issue of tenders	Opening of tenders	Award of Contract	Completion
Central Quarrying Contract	May 26, 1961	July 20, 1961	Sep. 15, 1961	Mar. 31, 1967
Mangla Dam Civil Works	June 1, 1961	Nov. 15, 1961	Jan. 20, 1961	July 1, 1968
Trimmu-Sidhnai Link	June 23, 1961	Nov. 1, 1961	Feb. 13, 1962	Apr. 14, 1965
Sidhnai Barrage	Sep. 1, 1961	Dec. 12, 1961	Mar. 24, 1962	Mar. 31, 1965
Sidhnai-Mailsi Link	Sep. 23, 1961	Dec. 20, 1961	Apr. 20, 1962	May 1, 1965
Mailsi Syphon	Sep. 30, 1961	Feb. 8, 1962	May 18, 1962	Mar. 31, 1965
Flood Warning Radio Network	Nov. 28, 1961	Jan. 15, 1962	Apr. 28, 1962	Oct. 31, 1962
Trimmu-Sidhnai Gates	Dec. 15, 1962	Feb. 15, 1962	May 25, 1962	Nov. 17, 1963
Mailsi-Bahawal Link	Feb. 10, 1962	May 10, 1962	—	—
Sidhnai Barrage Gates	Feb. 2, 1962	June 1, 1962	—	—
Mailsi Syphon Gates	Feb. 2, 1962	June 1, 1962	—	—
Turbines for Mangla	Apr. 10, 1962	Aug. 2, 1962	—	—
Generators for Mangla	June 28, 1962	Oct. 2, 1962	—	—
Intake Gates—Mangla Dam	July 19, 1962	Oct. 18, 1962	—	—

MANGLA DAM PROJECT

Description

The Mangla Dam Project is multipurpose in character; it is designed to conserve and control the flood water of the Jhelum river, and, in addition, produce electricity. Under the Settlement Plan, the Indus Basin Development Fund will provide funds for the creation of a reservoir of 4.75 million acre feet capacity (live storage) and a power station with 300,000 kilowatts installed capacity. Supplies developed at Mangla will be used for replacement of the water that will be withdrawn by India from the eastern rivers under the Indus Waters Treaty.

The main features of the project consist of a 380 feet high and 11,000 feet long earthen dam at Mangla, a subsidiary embankment at Sukian, a dyke at Mirpur or in case it proves technically infeasible an auxillary dam at Jari, two spillways, a power house, and the Bong Canal involving a total fill of about 108 million cubic yards. While the earthfill dam at Jari will be 234 feet high and 5,700 feet long, the Sukian dyke will be 80 feet in height and 17,000 feet in length. Of the two spillways, the main spillway will have a discharging capacity of 1.2 million cusecs and the other called the emergency spillway, will have a capacity of 212,000 cusecs. The main dam and the ancillary works, in addition will have built-in facilities for raising the dam by another 40 feet at some future date. This will increase the storage capacity at Mangla by another 3.0 maf and raise the power potential to 900,000 kilowatts. However, the additional cost of making this provision for raising, initial as well as final, and for developing power in excess of 300,000 kilowatts will be the liability of the Pakistan Government.

As a result of further investigations and studies during the year under review it was found necessary to incorporate certain major design changes in the project. These were:

a) The construction of an earthen dam at Jari instead of the Mirpur dyke. This was necessitated by the fact that the foundation conditions at Mirpur were such as would be unable to support the dyke in case of an earthquake.

b) The reduction of the discharge capacity of the Barakas emergency spillway channel from 350,000 cusecs to 212,000 cusecs. This was necessitated by the limited discharging capacity of the Barakas channel. The reduction in turn in the spillway capacity necessitated the raising of the main dam by super imposing on it a six feet high 'cap' so as to absorb the additional flood waters which, had the Barakas discharging capacity been adequate would have escaped over the spillway.

c) The grout curtain at the Mangla dam site and at the Sukian dyke to be substituted by a clay filled cut-off trench. This became necessary due to the poor results of the bed rock grouting tests at Mangla.

Cost

The total cost of the project, according to the cost estimates prepared in March, 1962, comes to Rs 2,323.34 million which is inclusive of the costs for the provision for future raising, engineering and administration, duties and taxes etc. These cost estimates are based on the tendered rates of the Atkinson consortium which has been awarded the contract for the civil works. This estimate, however, is exclusive of land and resettlement costs, which amount to Rs 252.47 million.

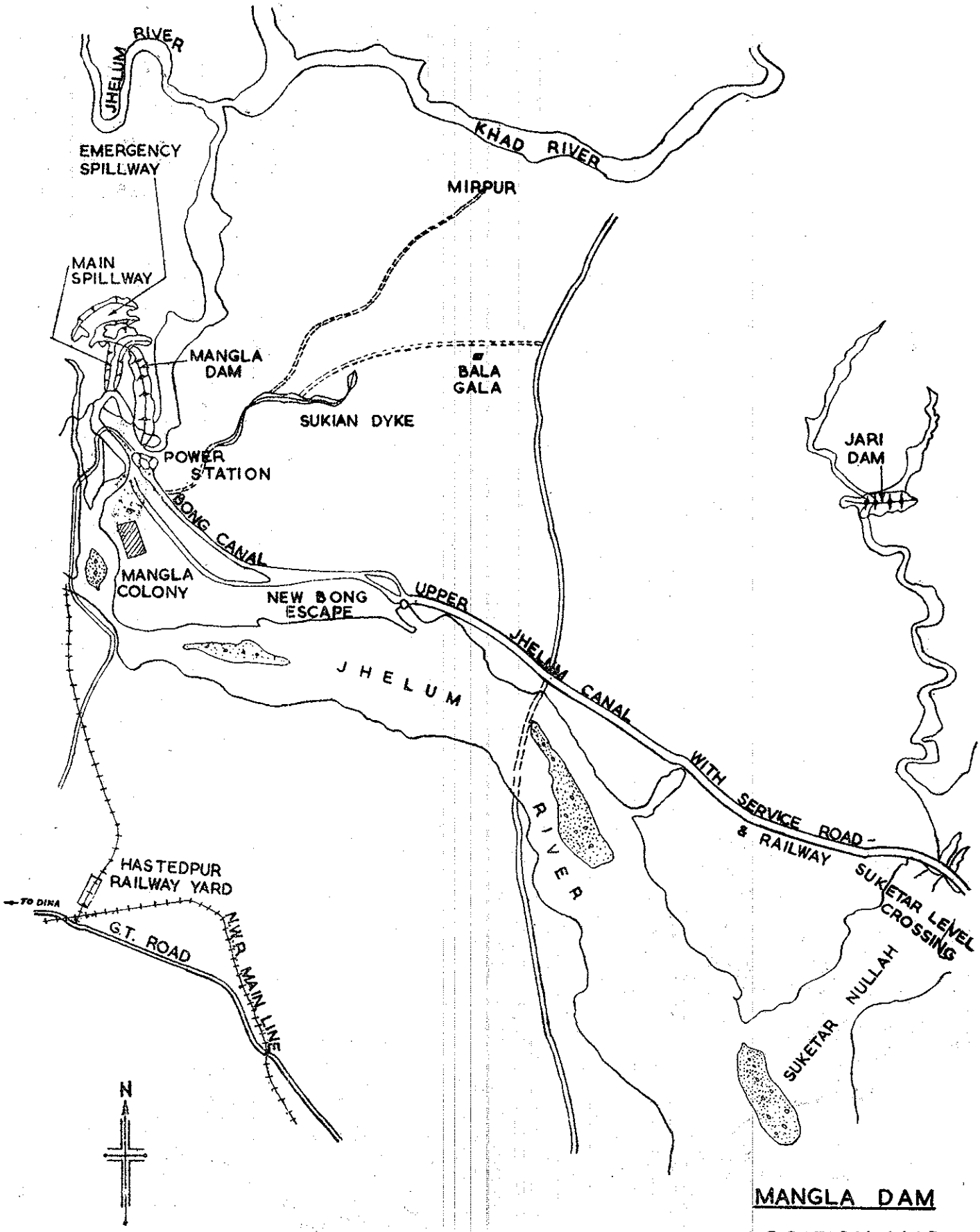
PROGRESS

Site Investigations

Detailed site investigations were carried out during the period under report with a view to developing further the designs so as to economise on costs. Drilling in various areas of the dam site and appurtenant works was continued. The progress achieved during the period was 2,500 feet of percussion boring and 25,000 feet of diamond drilling. In addition, excavation of open pits in the various borrow areas also continued and in all 2,500 round feet of open pits were excavated. Two inspection shafts, 4 feet in diamter, were sunk upto 134 feet deep in the Sultanpur peninsula to examine the bedrock under the main dam. In order to determine a suitable type of grout for the bed rock and the method of grouting, tests were carried out in the left abutment of the main dam, and trenches were excavated to see the effectiveness of grouting. In the spillway and the power house tailrace areas the original drilling programme was extended. This programme has since been completed with the exception of a few tests to locate the paths of the fault zones. Geological mapping of the left abutment of the main dam and Barakas emergency spillway channel was also completed during the period under report. In order to study the "erodability" of the Barakas emergency spillway channel a scour test is to be carried out there. In this connection test channels are nearing completion and the construction of trial embankment is in progress. For protecting the upstream slope of the main dam from the hazards of erosion by wave action large quantities of stones will have to be dumped along the fall. In order to locate the source of suitable rip rap required for this work, a site near Wah has been under investigation for some time in the past and work continued on it during the period under report. Samples were taken and tested in the laboratory after the completion of the geological mapping of the site. As it was apprehended that this quarry may not be able to meet all the requirements of rip rap, other sites were also investigated. As a result a promising site has been found near Tarakki in the Domeli area. It is proposed to drill a few confirmatory bore holes in this area to supplement the visual information. Extensive field investigations were also carried out in the Jari dam site area during the period under review. Excavation of open pits and adits was done. In all five adits have been completed in the left abutment and five more are contemplated on the right bank.

Laboratory Tests

Density and moisture content tests were carried out on core samples gathered



MANGLA DAM
LOCATION MAP

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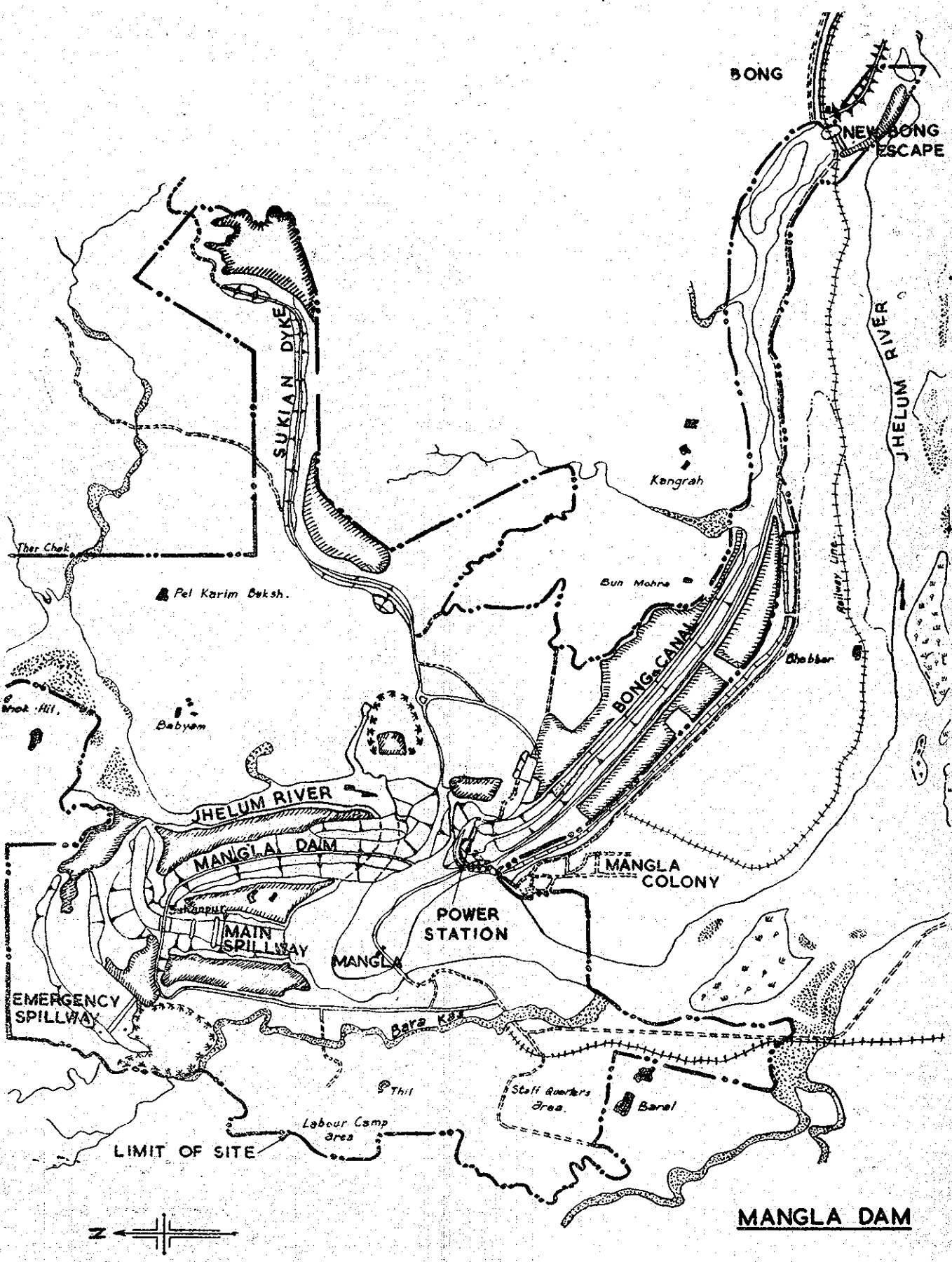
Scale in Miles.


BONG
NEW BONG ESCAPE
SUKIAN DYKE
JHELUM RIVER
Kangrah
Ther Chak
Pel Karim Baksh.
Bun Mohra
Railway Line
Chobber
BONG CANAL
Babyam
JHELUM RIVER
MANGLA DAM
MANGLA COLONY
POWER STATION
MAIN SPILLWAY
MANGLA
EMERGENCY SPILLWAY
Bara Kas
Thil
Staff Quarters Area
Barel
Labour Camp Area
LIMIT OF SITE
N
MANGLA DAM
SITE PLAN
2,000 0 2,000 4,000 6,000 8,000 10,000
Scale in feet.

from bore holes drilled at various sites. Grading analysis continued on the material from the open pits in the Balagala area and from the bore holes in the Babyam and Therchak areas. Unconfined compression tests and triaxial tests on samples from various areas were carried out. Tests were also continued on monthly samples of cement from Wah. Abrasion and attrition tests were done on the lime-stone samples from the Wah quarry.

Preliminary Works

A foot-way, 4 feet wide, has been erected along the downstream side of the steel super-structures of the access bridge over Jhelum river. During the period under report the construction of surface drains, water supply lines and sewerage treatment plant was completed in the Thill labour camp and Baral supervisory camp. An 8-bed hospital in the left bank colony was completed during the same period. An additional filter bed was also provided in the site area in order to meet the increasing water requirements of the area. With the arrival of the contractor for civil works at the site various works are gradually being handed over by the Mangla Dam Organization. Some of the works which have been handed over to the contractor are the Baral Colony, the Water Supply and Sewerage System, the Dina-Mangla Road, the Access Bridge and the Hastedpur-Mangla Railway Line.

Engineering Designs

Hydraulic model studies of energy dissipation arrangements for the power station tailrace during diversion were continued at Lahore and Nandipur. Tests were also carried out on the model of the emergency spillway with stilling basins for both 600 feet and 480 feet wide channels. In addition to these, various model studies like instantaneous pressure measurements on the baffle walls for energy dissipation in the power station tailrace and the main spillway studies were continued at Willingford, UK and Minneapolis, USA.

Tenders for Civil Works

Tenders for the civil works of the Mangla Dam Project were opened in London on 15th November, 1961. Out of the eight consortia prequalified to tender only four submitted their bids, the rest having withdrawn earlier. The bids were as follows:

1.	Guy F. Atkinson Consortium USA	Rs. 1,685,534,652
2.	Pakistan Contractors USA and continental firms	Rs. 1,783,331,549
3.	Utah Consortium USA and continental firms	Rs. 1,812,471,359
4.	Mangla Contractors USA and continental firms	Rs. 2,196,491,097

After a detailed scrutiny of the bids the contract was awarded with the concurrence of the IBRD to the lowest bidder M/s Atkinson Consortium for Rs 1,685,534,652 on 20th January, 1962. This contract is said to be the biggest single unit price contract for civil works ever awarded in the world.

Electrical and Mechanical Contracts

Tender enquiries for Contract No. 4, (Turbines) were issued on 1st April, 1962,

to 17 prequalified firms. The tenders are expected to be opened in London on 2nd August, 1962. Tenders for Contract No. 5 (Generators) were issued on 30th June, 1962, to 13 prequalified firms and will be opened on 28th September, 1962.

Procurement of Equipment

Plant and equipment comprising heavy earthmoving machinery, concrete mixers and vehicles etc. amounting to 23.94 million dollars and representing about 43 per cent. of the overall equipment has been ordered by the contractor. Six train-loads of machinery have already arrived at the site, and this amounts to about 70 per cent. of the orders placed so far.

Construction Contracts

The contractor arrived at the site during February, 1962, and took in hand the construction of houses for his employees and the consulting engineers' staff, the project hospital and school. A considerable portion of these works is being done through local firms under sub-contracts. Excavation of approaches to tunnels in the left bank is in hand. The work will be in good stride by October, 1962. The pace of progress set by the contractor and the manner in which he is mobilising for it promises earlier than scheduled completion of the project if natural hazards do not intervene. Nearly 10,000 men were employed on the project including 200 expatriates.

MANGLA DAM RESETTLEMENT ORGANIZATION

The Mangla Dam Resettlement Organization was set up in July, 1959, to resettle the 81,000 people affected by the construction of the dam. The organization deals through its two main sections, with both the engineering and the revenue matters involved in resettlement. The Engineering Section is responsible for the planning and construction of new town-ships, hamlets, roads, small earthen dams for meeting the water requirements of the towns and hamlets, and assessment of the built-up property that will be affected by the schemes. The Revenue Section acquires land for the various project features, selects land in West Pakistan for resettling the affected people and makes arrangements for shifting of the displaced persons to their new habitats. Progress achieved was as follows:

a) Engineering

Work continued on the construction of the New Mirpur Town which is to house the displaced persons of the existing town. During the period under report 100 houses were completed while 20 were under construction. To meet the immediate water requirements of the new town three tubewells were planned; one of which has already been completed and the other two are nearing completion. Two hamlets, one at Mangla and the other at Sultanpur, were completed during the period under report. The Mangla hamlet has since been occupied completely by the displaced persons of Azad Kashmir territory while most of the houses in the other hamlet have been purchased by the displaced persons of West Pakistan territory.

Two earthen dams were also completed during this period; one at Akalgarh and the other at Balagala. While the first will cater for the water needs of the proposed hamlet at Akalgarh, the second will store up water for the New Mirpur Town.

The work of assessment of built-up property in the reservoir area was stepped up still further. Out of the 24,200 houses, 22,832 houses have been assessed so far or in other words 94 per cent of the assessment work was completed.

In order to ensure a regular supply of irrigation water to the new lands allotted to the displaced persons in West Pakistan, an Executive Engineer's division was opened temporarily with headquarters at Lyallpur.

b) Revenue

The work of measurement of fields, preparation of the necessary revenue record and assessment of compensation for the lands and trees to be acquired also made substantial progress. In all 4,784 fields were measured and their record prepared bringing the total so far measured to 167,594 (95 per cent). Assessment of 14,735 acres of land and 433,011 trees was also done bringing the total to 26,339 acres (42 per cent) and 587,239 trees (65 per cent) assessed so far respectively.

Disbursement of compensation also made steady progress. The disbursement in Azad Kashmir territory was Rs 13,127,454, bringing the total amount so far disbursed as compensation to Rs 21,433,618. For the West Pakistan lands the disbursement was Rs 2,837,743, during the report period; the total now being Rs 3,302,580.

The affected population (agriculturist class) continues to be resettled on lands in West Pakistan. During 1961-62, 403 families from Azad Kashmir and 843 from West Pakistan were shifted out of the project area, which brings the total number of families evacuated out of the site area to 1,265. Of these 826 families have already been resettled on lands allotted to them in West Pakistan. The remaining 439 families are yet to be transported to their new lands from their present temporary abodes.

Efforts were continued to procure land at various places in West Pakistan for resettling the affected population. During the period under report, 1,780 acres were secured in Multan and 9,302 acres in Dera Ghazi Khan district.

Visit of IBRD's Land Survey Mission

A Land Survey Mission of IBRD headed by Sir Blyth Wace arrived in Pakistan in the first week of November, 1961, to take up the assessment of land compensation for the various Indus Basin Projects. The Mission completed its assignment and left for London in the third week of March, 1962. The Mission is to finalize its report in London for submission to the World Bank.

Project Cost and Expenditure

The total cost of the project comes to about Rs 252 million for the first stage of Mangla dam construction that is, when raised to a height of 380 feet. During the year 1961-62 the total expenditure on the project was Rs 26.70 million. The total expenditure to-date is Rs 49.90 million out of which Rs 36.50 is reimbursable.

TARBELA DAM PROJECT

Description

The Tarbela Dam Project is the second of the two storage projects provided in the Settlement Plan. Its aim is to store the surplus summer flows of the Indus, now going waste to sea partly for use as replacement supplies on the eastern river areas and partly for new development. The project as provided in the Indus Waters Treaty was that of 1954 Feasibility Report with 5.1 maf gross capacity. However due to much higher sediment load as actually observed in 1960 and 1961, it was found that the reservoir of 5.1 maf capacity would probably lose its entire storage capacity in 35 to 45 years against the original estimated life of 77 years based on an assumed siltation rate. The project as adopted now stands changed both in respect of its scope and dimensions. It will entail a rockfill dam 400 feet high and 9,200 feet long at the crest. Seepage through the dam will be controlled by an impervious core and through the foundation by a long upstream clay blanket. Reservoir capacity will be 8.4 million acre feet gross and 6.6 million acre feet effective.

The project will involve 150 million cubic yards of earthwork and nearly 5 million cubic yards of concrete (more than the total quantity in the famous Boulder Dam in USA). The reservoir will cover an area of 51,000 acres extending 45 miles upstream. The ultimate power potential will now be 1,500,000 kilowatts with an annual energy output of 2.9 billion kilowatt hours primary and 4.2 billion kilowatt hours secondary. Facilities for releasing water upto 125,000 cusecs for irrigation purposes during the dry season are provided for. Flood spillway capacity will be for 1,500,000 cusecs.

Power facilities will not be a part of the initially constructed project. Certain essential provisions, however, will be made in the initial construction to permit the addition of power facilities later on without endangering the safety of the dam and the abutment.

The most significant long range aspect of the project will be its diversion capability if the dam is constructed with its top at or above an elevation of 1,530 feet. This will enable the diversion of the Indus flows into the off-channel storages on the Haro and Soan rivers and later on in the Jhelum basins. The aggregate gross capacity of these pouch storages will be of the order of 40 million acre feet. The life of such side-storages will be practically indefinite because of the silt-free water diverted from Tarbela. Besides this large storage potential there can be power development up to 4,000,000 kilowatts. In fact, a dam at Tarbela, will pave the way for a large scale and phased development of irrigation and power in West Pakistan. This will be many times more than the capacity of the parent reservoir which is susceptible to relatively rapid depletion because of the high siltation rate.

Cost

According to the first project planning report estimate prepared in January, 1962, a project of 8.4 million acre feet gross capacity will cost Rs 2,622 million. This includes a sum of Rs 145 million as initial provision for raising the dam at a later stage to its ultimate capacity of 12.1 million acre feet and Rs 112 million for initial power facilities. This estimate however is likely to be revised upward when the final project planning report is ready in November, 1962. The main cause of increased cost will be the changes in design and location of the spillway and outlet release structures, whose location on the left bank, as proposed in the earlier report, the detailed investigations of foundation conditions carried out this year make no longer feasible.

The cost of Rs 1,900 million reported last year was based on preliminary estimates prepared in June, 1960. The present costs have increased due to increase in the reservoir capacity from 5.1 to 8.4 maf, increased construction period and addition of duties and taxes.

Progress

At the close of the period under report, the Tarbela Dam Project stands near the conclusion of the definite planning phase. The contract can be awarded by early 1965 and the project completed by 1973 if financial problems do not come in the way.

Field Explanations

Field investigations consisting of core drilling, percussion boring, test pitting, adit driving, geological mapping and field survey etc. continued during the period under report leading to the production of the first Project Planning Report, released on January 8, 1962. Work on drilling, tunnels and adits etc. continued in three shifts.

Location of the left bank spillway dam in Dal Darra as proposed in the Project Planning Report was subject to the foundation rock under the spillway being found competent to support a concrete dam 350 feet in height. For this purpose a programme of excavating shafts and tunnels to study the rock conditions below the proposed dam was initiated late in January, 1962. Unfortunately the rock encountered even upto depths of 200 to 300 feet showed the existence of weak zones of fractured rock beyond the realm of remedial measures except at prohibitive cost. In consultation with the special consultants and senior engineers of the project consultants the site was abandoned on June 30, 1962.

Earlier in April, 1962, field investigations had been initiated on two alternative sites also on the right bank for the location of the spillway, outlet release and diversion structures. This programme consisting mainly of drilling and adits driving continued round the clock. A supplement to the project planning report of January, 1962, will be issued in November, 1962, in which the final site of the spillway and appurtenants along with cost estimates will be finally fixed.

Quantitative progress on field investigations and other preliminary works is as below:

Item	Unit	During 1961-62
Drilling in alluvium	Feet	9,148
Drilling in rock	Feet	19,072
Shallow test pits	Number	576
Deep shafts	Feet	4,736
Adits and tunnels	Feet	225

Expenditure

During the year under review the expenditure on the Tarbela dam project was Rs 14.23 million bringing the total to Rs 45.14 million.

LINK CANALS PROJECT

Description

One of the seven new link canals, the Sidhnai-Mailsi-Bahawal Link, was sub-divided during the year into two links for construction purposes—the Sidhnai-Mailsi link and the Mailsi-Bahawal link respectively. Both will serve exactly the same functions as the original single link.

The primary function of the link canals is to replace the waters of the (eastern) rivers, with flows from the Indus, the Jhelum and the Chenab rivers. The southern-most link system comprises the Trimmu-Sidhnai, Sidhnai-Mailsi and Mailsi-Bahawal link canals. This system of canals will transfer water from the Trimmu Barrage to the lands originally receiving supplies from the Ravi and the Sutlej rivers. This canal system will also feed the existing Bahawal Canal through the proposed Mailsi Syphon.

The northern-most canal system comprises the Rasul-Qadirabad, Qadirabad-Balloki and Balloki-Suleimanki II links. This system of links will carry water from the Jhelum river, including releases from the Mangla Dam, from a point just below Rasul, across the Chenab at Qadirabad, to the Ravi at Balloki and on to the Sutlej upstream of Suleimanki. This new canal system will operate in conjunction with the existing Marala-Ravi, Bambanwala-Ravi-Bedian-Dipalpur and Balloki-Suleimanki I link canals that are being remodelled.

Two other new links namely Chasma-Jhelum and the Taunsa-Panjnad are also to be built. The first will carry surplus flows from the Indus, including releases from the storage at Tarbela, from a new barrage to be built at Chasma to the Jhelum upstream from Trimmu for ultimate use in the eastern river areas through the proposed Trimmu-Sidhnai, Sidhnai-Mailsi and Mailsi-Bahawal link canals. The Taunsa-Panjnad link will transfer water from the Indus from the existing Taunsa Barrage, to the Chenab, upstream of the Panjnad headworks for use by the existing Panjnad canals.

The overall length of these link canals is 391 miles. Their construction requires some 344 million cubic yards of earthwork which is almost four times the estimated amount of earthwork required for the main dam at Mangla. The link canals will have discharge capacities varying from 4,000 cusecs to 21,700 cusecs. The aggregate discharge capacity of all the eight new link canals flowing at the same time is in excess of 100,000 cusecs.

Besides the excavation, the eight new link canals also require the construction of several hundred structures including 26 major regulators, crossings and falls; 14 railway bridges; 58 arterial and district road bridges; and about 350 village road and foot bridges and minor canal structures. The land to be occupied by the new links will be

over 35,000 acres. Their construction will require over a million tons of concrete aggregate and 250,000 tons of portland cement.

The Trimmu-Sidhnai link is scheduled to be completed by April 14, 1965; the Sidhnai-Mailsi link by May 1, 1965 and the Mailsi-Bahawal by March 31, 1965. Under the original schedule, Qadirabad-Balloki link was to be completed by March 31, 1967 and the Chasma-Jhelum link by September 30, 1969. The Rasul-Qadirabad and the Balloki-Suleimanki links were set for completion by March 31, 1967, and the Taunsa-Panjnad link by June 30, 1967. Because of the limitations so far of the funds committed to the Indus Basin Works the scheduled dates of completion of these links had to be postponed by about a year.

Cost

The cost of the new link canals as re-estimated in March, 1962, is Rs 1,728.1 million. This represents an increase of Rs 543.7 million over the original cost estimate of Rs 1,184.4 million made in June, 1960, and is accounted for by the inclusion in the project of items which, for lack of data, could not be included in the estimates prepared in June, 1960, some rise in prices, and change in quantities as established by more detailed investigations.

Progress

At the end of the year, progress on the design and construction of the link canals was essentially on schedule, except for the issuance of the contract documents for Qadirabad-Balloki link which as explained elsewhere had to be deferred. Contracts were awarded for the construction of the Trimmu-Sidhnai link, the Sidhnai-Mailsi link and for the supply of fixed-wheel gates for the Trimmu-Sidhnai link canal. Tenders for the construction of the Mailsi-Bahawal link canal were opened on May 10, 1962, and this contract is likely to be awarded shortly. Tenders for the supply of fixed-wheel gates for the Sidhnai-Mailsi and the Mailsi-Bahawal link canals were invited on June 29, 1962. These tenders are scheduled to be opened in Lahore on August 16, 1962.

The progress on individual links was as follows:

Trimmu-Sidhnai Link: Tenders for the construction of the Trimmu-Sidhnai link were opened on November 1, 1961, and the contract awarded to Kaiser Engineers, Pakistan, Inc. of USA on February 13, 1962.

Tenders for the supply of fixed-wheel gates for the link were opened on February 15, 1962, and the contract was awarded to the Batala Engineering Company of Pakistan on May 25, 1962. The notice to proceed with the manufacture of the gates was issued on May 26, 1962.

Kaiser Engineers started work on their main construction camp at Shorkot during the latter part of the reporting year. The clearing and rough grading of the camp site including the grading of the streets and building sites was completed. Construction of buildings was taken in hand. An airstrip was also built and placed in service at the Shorkot camp.

By the end of the year about 60 per cent of the contractor's construction equipment and special plant had arrived on the job. Construction of the canal was started and about 20 per cent of the canal right-of-way was cleared and stripped. Excavation in the canal prism was started near R.D. 136. About 1,200 men were working on the job, of whom 40 were expatriates.

Sidhnai-Mailsi Link: Tenders for the construction of the link were opened on December 20, 1961. The construction contract was awarded to Costruzioni Generali Farsura S.P.A. and Impresa Astaldi S.P.A., of Italy on April 20, 1962. Tender documents for the supply of fixed-wheel gates for the Sidhnai-Mailsi link were issued on June 29, 1962, and the gate tenders are scheduled to be opened on August 16, 1962.

The contractor received his first consignment of vehicles towards the end of the year under report. Work was started on a brick kiln near R.D. 194 of the link to manufacture bricks for the construction of camp buildings at Vehari.

Mailsi-Bahawal Link: Tenders were opned on May 10, 1962 and were processed by Wapda and its consultants. Recommendation for the award of the contract was made to the Bank towards the end of the year under report. This contract is likely to be awarded in August, 1962.

The fixed-wheel gates required for the Mailsi-Bahawal link were included in the tender for Sidhnai-Mailsi link gates, which was issued on June 29, 1962, and is scheduled to be opened on August 16, 1962. The preparation of designs, plans and specifications, as a part of the tender documents, was completed during 1961-62. For reasons given earlier the issue of the tender documents scheduled for June, 1962, was held in abeyance. Design studies were continued on numerous problems, including link hydraulics, surface drainage, silt ejection and the design and layout of the Lower Chenab Canal Feeder. Preparation of the draft of the design report was initiated.

Pre-qualification inquiries were received from 91 contractors in response to a notice of intent to call for tenders that was advertised on a world-wide basis in October, 1961. Of these 37 applied for pre-qualification subsequently. Thirty-six contractors were pre-qualified to receive the tender documents.

Chasma-Jhelum Link: Field surveys and mapping required for detailed designs were essentially complete by the end of the year. A special study was made of an alternative alignment of the link, proposed by the Irrigation Department, which lead to the original alignment proposed by Tipton and Kalmbach, Inc., being finally selected and approved for construction.

Contractors for the construction of Chasma-Jhelum link are yet to be pre-qaulified.

Other Links: These include Rasul-Qadirabad, Balloki-Suleimanki II and Taunsa-Panjnad link canals. Aerial surveys and topographic mapping have been completed. The pre-qualified contractors selected for the Qadirabad-Balloki link are also qualified to tender on the Rasul-Qadirabad link, without the necessity for further pre-qualifica-

tion. Survey work on the preliminary field alignment of the Rasul-Qadirabad link was commenced in the latter part of the year under report.

Expenditure

The total expenditure on new link canals to the end of June, 1962, was Rs 41.4 million, of which 17.4 million was in local currency and the equivalent of Rs 24.0 million was in the foreign exchange. During the year under report the expenditure was Rs 29.4 million, including Rs 10.8 million in foreign exchange.

BARRAGES PROJECT

Description

The Settlement Plan includes the following four barrages and one gated syphon for diversion of supplies coming down the rivers into the link canals off-taking from these barrages.

Chasma Barrage: This will be the largest of the four to be constructed on the Indus and will be about 50 miles downstream of the existing Jinnah Barrage. It will be 4,200 feet in length with a flood discharge capacity of one million cusecs. Supplies coming down the Indus river including releases from the Tarbela reservoir will be diverted by the Chasma Barrage into the Chasma-Jhelum link.

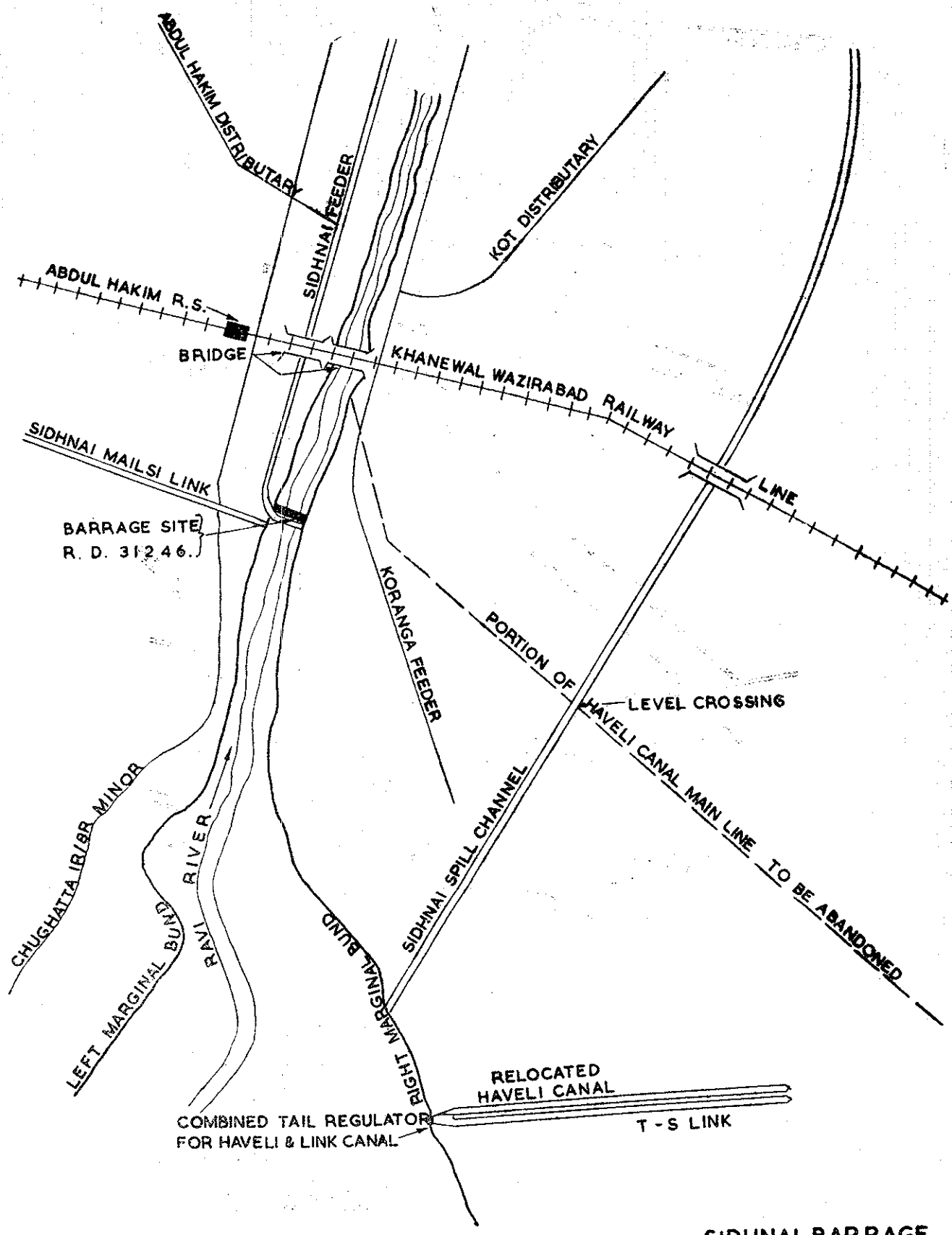
Rasul Barrage: This will be built on the Jhelum, 3 miles downstream of the existing Rasul Barrage, for the diversion of releases from the Mangla reservoir into the new Rasul-Qadirabad link. It will be 4,000 feet long with a flood discharge capacity of 900,000 cusecs.

Qadirabad Barrage: Located 22 miles downstream of the existing Khanki weir on the Chenab, it will help divert supplies received from the new Rasul Barrage into the new Qadirabad-Balloki link. It will be 4,190 feet long with a flood capacity of 900,000 cusecs.

Sidhnai Barrage: The new Sidhnai Barrage on the Ravi will be located 6 miles upstream of the existing Sidhnai weir. It will be 712 feet long and will cater for a maximum flood discharge of 150,000 cusecs with a spill channel capacity of 30,000 cusecs in addition. It will divert flows received through the Trimmu-Sidhnai link. The construction of this barrage at a new site will entail the relocation of the railway and road bridge at Abdul Hakim, and of the Sidhnai and Koranga canals from upstream of the new barrage.

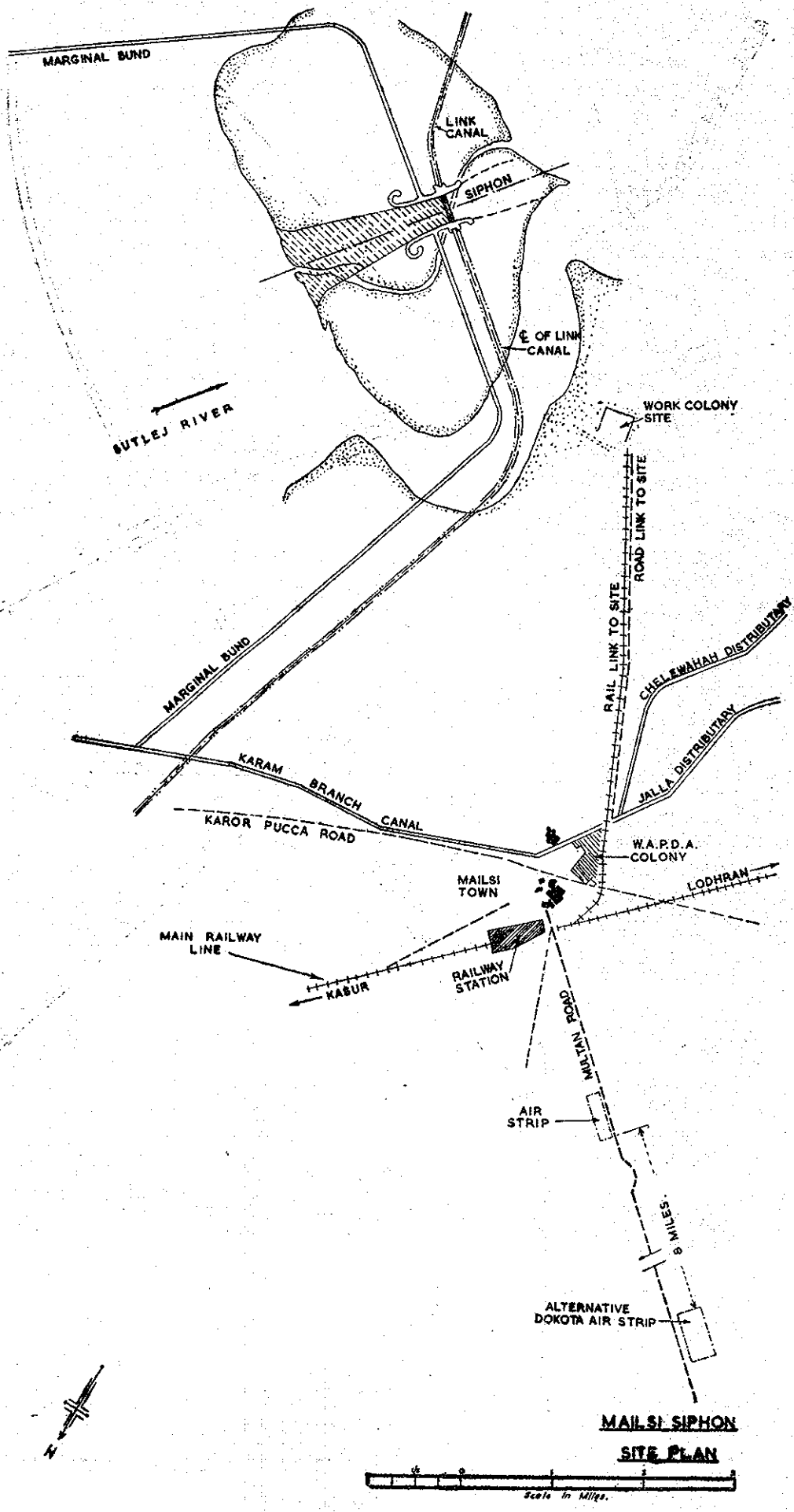
Mailsi Syphon: A gated syphon will be constructed on the Sutlej 25 miles downstream of the existing Islam Barrage. Originally it was proposed to construct a barrage. But later studies and investigations established that a syphon for taking across the river supplies brought through the Sidhnai-Mailsi link was a better proposition. The syphon will be a concrete structure 2,400 feet in length comprising 4 barrels each 13.5 feet square with a total discharge capacity of 5,200 cusecs. The river discharge capacity over the syphon will be 350,000 cusecs. There will also be an over bridge across the river which will facilitate the operation of the gates.

The combined length of the four barrages and the Mailsi syphon will be about 3 miles; about 40 per cent of the total length of the existing weirs and barrages in West Pakistan. The aggregate discharge capacity would be 3.33 million cusecs and will affect diversion into the off-taking canals to a total capacity of about 99,000 cusecs.



SIDHNAI BARRAGE

SITE PLAN



MAILSI SIPHON

SITE PLAN

Cost

The total cost of the Barrages Project including the Mailsi Syphon is estimated at Rs 1017.8 million.

Progress

Sidhnai Barrage: Tenders were opened in London on December 12, 1961, and the main contract was awarded to Messrs Societe Dumez of France on March 24, 1962. Soon after the contractor reached the site and started work on his camp and other preliminaries. Upto the end of June, 1962, the contractor had completed about 15 per cent of the colony and had started construction of the site office, railway siding and other works. During this period the contractor's plant and equipment also started arriving at the site. The construction of engineers and Wapda's camp is the responsibility of Wapda. Upto 30th June, 1962, 70 per cent of buildings and 25 per cent work on roads, water and electric supply had been completed.

The barrage is scheduled for completion by the end of March, 1965.

Mailsi Syphon: Tenders for the construction of the Mailsi Syphon were issued on September 30, 1961, and were due to be opened on January 11, 1962. Subsequent to the issue of tender enquiry it was decided to include 3.1 miles of the Mailsi-Bahawal link in the syphon contract in order to place the work of river diversion in the hands of one contractor. The opening of tenders was, therefore, postponed to February 9, 1962. The consortium of Messrs Gammon (England) Limited, Compaigne Francaise D'Enterprises of France and Christiani and Nielsen of Denmark being the lowest bidder was awarded the contract amounting to Rs 108.1 million, on May 18, 1962. The contractor started work in the first week of June, 1962, on exploratory borings at the proposed syphon site and by the end of June, 75 per cent of this work was completed. The contractor also started the construction of his camp. The project is set for completion by April, 1965.

The progress of preliminary works, being carried out by Wapda, upto the end of June, 1962, included 80 per cent construction of the rail and road access to the syphon site, and of the residential colony, the provision of electricity on a temporary basis by a mobile generation set till the work on the 66 kVa line is completed.

Rasul and Qadirabad Barrages: The preparation of the tender documents and drawings is in progress. The sites for the Wapda colony and contractor's colony have been selected.

Chasma Barrage: Site investigations for the proposed barrage have been completed and the site is tentativley fixed at about 50 miles downstream from the existing Jinnah Barrage. Annual river survey extending upto 12 miles upstream and 4 miles downstream of the proposed site has been carried out.

Expenditure

The total expenditure on the Barrages Project was Rs 37 million of which Rs 25 million was incurred during the year under report.

REMODELLING THE EXISTING LINKS AND CANAL SYSTEM

Description

Three existing link canals, two of the old headworks and six irrigation canals have to be remodelled as a part of the Indus Basin Settlement Plan to fit into the new system of Indus basin water control. This work is being done by a special agency, called the Remodelling Organization, which is under the day to day control of the Irrigation Department of the West Pakistan Government but draws its budget from and renders account to Wapda according to the usual rules and regulations of the Authority. The major items of remodelling works are described below.

Marala Headworks: The remodelling of the Marala Headworks is imperative for the proper functioning of the Marala-Ravi link which is an important chain in the Indus Basin Settlement Plan. Many proposals were put forward by the various agencies for dealing with the problems at the Marala Headworks, but those selected for consideration are the construction of a new barrage, 2 miles downstream of the present headworks at an estimated cost (preliminary) of Rs 112 million, or the remodelling of the existing weir by providing a subsidiary weir and other allied works, at an estimated cost of Rs 61.8 million.

Model tests are being conducted to determine the relative suitability of the above mentioned two proposals. Office studies are also being carried out to work out firm cost estimates of the two proposals and as soon as they are completed, a decision as to the final solution of problems at Marala Headworks will be taken.

Marala-Ravi Link: Ever since its construction a heavy silt charge has been entering the link resulting in heavy silt desposits in the head-reach. Consequently, the capacity of the link has been reduced considerably, and to remedy this it has been proposed to regrade bed slope of the link to 1/8333 against the original slope of 1/10,000. This operation has made necessary the remodelling of several bridges, syphon tops and falls. Besides, successive floods have repeatedly damaged the link, interrupting the transfer of supplies from the Chenab to the Ravi. To safeguard against this it has been considered necessary to increase the capacity of existing cross drainage works and to construct 13 new inlets to increase the flood disposal capacity of the link. Due to the regrading of the Marala-Ravi Link and the consequent lowering of the full supply level, the off-taking distributaries which irrigate 150,000 acres in Sialkot district will be adversely affected and remodelling measures will have to be taken to feed them adequately. A subsidiary outfall is also necessary to protect the old outfall, whose safety has been seriously jeopardized by extensive retrogression in the tail reach of the Link.

Bombanwala-Ravi-Bedian-Dipalpur Link: This link is meant to deliver 2,700 cusecs supply to the Central Bari Doab canal and about 2,000 cusecs into the Dipalpur canal. It is vulnerable to flood damages which necessitated increase in its cross-drainage capacity. Besides, its bed slope is to be steepened to lower the full supply level in certain reaches.

Balloki Headworks: Remodelling of the Balloki Headworks is necessary to increase the existing capacity of the Balloki-Suleimanki Link from 152,00 to 18,500 cusecs in the first 14 miles of its length. Increased withdrawals at the Balloki Headworks have caused objectionable changes in the approach of the river. Remedial measures in the form of training works, therefore, have to be undertaken to correct the river approach conditions.

Balloki-Suleimanki Link: The existing Balloki-Suleimanki Link will have its capacity increased from a discharge of 15,200 to 18,500 cusecs in the first 14 miles, from which point the Balloki-Suleimanki Link II will take off. This will require strengthening of the hydraulic structures, checking erosion of the banks by stone pitching, setting back of the spoil banks and an inlet for the disposal of the spill from the Hudiara Nullah. Strengthening of the left bank from mile 21 to tail is also necessary in order to make it safe against all eventualities.

Cost

The total cost of the remodelling works given in the last annual report was Rs 285.6 million, but it has since been reduced to Rs 251.5 million as a result of the review and scrutiny and changes in design so far carried out by Wapda.

Progress

The works completed during the year under report and the overall up to date percentage progress achieved on each project is given below:

Name of Project	Up to date overall percentage progress
1. Marala Headworks	12 per cent
2. Marala-Ravi Link	70 per cent
3. B.R.B.D. Link	70 per cent
4. B.S. Link	30 per cent
5. Balloki Headworks	4 per cent

Expenditure

The total up-to-date expenditure on the remodelling and ancillary irrigation works is Rs 25.2 million, out of which the expenditure during the year under report was Rs 6.6 million.

COMMON SERVICES

Description

Wapda has been giving attention to problems connected with the transport of equipment and the supply of materials such as cement, stone, fuel, explosives and oxygen and to rapid communications between the various Settlement Plan projects. Given below is a brief account of what has been done so far to help the contractors and suppliers.

Progress

Port of Karachi: An area of 11,649 square yards was obtained at the Port of Karachi for the storage of 40 per cent of the maximum tonnage to be received during any month. A procedure for allocation of the area on rental to the Indus Basin contractors has been framed. An area of 3,324 square yards was allotted to Mangla Dam contractors and 2,800 square yards to Societe Dumez.

Import and Customs Clearance: According to the conditions of contract, contractors are solely responsible for arranging the import permits and for clearing the goods through customs. Wapda is aware of the difficulties experienced in this respect by contractors and is trying to make special arrangements with the Chief Controller of Imports and Exports and other government departments. Information on import permits and customs clearance procedures is being collected to put in the form of a brochure for the guidance of all contractors and expatriates coming to Pakistan.

Railways: In order to meet the requirements of cement, additional capacity was installed at the two new cement factories at Daudkhel and Hyderabad and further extensions are planned at Daudkhel, Wah and Rohri. Two new cement plants were approved at Karachi and Hattar. The former will serve the Karachi area and West Pakistan, and the latter the Tarbela Dam project and the federal capital at Islamabad.

On October 28, 1961, Wapda signed an agreement with Messrs Ismail Cement Industries Limited who are constructing a new cement factory at Gharibwal so that the production from this factory is exclusively reserved as a first priority for the Indus Basin projects. The Government of Pakistan sanctioned Rs 2.5 million to provide road and railway links to the Gharibwal Cement Factory and Wapda was entrusted with this job. The road link between the existing Jhelum-Pind Dadan Khan highway and the factory site was opened to traffic, and the railway link between Gharibwal and the factory site has been completed except for two road bridges which are in progress. The contract for the construction of the factory building was awarded by Ismail Cement Industries Ltd. to Gammon (Pakistan) Ltd. The work is progressing according to schedule. The factory is likely to go into production by the middle of 1963.

Central Quarrying Contract: Three quarries to provide crushed coarse sand, aggregates and revetment materials were selected at Sikhanwala, Jhelum and Mari Indus. Arrangements for a Central Quarrying Contract were made to achieve better uniformity and higher quality of materials at lower cost.

Tenders were opened at Lahore on 20th July, 1961. Messrs Gammon (Pakistan) Limited in cooperation with Pegson of United Kingdom offered the lowest tender amounting to Rs 69.08 million and were awarded the contract on 15th September, 1961. The construction of the engineers' residences and the railway spur track at both the Bulland Hill and Jhelum sites was essentially completed. The contractor has imported all the special plant required for the job. The installation of the main plant at Jhelum is almost complete while that at the Bulland Hill site is in progress. Pending the completion of the main plants the delivery of aggregate from the pilot plant at the Bulland Hill site started in April, 1962, and all demands were met according to schedule. Sand was supplied from the sand deposits at Campbellpur.

Tele-communications: A proposal for connecting Lahore with fourteen project centres through a net work of high frequency radio telephone and radio teleprinter communication with the additional provision of eleven VHF base and forty seven mobile units was submitted to IBRD Consultants on 6th January, 1962.

Flood Warning System: Arrangements were made to set up a flood warning system in the catchment areas of the Indus river in West Pakistan as well as in India and India-held Kashmir. Twenty-four flood warning stations were planned in Pakistan and seven stations in India. Tender documents in respect of stations in West Pakistan were issued on 19th December, 1961. Tenders were opened on 15th January, 1962, and the contract awarded to Messrs Radifon Ltd. of United Kingdom on April 28, 1962. It is hoped that all the equipment will be in the country by November, 1962. Specifications for the equipment required for the installation of flood warning stations in India have been sent to the Pakistan Commissioner for Indus Waters for onward transmission to the Indian Commissioner.

Wapda has entrusted operation of the flood warning stations in Pakistan to the West Pakistan Police Department, who have installed their own equipment as a temporary measure at 15 stations to give flood warnings during the 1962 flood season.

Fuel Oil Contract: Tenders for the central fuel oil contract, issued on 29th May, 1961, were received and opened on the 17th July, 1961. Since the trade was not prepared to accept the rigid conditions of the contract and without those conditions a central fuel oil contract offered no particular advantage it was decided later on, to drop the proposal of a central fuel oil contract for all the Indus Basin projects. The construction contractors have been informed that they will be free to make their own arrangements for the supply of fuel oils and will not be required to purchase them from any particular supplier.

Indigenous Goods: The problem of ensuring that Pakistani suppliers get a fair share of business in connection with the Indus Basin Settlement Plan works and are provided with incentives which will enable them to compete with foreign manufacturers in supplying goods to the Indus Basin contractors remained under active consideration and various suggestions in this connection were made to the Government of Pakistan. Accepting the recommendations the Government have decided that in order to encourage local manufacturers to supply goods to Indus Basin projects, at competitive rates, local suppliers will be entitled to claim a rebate of custom duty, excise duty and sales tax on a number of indigenous articles when supplied to Indus Basin Contractors.

WATERSHED MANAGEMENT PROJECT

Wapda made an active start to tackle the problem confronting the rapidly increasing menace of soil erosion in 1959. This was done on the specific recommendations of its consulting engineers, Hunting Technical Services Ltd, who were entrusted with the job of suggesting improvements in the management of watersheds of West Pakistan's rivers and to check the inflow of silt into some of the proposed reservoirs.

After the initial difficulties of staffing which were encountered in the years 1959-60 and 1960-61, the project recorded considerably more activities during 1961-62. Seven demonstrations areas were added during the period under review against three areas in 1960-61. The ten areas of the project are now scattered over 183,000 acres. These areas alongwith their acreage are as under:

1960—61
(West Pakistan)

	Name of the Area		Acreage
1	Upper Kanshi (Kahutta)	..	25,600
2	Kas Bishandaur (Gujjar Khan)	..	42,240
3	Khaner Kas (Murree)	..	32,640
	Total	..	100,480

1961—62
(West Pakistan)

4	Batrasi Garhi Habibullah (Mansehra)	..	9260
5	Azad Pattan (Panjar)		10,250
6	Kas Bhai Khan (Gujjar Khan)	..	16,000
	Total	..	35,510

Azad Kaghmir

7	Barsala (Muzaffarabad)	..	5660
8	Mhilwani Kas (Bagh)	..	23,200
9	Rawalakot	..	10,880
10	Pind Nallah (Mirpur)	..	7,680
	Total	..	47,420
	Grand Total	..	183,410 acres.

PROGRESS:

The progress achieved during 1960-61 had been restricted mostly to planning

or to the winding up of the work which had been carried out by the consulting engineers. The progress during the period under review in various sectors was as follows:

Watershed Planning

For demonstration purposes a catchment area measuring approximately 1,83,400 acres was covered during the period under review. Detailed soil surveys, forest surveys, soil range surveys and engineering services were taken up for watershed planning to determine the nature and extent of water management practices that were required to be executed in small sub-catchments when taken as planning units. With this objective ten demonstration units, as mentioned above, were sub-divided into 321 planning units and detailed soil surveys of parts of the demonstration areas was carried over 43,000 acres. In addition, reconnaissance for soil surveys was carried out in another area of 34,700 acres.

During the period under review a regular plan of the Numb Romal sub-watershed of Khaner Kas area was issued on the basis of the investigations completed by this division. The result of investigations on different sub-watersheds in an area of 34,759 acres was administratively approved and the work commenced in February, 1962.

Land Treatment Measures:

To improve the agricultural practices and to ensure that the land was put to proper use, a series of operations were carried out in the project area. An expenditure of about Rs 148,000 was incurred for these operations which made appreciable contribution to the villagers' income. These operations included: new Atbandi; improvement of existing atbandi; diversions both earthen and stone; dry stone Outlets; chutes; improvements of ponds; dry stone check dams; dry stone plugs; earthen check dams, masonry spurs; road drainage, spillways etc.

Afforestation and Grassland Improvement:

Ground preparation that is, trenching and patch making for afforestation purposes and for improving production of better grass was extended to about 7,000 acres at a cost of about Rs 47,000. To meet the prospective requirements of seeds of more palatable varieties, nurseries were started in an area of three and a half acres at a cost of Rs 8,600. Brush gully plugs were also made to improve grass production.

Engineering:

The Watershed Management formulated a scheme for providing masonary and earthen structure which would check a rapid run off of water and at the same time would reclaim eroded land, which once was cultivable. The owners of these cultivated lands, due to financial could never afford the limitations construction of such structures and the problem remained unsolved till Wapda decided to bear the whole cost of such structures. A number of such structures have already been erected by the Watershed Management at a cost of Rs 41,000. According to this scheme the

reservoir will utilize the water stored for irrigation purposes. Some of the structures have already been constructed and new lakes formed. In addition, there are a number of dams now nearing completion.

Encouraged by the results of this scheme, the Watershed Management has now selected over 100 sites for raising such structures in different parts of the sub-catchment areas. Out of these about 60 have been designed to meet the requirements from topographical or strength point of view and are bound to prove very useful.

Soil Survey:

In spite the handicaps of shortage of staff all possible efforts were put into surveying the maximum area during the period under review. Details of the area surveyed during 1961-62 were as follows:—

Name of Pilot Area	Area surveyed during the year
Kas Bishandaur	.. 8,384 acres
Bhai Khan	.. 8,797 acres
Upper Kanshi	.. 4,641 acres
Khaner Kas	.. 2,579 acres
Azad Pattan	.. 1,272 acres
Batrasi Garhi Habibullah	.. 3,030 acres
Barsala area	.. 3,308 acres
Mhilwani Kas	.. 4,226 acres
Rawalakot	.. 4,660 acres
Pind Nallah	.. 2,265 acres
Total	.. 43,163 acres

Reconnaissance Soil Survey

Bhai Khan	.. 15,200 acres
Azad Pattan	.. 10,250 acres
Batrasi Garhi Habibullah	.. 9,260 acres
Total	.. 34,710 acres

Evaluation Studies:

A number of evaluation studies were carried out on the available data. The equation Q=CIA, has been used successfully to design a soil conservation structural measures.

Q=Maximum run-off at the catchment outfall
C=Run off co-efficient
I=Intensity of run fall
A=Catchment area

During the next financial year the scope of investigations is expected to be enlarged. A number of instruments such as water level recorders and rain gauge recorders are proposed to be installed at suitable sites. In some cases, however, the apparatus for such studies had already been purchased and work commenced. A total expenditure of Rs 60,000 has been incurred in this behalf.

Three sites for crop lands investigations have been selected. These are situated in Daryala Khaki, Kallerian and Kashmiri Bazar Watershed of Kas Bishandaur, Upper Kanshi and Khaner Kas pilot project, which are representatives of the Potwar plateau, sub-mountainous and mountainous regions respectively.

In order to record the intensity of rain fall etc., climatological installations are also observed. Rain gauge stations within a radius of 5-miles of the project area have been set up and data is being collected regularly.

Rat Control:

A great menace in the whole of Mangla dam catchment area, specially to the crops are the rats. They damage the crop and increase the soil erosion by digging the holes in the "watts" thus contributing greatly to accelerated erosion and silt influse in the run off contributing to the Jhelum flow. An intensive programme for their control was undertaken during the year 1961-62 and an area of approximately 35,000 acres was covered. An expenditure of approximately Rs 16,000 was incurred on this operation which included purchase of poisons and appliances.

h) **Agronomic Practices:**

Agronomical practices in the catchment area which fall under the projects of the Watershed Management were also improved. In most of the regions the most common rotation is wheat-fallow-wheat or any other rotation by which most of the land remains fallow during the monsoon. These bare fields enormously increase the contribution of silt in the rivers. Keeping this in view and considering the economic conditions of the farmers, crops like groundnut were introduced. The groundnut, it may be mentioned, protects the land during rains. The groundnut seed worth Rs 10,000 was distributed to farmers on recovery basis. About 284 acres of crop were sold under the technical supervision of the staff of the Watershed Management.

FUTURE PLANS:

It is expected that the present programme will be extended to five years, during which an area of 200 square miles will be covered by various projects. The operational phase may continue for next 25 years and the target for observation of the project will be over 100 square miles.

EXPENDITURE:

The estimated cost of the project for the first five years is about Rs 10 million including Rs 826,000 in foreign exchange. The expenditure up to the end of June in various sectors was 2,332, 858 out of which Rs. 528,000 was in Foreign Exchange. During the year 1961-62 the total expenditure was Rs 992,654.

GENERAL INVESTIGATIONS

The aim of this project is to carry out comprehensive investigations relating to surface and ground water, hydrology, soil, and drainage and reclamation, along with individual basin studies, so as to enable Wapda to develop the water and power resources of West Pakistan on a unified and multi-purpose basis. The progress achieved on this project during 1961-62 is described in this chapter.

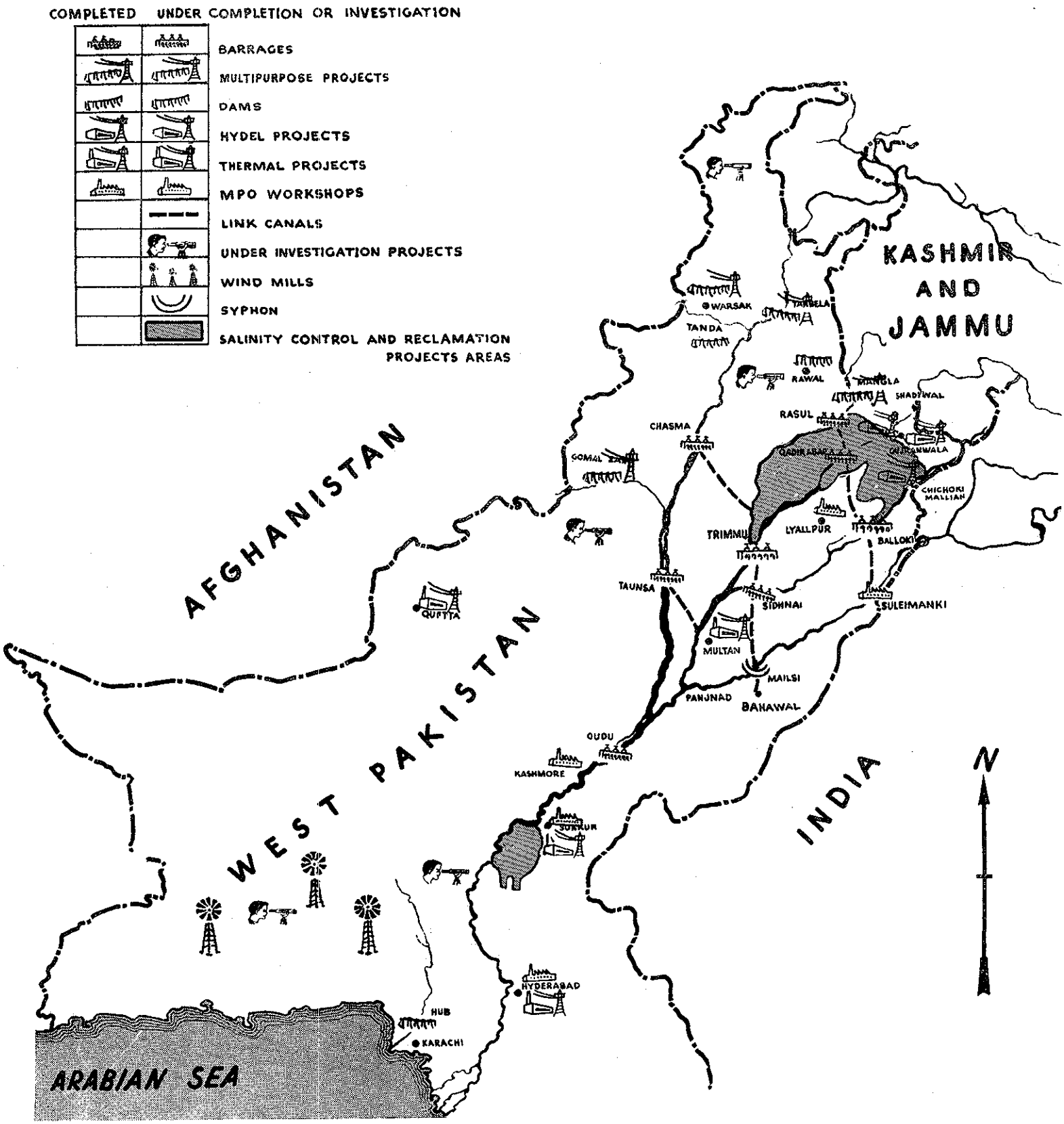
Preparation of Master Plan

Under the Wapda charter the Authority has to prepare for the approval of the Government a comprehensive plan for the development and utilization of the water and power resources of West Pakistan on a unified and multipurpose basis. As a first step towards the preparation of the Master Plan an attempt is being made to frame an appraisal report dealing generally with problems connected with the development of water and power resources. While this appraisal report is being prepared, independent action has been taken to outline the problems and indicate the solutions regarding four urgent problems. These are: the control of waterlogging and salinity; the additional power generation required for 1965-68; a detailed study of the growth in the West Pakistan power load; and a study of the navigation potential on the link canals to be constructed under the Indus Basin Settlement Plan. Detailed reports on these problems were prepared during the period under report.

Work continued on the appraisal report and numerous basic studies on the following aspects of the report have been completed.

1) Conjuctive surface and ground water operations studies to supply water to 29 million acres on a single year basis for average and minimum water-supply years.
2) Estimates of 1975 population and acreages of crops necessary to support that population.
3) Schedules for completion of existing schemes to provide additional irrigated acreage were obtained and corelated with needs.
4) Schedules for all contemplated work on the Indus Basin projects, salinity control and reclamation schemes, development schemes, and the electrification programme were prepared to indicate basic financing requirements.

The supporting study of all large Indus and off-stream storage possibilities from Kalabagh to Tarbela was reviewed and was made up-to-date. The flow charting for the Master Plan operation studies to be carried out on an electronic computer was completed during the period and inquiries were sent out to obtain data on available equipment and personnel in various European cities. Miscellaneous charts and drawings


COMPLETED
UNDER COMPLETION OR INVESTIGATION
BARRAGES
MULTIPURPOSE PROJECTS
DAMS
HYDEL PROJECTS
THERMAL PROJECTS
MPO WORKSHOPS
LINK CANALS
UNDER INVESTIGATION PROJECTS
WIND MILLS
SYPHON
SALINITY CONTROL AND RECLAMATION PROJECTS AREAS
KASHMIR AND JAMMU
AFGHANISTAN
WEST PAKISTAN
INDIA
ARABIAN SEA
WARSAK
TARBELA
TANDA
RAWAL
MANGLA
SHADIWAL
RASUL
CHASMA
GOMAL
QADIRABAD
CHICHOKI MALLIAN
TRIMMU
LYALLPUR
BALLOKI
TAUNSA
SIDHNAI
SULEIMANKI
QUETTA
MULTAN
MAILSI
PANJNAD
BAHAWAL
OUDU
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SUKKUR
HYDERABAD
HUB
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were prepared or revised during the period to accompany the appraisal report or supporting volumes. The following special reports relating to master planning were prepared:

i) Economics of Tarbela Dam,

ii) Alternative storage sites on Indus River,

iii) Annual cost of the Indus Basin Project.

Basic studies were initiated for three additional reports, and work continued on collecting and analysing basic agricultural and economic data for use in the Master Plan and project planning studies.

General Hydrology: Surface Water

The Surface Water Circle of Wapda continued its collection and analysis of sediment samples, survey of snow accumulation and observation of hydrometerological phenomenon. It also published the observed data and results derived therefrom in their monthly bulletins. The following data collection stations have been in operation during the period:

1.	Discharge measurements stations	..	43
2.	Non-recording hydro-meterorological stations	..	22
3.	Recording hydro-meterorological stations	..	27
4.	Evaporation stations	..	15

A programme for storm studies in West Pakistan were initiated in co-operation with the Meteorological Department. Measurements were made on 11 major canals under the data observation programme for a hydraulic survey of West Pakistan canals. A snow survey was carried out in the Kaghan valley along 8 snow survey courses.

Ground Water and Soils Investigations

These investigations are being carried out in various areas of West Pakistan for the dual purpose of controlling the salinity and waterlogging in the irrigated areas of West Pakistan and for the development of ground water for additional water supplies. (The progress achieved by WASID is discussed in a separate chapter).

River Basin Investigations

Basin-wise studies of various rivers of West Pakistan are being carried out by Wapda both to help in the preparation of the comprehensive water and power master plan mentioned above and to prepare definite projects for their integrated development. A brief resume of the progress achieved during the period under report is given below:—

Porali River Basin

During this period a supplementary report to the basin appraisal report has been prepared. These reports have indicated 8 dam sites on Porali River, five on Kud, one on Khantra and one on Windor. Further work of collection of basic hydro-metreological and other data is being continued.

Kachhi Plain (Sibi-Jhatpat) Area.

Detailed topographical surveys have been completed for all the proposed reservoir areas and dam sites except that of Boji site. Geological mapping was completed for Babar Kach, Naulung, Mangi, Anambar and Ghatti Bridge sites. About 650 feet of exploratory drilling has been carried out at Baber Kach. Semi-detailed soil surveys have been carried out for about 4,76,800 acres of land under the proposed command of Nari Bolan (Phase II), Talli and Mulla river schemes.

Kurram River Basin

A multipurpose scheme known as Kurram Ghari Project has been completed by the Irrigation Department. This project forms the pivot round which further development of Kurram river waters must revolve. A study to store flood water at Kurram Tangi has been taken up but no appreciable progress can be made on the project due to access difficulties. During the period under report hydro-metreological data was collected for the years 1914-1930 and for 1957-61.

Aerial Surveys

A preliminary estimate of aerial photography requirements for the planning and development programme for the period 1962-65 was prepared. This is given below:

Photo Scale	*Application*	*Requirements*
1:40,000	Strip maps for river valleys ..	6,000
1:15,540	Strip maps for river valleys ..	4,300
1:15,840	Maps of irrigable areas outside the Sind and Punjab areas	7,500
1:4,800	Large scale maps of dam sites ..	340
	Total ..	18,140

Warsak Re-regulating Reservoir

The installed capacity of the Warsak power house is 160,000 kw but during the low flood periods it can give only 90,000 kw peak power. This is due to the limitations imposed on the Warsak reservoir operation by the irrigation water requirements of the Kabul river canals taking off about two miles below the dam site and inundation canal serving the riverain areas further downstream. For the operation of the Warsak reservoir independent of the irrigation requirements and to increase the low-flow period peak power to that installed, it is proposed to construct a re-regulating reservoir at the Kabul river canal head.

During the period under report considerable progress was made on the preparation of the reconnaissance report on this project as given below:

(a) Preliminary design and estimate on the 6,000 acre feet reservoir was brought to near completion.

(b) Work was started on the preparation of designs and estimates for the canal and syphon alternative plans.

(c) Action was taken to speed up the collection of design data, lack of which has impeded the progress of investigations.

Small Hydel Schemes in Gilgit Agency

Preliminary investigations of 4 hydel schemes in Gilgit Agency were completed. These schemes are for Naltar, 28 miles northwest of Gilgit on Naltar Nullah, for Baltit on Hasanabad Nallah about 60 miles north of Gilgit, for Gilgit town on Kargah Nullah and for Chalt on Chaproat Nullah near the summer capital of Nagar state. Of these, feasibility reports for Baltit and Naltar schemes were completed and submitted to the Government. The former provides for generation of 200 kw, with a provision to increase it later to 600 kw, at a total cost of about Rs 1.6 million while the later envisages the construction of a 90 kw hydel plant at an estimated cost of Rs 500,000. The feasibility report of the Gilgit scheme is under preparation.

Feasible Schemes

Included in Wapda's portfolio of schemes on which feasibility reports have been prepared and details given in previous annual reviews are plans for the Karachi Irrigation Project and Gomal Zam Multipurpose Project. The first mentioned, originally known as the Hab Dam Project, is proposed to be built 35 miles northeast of Karachi to impound 773,000 acre feet of water to irrigate about 84,000 acres of cropped area. It also has a hydel potential but this aspect is not included in the present scheme estimated to cost Rs 88.6 million. During 1961-62, Wapda worked on a plan to reduce the foreign exchange component of Rs 49 million by making greater use of equipment available with MPO.

The Gomal project in Dera Ismail Khan provides for the construction of a 2.5 million acre feet capacity reservoir at Khajuri Kach with a power house of 73,000 kw installed capacity. During 1961-62 the cost of the project was estimated at Rs 200 million and a detailed report was completed on the Mian Noor reservoir which is a part of the overall project.

TANDA DAM PROJECT

The Tanda dam is the first important irrigation project to be started by Wapda in the Frontier regions of West Pakistan. The area selected for development is in the valley of Kohat, 40 miles south of Peshawar. The valley is an oval shaped basin in which is situated the town of Kohat. The project features are dispersed throughout the area surrounding the town. The location of the proposed reservoir is across the Kohat Toi, four miles to the west of the town and the lands to be irrigated lie along Kohat-Khushalgarh road eight to fifteen miles east.

Alternatives

After thorough investigations for which help was taken from all possible sources, two alternatives were suggested in the feasibility report prepared in April, 1962:

i) One of the alternatives suggested was the utilization of the 70,000 acre feet of water from the reservoir for 15,000 acres of land in perennial irrigation. This was based on the theory of intensive cultivation with an intensity of 175 per cent and this would have resulted in an increase of Rs 7.4 million annually in the value of gross production, that is, Rs 493 per acre of which Rs 250 per acre would have been the net increase in the income of the farmers.

ii) The second alternative was based on the principle of extensive irrigation and was designed to provide 150 per cent intensity of irrigation on a culturable commanded area of 32,500 acres with a kharif and rabi ratio of 60:90. In the general interest of the people of the valley it was agreed to adopt this scheme for extensive cultivation which was more acceptable and satisfying though less economical.

Features

Planned for construction under this development are the following principal features:

(1) A 113 feet high earthen dam to be constructed at the mouth of a dry off-channel basin forming a reservoir having a live storage capacity of 64,800 acre feet.

(2) A diversion system comprising a diversion weir to be constructed in the Kohat Toi to divert its flood flows into a 3,000 cusec feeder canal emptying into the reservoir through a 10 feet diameter inlet tunnel.

(3) Outlet works for releasing water from the reservoir for irrigation: a 6 feet diameter concrete lined pressure tunnel, controlled by two 42 inch Howell Bunger valves.

(4) A spillway to protect the dam from overtopping, consisting of a 30 feet un-

controlled weir discharging through a 10 feet diameter concrete lined tunnel.

(5) A distribution system for the delivery of irrigation water, consisting of a concrete-lined main canal and unlined distributaries and minors.

(6) A drainage system—mostly deferred till it is needed—consisting of such facilities as are required to control the level of the water table and prevent waterlogging.

Cost

The total estimated cost of the project as mentioned in the feasibility report is Rs 45 million. It is estimated to be completed by the end of 1964.

PROGRESS

Hydrology: Most of the attention was given to the hydrological observation during the period under review. A complete flood hydrograph for the 1961 monsoon was obtained with the help of the automatic gauge recorder fixed on Kohat Toi by Wapda's Hydrological section.

Investigation of diversions from Kohat Toi between the proposed Weir near Kaghazai village and Jarma Weir were started. Gauges were established on each off-take site which are being read twice daily. The purpose of this investigation is to determine water rights along Kohat Toi below Tanda dam diversion for further release of water, past the weir.

Project Area Survey: A large scale survey 1"=400' of the irrigable area was carried out by the Wapda Survey Party. The maps so obtained are being used for the layout of canals, minors and water courses and also for the final chakbandi of area. These maps serve as ordinary village plans (Shajra's) as permanent records with the revenue authorities. Besides this, these were expected to be helpful in designing ultimate cropping pattern over the project plan in order to achieve the estimated returns through the guidance of the agricultural department.

Topo survey of the reservoir extending upto weir site including dam abutments, feeder canal, inlet, outlet and spillway tunnels was completed on large scale. The maps prepared are being used for the design purposes.

Foundation and Material Investigations: Foundation investigation of the dam site, soil exploration and studies dealing with the suitability of the dam fill material were completed.

Except for the shear and consolidation tests which were carried out in the laboratories of Engineering College, Peshawar, Mangla dam and Baran dam projects and A.C.E. Lab. Karachi, all the other tests were performed in the Field Soil Testing Lab. at Tanda dam.

Soil Investigation: Because of the substantial superiority in productive capacity

and general suitability under intensive irrigation of the Buchiana and Chuharkana soils, it was considered important to have the line of demarcation between the soil carefully identified so that the project boundary could be properly delineated.

In this connection, a WASID party started and completed a semi-detailed soils survey of the project area. This soil survey enabled the selection of the boundaries of the commandable area restricted to Buchiana and Chuharkana soils. Moreover, chemical and physical characteristics of the soil for use in planning the distribution and drainage systems were also obtained.

Expenditure

The total expenditure on the project up to the end of June, 1962, was Rs 356,084.

GOMAL RIVER SCHEME

The Gomal River Scheme was first advocated in the later half of the 19th century, for the control of floods in the Gomal and their utilization for irrigation purposes in the Dera Ismail Khan district.

Dera Ismail Khan is a vast fertile plain but has scanty rainfall and perennial flow. The proximity of Indus River has rendered very limited help to this district through an inundation canal known as Paharpur canal. About 50,000 acres out of total culturable area of 1.8 million acres receives water from this canal. About 50,000 acres are being irrigated from tubewells that have been sunk recently. A good portion of the population of this district depends for its livelihood on flood irrigation which is uncertain and of limited utility. The floods of the Gomal and other streams emerging in Dera Ismail Khan plain cause serious damages to lands, roads and villages.

Some time back engineers were asked to prepare a scheme for the control of the Gomal and its utilization for various national needs. The Irrigation Department took up the studies and proposed the construction of a dam on the Gomal at Gulkach. These investigations and some preliminary construction works continued till October, 1959, when Wapda was asked to take over the scheme. In conformity with Wapda's policy of overall basin appraisals of all major streams, Gomal River was also studied under the same principle. The work was divided into two major phases:

(a) A basin appraisal report.

(b) Project planning report by December 1962.

In March 1961, the basin appraisal report was published and feasibility of a very good economical multi-purpose project was established. It was found from the feasibility report that 255 million units (kwh) of energy could be produced. Irrigation facilities could be provided to over 1,60,000 acres of cultivable land. In addition, by this scheme, complete flood control could also be provided. This scheme when presented to Provincial Development Working Party was approved. Some changes, as suggested, were incorporated and a revised scheme was sent to the Central Development Working Party.

Briefly mentioned the scheme envisages the construction of a 450 feet high arch dam at Khajuri Kach in South Waziristan Agency. This dam will create a storage of 2.55 million acre feet which is 5 times the average annual run off. Water will be led from this reservoir through a 3.75 mile long concrete lined tunnel to the Khajuri power house where after generating electricity water will flow into Gomal River. After flowing for a distance of about 22 miles the water will be diverted into the Mian Noor Reservoir through a diversion weir at Kot Azam. The Mian Noor reservoir will be created by the construction of a 67 feet high and 3,400 feet long earthen dam. Two

dikes 10,000 feet long will later be built on the left and right sides. There from a perennial canal with 680 cusecs capacity which will supply water to culturable lands in Kulachi Tehsil.

PROGRESS

Of the mentioned basic component of the scheme the phase-II work, has been completed for Mian Noor reservoir in a report published in June 1961. All field work required for phase-II Khajuri dam and power has been completed and a report is under preparation in the office of the consulting engineers, Energoprojekt in Belgrade. That report is due for publication by the end of 1962. Survey and estimates for the finalization of the project has also been completed and the scheme is ready for execution in all respects provided the necessary funds are made available. It may be mentioned that soil surveys for suitability of crops have been carried out and more detailed investigations on this part of the project are in hand.

Since Wapda took over the charge of the Gomal river scheme, the following work has been done:

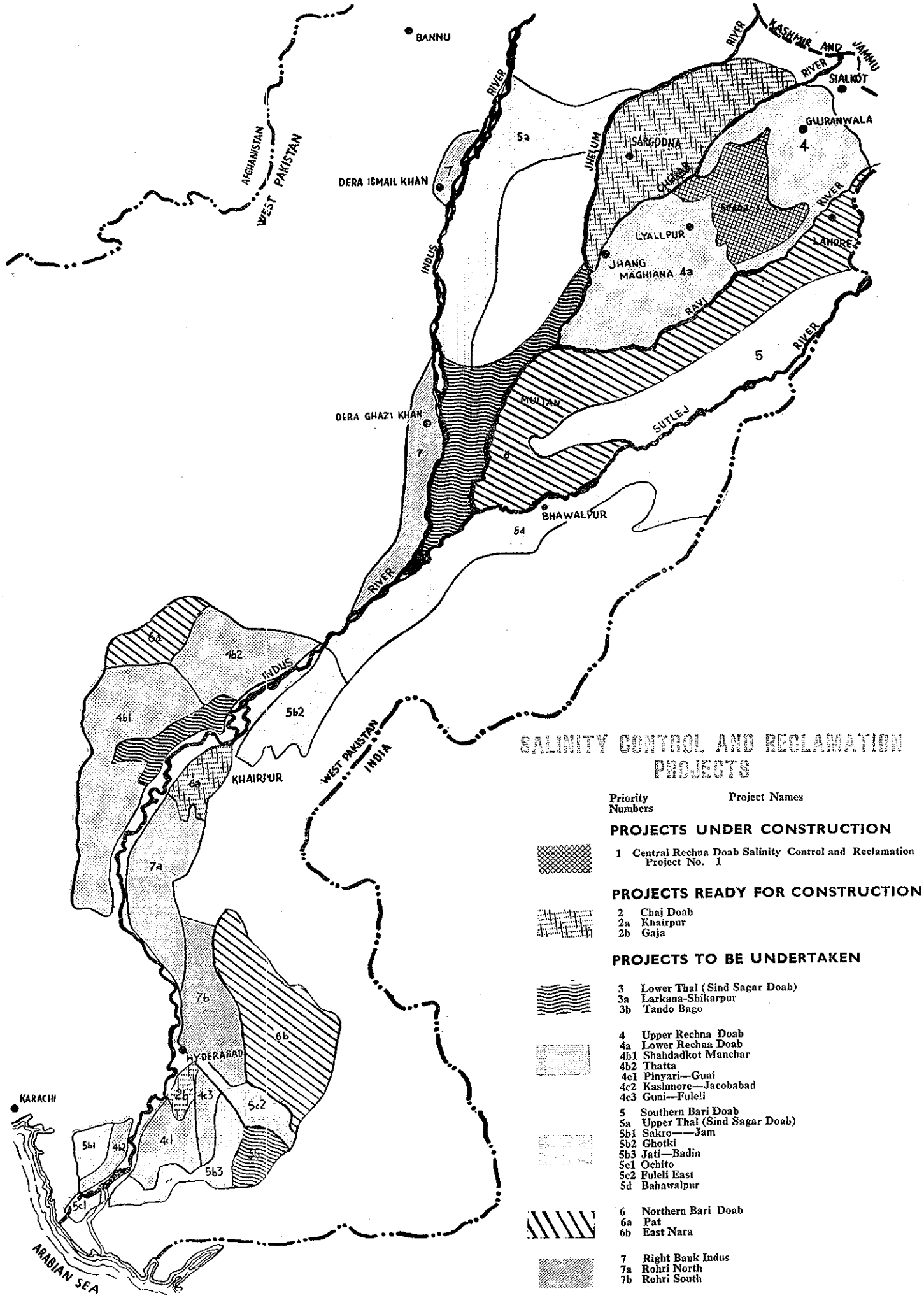
1. Establishment of level control throughout the scheme area.
2. Topographic maps of all component of the scheme.
3. Complete geological exploration and materials selections for the Mian Noor dam and preparation of the project planning report.
4. Complete geological investigation of Khajuri dam, reservoir and power house.
5. Setting of the tunnel alignment within an accuracy of one meter.
6. Soil survey of 260,000 acres of land out of which will be selected 160,000 acres.
7. Complete study of the hydrology of Gomal River.
8. Economics of the scheme in agriculture and power generation.
9. Survey and estimates for the lines of the communication to Khajuri dam.

Wapda had the following work under execution towards the end of the present report period:

1. Field grouting tests at Khajuri.
2. Detailed soil survey of irrigation area.

The schedule of financial expenditure, in rupees, is as below:

1.	Total estimated cost of the project	200 million
2.	Expenditure incurred upto 15-10-1959 by Irrigation department ..	5,805,034.58
3.	Expenditure incurred between 15-10-1959 to 30-6-60 (Wapda)	3,787,108.09
4.	Expenditure incurred during financial year 1960-61 ..	1,620,773.73
5.	Expenditure incurred during financial year 1961-62 ..	498,589.07
6.	Total expenditure by Wapda ..	5,906,410.89
7.	Total expenditure incurred during Government and Wapda	11,711,505.47



SALINITY CONTROL AND RECLAMATION PROJECTS

Priority Numbers — Project Names

PROJECTS UNDER CONSTRUCTION

1 Central Rechna Doab Salinity Control and Reclamation Project No. 1

PROJECTS READY FOR CONSTRUCTION

2 Chaj Doab
2a Khairpur
2b Gaja

PROJECTS TO BE UNDERTAKEN

3 Lower Thal (Sind Sagar Doab)
3a Larkana-Shikarpur
3b Tando Bago

4 Upper Rechna Doab
4a Lower Rechna Doab
4b1 Shahdadkot Manchar
4b2 Thatta
4c1 Pinyari—Guni
4c2 Kashmore—Jacobabad
4c3 Guni—Fuleli

5 Southern Bari Doab
5a Upper Thal (Sind Sagar Doab)
5b1 Sakro——Jam
5b2 Ghotki
5b3 Jati—Badin
5c1 Ochito
5c2 Fuleli East
5d Bahawalpur

6 Northern Bari Doab
6a Pat
6b East Nara

7 Right Bank Indus
7a Rohri North
7b Rohri South

CONTROL OF WATERLOGGING AND SALINITY

Wapda's two agencies engaged in controlling waterlogging and salinity—the Ground Water and Reclamation Division and the Water and Soils Investigation Division—have substantial progress to report for 1961-62 for the four main stages of the fight against these twin threats to the agricultural economy of West Pakistan. These stages are: investigation, formulation of projects, construction and management. The Ground Water and Reclamation Division is at present charged with the responsibility for the construction of projects, for their management, the formulation of projects, and investigations in the Sind area covered by the irrigation systems fed from the Sukkur, Gudu and Ghulam Mohammad barrages. The Water and Soils Investigation Division is carrying out a programme of investigations covering about 23 million acres in the Rechna, Chaj, Thal and Bari doabs, in the Bahawalpur and Rahimyar Khan districts, and some sites in the Peshawar-Mardan area.

In Central Rechna doab 213 completed tubewells had been energised by the end of June, 1961. During the current reporting period GWRD raised the number of operating tubewells to 1345 and was also managing them as an interim measure. In three months from March to June, 1962, these tubewells lowered the water table by 3.27 feet and there were substantial increases in the cropped area because of the additional water available through pumping. GWRD revised its project for the Khairpur area and Wapda is now negotiating with the International Development Association of the World Bank for an 18 million dollar loan to finance the foreign exchange requirements of the project. The Gaja project is also ready and an application is being made to IDA for a loan. Investigations are being completed in the Kashmore-Jacobabad, Shahdadkot-Mancher and Thatta-Sakrojam areas. A project for the ower Thal area is being formulated and is expected to be finalised by the end of 1962. In the Chaj doab Wapda has already let out the contract for the Lalian scheme and similar action is expected shortly for the Mona scheme. WASID has completed its investigations in the Thal, Rechna and Chaj doabs and has made substantial advances in the Bari doab and Bahawalpur. Further details of the progress made by GWRD and WASID during 1961-62 are given further on in this report.

UNDERGROUND WATER RESERVOIR

Apart from the progress outlined above, considerable interest was roused during 1961-62 at the Wapda disclosure that most of the Upper Indus Plain is underlain to depths of 1000 feet or more by unconsolidated alluvial sediments which are saturated to within a few feet of the land surface. In other words there is a vast reservoir of ground water—perhaps, the largest of its kind in the world—which according to tentative estimates can yield 1900 million acre feet of fresh water. This is equal to 10 times the yearly average discharge of the entire Indus basin and probably is more than

the total quantity of water that will be available from both the Mangla and Tarbela dams over a period of 100 years. This discovery was made during the course of investigations into the problem of waterlogging and salinity. Experts in hydrology, geology and soil mechanics have estimated that in the Chaj, Rechna, Thal and Bari doabs nearly 16 million acres of the present gross area of irrigation have spread out beneath them this reservoir of ground water. This discovery is of great significance to the economy of West Pakistan, which has more culturable land than can be irrigated from its surface water supplies. The reservoir can be reached through tubewells, and it is estimated that high capacity wells yielding 5 cusecs or more can be developed at virtually any site.

Under the present irrigation system the average potential rate of recharge to this underground reservoir is between 11 and 13 million acre feet per year. Of this about 8 million acre feet are contributed as a result of the current irrigation activities, that is, mainly from canal seepage, and between 3 and 5 million acre feet from natural sources. Under conditions of full supplies to the irrigated lands, and maximum development of the aquifer, the average annual rate of recharge to the fresh water zone will be between 1 foot and 1.2 feet. On this basis the perennial ground water yield will be about 16 million acre feet per year. But for the first 10 or 15 years the rate of withdrawal can be 19 million acre feet, and this can be justified on several counts. Among them is the time needed to complete the barrages, dams and link canals that are necessary to control the diversion of surface water supplies in the Indus basin. During this interval the need for supplementary ground water supplies will be most acute. Also from the point of view of both land reclamation and water conservation it is desirable to depress the water table as quickly as possible.

As has been indicated by the figures for recharge and withdrawal the level of the ground water will be gradually lowered and it may take about 30 to 40 years to reach the level that existed before irrigation started. At that level withdrawals will be adjusted to stabilise with recharge and keep a steady 16 million acre feet of water flowing upwards for use as and when required. This also does not mean that it will be unnecessary to stop all canals from leaking by lining them. Canal seepage will have to be controlled in areas where soil and salinity conditions are unfavourable, especially in many regions of the Lower Indus Plain. Investigations in the Lower Indus Plain are still in progress, and while the ground water there is generally more brackish a considerable quantity of it may be suitable for irrigation purposes.

US INTEREST IN THE PROBLEM

Wapda's annual report for 1960-61 mentioned the increased national and international interest in the prevention of waterlogging and the reclamation of waterlogged and salted lands in West Pakistan. Following talks in Karachi between President Mohammad Ayub Khan and the United States Vice-President, Mr Lyndon B. Johnson, in May, 1961, the Pakistan President had further talks on the subject in Washington with President John F. Kennedy. This was during the Pakistan President's visit to the United States in July, 1961. Within days of this meeting the US Presi-

dent asked his Science Advisory Committee to tackle the scientific, technical and economic aspects of West Pakistan's waterlogging and salinity problem. This committee took up the question on the 20th of July, 1961. A panel of experts was appointed and they held several meetings, some of which were attended by the Pakistan President's Science Adviser, Dr Abdus Salam, and Wapda's consultants and advisers. Early in September, President Kennedy wrote to President Mohammad Ayub Khan informing him of the progress made by the US panel of experts and announcing that a team of scientists, engineers and economists would visit West Pakistan for an on the spot inspection and evaluation, and discussions with experts associated with Wapda and other government agencies.

Within four weeks of this letter the first group of President Kennedy's team arrived in West Pakistan, headed by Dr Roger Revelle, Science Adviser to the US Secretary of the Interior. A few days later the leader of the full team, Dr Jerome B. Wiesner, Special Assistant for Science and Technology to President Kennedy, also arrived in West Pakistan. The two groups comprised a dozen members; all of them eminent scientists, technicians, and economists. These groups held several discussions with Wapda's Chairman, Members, engineers and other experts. They also visited various Wapda projects and held discussions with representatives of the Pakistan Government, the West Pakistan Irrigation Department and the Agricultural Development Corporation.

On their return to the United States, these experts began work on various aspects of the problem. These included a comprehensive and detailed analysis of the probable effects of the different proposed systems for combating waterlogging and salinity, and at the same time increasing the supply of irrigation water, with the objective of identifying the best and most practical system. Also under examination are applicable irrigation techniques and management plans, and for this purpose Wapda's first project in the Central Rechna Doab was selected to provide a means for checking the analytical studies as well as the efficacy of the tubewell approach. The problem of management which would be complicated by the necessity both to lower the water table and to increase and stabilize the water supply for irrigation is being given special attention. The problem of maintaining and increasing the harvest from irrigated lands when more water becomes available is being studied by specialists of the US Department of Agriculture. Also under study is the extent to which the equipment and materials needed in these enterprises could be supplied by Pakistan's own industrial units, either from existing or new plants.

During May, 1962, the Wapda Chairman, on a visit to Washington, had further talks with Dr Jerome B. Wiesner and Dr Roger Revelle. At this meeting Mr Ghulam Ishaq learnt that the US Scientists Mission had endorsed the Wapda technique of fighting salinity and waterlogging. It was indicated that some refinements in these techniques would be suggested and that the mission might recommend that the duration of the programme be extended to 20 or 25 years compared to the 10 or 15 years suggested in the Wapda master plan. The report is expected early in 1962-63.

WAPDA'S MASTER PLAN

Wapda's master plan for the control of waterlogging and salinity was prepared towards the end of 1960-61 under instructions from the President of Pakistan. In its report, of which the operational programme forms part, Wapda pointed out that West Pakistan was losing an estimated area of 100,000 acres each year through the spread of waterlogging and salinity. To realise the gigantic proportions and the fearsome consequences of this threat it is necessary to remember that according to the land-use data available for about 116 million acres (out of West Pakistan's total land area of 198 million acres) only 61 million acres are fit for cultivation. At present about 39 million acres are cropped annually to some degree. Of this area 33 million acres are under the command of irrigation systems which make possible the average annual cropping of just over 24 million acres. A comprehensive survey of the Indus plain made 8 years ago showed that 11.3 million acres were mostly waterlogged or poorly drained, another 4.8 million acres were severely saline and in an additional 11.2 million acre saline patches were common. Since that survey, another half a million acres are estimated to have been severely affected.

Nature of the Problem: The problem of waterlogging and salinity in West Pakistan has developed in the past seven decades with the introduction of barrage controlled irrigation. The water passing through the new irrigation system gradually destroyed the equilibrium between ground water recharge and discharge. Seepage from canals and from the new lands brought under irrigation formed an additional recharge for the ground water which was beyond its capacity to discharge. Over large areas of the Upper Indus Plain water tables rose at rates varying from 6 inches to 2 feet or even more every year. In the lower Indus valley the ground water did not rise so rapidly but the effect was more or less the same since the previous water tables did not lie at lower depths because of the low altitude of the land and its nearness to the sea. As a consequence about two decades ago the water tables had risen to within 10 or 15 feet of the ground surface and today they are higher. This affected the drainage capacity of the soils and the increased evaporation of water resulted also in an increased accumulation of the salts from the soils and from the irrigation water, in the root zones of the crops. Salts which are inherently present in arid soils but are not a major problem when water tables are low become a very serious menace when with increased waterlogging they enter and remain in the root zone.

In the last 50 years different measures were tried to defeat salinity and waterlogging but none of them was intensively pursued or extensively applied. The first big project was undertaken by Wapda three years ago in the Central Rechna Doab and progress on this is described in the following pages. But with this project only the fringe of the problem has been touched, and according to the overall programme formulated by Wapda another 25 major projects will be needed.

The seriousness of this problem is underlined further by statistics which show that West Pakistan's population of about 43 million depends on 39 million acres for food and

fibre, and the bulk of them depend on agriculture for livelihood. With an annual population increase approaching one million persons, and with the loss of irrigated land at the rate of 100,000 acres each year, the problem created by waterlogging and salinity has to be solved quickly and permanently.

Remedy: According to the Wapda plan the following steps should be taken to achieve the optimum output from the irrigated areas of West Pakistan:

1) The lowering of water tables where high levels have impaired the ability of plants to thrive or have resulted in the salinisation of the soil.

2) Flushing of salines out of the root zones of plants and keeping the ground water down to a level where the upward capillary movement of ground water will not occur, and the salinity problem cannot recur.

3) Providing as nearly as possible an optimum irrigation water supply, in order that the greatest possible level of agricultural production be attained.

4) Maintaining all irrigation and drainage facilities at the highest possible standards.

5) Maintaining cropping patterns to provide for the proper diet and nutrition level; and to provide insofar as is possible, cash crops for export or for raw materials.

6) Improving irrigation practices, soil management, and farming methods to make the most efficient use of the irrigation, water supply, and the drainage facilities provided.

Size of Programme: Proposed in the reclamation programme are 26 projects which will benefit 29 million acres under the command of the existing systems. They comprise 10 reclamation schemes in the northern part of the Indus plain and 16 projects in the southern area. The reclamation schemes of the northern zone are based primarily on the utilisation of tubewells for subsoil drainge, combined with drainage for the removal of storm runoff. In the southern zone, the reclamation schemes consist primarily of open drains for the removal of subsoil and surface water supplemented with tubewells in those areas where it is feasible to provide subsoil drainage by this means. In all, the programme which is tentative at this stage embodies the construction of some 31,500 tubewells, 7,500 miles of major drainage channels, and 25,000 miles of supplemental drains. Thousands of corollary works such as bridges, culverts, pump houses, and other miscellaneous structures will be required as well. To provide power for the operation of the tubewells and the pumping plants will require the provision of another 600,000 kilowatts of generating capacity in addition to the capacity of 200,000 kilowatts already allocated to reclamation under earlier plans, several hundred miles of high tension transmission lines and 36,000 miles of secondary distribution lines.

Cost of Programme: The provisional capital cost of the tentative programme and the return that will be realised with reclamation are:

		Rupees
Total Capital Cost of 26 Projects (exclusive of power facilities)		3400 million
Total Annual Project Costs (including cost of electric energy)		4000 million
Annual increase in Gross Value of Crops after the Reclamation		3600 million
Increased Cost of Crop Production	1200 million	
Annual Project Costs	400 million	
		1600 million
Benefit-to-Cost Ratio		2.25:1

The capital cost of power supply facilities, including the generation, transmission, and distribution facilities required to supply electric energy for the reclamation works is of the order of Rs 2500 million.

Effect of Programme: Estimates have been made in the overall programme for the crop yields that are expected to be attained through the control of water-logging and salinity after adequate drainage is provided and full use is made of the supplemental water supplies made available by the reclamation works. These studies indicate that in most areas with reclamation, the total crop production will be about double if not more of what is obtained at present. It is also estimated that with reclamation the increased gross value of crops raised in a single year will be more than the capital cost of the reclamation works. This does not, however, present the entire picture because the farmers will incur certain additional production costs to attain the higher yields possible with reclamation. Taking into account increased production costs for additional equipment, labour, seed, and fertilizers, which have been conservatively estimated to increase present farm production costs about 50 per cent, there will still remain a substantial increase in the net income of the farmers. On an average the net increase in farm income is estimated at Rs 69 per acre in the northern zone and Rs 58 per acre in the southern zone.

This shows that besides being justified as a means of providing drainage and permitting the reclamation of waterlogged and saline lands, the programme has a high order of economic feasibility because there will remain a substantial net return to the landowner after payment of the entire cost of construction and operation of the reclamation works. On the basis of the economic analysis the overall benefit-to-cost ratio of the reclamation programme is approximately 2.25:1 as indicated below:

	(all values in million of rupees)		
Item	Northern Zone	Southern Zone	Total
1. Gross value of crop production after reclamation	5,058	2,403	7,461
2. Gross value of crop production prior to reclamation	2,666	1,320	3,986
3. Gross value of incremental crop production	2,392	1,083	3,475
4. Annual cost of reclamation programme	291	103	394
5. Increased costs of production after reclamation	857	318	1,175
6. Total Costs (Items 4 and 5)	1,148	421	1,569
7. Benefit: Cost Ratio (item 3/item 6)	2.1:1	2.6:1	2.25:1

The most tangible benefit accruing from the programme will be the opportunity to reduce foreign exchange expenditures on food imports. Pakistan has been importing food at rates in excess of 800,000 tons per year for the past several years. It is estimated that with control of waterlogging and salinity, the overall food production from presently irrigated lands can be increased by at least 15 million tons per year.

Other indirect benefits will accrue from the construction of the projects. The construction of electric distribution facilities to supply power for the tubewells and villages within the area will lead to a much higher standard of living and greatly enhance opportunities for the development of agricultural industries. Improvements in diet and health that will result from the increased food production and elimination of waterlogging cannot be evaluated precisely in monetary terms. Nevertheless, the improvement in diet will be substantial. Elimination of swampy areas will reduce considerably the opportunity for flies and mosquitoes to breed and can be expected to lower the incidence of water borne diseases.

EFFECTIVENESS OF TUBEWELLS

Along with the preparation of the master plan, Wapda also undertook, with the help of its consultants, Tipton and Kalmbach Incorporated of Denver, USA, an intensive study of the effectiveness of the tubewells working in the Jaranwala area. These tubewells were installed by the Irrigation Department and are being operated by them. The scheme covered a roughly rectangular tract, about 140 square miles in area, situated about 45 miles west of Lahore in the Rechna doab and was irrigated by the Lower Chenab Canal system. The gross area was 90,870 acres out of which 6,865 acres were not allotted any water from the canals, while another 7,630 acres were under villages and roads. Prior to irrigation the water table in this area was 40 to 50 feet below the surface but by 1945 it had risen to 10 feet of the surface.

The consultants report said that during the first 3 years period the saline area in the Jaranwala scheme had decreased from 60 to 30 per cent of the total area, and the value of the crop production had increased from Rs 6.6 million in 1956 to Rs 10.1 million in 1960. The consultants added that their study had conclusively shown that the operation of the reclamation tubewells in the Jaranwala area had accomplished much in the alleviation of waterlogging, reduction in salinity, and reclamation of land that had gone out of production. As this area was generally typical of many of the problem areas in the affected regions in West Pakistan the consultants expressed the belief that their study found an excellent example of what could be accomplished with tubewell reclamation. Considering that the results in the Jaranwala scheme had been achieved when all the works necessary for the efficient distribution of the tubewell water had not yet been fully completed Wapda's confidence in its approach to the problem, as outlined in the master plan, was further reinforced. More evidence in favour of this approach came recently with the working of the Wapda tubewells in the Central Rechna Doab, where the ground water level has gone down by over 3 feet within a 3 month period.

SALINITY CONTROL AND RECLAMATION PROJECT NO. I

This project, which is generally known as the Central Rechna Doab Project, is one of the 26 mentioned earlier in connection with the master plan for the reclamation of waterlogged and saline land in West Pakistan. It was sanctioned by the West Pakistan Government in April, 1959, and subsequently approved by the Planning Commission in February, 1960. It was one of the first projects undertaken by Wapda, and it was based on the results of investigations and voluminous research and material and data compiled by several other agencies before Wapda came into the picture. Work on this project was taken over by Wapda from 1st March, 1959, after a loan had been secured from the US Development Loan Fund (now incorporated in the US Agency for International Development) for 15.2 million dollars for financing the foreign exchange expenditure for the installation of the tubewells and for their electrification. The electrification of the tubewells, however, is an independent project. Under the Colombo Plan Wapda received from Australia about 400 motors, control panels and other electrical equipment and about 150,000 feet of tubewell pipes for the project.

The Central Rechna Doab is extensively affected by waterlogging and salinity. Before the tubewells began working the water table in 45 per cent of the area was within 6 feet of the ground surface and about 40 per cent of the area was saline. And also before the Wapda tubewells began working, irrigation supplies in the area were spread so thinly that adequate crop yields were difficult to obtain. All these factors combined to limit the agricultural potential of the area and the deterioration of land was resulting in a decline of productivity every year.

The area covered by the project lies in the central part of the doab between the Ravi and the Chenab rivers, covers Harse Sheikh, Beranwala, Zafarwal, Hafizabad, Shadman, Shahkot, Sangla Hill and Khangah Dogran, and is served by the Lower Chenab Canal system. The gross area under the project boundary is 1.2 million acres of which 1.1 million acres is classed as culturable commanded land. To achieve the desired objectives, the project has been conceived as a tubewell drainage-cum-irrigation project. The tubewells serve a dual purpose. Pumping from the ground water reservoir lowers the water table, and the tubewell supply mixed with canal waters is utilized for leaching the salts and supplying the optimum crop requirements. The quality of the ground water in the whole area is usable directly or by mixing it with canal water. The plan is that with the start of pumping the tubewells, the water table will start declining as water will be withdrawn from the ground water storage. This withdrawal of the ground water can be continued for the expected life of 40 years of the tubewells without excessively depleting the ground water storage or increasing the pumping lift beyond economical limits.

Main Features of the Project: The total cost of the revised project is estimated

at Rs 92.1 million (foreign exchange: Rs 42.6 million) and the number of tubewells at 1795. In determining the tubewell pumpage, requirements for irrigation and drainage have been kept in mind. The tubewell pumpage and canal supply will raise the annual intensity of irrigation to more than 100 per cent and will increase the number of acres irrigated by 180,000. The annual water requirements of the crops in the project area and for the control of salinity have been worked out at 2.75 million acre feet per year, measured at the heads of distributaries for canal supplies and at the heads of water courses for tubewell supplies. Of this, 1.5 million acre feet per year will be supplied from the ground water by the tubewells constructed under the project. The depths of these tubewells range from 225 to 300 feet and their capacities from 2 to 5 cusecs. This capacity is designed to be 20 to 25 per cent more than the long-time average peak monthly pumping demand in order to provide for requirements in drought periods and changes in cropping patterns and intensities. The operation of the tubewells is by electric motors having an aggregate capacity of about 60,000 kilowatts. The annual power consumption will vary from 97 million kwh to 177 million kwh with the gradual increase in the pumping lift.

Financial and Economic Aspects: Studies made by Wapda indicate that after the completion of the construction of the project, the elimination of waterlogging and salinity and the availability of irrigation suppiles for optimum crop requirements will result in a considerable improvement in yields per acre. For the principal crops the present and future yields are compared below:

	Yield in maunds per acre with reclamation and other Improvements	
	Present	**Future**
Rice	15	25
Maize	12	25
Millets	8	15
Cotton	6	12
Wheat	12	22
Grams	8	25
Sugarcane (Gur)	33	50
Oilseeds	6	8

It is with the increase in yields per acre and the additional area which can be cropped that the total crop production is estimated to increase by more than 500,000 tons per year. The project can, therefore, be expected to reduce the food shortage to a great extent and lead to a considerable saving in the foreign exchange at present spent on food imports. The present gross value of crop production in the Central Rechna Doab area is estimated at Rs 124 million, which is anticipated to increase to Rs 252 million after reclamation. The annual increase in productivity is, therefore, more than 100 per cent and is nearly equal to the entire capital cost including electrification.

For the tubewell part of the project the annual operational and maintenance charges are estimated to average Rs 16.3 million during the 40-year life of the tubewells. This annual cost includes fixed charges for the repayment of capital and the interest thereon at 4 per cent in 20 years, a provision for a sinking fund to replace pump and motors at the end of the first 20 years and to replace the complete tubewells at the end of 40 years. In the above calculations it is estimated that the annual charges for power will average about 54 per cent of the total annual costs. Based on a culturable commanded area of 1.1 million acres, the average annual cost is Rs 14.8 per acre. With the anticipated increase in productivity after the payment of this additional charge and the additional farm costs that will be entitled, the anticipated net increase in farm income is Rs 69 per acre per year.

Progress: As already stated in the previous annual reports the tubewell construction was done partly through contract and partly through Wapda's own forces. The contractor, Messrs Harold T. Smith International, S.A., was responsible for the construction of 1014 tubewells while the remaining 781 tubewells were constructed by departmental forces under the technical supervision of the project consultants, Tipton and Kalmbach Inc. The progress during 1961-62 is indicated by the following table:

	30-6-1962	30-6-1961
1. Tubewells drilled, cased and shrouded	1795	1791
2. Tubewells tested	1795	1740
3. Concrete pump bases	1795	1372
4. Pumps and motors installed	1542	1073
5. Tubewells accepted as complete	1345	1008
6. Operator quarters completed/constructed	347	173

Completion of the construction work on the Central Rechna Doab Project was delayed partly because the local pumps manufacturing firm with whom an order was placed for the supply of 700 pumps and 400 motors could not keep to the schedule for the supply of this equipment of acceptable standard and partly owing to the delay to the receipt of equipment for electrification under DLF (now incorporated in AID). It is expected that the remaining construction work will be completed by the end of 1962.

Expenditure

Expenditure on this project during 1961-62 was estimated at Rs 12.75 million.

MANAGEMENT AND OPERATION OF PROJECT NO. 1

The original plan was that the completed tubewells would be handed over by Wapda to the Irrigation Department for operation. However, the West Pakistan Government decided in August, 1961, that as an interim measure Wapda should operate and manage these tubewells. Accordingly, Wapda set up the Directorate of Land and Water Management in September, 1961. This directorate has been charged with the carrying out of a co-ordinated programme of work in three different fields: the physical operation and maintenance of 1795 tubewells in the Central Rechna Doab; water distribution from canals as well as from tubewells, construction of works on water courses pertaining to such distribution, collection of data on water use, behaviour of ground water, and drainage studies; and the introduction of a new cropping pattern through a well organised extension service, use of crop rotation, better seeds and commercial fertilisers, studies of the behaviour of the soil fertility and salinity, and the collection of agricultural data for statistical analysis.

In this new task Wapda's immediate problem was to find suitable men, and it quickly trained over 1,000 operators and technicians for the tubewells. Some time was lost in training this personnel and the first few months of working the tubewells were, therefore, of low efficiency. The cultivators also were not fully prepared to receive the tubewell water in the rabi season as they were not sure about the efficiency and dependable operation of the tubewells. Another factor contributing to low working efficiency for the early months of operation was lack of distribution works. These works were originally to be constructed by the Soil Reclamation Board in all the schemes in the Central Rechna Doab but as this work had not started in most of the areas till September, 1961, it was decided that Wapda should take up on behalf of the Board the construction of these works in 4 of the 8 schemes areas, that is, in Harse Sheikh, Beranwala, Hafizabad and Shadman. Because of the time lag in the receipt of the permanent installations required for electrification and the various improvisations that had to be resorted to as a consequence, the supply of power to the tubewells during the initial months of their operation was far from being altogether unsatisfactory. In spite of these drawbacks the average working hours for all the schemes for the first 7 months were 62 per cent but during the last 3 months of the reporting period this average had gone up to 84 per cent. The break down of the 16 per cent lost during the latter period was: No distribution works, 6 per cent; mechanical defects, 5.9 per cent; no demand, 3.2 per cent; and electrical defects, 1 per cent.

During the first 7 months the Wapda tubewells in Shadman, Hafizabad, Khangah Dogran, Sangla Hill, Beranwala, Harse Sheikh and Shahkot pumped out 0.6 million acre feet, which gives a depth of water over the gross area for the 7 months as slightly more than one foot. This rate of pumpage is higher than the rate of 1.25 feet per gross

acre per annum considered necessary to lower the water table. For the remaining 3 months of the review period another 0.4 million acre feet of water was pumped out bringing the total to about a million acre feet in 9 months.

There was also an increase in the cropped area. In the Khangah Dogran scheme the increase was of the order of 13,000 acres (42 per cent) and in Hafizabad about 8,500 acres (16 per cent) over the figures for the previous year. In other scheme areas the increases (Sangla Hill, 1400 acres; Beranwala, 110 acres and Harse Sheikh, 835 acres) were not significant because many of the tubewells came into operation late in the sowing period.

To see what effects the working of tubewells were having on the water table, the Land and Water Management Directorate studied the working of 52 selected tubewells in six scheme areas. These tubewells were selected so that the average of ground water depths recorded at their sites in a particular scheme was representative of the regional water table in the scheme area. The observations recorded have not yet been analysed in detail and, therefore, the exact quantitative assessment of the lowering of the water table cannot be given at present but a definite trend towards the lowering of the water table is obvious. In three months between March and June, 1962, the water table has been lowered by 3.27 feet. This lowering of the water table over such a large area is the greatest achievement of the project during the short period of its operation.

The present report covers the full rabi period (October-March) and half of the kharif period (April-June). As the kharif period has been only partially covered the expenditure incurred in the rabi period alone has been assessed so far. The total expenditure incurred during the rabi period on the operation and maintenance of tubewells in completely commissioned scheme areas was Rs 2.3 million. The total cropped area during the rabi season in these schemes was about 3,30,000 acres.

The question of the recovery of water charges from the cultivators covered by the Central Rechna Doab project is under the consideration of the West Pakistan Government.

Expenditure

During 1961-62 the expenditure on the Central Rechna Project was Rs 12.7 million.

SALINITY CONTROL AND WATERLOGGING PROJECT NO. II

This project is located in the Chaj doab between the Chenab and the Jhelum rivers. After the formulation of the project for the Central Rechna Doab, Wapda in December, 1959, appointed Tipton and Kalmbach Inc. as its consultants to review the extent of waterlogging and salinity in the Punjab area; select the areas in which drainage and reclamation was most urgently required and if feasible reclamation projects could be developed in them; determine the most feasible method of achieving drainage and reclamation; develop a preliminary estimate of the cost of the project; and evaluate the anticipated tangible and intangible results that would follow the completion of the drainage and reclamation projects.

Studies carried out in pursuance of the above objectives led to the selection of the irrigated areas in the Chaj doab for undertaking the next salinity control and reclamation project. The basic considerations in the selection of the area being its present or potential need of reclamation; the possibility of its reclamation to a high degree of productivity within a short period of time; the acceptable quality of its ground water supply till the other water supplies become available; and the availability of electrical power at a reasonable cost. An analysis of the geologic, hydrologic, soils and other data which had been collected for the Chaj doab by the Ground Water Development Organization and further studies carried out by the project consultants established that a technically and financially feasible scheme for the control of salinity and waterlogging could be undertaken in the Chaj doab.

Objectives of the Project

The Chaj doab is extensively affected by waterlogging and salinity. In 49 per cent of the area the water table is within 5 feet of the ground surface and only in 7 per cent of the area it is deeper than 15 feet. Forty per cent of the area is affected sufficiently to be mapped as saline and another 7 per cent is severely damaged. Apart from this the drainage in the area is inadequate and the recurring floods during the rainy season not only cause widespread damage to agricultural lands, crops, and property but lead to further spread of waterlogging.

At present irrigation supplies in the area are spread so thinly that adequate crop yields cannot be obtained. The present duty is 450 acres per cusec of authorised outlet discharge and the intensity of the irrigation is about 90 per cent. In practice the outlet discharges are only 84 per cent of those authorised so that the effective duty is 550 acres per cusec only.

All these factors have combined to limit the agricultural potential of the area and the continued deterioration of land is resulting in a decline in productivity every year whereas the demands are increasing with the growth of population. It is estimated

that the lands in the Chaj doab produce 44,000 tons less food annually (valued at Rs 17.6 million) than before the waterlogging and salinity started. Moreover, the decline in food production in the Chaj doab annually at present is about 1000 tons. Wapda's Salinity Control and Drainage Project No. 2 aims at: lowering the water table, removing salts from the soils by leaching, removing floods hazards by proper surface drainage, supplying additional water to fulfill the consumptive use requirements of crops.

On completion of the project about 1.98 million acre feet of water required for the purposes of drainage and supplementary irrigation in the project area will be obtained from 300 tubewells. This will raise the value of annual crop production from the present Rs 274 million to Rs 557 million after proper reclamation has been effected.

The total estimated cost of the project which includes its electrification would be Rs 300 million. The annual increase in productivity (i.e. from Rs 274 million to Rs 557 million) is, therefore, more than the entire capital cost of the project.

Location

The area selected for this project includes all but a small portion of the Upper Jhelum and Lower Jhelum Canal systems in the Chaj doab. The project area that lies outside the canal systems is a strip of land on the upstream side of the Upper Jhelum Canal in the Gujrat plain. The gross area under the project boundary is 2.27 million acres out of which 2.10 million acres are classified as culturable commanded land.

Nature of Project

To achieve the desired objectives, the project has been conceived as a tubewell drainage-cum-irrigation project, supplemented with surface drains; surface drains being an additional feature when this project is considered in the context of that in Central Rechna. The tubewells will serve a dual purpose; pumping from the ground water reservoir will lower the water table and a major portion of the tubewell supply mixed with canal waters will be utilised for leaching the salts and supplying the optimum water requirements of crops.

The surface drainage problem is not uniform all over the Chaj doab. In the zone between the Upper Jhelum Canal and the Kashmir boundary, due to adequate slopes, drainage is no problem. The area between the Upper Jhelum Canal and the proposed alignment of the new link connecting Rasul with Qadirabad has the most severe drainage problem in the doab. The remainder of the area comprising more than half of the doab does not present a serious drainage problem as the rainfall is not excessive.

The total length of existing drains in the Chaj doab is about 980 miles. This system, although it covers most of the doab, does not cater for many extensive local areas and due to the low design capacities and lack of effective maintenance is inadequate to cope with the drainage. For catchment areas varying from 10 to 100 square miles the existing drains provide a discharge from 5.5 to 2.5 cusecs per square mile whereas for effective drainage 10 to 7 cusecs per square mile is considered to be necessary.

Under this project, therefore, it is proposed to increase the capacities of the existing drains in line with the new design criteria and to provide drains in those areas which are not covered. About 50 new drains having a total length of 450 miles have been incorporated in the project, each to cater for areas 2 to 100 square miles in extent. The total area for which new drains have been proposed measures 1050 square miles or 35 per cent of the project area and the total designed capacity of all the new drains is 8,800 cusecs.

Out of the 450 miles of new drains to be built under the project, field surveys for 223 miles were completed during 1961-62, and detailed chakbandi plans for 215 tubewells for the Lalian and Mona reclamation scheme areas were prepared during the same year.

The project involves the construction of 3300 tubewells in addition to the 450 miles of drains referred to above. Of the tubewells 2,140 will be from 200 to 300 feet deep while 1,160 will be about 50 feet deep. They will be run by electric motors having a total installed capacity of 95,000 horse power with an annual power consumption varying from 115 million kilowatt-hours to 185 million kilowatt-hours. The increase in the irrigation supplies by tubewell pumpage will make it possible to provide optimum crop requirements and to crop an additional area of 265,000 acres annually.

Progress

The siting of tubewells and drains was completed during 1961-62 for the Lalian (155,000 acres) and Mona (104,000 acres), and similar work was taken in hand for the Khadhar, Phalia and Sohawa schemes in the same project. The contract for the construction of 160 tubewells in the Lalian area was awarded to a Yugoslav firm, Messrs Ingra, under a barter agreement with Yugoslavia. The contract for 140 tubewells in the Mona scheme is to be awarded shortly and the construction work is expected to begin at the end of 1962. A loan application for 815 tubewells in the Chaj doab has been submitted to the United States AID Mission for securing the necessary funds to undertake the work.

Expenditure

During the year under review the total expenditure on the Chaj project was Rs 513,000.

SALINITY CONTROL AND RECLAMATION PROJECT NO 3.

(Lower Thal)

The collection of basic data for the drainage of reclamation project No. 3 (Lower Thal) below Taunsa which was started in 1960-61 was virtually completed during the year under report. The editing of the project feasibility report is in progress and is expected to be complete by March 1963.

The total project area is about 1,000,000 acres and according to the present estimates about 2400 tubewells and 210 miles of drainage channels will be required for the control of waterlogging and salinity.

Expenditure

Expenditure on this project (Salinity Control and Reclamation Project No. 3) during 1961-62 was Rs 1.19 million.

WATER AND SOILS INVESTIGATIONS

As already mentioned in earlier chapters ground water investigations on a large and scientific scale in the Rechna, Chaj and Thal doabs in the Punjab area and in Bahawalnagar were started in 1954 when the Ground Water Development Organization was set up in the Irrigation Department in cooperation with the ICA. The GWDO was transferred to Wapda on the first of April, 1960, and it was renamed as Water and Soils Investigation Division (WASID). After this transfer the scope of WASID was enlarged and new areas like the Bari doab and districts of Bahawalpur, Rahimyar Khan, Dera Ismail Khan, Dera Ghazi Khan, Bannu, Kohat and Hazara were included in these investigations.

Progress

During the period under review, investigations for ground water development and soil and land classification in the irrigated areas of the Bari doab and in the Bahawalpur area were carried out by WASID. The purpose of these investigations is to evaluate the land and water resources of the country. These investigations form the basis of development schemes for the utilisation of ground water for irrigation and waterlogging and salinity control purposes. For the preparation of the ground water reclamation project in the Central Rechna, Chaj and Lower Thal doabs the basic data supplied by WASID has been exclusively used.

Investigations

The progress made under various categories of investigations such as test drilling, resistivity surveys, pumping tests, water level measurements, soil survey, and water sample collection to the end of June, 1962, is summarised below:

1.	Rechna Doab	Investigations completed
2.	Chaj Doab	Investigations completed
3.	Thal Doab	Investigations completed
4.	Bahawalpur and Rahimyar Khan	91 per cent drilling complete
5.	Bari Doab	100 per cent drilling completed and 75 per cent of pumping tests completed. Drilling in the Bari doab was to be a phased programme. The first phase is complete.

Soil Surveys

Soil surveys were conducted by WASID on a semi-detailed basis. The purpose of these surveys is to make a soils inventory of the land potential for the formulation

of further irrigation and drainage projects. The progress achieved during the period under review is shown below:

Bari Doab (75,00,000 acres)	12,34,400	
Bahawalpur Area (45,00,000 acres)	31,000	
Tanda Area	30,000	(Semi-detailed survey)
Damrakas	10,000	(Semi-detailed survey)
Kacchi Plain Area	4,76,800	(Special reconnaissance survey)

Salinity and Alkalinity Survey

The salinity and alkalinity survey carried out during the year ending June, 1962, is shown below:

Rechna Doab	11,00,000 acres
Chaj Doab	15,00,000 acres

Laboratory Work

Laboratory analysis of soils, water samples and geologic samples was continued. The progress made during the period under report is given below:

1.	Soils samples	9116
2.	*Water samples (Deep and shallow)*	7694
3.	Geologic samples	338
	Total	17,148

In addition to the areas mentioned above ground water investigations have also been started on small individual schemes in the Peshawar, Mardan and Rawalpindi areas. These schemes have been framed to develop ground water locally for irrigation purposes. At present test drilling with Hydromaster percussion rigs has been carried out in the Shera Kera area (Peshawar), Macchai Branch Scheme area (Mardan) and Damrakas area (Rawalpindi). A few test tubewells have also been installed in these areas to determine the hydrologic properties of the aquifer.

Till the end of June, 1962, reports on various aspects of investigations connected with soil survey, water quality, water level measurements, and precipitation studies have been published by WASID. The first draft on the hydrology and geology of the Rechna doab is under review.

INVESTIGATIONS AND PLANNING IN THE LOWER INDUS PLAIN

Agricultural productivity in the irrigated areas of the Lower Indus Plain has been declining on account of waterlogging and salinity because no remedial measures have been undertaken there. Under a Wapda project investigations were started in 1959 to determine the extent of waterlogging and salinity, and to evaluate the prevailing conditions so that reclamation measures could be taken in hand. This project, formally approved by the Economic Committee of the Cabinet in April, 1961, provides for a survey of the soils, determination of the ground water conditions, study of water use and water application methods, cropping patterns and determination of the feasibility of reclamation measures either by the use of tubewells or by a system of open drains. A drilling programme has also been incorporated in the project to evaluate the ground water and sub-surface conditions.

Work under the project originally planned to be done in three phases is now being done in two phases and is to be completed by October, 1963. The work on the first phase was initiated through Messrs Hunting Technical Services Limited, London, and provided for investigations in the irrigated areas of Sukkur and Gudu barrages excluding the areas commanded by the Rohri and Nara canals. Subsequently, the scope of the work entrusted to Messrs Hunting Technical Services Ltd., was extended, and the entire area within the command of the Ghulam Muhammad barrage was also included in the first phase investigations. The estimated cost of the investigations programme for both phases is Rs 21.6 million while for Phase I it is Rs 8.4 million.

The first phase investigations in the Sukkur, Gudu and Ghulam Muhammad barrage commands were essentially completed in the field early in 1961. These consisted of: (a) a regional soil, salinity and ground water survey in the Ghulam Muhammad barrage and the right bank command of the Sukkur and Gudu barrage over an area of nearly 8 million acres; (b) semi-detailed survey in the Khairpur, Gaja and Tando Bago areas covering 600,000, 115,000 and 335,000 acres respectively; (c) ground water and geologic explorations by means of 56 bore holes and 30 test tubewells; (d) hydrologic, agronomic and drainage studies.

To maintain a continuity in the programme the second phase of the project was taken in hand early in 1961. By the end of June, 1962, detailed soil investigations had been virtually completed in the Kashmore-Jacobabad (1.48 million acres), Shahdadkot-Mancher (1.82 million acres) and Thatta-Sakrojam (0.32 million acres) areas. Water quality and land use study in these areas is now in hand. The construction of drains in the Khairpur Pilot Project has been completed. Various agricultural, reclamation and drainage trials are being carried out. In addition to the reconnaissance survey in the Ghulam Muhammad barrage area, detailed investigations in the Gaja (127,000 acres), Tando Bago (341,000 acres), Khairpur (525,000 acres) had been com-

pleted and project reports had been prepared during the year 1960-61. During 1961-62, reconnaissance investigations were completed and a report prepared on the entire area on Sukkur-Gudu Right Bank Command. Detailed investigations were also completed and reports were prepared on the Larkana-Shikarpur (504,000 acres) area. Similar detailed investigations were initiated in the Shadadkot-Mancher (1.82 million acres), Kashmore-Jacobabad (1.48 million acres), Thatta-Sakrojam (0.32 million acres) acreas. Detailed soil surveys in these areas have been completed.

Work on the agricultural, leaching and other reclamation trials was started on 1,000 acres in the Khairpur pilot project. The results of these trials are expected to prove very valuable in the formulation and operation of the present and future reclamation projects.

Khairpur Pilot Project

During investigations in Lower Indus Basin Projects, need was felt to establish a pilot project in the area to study the economic and technical feasibility of various modes of surface and sub-surface drainage such as open drains, tile drains and tubewells; the idea being to establish the comparative merits and demerits of the various methods of drainage for information and guidance in the formulation of drainage projects. In addition, it was considered that detailed recommendations for the treatment of saline lands should be based on leaching trials and that these should be linked with a study of the spacing of drains and the flow of groundwater in open and tile drains. It was also considered necessary to conduct crop trials at the same time. To carry out all these studies about 85 acres of saline and waterlogged land which had been lying uncultivated for a number of years was selected near Khairpur, and various trials were studied. It is proposed to increase the area of the pilot project ultimately to about 1000 acres in order to isolate sufficient land from influences outside the pilot project. Useful data is being collected from the reclamation leaching trials and the study of drainage in the pilot project.

Expenditure

The total expenditure on investigations and project planning in the Sind area during 1961-62 was estimated at Rs 561 million.

SUKKUR BARRAGE DRAINAGE AND SALINITY CONTROL PROJECT NO. I

This project has been formulated as a result of the investigations outlined in the previous chapter. It covers the Khairpur area on the east bank of the Indus downstream of the Sukkur barrage.

Agriculture in Khairpur is wholly dependent on the feeder canals sustained by the Sukkur barrage. The water of these canals presently supports the growth of 251,000 acres of kharif cropping and 326,000 acres of rabi cropping. The principal crops are wheat, winter oilseeds, cotton, sorghum and fodders, with a smaller area of sugar cane, rice and orchards. The gross annual value of the agricultural product is Rs 86 million.

Since the construction of the Sukkur barrage in 1932, and the adoption of a perennial system of supplies, there has been a slow and steady rise in the water table, with steadily increasing salinization. Sixty per cent of the area is now affected to some degree by high water tables and salinity and about twenty per cent is affected by serious waterlogging. The present level of production is being maintained by concentrating cultivation on the better lands in the commanded area and by the application of large quantities of excess water in the rabi season. Such practices in the absence of a drainage system will inevitably increase waterlogging and salinity and the agricultural output will progressively decline. To halt the progressive reduction in output and to provide conditions in which agricultural production can be increased the provision of a drainage system for the control of the water table is essential.

The Plan

Wapda has planned the immediate construction of a tubewell drainage scheme for those areas most severely affected by waterlogging and salinity, the cultivable commanded area involved being 318,000 acres in northern Khairpur, both east and west of the Rohri canal. The culturable commanded area of the whole Khairpur command is 683,500 acres.

Cost

The estimated capital cost of the recommended works is Rs 152.9 million.

Project Features

The original project was to drain the areas east of the Rohri canal by open channels and by tubewells on the west of the canal. This was re-examined and it was decided that tubewells would provide the most effective and economical drainage on both sides of the Rohri canal. The revised project provides for a tubewell field of 568 wells disposed on a triangular pattern grid at a normal distance of 6,730 feet apart. These

will lower the water table everywhere within the project area to at least seven feet below the ground surface. Wherever possible water pumped from the wells will be reused, but where this cannot be done the well will discharge into a system of shallow unlined drains, from which the discharge will be pumped into the Rohri canal. The project includes the construction of an electrical distribution netwrok for the supply of power from Wapda's thermal power station (now under construction at Sukkur) to the wells and pump stations.

The following consolidated annual costs include amortization of capital at four per cent over 40 years, a sinking fund of four per cent over 20 years, running costs, maintenance, interest on capital during construction and all other charges. The average annual benefits are obtained by assuming that the annual benefit increases uniformally over the first 15 years and is, thereafter, constant. The benefits include those arising from additional water from tubewells. The benefit to cost ratio is calculated for a period of 40 years.

Average annual benefits	Rs 30.9 million
Average annual costs	Rs 15.3 million
Benefit: Cost ratio	2:1

Loan Application

After approval the project report was submitted along with a loan application to the International Development Association of the World Bank for the foreign exchange requirements of the project. IDA has agreed to advance 18 million dollars for this purpose.

Construction work on the project is expected to begin early in 1963.

GHULAM MOHAMMAD BARRAGE DRAINAGE AND SALINITY CONTROL PROJECT NO. I

This project for the Gaja area has also been formulated as a result of Wapda's investigations in the Lower Indus Plain. It is one of the 9 separate drainage projects which are included in the Ghulam Mohammad Barrage command. The gross area covered by the Gaja project totals 94,300 acres and lies about 25 miles south of Hyderabad. Until recently it was served by a number of inundation canals taking directly off the river, but since 1957 it has been supplied from the new barrage through the Gaja Branch.

The soils are Indus alluvial deposits of high potential value but the most important restriction on their development is their salinity. Forty-four per cent of the project area suffers from serious salinity, and the area will never reach full development without large scale removal of salts. The ground water is at an average depth of 6.7 feet from the surface, and 22 per cent of the area has ground water within 5 feet of the surface. All the evidence shows that the average depth to ground water is decreasing, and it is estimated that in 4 years time 42 per cent of the area will have the ground water within five feet of the surface. Such a condition will require drainage as a matter of urgency and will nullify any plans to establish an intensive and prosperous perennial irrigation scheme in Gaja.

The Wapda plan is that the overall annual intensity of cultivation within the project boundary of 120 per cent of the commanded cultivable area should be the aim for development, made up of 60 per cent in kharif and 60 per cent in the rabi season. The total annual cropped area would then be nearly 105,000 acres. These intensities can be achieved without enlarging the major supply channels. However remodelling of some smaller canals is essential for the successful operation of the project and development of the area. The present canal design allows only for 45 per cent kharif intensity, so that distributaries, minors and watercourses, with their outlets, must all be enlarged. In addition four new minors should be constructed running parallel to the parent channel and taking off at two new cross regulators. These will enable proper control and distribution of supplies to be made during the rabi season when requirements are much below the canal design capacity and during the early years when development is only partially complete. Construction of additional canals is also required to bring non-perennial supplies from the adjacent Guni and Pinyari canals to the area in the south which should be excluded from the perennial area.

In choosing the best method for draining the Gaja area Wapda has compared the main alternatives of seepage drains, both open and tiled, with tubewells. This study shows conclusively that tubewells provide the cheapest and best solution. The project provides for a well field of 184 gravel shrouded wells up to 200 feet in depth, disposal

channels for the well discharge and an electrical distribution network to supply power to the wells. The power required is 3,800 kilowatts which will have to be met by extending the capacity of the Hyderabad thermal station.

The total cost of the project is estimated at Rs 57.1 million, including Rs 19.5 million for tubewells, Rs 24 million for the disposal system, Rs 8.3 million for electrification and Rs 5.3 million for custom taxes and duties. An application has been made to the International Development Association of the World Bank for a loan to finance the foreign exchange cost which is estimated at Rs 34 million.

The total agricultural output from the Gaja area is calculated to rise from Rs 12.5 million without drainage to Rs 28.9 million with drainage, an increase of Rs 16.4 million. The average net annual benefits are obtained by assuming that the annual benefit increases uniformly from the start of construction until the end of the twentieth year, when full development is attained, and stays constant after this. The average annual benefit over the first 40 years is thus Rs 9.1 million. If Rs 4 million is included for canal remodelling in the average consolidated annual cost, although it should be carried out whether drainage is provided or not, the benefit to cost ratio is 1.5:1 which shows a comparatively low level of profitability for the project. No account, however, has been taken of the indirect benefits that will be derived from the drainage works and the increased prosperity of the area. In addition without the project we consider that the rising level of salinity might make sugar cane cultivation uneconomic and thus jeopardise the capital already invested in a sugar mill.

GUDU BARRAGE PROJECT

The Gudu Barrage is located near Kashmore on the Indus on the northern most boundary of Sind. This barrage with 65 spans of 60 feet each, two fish ladders, and a lock channel for navigation, will give an assured water supply to the Sind and Baluchistan areas to the north of Sukkur and Rohri. This area has been under irrigation by inundation canals dependent on excess water in the river which is an uncertain factor. The barrage has been designed to feed two main canals on the right bank, the Desert Feeder with a discharge capacity of 13,245 cusecs and the Begari Sind Feeder with a discharge capacity of 14,780 cusecs. On the left bank there will be only one canal, the Ghotki Feeder, with a discharge of 8,500 cusecs.

The Desert Feeder will supply water to the existing Desert Canal system, and to the Pat Feeder, a new canal about 115 miles in length which is expected to bring about five hundred thousand acres of virgin soil under cultivation. The Begari Sind Feeder will provide water supplies to the existing Begari, Uner, Sind, Rajab and Chitti canal systems. The revised length of the Begari Sind Feeder will be between 80 to 81 miles which will be excavated anew. The Ghotki Feeder is a new link, 9 miles in length, and will link up the existing left bank canal system.

With the completion of this project, annual cultivation in the area will increase by about 100 per cent on full development. The existing irrigated area is about 950,000 acres, which also suffers from the vagaries of the river. It is expected that after full development nearly 2,470,000 acres, including dubari, but excluding forests, will be irrigated.

Progress

The project was divided into two phases. The first phase covered the completion of the headworks and the feeders, and linking the feeders with the exsiting inundation canal system so that it gets an assured water supply from the barrage. The second phase includes the construction of the Pat Feeder and of the new distributing canals, and the remodelling of existing canals.

The first phase of the project is now practically complete except that the left bank canal system has not yet been linked with the barrage. This will be done before next kharif season. The headworks were completed as per schedule by the middle of March by diverting the river through forty spans of the barrage. Towrds the end of June 1962, however, the river was flowing through the entire width of the barrage. The diversion of the river through the barrage was a gigantic operation requiring an enormous quantity of earthwork and a veritable battle with the river. This battle was fought and won, against great odds, and was made possible only by ceaseless work and extreme devotion to duty of the personnel responsible for this work.

The river diversion delayed the canal digging by about a month. The crucial diversion operations required a state of preparedness with all available resources in

manpower and machinery. Concentration of these at the headworks hindered the canal works and by the time equipment and staff were released from the diversion operations, towards the end of March, the canal works had gone into arrears. The remaining period for completion of canal works to enable them to receive the supplies for kharif cultivation was extremely limited but were completed in time by working round the clock. The Begari Sind Feeder was opened in the third week of May and the Desert Feeder in the beginning of June. The magnitude of the task handled may be judged from the fact that the Begari Sind Feeder involved about 1,000 million cubic feet of earthwork in addition to the construction of four major regulators which are like miniature barrages.

The construction of new distributing canals and remodelling the existing ones formed part of the second phase and was taken in hand to extend the benefits of assured supplies to as much land as possible. During the period under review quite a number of new canals were completed and a few old ones remodelled. Some of the new canals completed on the right bank have started irrigating lands in this kharif season. Some of the new canals which are functioning are Buxapur, Allahabad, Moosa-Garhi Chand, Ahson, Gul Tajedro, Bahadurpur, and Bhuto. About 300 million cubic feet of earthwork has been done on these channels in addition to the construction of a number of regulators and bridges.

Completion of these channels which formed part of the second phase has enabled the project to release about 70,000 acres of waste lands for disposal for kharif, 1962. About 30,000 acres of these lands have been actually disposed of bringing in revenues totalling more than Rs 12 million to the project. The completion of the barrage and feeders on schedule has saved the vast tracts of land in Sukkur and Jacobabad districts which were otherwise bound to be adversely affected due to the low level of the Indus this year. But for the barrage the irrigation system of this region would have suffered very considerably as none of the canals would have been able to draw their customary supplies. The successful operation of the left bank canal system which did not receive water directly from the barrage this season was also entirely due to the ponding up at the barrage which gave about two feet of higher water level at the head of the inundation canal. The completion of barrage and feeders as per schedule averted a serious drought. In terms of money this loss would have run into millions of rupees.

Cost

The project was originally estimated to cost Rs 370 million. But due to a number of reasons it has now been estimated at Rs 474 million. These include the revaluation of the rupee; after the preparation of the original estimates which increased the foreign exchange component; increase in the cost of local material because of the revaluation of the rupee, at least 20 per cent increase in the cost of labour wages during the period of construction; and increase due to redesigning of the RCC structure of the barrage for the provision of increased discharge on the basis of floods experienced during the period of construction. The major increase, however, was for bringing an additional area of half a million acres under the command of the barrage in Kalat and Quetta divisions by the construction of 115 miles long Pat Feeder. The revised project estimates are now being studied.

RAWAL DAM PROJECT

The Rawal Dam, situated on River Kurang, nine miles from Rawalpindi, was the first major project to be taken in hand by Wapda in the Federal Capital area of Islamabad. It was also the first large masonary dam to be built in Pakistan. It was designed and constructed by the Pakistani engineers and contractors without any external financial aid. The conception and implementation of the Rawal dam project were based on several factors such as a good site, a dependable catchment area, and proximity to the Rawalpindi urban area.

The Rawal dam, as it stands today, is 100 feet high from the river bed and the main structure is 700 feet in length. It is designed to hold back summer flow of Kurang in a lake of about three square miles. This lake has a storage capacity of 47,500 acre feet at full reservoir level, and is meant to provide water to the Rawlpindi and Islamabad areas for domestic, industrial and agricultural purposes. When fully operational it will supply filtered potable water upto 14 million gallons a day and irrigation supplies to 12,000 crop acres annually. The Rawal lake also provides recreational attraction to tourists and people of Rawalpindi and nearby villages.

Progress

During the year under review the remaining work of the irrigation channel i.e. seven miles length of channel, and beautification of the area around the dam was completed. The construction of water courses to utilize the water of the irrigation channel has also been completed. The dam was formally inaugurated by the President of Pakistan on 17th May, 1962.

Orders for the supply of equipment for the new filteration plant, which will have the capacity to cope with a demand of 14 million gallons per day of treated water to Rawalpindi and cantonment areas etc., were placed during the period under review. The equipment for the first phase, which consisted of Clarifier, Flash Mixer, Distribution Chamber, Valve Chamber and Intake Chamber, has since been received. Tenders for the construction of civil works of the filteration plant were also invited. The actual work commenced on 30-3-1962 and about two third of the work of first phase was completed towards the end of the financial year 1961-62. Work on second phase which consists of filter building, filter beds etc has also been started.

Supply of water to the farmers from the irrigation channel has begun for irrigation purposes. About 3.3 million gallon of drinking water through ten slow sand-filter beds was also being supplied from irrigation channels daily to Rawalpindi, by June 1963.

The total expenditure on the project till the end of June 1962 was Rs. 16,086,128.00 out of which Rs. 2,231,182.00 was spent during the year 1961-62.

MACHINERY POOL ORGANIZATION

The Machinery Pool Organization was constituted by the West Pakistan Government in May, 1959, and actually came into existence on 1st July, 1959. It was set up under a scheme approved by the Economic Council of the Central Cabinet. The Machinery Pool Organization, generally known as MPO, is a semi-autonomous body governed by the Machinery Pool Board. The Wapda Chairman is the ex-officio Chairman of the Board and Wapda's Chief Engineer (Water) and Chief Engineer, Irrigation West Pakistan, were its ex-officio members prior to the reorganization of the West Pakistan Government departments. With the abolition of the post of Chief Engineer (Water) by Wapda and of the post of Chief Engineer (Irrigation) by the Provincial Govenment, new nominations by the Government are awaited.

The Machinery Pool Organization was set up primarily to undertake the unified and coordinated use of all heavy earthmoving and construction equipment including the ancillary plant belonging to Wapda and the Provincial Irrigation Department. The basic concept of the project is to pool under one agency the entire equipment in West Pakistan and make its development and utilization on civil engineering projects economical by improving the efficiency and the output of individual pieces of equipment and bringing them upto or near the internationally accepted standards. The objectvies of the MPO are:

1. To maintain an inventory of the entire construction and specialized units of machinery described above. All such units are transferred to MPO books.
2. To control the development of the units so pooled on various projects in accordance with the work load.
3. To assess future work loads of the various projects of Wapda and Irrigation Department and plan purchases of equipment after taking into consideration the potential of the equipment already with MPO.
4. To survey and write off those pieces of equipment which are beyond economic repairs.
5. To introduce the rental system of operating the plant on internationally accepted rental rates.
6. To establish Ledger Asset Cards for each piece of equipment and record its performance with economical considerations.
7. To organise, repair and overhauling facilities of machinery in the pool on scientific lines and to establish well-equipped workshops for this purpose.
8. To introduce and standardize field maintenance and periodical checking of

the plant working in the field. It is also to be ensured by MPO that units out of operation in the field are returned immediately to the base workshops.

9. To establish Central Repair Workshops and Warehouses in such a manner that small ill-equipped workshops existing at the time MPO's inception of the are eliminated.
10. To introduce and set up a modern Master Card System of warehousing the spare parts in the zones and in the Head Office.
11. To introduce a programme of manufacturing standard replacement parts in the base workshops.
12. To standardize the construction equipment to a few good makes only so as to reduce the spare parts problem, and at the same time facilitate the repair, maintenance and operation of the plant.
13. To introduce the commercial accounting system and manage the project on a self-liquidating basis through a revolving fund.
14. To create a depreciation reserve fund for the normal replacement of the plant.
15. To take over field operations of equipment gradually and execute civil engineering projects on unit cost basis.

Progress

The MPO started its operations in the first week of June, 1959. The progress achieved since the start through the period ending 30th June, 1961, has been covered in the annual reports of the organization for the year 1959-60 and 1960-61. The progress made by the organization in different fields and wings is during 1961-62 is described briefly in the following paragraphs:

Equipment Control Wing

An average performance efficiency of 69 per cent for major units and 88 per cent for minor units was achieved by MPO during the period under review. In addition, the inventories carried out during the preceeding year have been properly prepared up and posted up-to-date. Asset Cards for each piece of equipment are being maintained. A rental system has been introduced for plant which wastaken over by the MPO falling in any of the following categories:

i) Plant purchased by MPO.

ii) Plant taken over by MPO from the completed projects of Wapda and Irrigation Department.

iii) Plant purchased for Indus Basin Projects.

In case of plant purchased against specific projects, rental rates introduced do not include the element of depreciation.

Salvaged Equipment

Equipment which was recommended to be written off by the consultants (details given in last year's report) was jointly inspected by representatives of the West Pakistan Irrigation and Power Department and MPO The case is now pending with the Provincial Irrigation and Power Department and is on MPO Board agenda.

Procurement Wing

The Master Card System of warehousing introduced in the four zonal warehouses located at Lyallpur, Jamshoro, Sukkur and Kashmore, is functioning satisfactorily. The Central Master Card set up at Lahore takes cognizance of all the warehouses, and recommendations and demands for fresh purchases are screened through the Central Warehouse before purchase action is taken. The Central Master Card Section is also working satisfactorily. The total cost of spare parts purchased, consumed and balance in the Warehouse of the Pool at the end of year 1961-62 was as below:

1. Spare parts received in all warehouses .. Rs 39,381,281.45
2. Balance of spare parts with MPO on 30-6-1961 .. Rs 61,857,872.57

The bulk of the spare parts were taken over from the Irrigation Department soon after MPO came into existence and represent mostly dead stock. An inventories of such parts was, however, put up to the MPO Board. The Board has directed that the reconciliation of the spares taken over by the Pool with the ledgers of the Irrigation Department should first be done before this case is finally decided. This was the progress at the time of writing of this report and is likely to be taken up at the next meeting of the Board.

A great hurdle in the way of the implementation of the objectives set forth for the successful operation of MPO regarding economic development and use of the plant, was overcome during the period under review. This involved finalisation of the maximum and minimum limits of individual replacement parts of all construction equipment.

A separate section for the purchase of equipment and ancillary plant started functioning under this wing. This section primarily deals with the purchase of spare parts and machinery both for Wapda projects and Irrigation Department. During the year under review, spare parts and equipment purchased by MPO was as under:

1. Spare parts .. Rs 18,991,871.00
2. Heavy earthmoving machinery purchased for Wapda projects Rs 1,201,122.00
3. Heavy earthmoving machinery purchased for Irrigation Department .. Rs 10,929,060.00
4. Transport for MPO and other projects of Wapda during July, 1961, to June, 1962 .. Rs 586,204.00

Equipment Repair Wing

The Equipment Repairs Wing comprises four base workshops located at Lyallpur, Kashmore, Jamshoro and Sukkur and one at Kadhkot. The entire West Pakistan has been divided and demarcated into four sectors according to the location of these workshops and each workshop caters for repairs, overhauling, maintenance and operation problem of entire equipment in its jurisdiction.

During the period under review the MPO repaired 3,225 pieces of major equipment and 2,273 pieces of minor equipment. The corresponding figures for the last year were 1,357 and 1,938 respectively. The break-up of the number of pieces of equipment for each workshop was as below:

1. **Kashmore Equipment Repair Workshop**			
a. Major equipment repaired	..	498	Jamshoro equipment
b. Minor equipment repaired	..	620	Repair workshop
2. **Sukkur Equipment Repair Workshop**			
a. Major equipment repaired	..	362	
b. Minor equipment repaired	..	893	
3. **Kandhkot Equipment Repair Workshop**			
a. Major equipment repaired	..	163	
b. Minor equipment repaired	..	148	
4. **Lyallpur Equipment Repair Workshop**			
a. Major equipment repaired	..	293	
b. Minor equipment repaired	..	438	
5. **Jamshoro Equipment Repair Workshop**			
(a) Major equipment repaired	..	473	
(b) Minor equipment repaired	..	274	

As a result of the introduction of the Rental System by the MPO the flow of the units into the workshops has considerably increased. It has thus enabled the project directors to handle the maximum work load with the minimum arailable plants. Idle plant and plant needing repairs now immediately finds its way to the base workshops and soon it leaves for the destined project, fully operational.

The four workshops which were initially taken over from the Irrigation Department of the West Pakistan Government have been completely reorganized and renovated. Additional plant such as fuel injection testing equipment, diagnosis test sets, dynamo meters, automatic track welders, track presses alignment testing etc., have been installed in these workshops so as to bring them at par with any other modern repair workshops maintained by MPO

With each of the workshops a foundary has been established for casting small parts and components. Casting and manufacture of the spare parts such as bushes, bearing, liners, rings, pistons have been started on a small scale and the scope will be enlarged as soon as skilled personnel become available.

Preventive Maintenance Wing

This Wing took a definite shape during the year under report. As was stated in the last report, for efficient operation of the machines it is absolutely essential that apart from backing the machinery by well equipped repair facilities it should also be backed by an efficient organization responsible for a periodical checking of the various important components, such as greasing, lubrications etc. This Wing is primarily responsible for the checking of the machinery at regular intervals as recommended by the manufacturers of the equipment and also to do the greasing, lubrication, minor adjustments and minor repairs. Shifting of the equipment to the base workshops whenever major repairs are involved is also the responsibility of this Wing. A number of mobile units and workshops have been purchased for this purpose. The total number of lube units has now increased to 48 from 24 last year and the number of portable workshops to 19 from 12, accordingly.

Field engineers of the rank of Senior Engineers along with a team of Assistant Engineers known as Assistant Field Engineers have been posted in all the areas and work under the direct supervision of the Area Superintendents. The mis-use of the machinery is also watched by this wing and glaring instances coming to the notice of the Organization are brought to the notice of the board.

Finance and Accounting

This wing, headed by a chartered accountant, has three different sections: dealing with general accounting, auditing and cost accounting. In each area separate accounting departments have been established and the same are headed by qualified cost accountants working directly under the Project Accountant.

ASSETS

The total value of the fixed assets of MPO as on 30th June, 1962 was about Rs 109.8 million. The break-up of this figure is given below. Equipment in transit and not included in the table below is worth another Rs 8.2 million.

SCHEDULE OF FIXED ASSETS & EQUIPMENTS

AS ON 30TH JUNE, 1962

	Cost at 30-6-1961	Additions (Disposals) during the year	Cost on 30-6-1962	Depreciation 30-6-1962	Book Value on 30-6-1962
	Rs.	Rs.	Rs.	Rs.	Rs.
Land	35,000	58,500	93,500	—	93,500
Building & Structures	5,165,547	2,089,304	7,254,851	347,586	6,907,265
Major Equipment	40,650,027	86,982,992	127,633,019	27,446,531	100,186,488
Workshop Equipment	2,916,441	(1,150,43)	1,766,010	742,962	1,023,048
Minor Equipment	6,306,980	(3,612,173)	2,694,807	1,365,416	1,329,391
Office Equipment	410,296	41,267	451,563	97,202	354,361
	55,484,291	84,409,459	139,893,750	29,999,697	109,894,053

Ghulam Muhammad Barrage Project

As already reported in the last report MPO was allotted the work of excavation of canals in Ghulam Muhammad Barrage area. The progress for the year 1961-62 (April-March) is shown under:

Total work allotted	372 million cft.
Actual work completed April 1961-March 1962	305 million cft.

The percentage of work comes to 82. The entire work could not be completed due to excessive rains during the months of August, September and October, in year 1961.

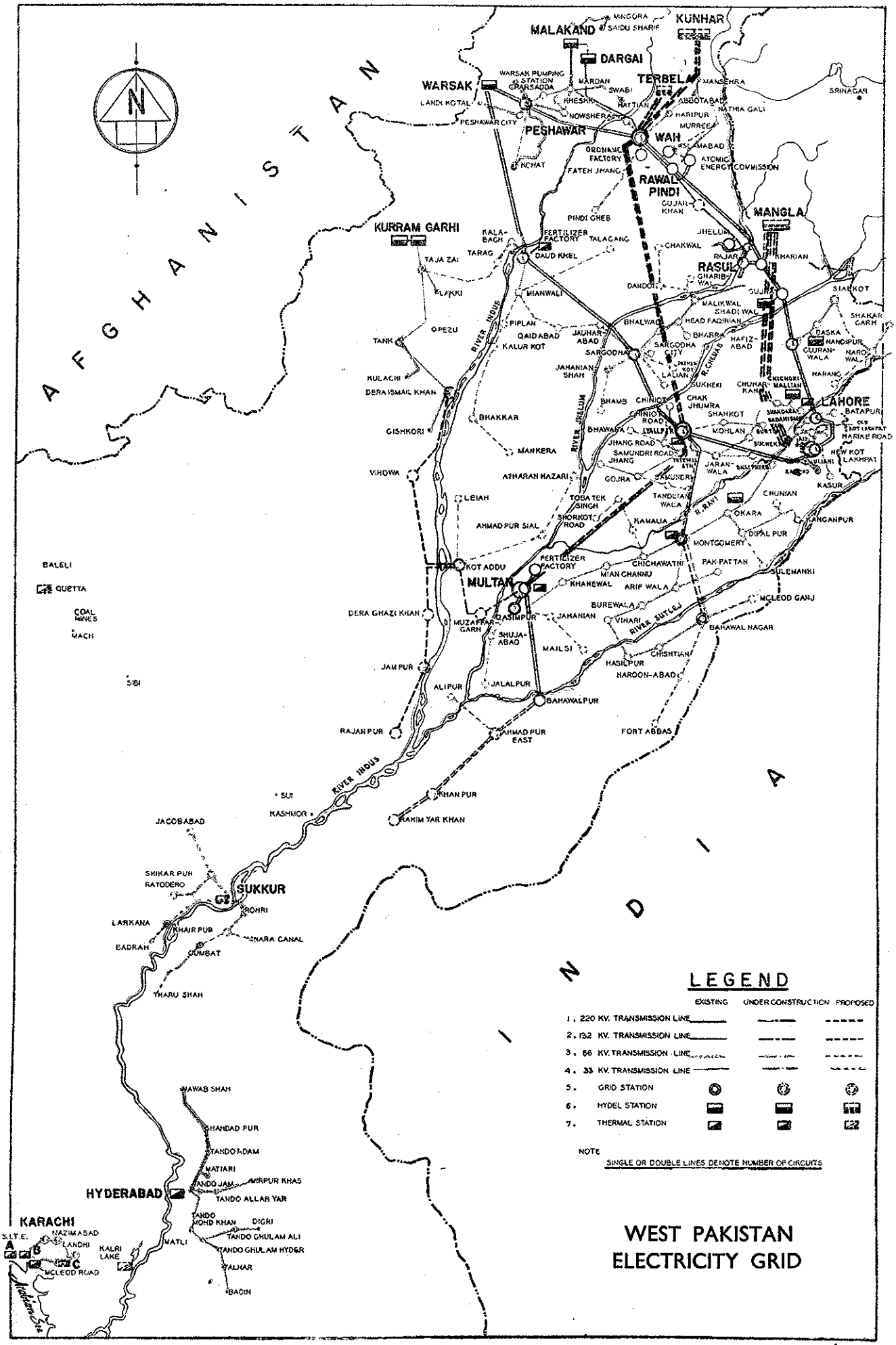
POWER DEVELOPMENT AND OPERATIONS

The Authority has several advances to report in the power sector in which it is responsible for the generation, transmission and distribution of electricity almost throughout West Pakistan—excluding Karachi but including some areas like Rawalpindi, Multan, Khanewal, Sukkur, Thatta and Quetta where it is running distribution lines, though on a limited scale, in parallel with those of the private companies operating in these towns. During the year under review there was, over the previous year, an increase of 28 per cent in the per capita consumption of electricity, an increase of 23 per cent in the number of consumers, an increase of 31 per cent in the generation of energy, an increase of 25 per cent in revenues, a decrease of 31 per cent in administrative costs as a proportion of the revenue collected, and an increase of nearly 80 per cent in the amount of interest paid by Wapda to the Government on its investment in the power system and on loans obtained for development. A significant feature of this progress is that with the exception of small generating sets in some isolated towns no new power station was brought into commission, but the growth in demand, generation, consumption and sales was made possible by extending the transmission and distribution network, by agumenting and renovating the existing distribution facilities and by reorganising the Power Wing and making it functionally possible for the operational staff to develop and sustain a commercial outlook and to maintain a closer and more satisfactory relationship with the consumers.

This report on the Power Wing's activities during 1961-62 includes a description of its generation, transmission and distributiion facilities and also covers briefly the history of power development since 1947. Without this background it may be difficult to assess the progress made since April, 1959, when Wapda took over the assets of the Electricity Department of the Government and realise the significance of the stage reached during 1961-62.

Generation Facilities

Nearly 90 per cent of the power system demand and consumers of electricity are in the area served by the main grid. This covers nearly 90,000 square miles of territory in the civil divisions of Peshawar, Dera Ismail Khan, Rawalpindi, Sargodha, Lahore, Multan and Bahawalpur. Connected to the grid are hydel stations at Warsak, Malakand, Dargai, Kurram Garhi, Rasul, Shadiwal, Chichoki Mallian and Renala; the steam stations at Shahdara, (temporarily closed), Lyallpur, Montgomery and Multan; and the diesel stations at Lyallpur and Burewala. The total installed capacity of these stations is 4,18,200 kilowatts (kw). Outside the main grid there are three zones—Lower Sind, Upper Sind and Quetta-Kalat. Except for the Lower Sind area where a small independent grid, fed mainly from the new Hyderabad thermal station, is now being installed the remaining areas are served by small isolated power stations. The


AFGHANISTAN
INDIA
N
MALAKAND
MINGORA
SAIDU SHARIF
KUNHAR
DARGAI
WARSAK
WARSAK PUMPING STATION GARSADDA
MARDAN
SWABI
TERBELA
MANSEHRA
SRINAGAR
LANDI KOTAL
KHESHKI
MATTIAN
ABBOTABAD
HARIPUR
NATHIA GALI
PESHAWAR CITY
NOWSHERA
PESHAWAR
MURREE
WAH
ISLAMABAD
ORDNANCE FACTORY
ATOMIC ENERGY COMMISSION
KOHAT
FATEH JHANG
RAWAL PINDI
GUJAR KHAN
MANGLA
PINDI GHEB
KURRAM GARHI
KALA-BAGH
FERTILIZER FACTORY
TALAGANG
JHELUM
CHAKWAL
RAJAR
KHARIAN
TARAG
DAUD KHEL
TAJA ZAI
RASUL
GHARIB WAL
DANDOT
SUJJAL
SIALKOT
LAKKI
MIANWALI
MALIKWAL
SHADI WAL
SHAKAR GARH
PIPLAN
BHALWAL
HEAD FAQIRIAN
TANK
OPEZU
QAID ABAD
JAUHAR ABAD
BHARRA
HAFIZ-ABAD
DASKA
GUJRAN-WALA
HANDIPUR
NAROWAL
KALUR KOT
SARGODHA
SARGODHA CITY
JAHANIAN SHAH
LALIAN
SUKHEKI
CHUHAR KANA
NARANG
KULACHI
DERA ISMAIL KHAN
BHAMB
CHINIOT
CHAK JHUMRA
LAHORE
BATAPUR
BHAKKAR
CHINIOT ROAD
SHAHKOT
GISHKORI
BHAWANA
LYALLPUR
MOHLAN
OLD KOT LAKHPAT
MARKET ROAD
JHANG ROAD
MANKERA
SAMUNDRI ROAD
JHANG
JARAN-WALA
NEW KOT LAKHPAT
VIHOWA
ATHARAN HAZARI
GOJRA
SAMUNDRI
KASUR
LEIAH
TOBA TEK SINGH
TANDLIANI WALA
CHUNIAN
R. RAVI
OKARA
KANGANPUR
AHMAD PUR SIAL
SHORKOT ROAD
KAMALIA
DIPAL PUR
MONTGOMERY
BALELI
KOT ADDU
FERTILIZER FACTORY
CHICHAWATNI
PAK-PATTAN
SULEMANKI
QUETTA
MULTAN
MIAN CHANNU
KHANEWAL
ARIF WALA
MCLEOD GANJ
COAL MINES
DERA GHAZI KHAN
QASIMPUR
JAHANIAN
BUREWALA
VIHARI
RIVER SUTLEJ
BAHAWAL NAGAR
MUZAFFAR-GARH
SHUJA-ABAD
MAILSI
HASILPUR
CHISHTIAN
JAM PUR
HAROON-ABAD
SIBI
ALIPUR
JALALPUR
BAHAWALPUR
RAJAN PUR
AHMAD PUR EAST
FORT ABBAS
RIVER INDUS
SUI
KASHMOR
KHAN PUR
RAHIM YAR KHAN
JACOBABAD
SHIKAR PUR
RATODERO
SUKKUR
ROHRI
LARKANA
KHAIR PUR
SINDH CANAL
BADRAH
GUMBAT
THARU SHAH
NAWAB SHAH
SHAHDAD PUR
TANDO ADAM
MATIARI
HYDERABAD
MIRPUR KHAS
TANDO JAM
TANDO ALLAH YAR
KARACHI
TANDO MOHD KHAN
DIGRI
S.I.T.E.
NAZIMABAD
TANDO GHULAM ALI
LANDHI
KALRI LAKE
MATLI
TANDO GHULAM HYDER
A
B
C
MCLEOD ROAD
TALHAR
BADIN
Arabian Sea
SRINAGAR
LEGEND
EXISTING
UNDER CONSTRUCTION
PROPOSED
1. 220 KV. TRANSMISSION LINE
2. 132 KV. TRANSMISSION LINE
3. 66 KV. TRANSMISSION LINE
4. 33 KV. TRANSMISSION LINE
5. GRID STATION
6. HYDEL STATION
7. THERMAL STATION
NOTE
SINGLE OR DOUBLE LINES DENOTE NUMBER OF CIRCUITS
WEST PAKISTAN
ELECTRICITY GRID

total installed capacity of the power stations in these three zones does not exceed 34,000 kw. Along with the stations in the main grid area this gives Wapda a total installed capacity of 4,52,100 kw which is about 550 per cent of the installed capacity in the same area at the time of Independence in 1947, and about 300 per cent of the installed capacity in 1959 when Wapda was entrusted with the responsibility of electricity generation, transmission and distribution in the province.

Transmission and Distribution

When Wapda took over the Electricity Department in 1959 its major transmission facilities were even more limited than its generation capacity. The major carrier of power in bulk was the 132 kilovolt (kV) line from Dargai to Wah, Rawalpindi, Jhelum, Rasul, Gujranwala and Lahore. Major additions to the transmission system started only in 1959 when arrangements were made for extensive additions and improvements throughout the grid area. While additions and improvements to the system are still in progress Wapda, at present, has 136 miles (single circuit) of 220 kV lines, 1120 (806 miles are double circuit) miles of 132 kV lines, 1500 (200 miles are double circuit) miles in 66 kV lines, and 500 (single circuit) miles of 33 kV line. Of these 353 miles of 132 kV and 29 miles of 66 kV lines were added during 1961-62.

Distribution

From the transmission network described above stems the distribution system which carries power to the ultimate consumers. It consists at present of more than 400 separate feeders which are supplied from approximately 120 distribution sub-stations where the higher transmission voltages are stepped down to the standard distribution voltages of 11 kV at which practically all the distribution feeders operate. Of these feeders and sub-stations 72 feeders and 23 sub-stations with a total capacity of 87,500 kVa were added during the year under report. Individual consumers are supplied power at 230 volts single phase or 400 volts at three phase, 50 cycles, by means of 11 kV transformers which are usually mounted on poles along the 11 kV feeders. The standard voltage for lamps and appliances is 230 volts and the voltage limits are intended to be plus or minus 5 per cent. A total of 82,583 consumers was added to the system during the year under report representing an increase, as already mentioned, of 23 per cent over the number of consumers during the previous year.

The distribution system as it now exists is on the one hand far too inadequate for the area and load that it serves and on the other, particularly in the old cities, has seriously deteriorated through age and requires large scale renovation and augmentation. A study made earlier in 1962 to segregate the investments in the various categories of the Authority's power system shows that the present distribution system investment is far too small to permit a proper service to the consumers. It is not so much the fact that investment in transmission and generation is too high but rather that investment in distribution is, and has remained, too low in the past. And there are historical reasons for this neglect of the distribution system in the past.

Most of the earlier electrification in the areas now served by Wapda was carried out in the late twenties and early thirties by private power generation and distribution companies. Supply of electricity was confined to cities and towns with heavy concentrations of urban population. The economic conditions of the thirties did not encourage making provisions in the system for any large scale increase in the demand for power. During the Second World War the demand for power, because of the sudden increase in economic activity, started building up rapidly, but there was no matching increase in the distribution facilities either because of the general shortage of services and materials available to the private companies or because of the desire of private companies to get the maximum returns on the minimum of investment. Then came independence in 1947 bringing in its wake new problems for the power industry. Most of the private electrical undertakings became evacuee concerns and the Government had to concern itself directly with their day to day management and operation. Independence also, after the initial dislocations could be taken care of, led to a new spurt of economic activity making it necessary for the depleted cadres—as a result of the partition of the sub-continent—of the Electricity Department of the Government to concentrate almost exclusively on bridging the gap between generation and demand. Not only was inadequate investment made in distribution by way of either renovation or augmentation during these years, despite the fact that the system was getting dangerously overloaded, the need for adequate engineering and a reliable standard of workmanship was also frequently sacrificed to accommodate somehow the requirements of the fast growing demand. The result was the inevitable deterioration in the quality of service to consumers manifesting itself in improper service voltages, excessive voltage variation and occasional outages.

Conscious of these basic shortcomings of the system, the Authority began, simultaneously with its intensive efforts to develop the generation and transmission capacity, a systematic study of the requirements of the distribution facilities also as an integral part of the over all power development programme envisaged for the second Five Year Plan period. Because of the lack of basic engineering data regarding the existing facilities, such as town plans and route diagrams, to prepare which aerial photography had to be resorted to, information regarding the sizes, capacity and location of distribution transformers, and the sizes, capacities and lengths of distribution lines for which the system had to be surveyed on the ground section by section, and forecasts about the future load growth for which special surveys had to be organised, the study took sometime to get properly underway. The first results of the study are now available and on their basis the renovation and augmentation of distribution facilities has been undertaken in eight towns. At the same time, in order to improve construction and workmanship special training courses have been organised and are intended to be offered in future for linemen, substation maintenance employees, distribution engineers and others. In areas where renovation has either been completed or is nearing completion there has been a marked improvement in the quality of service. Other areas and the completion of the entire programme will have to await the availability of funds.

The Authority considers that if lack of investment in distribution has not to plague the system further, future investment in distribution will have to be at a much higher rate than in the past. The present position is that about 47 per cent (Rs 598 million) of the total investment of Rs 1273 million in Wapda's power system is in generation, 23 per cent (Rs 293 million) in transmission and 30 per cent (Rs 382 million) in distribution. Projections made for the period upto 1980 show that the more desirable ratio would be: generation 40 per cent, transmission 20 per cent and distribution 40 per cent. On this basis of 40 : 20 : 40 ratio the distribution facilities are already short by Rs 127 million in investment and by the end of the current plan period when the investment in generation is expected to be Rs 831 million, and in transmission Rs 415 million, investment in distribution will have to be of the order of Rs 831 million. In other words to correct the imbalance of the past and to augment the system for a sufficiently reliable service an additional investment of Rs 449 million is necessary in distribution over the next three years which incidentally also explains why power distribution initiated by private enterprise is now altogether beyond the capacity and financial resources of private companies.

As described in detail later in this report the Power Wing has been completely reorganised. The reorganised set-up is a culmination of the process which was set in motion soon after the Authority took over the Electricity Department in order to better equip the Power Wing for the operation of a fully integrated power system on best commercial lines without duplication of effort and staff which the country with its limited technical manpower and shortage of capital funds can hardly afford.

OPERATIONAL RECORD

There are several ways of assessing Wapda's performance in the power sector since it took over the generation, transmission and distribution of electricity. The history of the power industry shows that in nearly half a century of the pre-Wapda period the total number of consumers in West Pakistan, excluding Karachi, had in 1958-59 grown to about 278,300 and the power consumed by them that year to about 537 million units. In little more than three years Wapda has increased the number of consumers to 442,000, by nearly 60 per cent, and the consumption of power to 929 million units, by nearly 73 per cent. In this chapter the Authority is presenting a series of tables to explain the progress achieved by it, to compare it with the two previous years and to make available more statistics for further analysis. The tables use the same basic statistics more than once but in different patterns to show, from various angles, the progress made in power generation and sales. An important fact that emerges with the help of these tables is that the per capita consumption of electricity in West Pakistan has grown from 14.7 units in 1959-60 and 18 units in 1960-61 to 23 units during the year under report. The latest figure is based on the current estimate that the population in the area served by Wapda is just over 40 million. And what gives this increase another dimension to measure the overall growth of power consumption is the fact that the annual number of units sold per conusmer has also increased from 1936 kwh in 1959-60 and 2076 kwh in 1960-61 to 2102 kwh in 1961-62.

Balance sheet

A balance sheet is one of the important means of assessing the growth and operational efficiency of a power system. The simplified form in which the Power Wing's balance sheets are presented in Table No. 1 need little interpretation but certain facts may be underlined. This table shows, for instance, the growth of investment in fixed assets from Rs 322 million on 1st April, 1959, to Rs 1273 million by the end of June, 1962—an increase of nearly 300 per cent in 39 months. Nearly 25 per cent of the fixed assets represents capital being used currently in the construction of new projects benefits from which in terms of more power for the consumers and more revenues for the Authority will be forthcoming in future years, when the system is developed more fully and some of the imbalance between investments in generation, transmission and distribution are corrected. The present revenue position is tabulated under the revenue account statement.

Table No. 1
POWER WING BALANCE SHEET
(Million of Rupees)

	As at 30-6-'60		As at 30-6-'61		As at 30-6-'62	
Fixed Assets ..						
Assets on Hand—1st April 1959 ..		322.3		322.3		322.3
New Construction		62.6		168.5		681.9
		384.9		490.8		1004.2
Less: Depreciation		11.6		24.0		46.8
		373.3		466.8		957.4
Add Construction in Progress ..		199.9		292.7		316.1
		573.2		759.5		1273.5
Current Assets						
Stocks and Stores ..	63.9		66.7		67.9	
Consumers' Bills Receivable	7.9		10.2		13.6	
Other Debts and Advances	8.5		7.7		16.9	
Due from Government on current transactions ..	4.0		2.8		1.9	
Wapda Water Wing ..	50.5		5.5		20.5	
Cash in Hand	14.9		16.2		12.5	
Total Current Assets	**149.7**		**98.1**		**133.3**	
Less Current Liabilities						
Creditors and Credit Balance	55.2		43.1		37.2	
Employee's Funds ..	—		0.4		2.2	
Deposits	3.7		3.8		9.1	
Total Current Liabilities	**58.9**		**47.3**		**48.5**	
Net Current Assets		90.7		50.8		84.8
Total Assets ..		**664.0**		**810.2**		**1358.3**
Source of Finance						
Debentures		—		—		50.0
Development Loan Fund		17.1		55.8		98.5
Provincial Government		545.2		630.2		726.9
Central Government		74.2		74.2		334.2
German Loan		—		—		66.7
Long Term Deposits		16.9		19.1		21.2
Accumulated Surplus		10.5		33.0		60.8
		664.0		**810.3**		**1358.3**

Revenue Account

This statement in Table No. 2 reflects the growth in the revenues of the Power Wing and also shows to what degree the direct operating costs and administrative costs have gone down. In revenues an increase of 57 per cent has been recorded in earnings during 1959-62 (Rs 74.7 million to Rs 117.3 million) ad of *25 per cent during, the present review period (from Rs 93.6 million to Rs 117.3 million).* In proportion the expenditures have gone down. The direct operating costs have varied from Rs 29.9 million in 1959-60 and Rs 30.5 million in 1960-61 to *Rs 24.9 million in 1961-62* which means that as a percentage of total earnings for the respective years the operating costs have gone down from about 40 per cent in 1959-60 and 32 per cent in 1960-61 to *21 per cent in 1961-62.* Administrative costs are not included in the direct operating costs but they too have gone down as a proportion of the revenue collected. In 1959-60 they were Rs 9.2 million, the following year Rs 10.4 million, *and in the year review Rs 9 million.* As a proportion of the revenues collected

Table No. 2

POWER WING OPERATIONS REVENUE ACCOUNT

(Million of Rupees)

EARNINGS	**1960**	**1961**	**1962**
Sale of Energy	74.2	93.0	116.9
Other Receipts	0.5	0.6	0.4
	74.7	93.6	117.3
EXPENDITURES			
Direct Operating Costs	29.9	30.5	24.9
Administrative Expenses	9.2	10.4	9.0
Depreciation	10.4	12.4	23.4
Interest	15.2	17.8	32.1
	64.7	71.1	89.4
OPERATING SURPLUS	10	22.59	27.9

they were, for the same period, 12.3 per cent. 11.1 per cent and 7.6 per cent. Considering the increase in the revenues collected over the three year period the proportion of administration costs chargeable to revenue has gone down. The operating surplus has risen from Rs 10 million in 1959-60 and Rs 22.5 million in 1960-61 to *Rs 27.9 million in 1961-62.* But as shown in Table No. 3, relating to revenue and working expenses, the percentage of net revenue to capital investment has gone down from 2.4 per cent in the first year and 3 per cent in the second year *to .22 per cent in the year*

under report. This is due to the increase, during 1961-62, in fixed assets, a considerable proportion of which represents either projects still being built or projects not yet fully developed. The ratio of net reveuue to the capital investment will improve with the development of facilites such as more transmission and distribution lines to enable a larger number of consumers to draw more power from the sources of generation.

Table No. 3
REVENUE AND CAPITAL INVESTMENT

	Particulars	July 59—June 60		July 60—June 62		July 61—June 62	
		Units sold (in millions)	Amount (Rupees)	Units sold (in millions)	Amount (Rupees)	Units sold (in millions)	Amount (Rupees)
1	Revenue from units sold.	603.3	69,448,567	745.9	87,372,676	929.2	110,797,190
2	Other Revenue ..		5,220,771		6,246,181		6,488,994
3	Total Revenue (item 1+2) ..		74,669,838		93,618,857		117,286,184
4	Working Expenses .		64,736,357		71,108,486		89,466,900
5	Net Revenue (item 3-4) .		9,933,481		22,510,371		27,819,284
6	Capital Investment (Progressive) ..		414,652,099		759,500,000		127,3500,000
7	Percentage of net Revenue to capital Investment ..		2.4%		.3%		0.22%

Energy Account Statement

This trend towards more consumption of power is becoming more marked every year with the addition of more facilities to the Wapda power system. This applies to the consumption of energy averaged out over a year and measured in kilowatt hours (units) or peak load demands measured in kilowatts. Table No. 3 serves not only as a supplement to the revenue accounts statement (Table No. 2) but also as a preface for the statement relating to the energy generated, consumed and sold. This statement in Table No. 4 gives figures for units of electricity generated at the power stations and used in power station auxiliaries, units sent out from the power station switchyards, units used in the grid stations and in transmission and distribution, and units ultimately sold to the consumers.

This table is largely self-explanatory but for those not familiar with the working of an integrated power system and the terminology of an energy account sheet the number of units shown as having been used in transmission and distribution needs some explanation. The percentage columns show that units used in transmission and distribution in the grid area as a percentage of the units generated in the grid stations have increased from 15 per cent in 1959-60 and 17.5 per cent in 1960-61 to 22 per cent in 1961-62. This is due to the increase of load on the old distribution system which results in a higher percentage of power being used up in distribution itself, and also due to the reason that during 1961-62 the load position was such that a larger proportion of the power requirements could be met from hydel stations. Of the hydel

Table No. 4

ENERGY ACCOUNT STATMENT

(in millions of units)

		Year 1959—60			Year 1960—61			Year 1961—62		
		GRID	ISOLATED	TOTAL	GRID	ISOLATED	TOTAL	GRID	ISOLATED	TOTAL
1	Units generated at power stations	723.20	58.23	781.23	927·27	60.10	987.30	1201.51	83.29	1284.80
2	Units used in auxillaries of power stations	35.75	4.07	39.82	32.51	3.01	35.52	40.35	4 72	45.07
3	Units used in auxillaries as percentage of units generated (Item 1)	5.0%	7.0%	5.1%	3.8%	5.0%	3.5%	3.3%	5.6%	3.5%
4	Units sent out	687.25	54.16	741.41	884.69	57.20	951.78	1161.16	78.57	1239.73
5	Units used in grid stations and works	18.54	2.04	20.56	32.38	2.88	35.24	32.52	5.30	37.82
6	Units used in grid stations and works as percentage of units sent out (Item 4)	2.6%	3.5%	2.7%	4.08%	5.0%	3.5%	2.8%	6.7%	3.05%
7	Units available for sale	668.71	52.12	720.83	862.31	862.31	54.23	916.54	1128.64	1201.91
8	Units sold (Sales to consumers)	534.69	48.31	603.30	699.66	49.34	746.00	863.20	66.00	929.20
9	Units used in transmission and distribution (Item 7 minus 8)	114.02	3.81	117.53	162.65	4.89	170.54	265.44	7.27	272.71
10	Units used in transmission and distribution as percentage of units generated (Item 1)	15.8%	6.5%	15.0%	17.5%	8.13%	17·2%	22.0%	8.7%	21.2%

stations the smaller power houses at Malakand, Dargai, Rasul, Shadiwal and Chichoki Mallian were fully loaded during the last two years so that the extra units needed had to come from Warsak. A greater part of the increase in demand in 1961-62, however, occurred at load centres closer to Multan in terms of transmission line capacities available during the year under review. Of the extra demand of 274 million units (this represents the increase in the total units generated during 1961-62 over the figure for the previous year) about 136 million units would normally have been generated at Multan if a reduction in the power used in transmission had been the only consideration. But in an integrated grid system other factors have to be considered. Multan being a thermal station the cost of power generation would have been high. The alternative was to produce power at the Warsak hydel station at practically no extra cost and pay the transmission toll at a rate determined by distance—in this case nearly 500 miles. The load situation in 1961-62 was such that it was possible to reduce generation at Multan to about 240 million units as compared to about 262 million units generated during 1960-61. This reduction, and not placing on Multan the burden of generating the additional 136 million units referred to earlier, resulted in a saving of about Rs 2.5 million in the cost of fuel alone. The use of units in transmission and distribution did not cost anything extra and could be compared to the loss of potential energy involved Warsak water passing over the dam instead of being diverted through the turbines.

Cost Components

Two of the tables (Nos. 5 and 6), supplementary in nature, show working expenses as components of the cost per unit of electricity produced and the cost per unit realised from various categories of consumers. Table No. 5 shows that the average cost has gone down from 10.7 paisas per unit in 1959-60 and 9.6 paisas in 1960-61 to 9.5 paisas in 1961-62. The same table shows that charges on account of fuel, maintenance and establishment have decreased from about 61 per cent of the cost per unit in 1959-60, and 57 per cent in 1960-61 to about 38 per cent in 1961-62. The increase in the other components come from fixed returns paid to the Government by Wapda on its investment in the power system and as interest charges for other loans received for the further development of the power system, and for depreciation of the plant in which as already stated the investment has increased almost four times since Wapda took over the integrated power system in April, 1959. As against the average cost of 9.5 paisas per unit in 1961-62 the average sale price has been 11.92 paisas per unit.

Table No. 6 shows how this increase has taken place in the average sale price per unit. This is mainly due to an increase, over the last year, of 22.3 per cent in the units sold to general consumers as compared to a 9.9 per cent increase in the units sold to industrial consumers. But to consider this increase in its proper perspective it is necessary to point out that there has been a decrease in the sale price of units sold to general consumers—from 22.48 paisas to 22.10 paisas. This is due to an increase in the units used per consumer and the tariff for general consumers under which there is

Table No. 5
WORKING EXPENSES
1962

Year Ended 30th June, 1960		Year Ended 30th June, 1961			Year Ended 30th June, 1962	
Expenditure Rs.	Cost per unit (New Paisa)	Expenditure Rs.	Cost per unit (New Paisa)	Nature of Expenditure	Expenditure Rs.	Cost per unit (New Paisa)
39,120,224	6.5	40,906,879	5.5	Fuel, Maintenance and establishment charges	33,965,42	3.6
15,200,000	2.5	17,803,293	2.4	Fixed return to Government on Capitals at charge and other interest charges	32,111,480	3.4
10,416,133	1.7	12,393,140	1.7	Depreciation	23,390,000	2.5
64,736,357	10.7	71,108,486	9.6	Totals ..	89,466,900	9.5

Table No. 6
SALE OF ELECTRICITY

Year Ended 30th June 1960		Year Ended 30th June 1961			Year Ended 30th June 1962	
Revenue	Paisas per unit sold	Revenue	Paisas per unit sold		Revenue	Paisas per unit sold
98,282,300	24.68	26.760950	22.48	General	.. 33,944,473	22.10
34,816,353	8.92	44.670150	9.9	Industrial	.. 53,435,382	10.5
4,819,322	7.1	7.533609	7.30	Agricultural	.. 13,124,681	7.38
1,137,414	21.7	1.393424	19.1	Public lighting	.. 1,734,539	17.3
4,414,102	10.4	7.014543	10.6	Bulk	.. 8,557,615	10.3
69,448,567	11.51	87.372676	11.71	Total	.. 8,557,615	10.3

a reduction in the rate after an initial consumption of 20 units per month. The increase in the average sale price of electricity sold to industrial consumers—from 9.9 paisas to 10.5 paisas—is due to an increase in the proportion of smaller industries as compared to the larger industries which pay lower rates per unit.

Pattern of Consumption

The patterns of increase in the use of electricity also makes an interesting study for those tracing the various paths of economic development in West Pakistan. The statement (Table No. 7) relating to the increase in consumption of electricity by various categories of consumers shows that there was an overall increase of about 65 per cent in the consumption of electricity during 1959-62—from 603 million units to 929 million units. *The increase recorded in 1961-62 was 24.8 per cent—from 746 million units to 929 million units.* Of significance are the statistics in this table showing an increase in power consumption for agricultural purposes. This has increased almost three times, from 67 million units to nearly 178 million units during 1959-62. Wapda's power tariff also has been framed to encourage the greater use of power in the agricultural sector which as a matter of national policy is receiving top priority in economic development.

Table No. 7

INCREASE IN UNITS

Period	General consumers (units)	Industrial consumers (units)	Agricultural consumers (units)	Public Light (units)	Bulk (units)	Total (units)	Percentage increase over last year
1959-60 ..	9,82,82,300	39,02,44,150	6,71,79,676	52,40,548	42,355,919	60,33,02,593	
Percentage of each category of units sold ..	*16.35*	*64.64*	*11.15*	*0.86*	*7.00*	*100*	
1960—61 ..	11,91,49,120	45,12,16,024	10,21,58,118	72,94,490	6,61,64,808	74,59,83,500	**23.4**
Percentage of each category of units sold ..	*15.70*	*70.32*	*13.50*	*0.78*	*9.70*	*100*	
1961-62 ..	15,35,27,830	50,52,93,075	17,78,180,06	10,017,495	28,5,50,709	92,92,07,615	**24.8**
Percentage of each category of units sold ..	*17.45*	*57.24*	*14.88*	*1.13*	*9.30*	*100*	

Increase in Consumers

Some references have already been made to the increase in the number of Wapda's consumers of power. As shown in Table No. 8 they have grown from 31 1,586 in 1959-60 to 359,282 in 1960-61 —an increase of 15.3 per cent—*and 441,929 in 1961-62—an increase of 23 per cent.* The category columns show that the proportions of general, industrial and bulk consumers have had very minor variations, that there has been some increase in the number of agricultural consumers but public lighting has failed to keep pace with the development in other categories.

Table No. 8

INCREASE IN CONSUMERS

Period	General	Industrial	Agricultural	Public Lighting	Bulk	Total	Percentage increase over last year.
1st July, 1959 to 30th June 1960	294,627	13,191	3,290	397	81	3,11,586	
Percentage of each Category of Consumers to total ..	*92.07*	*4.1*	*1.5*	*1.3*	*0.03*	*100*	
1960-61 ..	3,38,593	15,708	46,63	218	100	3,59,282	**15.3**
Percentnge of each Category of Consomers to total ..	*94.3*	*4.3*	*1.3*	*0.07*	*0.03*	*100*	
1961-62 ..	4,13,970	19,658	7,997	244	102.	4,41,971	**23**
Percentage of each Category of Consumers to total ..	*93.72*	*4.4*	*1.8*	*0.06*	*0.02*	*100*	

Table 9

GENERATING CAPABILITY DURING 1961-62

Hydel Station		Name Plate Rating (KW)	Actual Capability	Remarks
Warsak	..	160,000	100,000	Note No. 1
Malakand	..	9,600	15,000	Note No. 2
Dargai	..	20,000	15,000	Note No. 2
Rasul	..	22,000	11,000	Note No. 3
Chichoki	..	13,800	4,000	Note No. 3
Shadiwal	..	13,500	3,000	Note No. 3
Renala	..	1,100	1,000	Note No. 3
Kuramgarhi	..	4,000	2,000	Note No. 4
Sub-total	..	2,54,000	1,51,000	
STEAM STATIONS				
Multan	..	125,000	130,000	Note No. 5
Lyallpur	..	13,000	10,500	Note No. 6
Montgomery	..	8,500	5,500	Note No. 7
Sub-Total		146,500	146,000	
GAS TURBINE				
Multan	..	7,500	6,000	Note No. 8
DIESEL				
Lyallpur	..	10,200	7,000	Note No. 9
Grand Total	..	4,18,200	3,10,000	

No. 1.—Warsak output limited during winter months by flooding of down river irrigation bunds.

No. 2—Malakand and Dargai utilise the same water in sequence. Output limited during winter by river conditions.

No. 3—All of these plants are located on canals whose principal purpose is to satisfy irrigation requirements. Power output at time of system peak is distinctly a secondary consideration. The capabilities given reflect a number of years experience and are based upon the water releases ordinarily expected in December. It must be recognised that the capability of these plants is questionable. For example, on 11 July 1962 an Upper Chenab Canal siphon was breached and as a result the Chichoki Hydel Station was shut down for three days while repairs were being made. The station was restored to service for 5 days and then shut down again because of closure of the canal for high river flow conditions.

No. 4—Output limited during winter by river conditions.

No. 5—Name plate rating of each generator is 62.4 MW at 0.78 p.f. which permits continuous operation at 65 MW at normal power factor.

No. 6—Two units of the Lyallpur Stea, Station are now over 39 years old, having been purchased used 12 years ago. The two turbines are derated from 3500 to 2500 KW each because of removal of defective turbine blading.

No. 7—Two boilers in the Montgomery Steam Station have suffered damage due to what appears to be inadequate furnace volume for their rating. Pending major renovation work they are being derated 50%.

No. 8—The output of the gas turbine at Multan is limited by climatic conditions.

No. 9—The output of the Lyallpur Diesel Station is limited by diesel operating practices and maintenance requirements.

Table No. 10

TABLE SHOWING INSTALLED CAPACITY IN UPPER SIND AREA

S. No.	Station	Installed capacity in			Increase in capacity		
		1959—60	1960—61	1962—62	1960—61	1961—62	Total
1	2	3	4	5	6	7	8
1	Jacobabad	400	520	520	120	—	120
2	Larkana	866	1266	1866	400	600	1,000
3	Khairpur	270	520	520	250	—	250
4	Kot Diji	50	75	75	25	—	25
5	Tharu Shah	319	319	519	—	200	200
6	Dadu	300	300	300	—	—	—
7	Shahdadkot	95	220	320	125	—	125
8	Kandkot	—	40	120	40	80	120
	Total	2300	3260	4140	960	880	1840

Table No. 11

TABLE SHOWING INSTALLED CAPACITY IN LOWER SIND AREA

S. No.	Station	Installed capacity in			Increase in capacity		
		1959—60	1960—61	1961—62	1960—61	1961—62	Total
1	2	3	4	5	6	7	8
1	a) Hyderabad	5000	5000	5000	—	—	—
	b) Jamshoro	1500	1500	1500	—	—	—
	c) New Thermal	—	20,700	20,700	20,700	—	20,700
2	Tando Mohammad Khan	270	270	270	—	—	—
3	Mirpur Khas	725	1025	1025	300	—	300
4	Nawabshah	715	195	915	200	—	200
5	Sanghar	65	115	115	50	—	50
6	Shujawal	—	40	65	40	25	65
		8,275	29,565	29,590	21,290	25	21,315

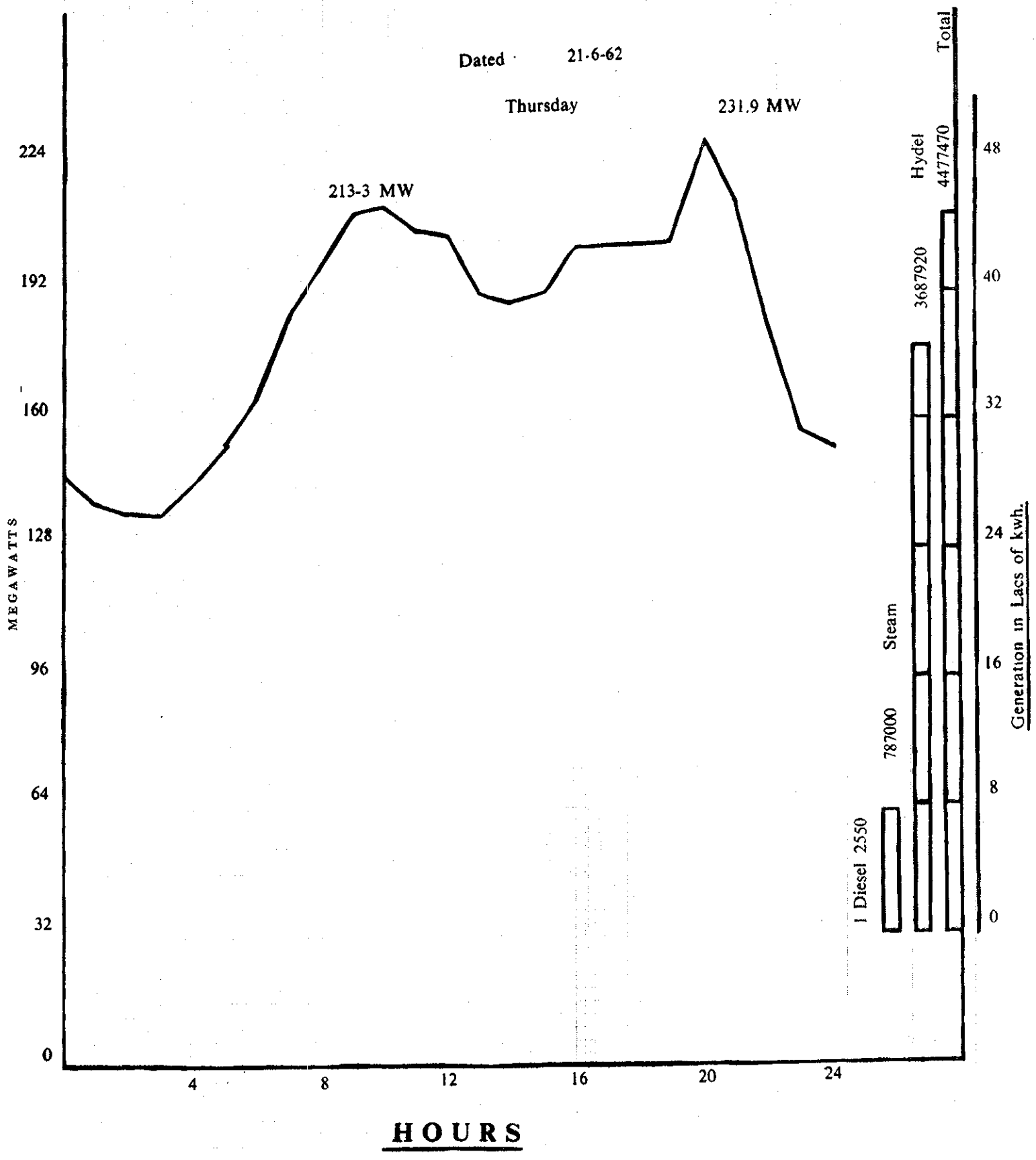
Installed and Firm Generating Capacity

The increase in the production, consumption and sale of energy shown in the above tables was made possible by the combined efforts of the Authority's staff engaged in the development of physical facilities and in commercial and operational activities. In the sphere of development, as shown in Table Nos. 9, 10 and 11, little was added during 1961-62 by way of major power stations. In 1959, the total installed capacity of the Wapda power stations was 119,200 kw of which 108.400 kw was in the

grid zone and 10,500 in the isolated stations in the Lower Sind, Upper Sind and the Quetta-Kalat areas. By the end of June, 1962, this total, installed capacity had increased to 452,100 kw. Because of the fact, however, that enough water is not available in winter to run the hydel stations to fuller capacity and also since many of the thermal power stations are obsolete the actual firm generating capacity of the system was much less. This firm capability is taken as the maximum sustained output for one hour at the time of the system peak which in the case of the Wapda system is taken as December when it is usually experienced. Also the largest single unit of any power station in a grid system is taken as a standby and in the case of the Wapda grid this is the 65,000 kw capacity of either of the two Multan steam units. In view of this, the firm capacity of the Wapda grid in the past three years has risen from 75,000 kw to 245,000 kw. For the total system the increase for the same period is from 85,600 kw to 279,000 kw. The maximum demand on the Wapda system as it developed during 1959-62 is shown in Table 12. And its diurnal pattern is indicated in the daily load graph for the day on which it touched the peak of 232,000 kw.

Table Ne. 12
MAXIMUM DEMAND

Yaar		Main Grid	Lower Sind	Upper Sind	Quetta Kelat	Total System	Annual increase
1958—59	..	104	4	—	2	110	
1959—60	..	131	4	—	2	137	27
1960—61	..	171	5	—	3	179	42
1961—62	...	232	13	—	3	249	70


Dated 21-6-62
Thursday
231.9 MW
213-3 MW
224
192
160
128
96
64
32
0
MEGAWATTS
4
8
12
16
20
24
HOURS
Total
Hydel
4477470
3687920
Steam
787000
1 Diesel 2550
48
40
32
24
16
8
0
Generation in Lacs of kwh.

84a

STAGES OF GROWTH

References have been made in the earlier chapters to the various stages of growth of the power system in West Pakistan. This, however, has been done mainly in a secondary capacity, in the context of reporting operational progress. For a proper perspective of progress both in the fields of operation and construction it is necessary to give in sequence and in broader scope the history of power development in West Pakistan.

When Pakistan attained independence in 1947 the total generating capacity of the public utilities in the area now comprising West Pakistan (excluding Karachi) was 60,000 kilowatts (kw). The main contributions came from the Malakand hydro-electric station in the North West Frontier region and from the Shahdara thermal station near Lahore. There were a few isolated diesel generating sets supplying local towns but most of these had been abandoned by their owners migrating to India. The condition of almost all such undertakings was poor and a great deal of work had to be done to rehabilitate them.

In 1952-53, the Rasul and Dargai hydro electric stations, with generating capacities of 22,000 kw and 20,000 kw respectively, were completed. The diesel plants in some of the towns were augmented at the same time and the total installed capacity of the North West Frontier and the Punjab areas rose to about 110,000 kw. Due to a growing demand this was soon proving inadequate and the need was felt for the installation of one or more central stations. While these were being considered and planned, certain additional capacity, aggregating about 20,000 kw was provided at Lyallpur, during 1955-57 to afford interim relief.

In order to utilize the available hydel and thermal power most advantageously and economically a scheme for the interlinking of the Malakand and Dargai hydro electric stations in the north with the Rasul, Shahdara and Lyallpur stations in the Punjab was undertaken. A 132 kV line was installed for this purpose from Dargai to Wah where it was connected to the existing Punjab grid.

The discovery of natural gas at Sui in 1953 opened up new possibilities of large scale power generation. In 1954, the Pakistan Industrial Development Corporation prepared a scheme for the construction of a 140,000 kw power station at Multan to operate with Sui gas as fuel. The scheme was scantioned by the Government in 1956 and work started at site in 1957. The station was completed and brought into operation by Wapda in February, 1960.

Simultaneously with the planning of the Multan power station a scheme was also prepared for transmitting its power to the load centres. This provided for the con-

struction of a 220 kV line between Multan and Lyallpur, and this high tension line was completed by the time the power station was commissioned.

In the Frontier region work had at the same time been started on the construction of a hydro electric station at Warsak. The plant and machinery for this power station was supplied as aid by the Canadian Government under the Colombo Plan. This station was planned for an initial installed capacity of 160,000 kw. This power station also was brought into operation by Wapda in early 1960.

As the work at Warsak advanced thought was given to the need for providing a transmission system of a suitable design for carrying the power generated from this station to various centres of load. At the instance of the West Pakistan Government, the P.I.D.C. was entrusted with this work. The design of the grid was developed through consultations between the P.I.D.C., the West Pakistan Government's Electricity Department and the Central Engineering Authority of the Pakistan Government, and finalized after a series of network analyser studies. The construction of the first segment of the grid connecting Warsak and Kharian, was started in 1958.

Unified Management

Upto this time various works connected with power development in West Pakisttan (excluding Karachi) were being carried out by different agencies such as the Pakistan Industrial Development Corporation, the Warsak Dam Organization and the Provincial Electricity Department. It was considered expedient at this stage to bring the entire power development programme under unified management and control and this led to the creation of Wapda in the latter part of 1958. Under its charter Wapda was required among its other assignments to:

i) prepare a comprehensive plan for the development and utilization of the water and power resources of West Pakistan on a unified and multi-purpose basis; and

ii) frame and execute schemes for the generation, transmission and distribution of power and undertake the construction, maintenance and operation of power houses and grids.

In early 1959, after a great deal of consideration, it was decided that the Electricity Department of West Pakistan should be transferred to Wapda. This was considered necessary in order to bring about a close co-ordination between power generation, transmission, distribution and the sale of energy and also to facilitate the effective and timely supply of power to the reclamation tubewell schemes. The Electricity Department was transferred to Wapda on 1st April, 1959, and together with the Power Development Directorate transferred from the P.I.D.C. in January, 1959, formed the Power Wing of Wapda.

The Power Wing originally comprised two banches, for Power Development for Operations each headed by its own Chief Engineer. The construction of all

new schemes was placed under the charge of the Power Development Branch, and the operation of the system, together with the management of the sale of energy to the consumers, under the Operations Branch. This arrangement continued until February, 1962, when the Power Wing was reorganised. A description and explanation of the reorganized set-up appears later in this report.

Power Projects

In the following tables are given names of projects which were in the course of execution and were transferred to Wapda for completion and operation, and those which were initiated subsequently by Wapda itself. The latter are shown in italics.

Generation

(1) Warsak Hydro-Electric Station.	Installed Capacity 160,000 kw	Completed in 1960.
(2) Shadiwal Hydel Scheme	Installed Capacity 13,500 kw.	Completed in 1961.
(3) Chichoki Mallian Hydel Scheme.	Installed Capacity 13,800 kw	Completed in1960
(4) Multan Natural Gas Power Station.	Installed Capacity 130,000 kw	Completed in early 1960.
(5) *Hyderabad Thermal Station*	*Installed Capacity 20,000 kw*	*Completed in 1961.*
(6) *Multan Thermal Station Extension.*	*Under execution Installed Capacity, 130,000 kw.*	*Completion in 1963.*
(7) *Quetta Thermal Station*	*Under execution Installed Cpacity, 15,000 kw.*	*Completion in 1964.*
(8) *Gujranwala Hydel Project*	*Under execution Installed Capacity, 13,800 kw.*	*Completion expected in 1963.*
(9) *Sukkur Thermal Station*	*Under execution Installed Capacity 25,000 kw.*	*Completion expected in 1964.*

Transmission

(1) Multan-Lyallpur 220 kv Line	Completed	Completed in *1959.*
(2) *West Pakistan High Tension Grid*	*Under execution*	*Partly completed and energised, completion of entire installation expected by 1963.*
(3) *Secondary Transmission and Distributiin Scheme.*	*Under execution*	*Completion in 1964.*
(4) *Hyderabad Grid*	*Under execution*	*Completion in 1963.*
(5) *Sukkur Grid*	*Under execution*	*Expected date of completion 1964.*
(6) *Quetta Grid*	*Under execution*	*Expected date of completion 1964.*

Future Schemes

The following generation, transmission and distribution schemes have been planned and depending on the availability of external finance are proposed to be undertaken during 1962-63.

(1) Lyallpur thermal station, with an installed capacity of 200,000 kw.

(2) Hyderabad thermal station (extension) with an installed capacity of 20,000 kw.

(3) Sukkur thermal station (extension) with an installed capacity of 25,000 kw.

(4) Village electrification covering about 2500 villages in the remaining Second Five Year Plan period.

These four are among the several schemes that have and will become necessary with the rapidly growing demand for power. Tables given in earlier chapters have already given evidence of the rate at which this demand is being met. As more and more transmission and distribution facilities are provided the demand will continue to increase at a rapid pace. In order to be able to meet this demand it is necessary that planning for the future be carried out well in advance. Wapda has taken steps in this direction firstly by initiating a power market survey in West Pakistan, excluding Karachi, and secondly by conducting system studies on a network analyser in order to determine how the system should be developed not only to meet the additional demand but also to ensure efficient operation. Wapda's general consultants, Harza Engineering Company International prepared in November, 1961, a report on the power needs of West Pakistan for 1965 to 1968 (that is, before power is available from Mangla). This showed that the maximum demand in the grid area in 1968 will be of the order of 588,000 kw which means a firm capacity requirement of 684,000 kw. The study is being projected further to cover the conditions likely to arise upto 1980.

The studies so far carried out indicate that on the completion of the Multan Power Station Extension Project and before Mangla hydel power is available it will be necessary to provide a thermal power station somewhere in the vicinity of Lyallpur with an installed capacity of 200,000 kw. This scheme is presently being processed through Government channels.

A market survey covering Hyderabad and Khairpur Divisions has already been prepared. This survey points to the necessity of further augmenting Hyderabad and Sukkur power stations. An extension of 15,000 kw at Hyderabad has consequently been planned and the scheme for the extension of Sukkur power station, which is still under construction, by another 25,000 kw is also under preparation. The grids associated with the previous schemes will also be suitably extended and augmented.

The planning of a system is a continuous process and has to be carried out in order to meet the changed conditions from time to time. Data and information are therefore, continuously being collected to keep planning abreast of the requirements of the country. It is expected that a complete survey of the future requirements of the province as actually carried out in the field will be available by the end of the fiscal year 1962-63.

POWER STATIONS

As already stated in the earlier parts of this report the power stations under operation or construction come under different categories because of their technical features and location. In the present chapter the power stations described are those which have been completed since 1959 or are under construction. First come the important hydel and thermal stations of the main grid followed by a description of the power stations and schemes in the Lower Sind, Upper Sind and Quetta-Kalat areas.

Warsak Power Station

The Warsak power station at present has 4 generators of 40,000 kilowatts each, and is a part of the multipurpose project built on the Kabul river about 20 miles north west of Peshawar. Since it came into operation in 1960 this hydel station has been a major source of power for the main grid area. In its first year of operation the station met a peak load of 60,000 kilowatts (equal to the total generating capacity in West Pakistan in 1947), and in the following year this increased to 96,000 kw. During 1961-62 the maximum load recorded was 137,000 kw, and during the same period it generated 527.5 million units (kwh) of electricity, that is, about 44 per cent of the total generation in the grid zone.

The Warsak dam is about 750 feet long, 235 feet high and 210 feet wide at the foundation. It has 9 spillways each 40 feet wide controlled by taintor gates and capable of dealing with a discharge of about 550,000 cusecs. The usual high flood in the Kabul river varies between 100,000 and 150,000 cusecs. The 26-mile long lake upstream of the dam, and extending to the Pak-Afghan frontier, feeds the power house through a concrete lined power tunnel (39 feet in diameter) branching off into six steel lined penstocks each of 18 feet diameter. This gives an operative head of 145 feet to the 4 generating sets of the power station. A provision has been made for the installation of two more generators to raise the final installed capacity from 160,000 kw to 240,000 kw. Before this is done some technical problems have to be resolved. As indicated in the description above the reservoir capacity of the Warsak lake is not very large, and the output of the station depends considerably on the flow of the river. In the case of the Kabul river the average winter flow is about one-fifth of the summer flow. The Warsak station, therefore, is not expected to run at full capacity during winter all the time.

Apart from these basic facts the actual position at Warsak is that if all the four units were to be put into operation simultaneously in winter the total quantity of water thus released would interfere with the irrigation system downstream of the dam. In the present circumstances the Warsak station cannot normally during winter be run to produce more than 90,000 kw, that is, slightly more than half of its

installed capacity. To enable the station to work at full capacity, when sufficient supplies for the purpose are available in the Kabul river, it will be necessary to build a re-regulating reservoir downstream of the dam. Without this new reservoir and modifications to the downstream irrigation works it will not be possible to increase the winter peaking capacity of the Warsak power house. This has already been pointed out to the Government which has commissioned the West Pakistan Irrigation Department to submit proposals in this connection.

The Warsak hydel station gradually became a Wapda project with the completion in 1960-61 of its construction by Canadian and Pakistani engineers. Wapda was given the task of bringing the four generators (40,000 kw each) into commission and putting them on commercial load. The Warsak multipurpose project also provides for the irrigation of about 120,000 acres of good culturable land in the Peshawar valley and the Mohmand tribal territory. It was originally conceived before Independence. In 1951, the first feasibility report on the construction of a dam across the Kabul river was completed. Next year,the Canadian Government, under the Colombo Plan, came forward to give technical aid for the execution of this project. Detailed investigations were carried out by H. G. Acres & Co., a Canadian firm of consulting engineers, and they submitted their report early in 1953. This was followed by an agreement between the Governments of Canada and Pakistan under which the Canadian Government was to provide the services of the consultants and general contractors, and supply the generating machinery, besides supplementing the construction equipment and materials not easily available in Pakistan. The work at Warsak actually started in 1956, and the river was diverted in August, 1957. The dam was completed in early 1960 and the installation of the generators during the second half of the year.

The operation of the power station presented no serious difficulties. Steps had been taken earlier to select and post suitable staff while construction was in progress. This made the staff familiar with the details of the equipment installed. Canadian advisors who stayed on after the commissioning of the station assisted and trained the staff in the operation of the power station. Arrangements have been made to send more engineers to Canada to receive further training on specialized equipment.

The power station was not provided with a separate house unit and depended for its supply of power to the auxiliaries at the time of starting up on a diesel generating station originally put up for meeting construction requirements. Arrangements have now been made to feed the station from the main power grid at Peshawar, thus eliminating the necessity of retaining the diesel station.

Since this is a multipurpose project, the apportioning of cost between power and irrigation is being examined by the Government. At present the estimated cost of the Warsak project is Rs 365 million of which Rs 260 million is the tentative figure adopted by Wapda as the cost of the power component of the project. The amount of Canadian aid is estimated at 50 million dollars.

Canal Hydel Stations

Connected also to the main grid are two hydel stations, at Shadiwal and Chichoki Mallian, based on canal falls. A third station based also on canal falls is nearing completion at Gujranwala.

Shadiwal Power Project. Like the Warsak project the Shadiwal hydel station was also financed by the Canadian Government under the Colombo Plan. It is situated on the Upper Jhelum Canal about 7 miles from Gujrat. The power house has two generators of 6,750 kw capacity each and operated on a head of 23 feet. A 5 mile 132 kV transmission line has been provided to feed this supply into the main grid at Gujrat. The total cost of the Shadiwal project is Rs 40.1 million with a foreign exchange component of Rs 17.8 million.

Due to limited supplies being available at present in winter in the Upper Jhelum Canal in the Shadiwal region the total capacity of the power station during the season is restricted to about 4,000 kw. Certain modifications to the canals are necessary before full power can be generated. These modifications will be undertaken in conjunction with the Indus Basin Settlement Plan and when completed will make it possible for the Shadiwal station to work to the maximum of its installed capacity. However, during summer, the station has been more productive and the maximum demand reached was 9,400 kw. Energy produced during 1961-62 was 39.3 million kwh. Since the operation of the station is dependent on the continuous running of the canal its power is not available to the grid during canal closures. The total canal closures during the period under review lasted 537 hours.

Chichoki Mallian Power Project. This power station is located on the Upper Chenab Canal about 20 miles from Lahore. It was the first station to be brought into commission by Wapda. The power house has 3 machines with a total installed capacity of 13,800 kw. They operate on a head of 22 feet. The dependable capacity of this station in winter is at present 6,000 kw only because of limited supplies of water available in the canal. During 1961-62, the Chichoki Mallian station generated 48.5 million kwh and the maximum demand on it reached 13,200 kw. The power station remained out of operation for 1,115 hours due to canal closures.

The location of this station is of special significance to Lahore. During outages on the main transmission grid power from the Chichoki Mallian station, because of its nearness to Lahore, can be diverted directly to the city by isolating the station from the rest of the system.

The total cost of the project is Rs 27.5 million.

Gujranwala Power Project. This hydel station is located also on the Upper Chenab Canal, upstream from Chichoki Mallian, near the village of Nandipur, about 7 miles north-east of Gujranwala. It will generate 13,800 kw through 3 turbo-alternator units of 4,600 kw each. As reported last year the commissioning of the station has been delayed because of the collapse of the spillway regulator and spill channel in

May, 1961. Wapda set up a committee to enquire into this failure of the structure and its report says that this was due to the Yugoslav consultants' radical design being incapable of standing the seepage and piping action, and the inadequate safeguards connected with the floatation gradient. During 1961-62, the spillway was redesigned with additional features to safeguard it. The station is now expected to be brought into commission in early 1963.

Multan Natural Gas Power Station

Along with the Warsak hydel station, at the northern end of the grid, the Multan thermal station near the south western extremity of the grid, was a major producer of electricity during 1961-62. The energy produced by it during the period under review was 240 million units (kwh) and the maximum load taken by the Multan station was 85,000 kw. The total installed capacity of the station is 135,700 kw but it has not been called upon to give its maximum generation so far partly because of the available contribution from the hydel stations and partly because of certain modifications which had to be carried out on one of its turbines. For so long as an adequate supply is available from the hydel stations the Multan station is being kept at a minimum generation of about 25,000 kw. During the period under review floods in the Sutlej river washed away the pipeline of the Indus Gas Company. Because of this the Multan station was put on oil firing for 23 days and about 4,500 tons of furnace oil was consumed during this emergency.

Run on natural gas piped from Sui, the Multan station is situated at Piran Ghaib near the Multan Branch Canal. Work on it was started by the PIDC but as reported earlier the project came over to Wapda in January, 1959. According to the original plan the Multan station was to have 2 hydrogen-cooled turbines capable of producing 65,000 kw of electricity each—the largest units in Pakistsn—and 2 gas turbines capable of producing 5,700 kw each. Later, one of the gas turbines was shifted to Hyderabad. The Multan station incorporates the single unit system by which each steam turbine is fed by its own high pressure boiler and is integrally connected to a machine transformer. The steam conditions are 1320 pounds per square inch pressure and a temperature of 960 degrees Farenheit. These conditions have been adopted in Pakistan for the first time. Arrangements also exist for close and open cycle cooling systems. In the open cycle system, water for cooling is obtained from the nearby Multan Branch Canal to which the water is returned after circulation. Cooling towers of suitable capacity have been installed for use during the canal closures. Automatic controls of the latest type have been installed and remote operations are possible from the central control room.

Some teething troubles were experienced in the operation of the power station during the year. These related mainly to the working of the station at low loads and to its tripping when required to take additional loads suddenly due to outages on other generating sources.

The cost of the Multan station is estimated as Rs 116 million.

Extension of Multan Natural Gas Power Station

Extension to the Multan power station has been planned to meet the power shortage which is expected by the winter of 1963. With a view to getting the project completed within the short period available it was decided to negotiate with the consortium of firms (A.E.G., Stienmuller, Brown Boveri and Hochtief) which supplied the plant and equipment for the existing station. At the same time, Kreditanstalt Fur Wieduafbau, a banking organization of Germany was approached for a loan to finance the foreign exchange expenditure. According to the agreement concluded with them 85 per cent of the foreign exchange cost (55 million D. marks) is to be met from this bank loan and the balance from Pakistan's own resources.

The new equipment will be manufactured to the same specifications as those for the present station and the general lay out of the station will also be on the same lines as the existing power house. The only major departure from the previous arrangement is the absence of the open cycle cooling system which has been discarded in favour of cooling towers in view of the problems occasioned by silt deposits.

The extension will add 130,000 kw to the generating capacity of the grid area. Two machines of 65,000 kw capacity each will be installed, with boilers and auxiliary equipment of the same type and design as the existing installation.

The civil works are being constructed by Messrs Gammons (Pakistan) as subcontractors to Hochthief, a member of the consortium.

The total estimated cost of the project is Rs 136.8 million with Rs 85 million as the foreign exchange component. The expenditure incurred uptodate is Rs 89.5 million out of which Rs 78.8 million is in foreign exchange.

Progress. The progress achieved on the extension project during 1961-62 is as follows:

i) **Housing Colony**

C type quarters	..	10 completed
D type quarters	..	35 completed
E type quarters	..	100 completed
F type quarters	..	100 completed

ii) **Main Power Station Building**

a) Side wall has been raised.

b) Roofing structure of the machine room has been installed and the false ceiling installation is under way.

c) End wall of the existing building has been partially demolished.

d) Crane rails have been laid out.

e) Foundations for Turbo-Generator No. 3 have been completed.

f) Foundations for Turbo-Generator No. 4 have been completed except for the upper block which remains to be concreted.

g) The overall work on the main power house building is 80 per cent complete.

h) The supporting structure of Boiler No. 3 has been erected, the drum placed in position, and the tubes are being installed.

i) The supporting structure of Boiler No. 4 is 50 per cent complete.

j) One block of cooling tower is 100 per cent complete while the second is 50 per cent complete.

The above progress is according to schedule.

Hyderabad Thermal Station

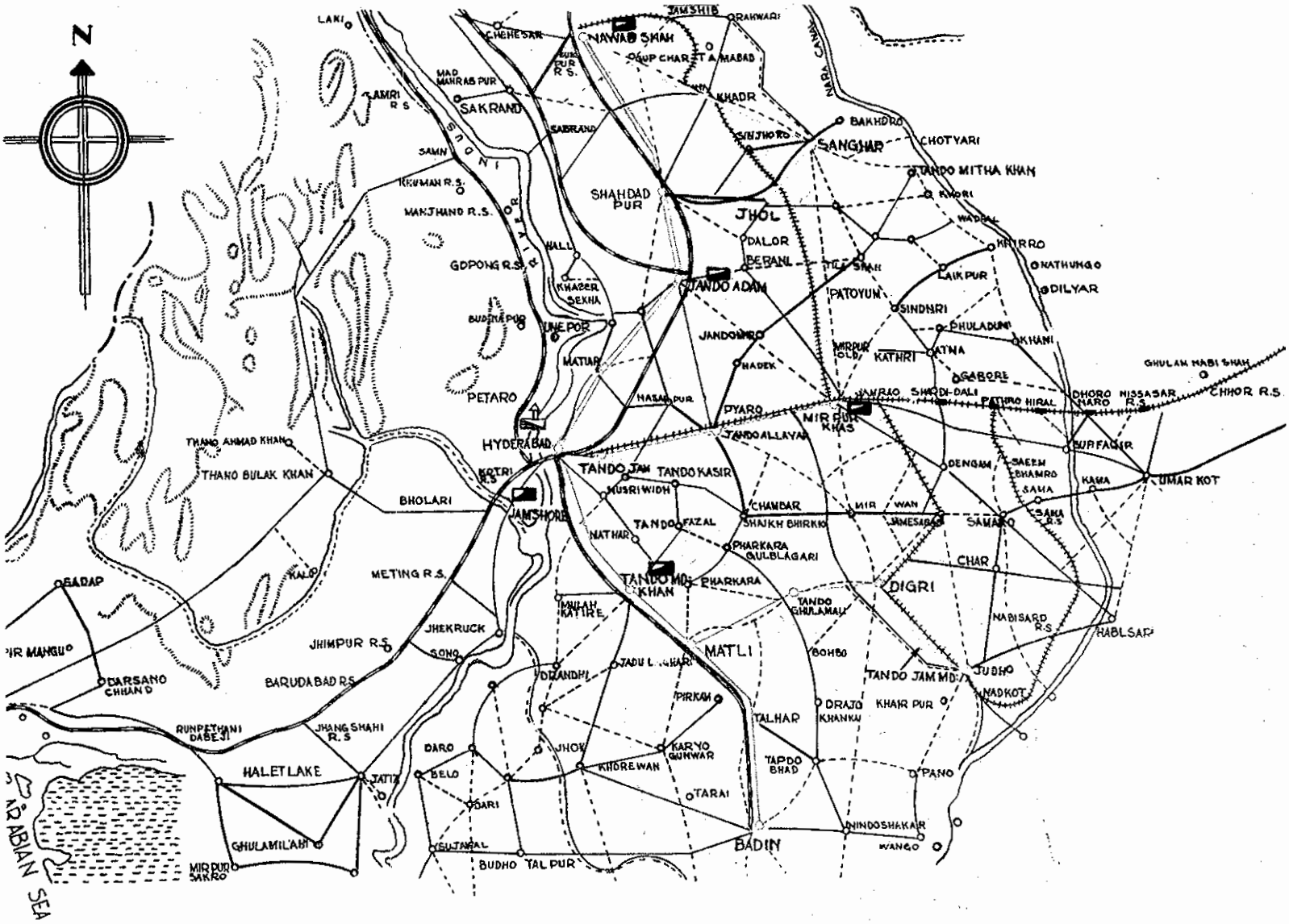
The Hyderabad thermal station was formally inaugurated by the President of Pakistan, Field Marshal Mohammad Ayub Khan, on 9th October, 1961. The station has an installed capacity of 20,700 kw and was brought into commission gradually during the previous year. Its gas turbine (5,700 kw) was brought into operation on Pakistan Day, 1961, with the two steam units (7,500 kw each) following in April and May. During 1961-62 the new station generated 43 million units (kwh) of electricity and met a maximum demand of 12,800 kw. The old thermal station at Hyderabad and the station at Jamshoro added another 13.8 million units of energy to the new transmission and distribution system in the Lower Sind region.

The load on the new thermal station is increasing rapidly. In view of this Wapda's scheme for an extension of this station by another 15,000 kw has been approved by the Government. Steps are being taken to implement this extension scheme with the help of a U. K. loan. It has also been decided to shift one generating set with a capacity of 8,000 kw from Shahdara (Lahore) to raise the total capacity of the Hyderabad station to 43,700 kw by 1965-66.

The significance of the new Hyderabad power station cannot properly be realised unless the power situation before its operation is described. Unlike the northern and central zones of West Pakistan the southern zone has no main power grid to which all the power stations are connected. The total installed capacity in 1959-60 of Wapda's isolated stations at Tando Mohammad Khan, Nawabshah, Mirpur Khas, Jamshoro, and the old Hyderabad station was 8,275 kw. With the completion of the new Hyderabad power station and additions to the capacity of the some of the smaller stations the total now for the Lower Sind area is 21,315 kw. This is shown in Table No. 9 on page 82.

Transmission Network

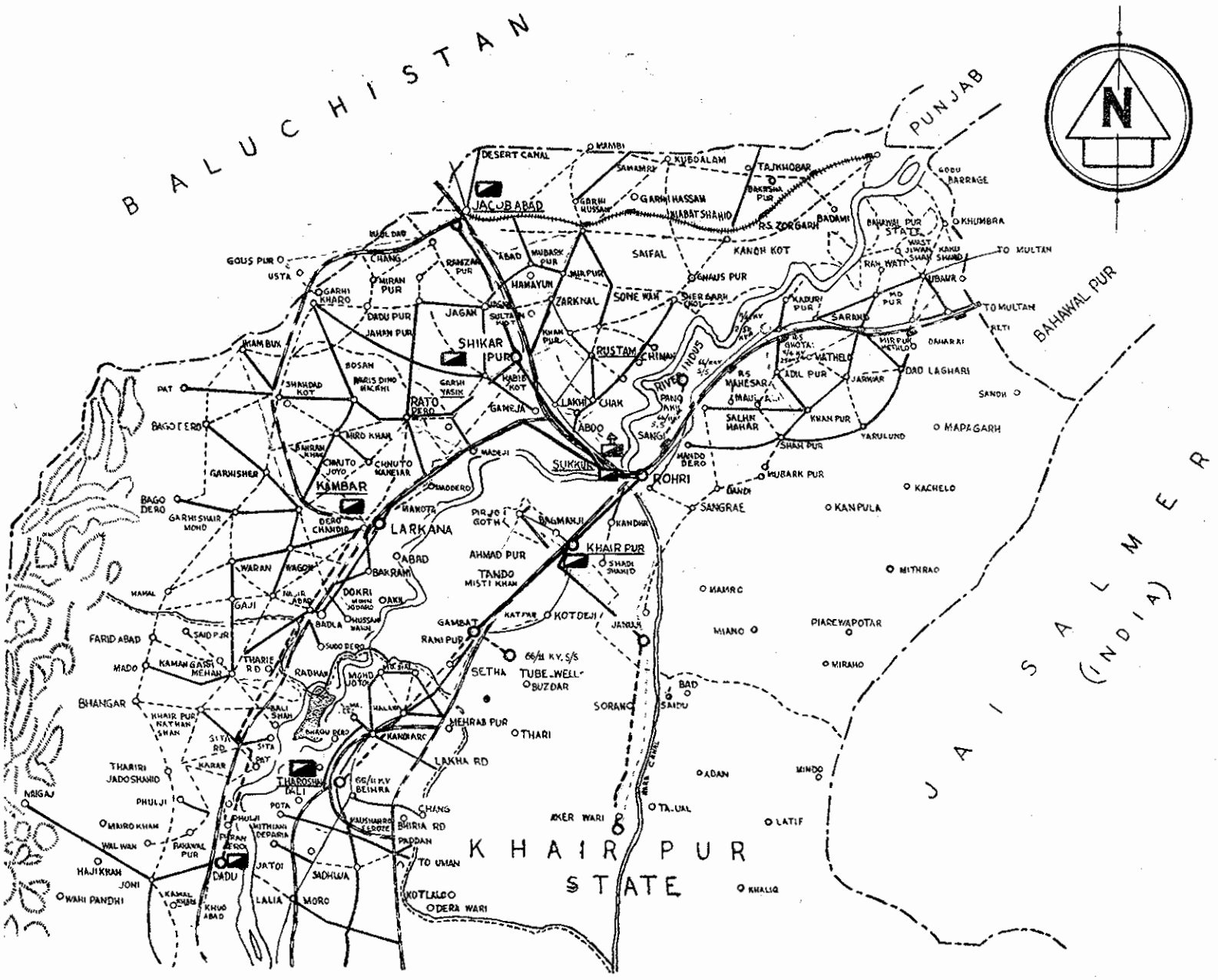
The capacity of the present thermal station was initially planned for 15,000 kw. This was enhanced by transferring to Hyderabad one of the two gas turbines originally ordered for Multan. The scope of the transmission and distribution system associated



REFERENCES

1. 66 KV LINES
2. 33 KV LINES
3. 11 KV LINES
4. BROAD GAUGE
5. METER GAUGE
6. PUCCA ROAD
7. KATCHA ROAD
8. THERMAL STATIONS
9. DIESEL STATIONS

TRANSMISSION & DISTRIBUTION SYSTEM IN LOWER SIND (HYDERABAD) THERMAL SCHEME



REFERENCES

1. EXISTING 66 KV LINES
2. EXISTING 11 KV LINES
3. THERMAL STATION
4. DIESEL STATION
5. PROPOSED 66 KV LINES
6. PROPOSED 11 KV LINES

TRANSMISSION AND DISTRIBUTION SYSTEM IN UPPER SIND SUKKUR THERMAL SCHEME

with the project was also completely revised in order to cover as much area around Hyderabad as possible. The transmission and distribution network covers Tando Jam, Tando Allahyar, Mirpur Khas, Tando Adam, Shahdadpur, Nawabshah and Tando Mohammad Khan where electrification was provided by small and uneconomical diesel generating stations—some of them privately owned. The network fed from Hyderabad is designed also carry power to the towns of Matiari, Bhitshah, Hala Jhol, Sanghar, Matli, Tando Ghulam Ali, Sakrand, Digri, Tando Jan Mohammad, Jhudo and Badin. The details of this transmission network are shown in the map facing page 94, and are described below:

1. Two single circuit 66 kV lines (aggregate length 74 miles) between Hyderabad and Nawabshah and feeding Matiari, Tando Adam and Shahdadpur, but for the time being to be energised at 33 kV. Incidentally, 66 kV lines are to be used for the first time in this region.
2. One single circuit 33 kV line extending from Hyderabad to Mirpurkhas (43 miles) and also feeding Tando Jam and Tando Allahyar.
3. One single circuit 33 kV line (45 miles) running between Hyderabad and Badin and feeding Tando Mohammad Khan, Matli, Tando Ghulam Ali and Digri.
4. One single circuit 33 kV line 90 miles from Hyderabad to Matli, and from Matli to Badin on one side and Digri on the other, feeding all these towns besides Tando Ghulam Ali.

By the end of the year under review most of the transmission lines had been completed and were carrying electricity for the towns of Tando Jam, Tando Allahyar, Mirpur Khas, Bhitshah, Hala, Sakrand and Matiari. The remaining 5 towns were expected to be fed electricity from Hyderabad by the end of 1962.

With the spreading network of transmission and distribution power lines in a radius of 70 miles from Hyderabad, Wapda has taken an important step in realising its ultimate objective of a super grid covering the Indus Basin and making possible the use of West Pakistan's power resources in a most economical and technically sound manner.

Cost

The overall cost of the project is Rs 44.3 million with Rs 27.3 million in foreign exchange. The entire cost of the project has been met from Pakistan's own resources.

Sukkur Thermal Station

During the year under review progress was made in preparing the designs and specifications of the civil works, and in placing orders for some of the equipment required for the Sukkur Thermal Station. This station is to have an installed capacity of 25,000 kw—two units of 12,500 kw each run on natural gas—and is being built on the right bank of the Indus at Sukkur. Similar to the thermal station at Hyderabad it will serve an area within a radius of 70 miles through a network of transmission lines which are being installed as a part of the project. A formal agreement with the Canadian Government for aid to the project under the Colombo Plan was signed at Sukkur on 14th March, 1962, by Mr Z. A. Bhutto, Pakistan's Minister for Fuel, Power and

Natural Resources, and Mr C.C. Ebberts, the Canadian High Commissioner in Pakistan. Under the agreement Canada will provide Rs 35 million for the foreign exchange component of the project, the total cost of which is estimated at Rs 53 million. A Canadian firm, Stadler Hurter, International, of Montreal, are the consultants for the power house, and the Canadian Hoosier Engineering Company, also of Montreal, for the transmission lines.

The purpose of the project is to supply power to a large number of towns mainly in the Upper Sind area of Khairpur Division. The present Sukkur power station is not run by Wapda but the Power Wing is responsible for the operation of small power houses in towns like Jacobabad, Larkana, Khairpur, Kot Diji, Tharushah, Dadu, Shahdadkot and Kandkot. The increases in their capacities—41.7 per cent during 1960-61 and 27.1 per cent during 1961-62—are shown in Table No. 10 on page 83 and the new generating sets added during 196-62 are mentioned in a later chapter.

A power market survey in the Upper Sind area shows that the new thermal station in Sukkur will not be able to meet the suppressed demand for industries in the surrounding towns, and the anticipated urgent demand for power for irrigation and reclamation tubewells within the next few years. To meet this shortage Wapda has already prepared a scheme to augment the new thermal station at Sukkur by adding another turbine of 25,000 kw capacity.

The transmission lines as planned at present are shown in the Upper Sind grid map on page 95 and described below:

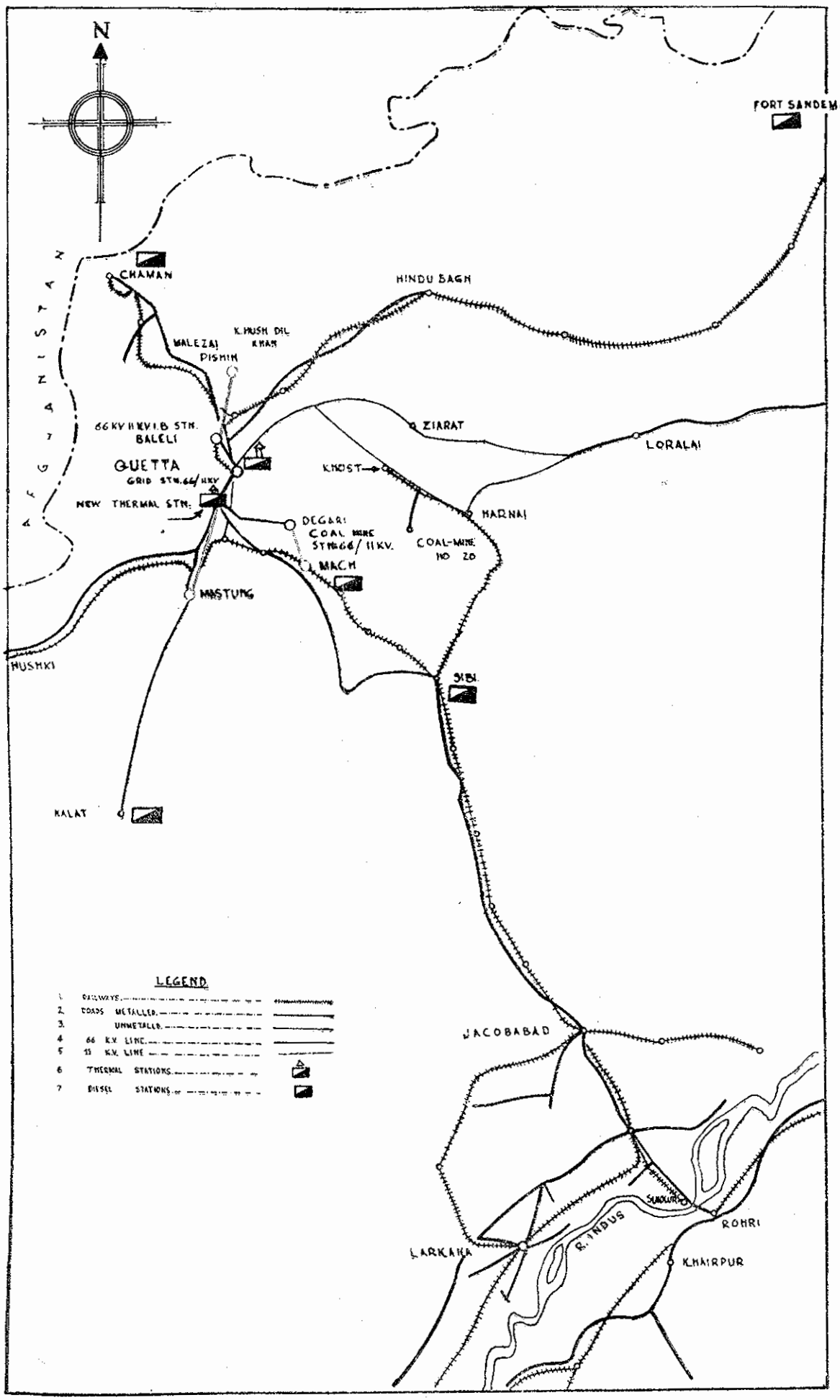
i) 66 kV double circuit lines from Sukkur to Rohri ..	.. 16 miles
ii) 66 kV single circuit from Sukkur to Larkana ..	.. 43 miles
iii) 66 kV single circuit from Rohri to Gambat ..	.. 41 miles
iv) 66 kV single circuit from Sukkur to Jacobabad ..	.. 53 miles
v) 66 kV single circuit from Khairpur Mirs to Nara Canal	.. 16 miles
Total	.. 169 miles

Quetta Thermal Station

The Quetta thermal station is under construction at Sheikh Manda, a village 4 miles from Quetta. The station will have a total installed capacity of 15,000 kw from three units of equal size. At present it is the only new power station in the Wapda system designed to use coal as fuel. This coal will come from mines in the neighbourhood of Quetta. In view of the shortage of water in the region a special type of dry cooling system will be employed.

At present Quetta is served by an old, almost obsolete, plant owned by a private company. The new station is being built to feed the nearby coal mines and the new industries sanctioned for the region. The Quetta thermal project also includes the building of a 90 mile network of transmission lines to carry power from Sheikh Manda to Quetta town, to the Deghari and Sor coal mines, to the irrigation pumping station at Baleli, and to the towns of Pishin and Mustang. A load survey carried out by

QUETTA THERMAL SCHEME



Wapda's consultants, the Kuljian Corporation, shows that the new station will be loaded up fully almost immediately after commissioning. The estimate is that over 9,000 kw of electricity will be required by domestic and industrial consumers, 1,600 kw for lift irrigation purposes and 4,000 kw for the mechanisation of the mines.

Progress

During the review period work on the preparation of specifications, tender enquiries and adjudication of bids for the power house machinery was carried out through the consultants for the project. Since the project is being financed from DLF the purchase of equipment is being made in USA. Orders have already been placed for the machinery and plant—for turbo-generators with Delaval Steam Turbine Company and for boilers with Riley Stoker and Company. The civil works and the erection of mechanical equipment have been entrusted to the Motherwell Bridge Company, and electrical installation to Gustav Hirsch and Company.

The preparation of specifications and tender notices for the transmission and distribution system were completed during the year. The tenders have been received and are under adjudication.

The following miscellaneous works at site have been carried out:

i) Temporary offices are 100 per cent complete.

ii) Temporary water and power supply is 100 per cent complete.

iii) Access road to the site is 40 per cent complete.

iv) Diversion road is 6 per cent complete.

v) Earth work for the railway siding, is in progress, and the procurement of track material by the railway authorities is in hand.

vi) Permanent stores building, excavation of foundations, and boring of concreting is 100 per cent complete; while the boring of column fittings is 80 per cent complete.

vii) The rough grading of the main power house building is 100 per cent complete, and the excavation of foundations is in hand.

The overall progress on the project is about 15 per cent and the project is scheduled to be completed by 1964.

Cost

The estimated cost of the project is Rs 37.3 million. The expenditure so far is Rs 3.6 million of which Rs 2.4 million is in foreign exchange.

TRANSMISSION AND DISTRIBUTION PROJECTS

In the grid zone covering Peshawar, Dera Ismail Khan, Rawalpindi, Sargodha, Lahore, Multan and Bahawalpur, Wapda has in hand or has virtually completed three major schemes for the transmission and distribution of electricity. As stated earlier when Wapda was organised in 1958 there was little by way of major transmission facilities. Since then major additions have been made through such schemes as the Multan-Lyallpur 220 Kilovolt Line Project, the West Pakistan High Tension Grid Project, the Secondary Transmission and Distribution Project, and the high voltage extensions carried out by the Operations Branch in the rural and urban areas. The following tables should give some idea of the progress made since Wapda took over this responsibility.

TRANSMISSION LINES

	Upto 31-3-1959	Upto 30th June, 1962
220 kV single circuit on double circuit towers ..	—	136
132 kV		
i) Double circuit ..	208	806
ii) Single circuit ..	118	314
66 kV		
i) Double circuit ..	144	200
ii) Single circuit ..	1054	1300
33 kV ..	408	500
11 kV ..	2750	6000
Number of completed sub-stations		
220 kV ..	—	2
132 kV ..	9	26
66 kV ..	50	67
11 kV ..	17	26

The main transmission and distribution schemes are described in the following paragraphs along with progress reports on them.

Multan-Lyallpur 220 Kilovolt Line

To transmit the power generated at Multan to various load centres a scheme for a

220 kV line between Multan and Lyallpur was prepared by P.I.D.C. The line was designed in conjunction with Messrs. Montecatini of Italy who were consulting engineers for the scheme. It is a double circuit line 130 miles long, with only one circuit strung at present. This is the first 220 kV line installed in Pakistan. A grid station for receiving power from Multan at 220 kV and stepping it down to 132 kV and 66 kV has been set up at Lyallpur as a part of the scheme. The estimated cost of the scheme was Rs 26 million. The actual expenditure on it to date is Rs 26.5 million.

A scheme for providing a second circuit on this line has now been approved by the Government. The foreign exchange cost for this scheme is to be met from a German loan. The cost of providing the second circuit is estimated at Rs 11.7 million with a foreign exchange component of Rs. 9.4 million.

West Pakistan High Tension Grid

With the building of the Warsak and Multan power stations it was considered necessary to provide an integrated network of high tension transmission lines to which these stations together with other generating stations on the system would be connected so that the power available from the various sources could be utilized in the most economical and technically feasible manner. For this purpose, a study was carried out to evolve the design of a high tension grid.

Features

As a result of this study the West Pakistan High Tension Grid Scheme was prepared, the main features of which are as follows:

i) A double circuit 132 kV line from Warsak to Kharain via Peshawar, Wah, Rawalpindi and Mangla.

ii) A double circuit 132 kV line from Warsak to Lyallpur via Daudkhel and Sargodha.

iii) A double circuit 132 kV line between Lyallpur and Montgomery.

iv) A double circuit 132 kV line between Lyallpur and Lahore.

v) 132 kV grid stations at Peshawar, Wah, Islamabad, Jhelum and Kharian on the Warsak-Kharian segment and at Daudkhel and Sargodha on the Warsak-Lyallpur segment.

vi) Extension to the Lyallpur grid station where the original installation was provided under the Multan-Lyallpur 220 kV Scheme.

vii) 132 kV grid stations at Montgomery and Lahore (Kot Lakhpat).

viii) Extensions to grid stations at Rawalpindi, Shalamar (Lahore) and Montgomery.

ix) A control centre at Lahore near Kot Lakhpat.

x) Carrier tele-communication, tele-metering and tele-control system linking the various generating and grid stations with the control centre at Lahore.

Progress

The following works have so far been completed and energized:

i) The double circuit 132 kV line between Warsak and Kharian.

ii) The double circuit 132 kV line from Warsak to Lyallpur via Daudkhel.

iii) The double circuit 132 kV line between Lyallpur and Montgomery.

iv) The double circuit 132 kV line between Lyallpur and Lahore.

v) 132 kV grid stations at Kharian, Daudkhel, Sargodha and Lyallpur.

vi) The Peshawar and Wah 132 kV grid stations are 80 per cent complete.

vii) Work on the 132 kV grid stations at Montgomery, Kot Lakhpat and Islamabad is in progress.

The above constitutes about 75 per cent of the total work. The entire scheme including the grid stations is scheduled for completion by the middle of 1963. The total cost of the scheme is Rs 121 million out of which the foreign exchange component is Rs 78.4 million. The expenditure so far is about Rs 104 million.

Secondary Transmission and Distribution Scheme

With the installation of additional generation and with prospects of more power becoming available on the grid to meet the growing load demand it became necessary to expand the secondary transmission facilities. The Secondary Transmission and Distribution Scheme was finalised soon after the creation of Wapda and submitted to the DLF for financing after the scheme's approval by the Government. The scheme is now in the process of implementation and covers the installation of 210 miles of 132 kV lines, 814 miles of 66 kV lines, 42 miles of 33 kV lines, 900 miles of 11 kV distribution lines and 492 miles of 400 volt lines.

It also provides for eight 132 kV grid stations, fifty five 66 kV sub-stations and five 33 kV sub-stations together with 11 kV distribution stations in 74 towns.

Renovation of the distribution systems in 9 towns is also included in this scheme. These towns are: Peshawar, Mardan, Nowshera, Sialkot, Gujranwala, Lyallpur, Sargodha, Montgomery and Lahore.

In respect of electrical equipment for transmission lines and substations, 28 out of 32 tenders have been issued and evaluated. Contracts based on 13 out of 28 tenders have been finalized. Letters of intent have been issued in all the 28 cases. The physical progress of the work against these tenders is given below:

TRANSMISSION LINES

I Supply and erection of 66 kV lines in Peshawar, Rawalpindi and D.I. Khan Divisions as below:

i) Peshawar 66 kV Line Ring.

ii) Wah-Pindi Gheb 66 kV Line.

iii) Daudkhel-Chakwal 66 kV Line.

iv) Daudkhel-Tarag 66 kV Line.

v) Tarag-Makerwal 66 kV Line.

The work has been started; 40 per cent of material shipped and 10 per cent of field work completed. The scheduled date for the completion of the contract is March, 1963.

2 Supply and erection of 66 kV lines in Mianwali and Sargodha areas as follows:—

i) Mianwali-Piplan 66 kV Line.
ii) Piplan-Mankera 66 kV Line.
iii) Sargodha-Quaidabad 66 kV Line.
iv) Sargodha-Jhanian Shah 66 kV Line.
v) Sargodha-Lallian 66 kV Line.

Shipment of material to the extent of 40 per cent has been made and progress in the field is about 20 per cent. The scheduled date for the completion of this contract is February 1963.

3 Supply and erection of 66 kV lines in Sargodha and Multan Divisions comprising the following:—

i) Chichawatni-Shorkot Town 66 kV Line.
ii) Gojra-Tandelianwala 66 kV Line.
iii) Dera-Din Panah-Atharan Hazari 66 kV Line.
iv) Kot Adu-Leah 66 kV. Line.
v) Lyallpur-Bhawana 66 kV Line.

Nearly 90 per cent of the material such as conductors, towers and earth wire has been shipped and 70 per cent of it received at site. Overall progress in the field is 50 per cent and the work is about one month ahead of schedule. The scheduled date for completion is February, 1963.

4 Supply and erection of the Lyallpur 66 kV Line Ring.

Work has been completed and the line energized.

5 Supply and erection of 132 kV. Line in Multan and Bahawalpur Divisions comprising the following:—

i) Multan—Kot Adu 132 kV line.
ii) Montgomery—Bahawalnagar 132 kV line.

Materials to the extent of 90 per cent shipped. Overall progress in the field is 50 per cent. The scheduled date for completion is April, 1963.

6 Supply and erection of 66 kV Lines in Lahore, Bahawalpur and Multan Divisions comprising the following:—

i) Lahore Ring 66 kV Line.
ii) Bahawalnagar—Fort Abbas 66 kV Line.
iii) Bahawalnagar—Mcleod Ganj 66 kV Line.
iv) Thing Junction to Chunian 66 kV Line.
v) Multan—Jalalpur 66 kV Line.
vi) Multan—Mailsi 66 kV Line.

Materials to the extent of 60 per cent have been shipped and Overall progress in the field is 35 per cent. The schedule date for completion is March 1963.

7 Supply and erection of 132 kV and 66 kV Lines in the Bahawalpur area comprising the following:

i) Bahawalpur—Rahimyar Khan 132 kV Line.
ii) Ahmadpur East—Alipur 66 kV Line.

All materials have been shipped and overall progress in field is 65 per cent. The scheduled date for the completion is November, 1963.

Sub-Station

8 Supply and erection of sub-stations in Lyallpur 66 kV Ring.

Material ready for shipment.

9 Supply and erection of the Multan Grid Station 132/66/11 kV Line.

Letter of intent issued, and the letter of credit is being opened. The scheduled date for completion is December, 1963.

10 Supply and erection of 132/11 kV sub-stations at Bahawalpur, Ahmedpur East, Khanpur and Rahimyar Khan.

Letter of intent has been issued and letter of credit is being opened. The scheduled date for completion is December, 1963.

11 Supply and erection of 132/11 kV sub-stations at Bhawalnagar, Kot Adu, Muzaffargarh.

Letter of intent issued, and letter of credit is being opened. The scheduled date for completion is March, 1963.

12 Supply and erection of 66/11 kV sub-stations at Tandalianwala, Bahwana, Harike Road, Batapur and Chunian.

Letter of intent issued and letter of credit is being opened.

The scheduled date for completion is November, 1963.

13 Supply and erection of 66/11 kV sub-station at Fort Abbas, Mcleod Ganj, Jalalpur, Shujaabad, Jehanian, Mailsi, Alipur, Hasilpur and Chishtian.

Letter of intent issued and letter of credit is being opened. The scheduled date for completion is December, 1963.

14 Supply and erection of 66/11 sub-stations at Shorkot Town, Toba Tek Singh, Kamalia, Jhang, Khanewal, Mian Channu, Chichawatni, Vehari, Burewala and Gojra.

Letter of intent has been issued, and letter of credit is being opened.

The scheduled date for completion is November, 1963.

15 Supply and erection of 66/11 kV sub-stations at Lalian, Kalabagh, Makerwal, Jehanian Shah (33/11 kV(Bhamb, Raiwind and Laliani.

Letter of intent has been issued and letter of credit is being opened. The scheduled date for completion is December, 1963.

16 Supply and erection of 66/11 sub-station at Leah, Ahmedpur Sial, Atharan Hazari, Quaidabad, Mianwali, Mankera, Bhakkar, Pipla and Jauharabad.

Letter of intent has been issued and letter of credit is being opened. The scheduled date for completion is December, 1963.

17 Supply and erection of 66/11 kV sub-stations at Fateh Jang, Pindi Gheb, Talagang, Chakwal, Dandot and Gharibwal. Letter of intent has been issued and letter of credit is being opened. The scheduled date for completion is November, 1963.

DISTRIBUTION LINES

18 Supply and erection of 218 miles of 11 kV line in Rahimyar Khan, Bahawalpur, and Bahawalnagar areas.

Letter of intent issued. The scheduled date for completion is November, 1963.

19 Supply and erection of 226 miles 11 kv distribution line in Ahmedpur Sial, Atharan Hazari, Bhawan, Jehanian, Khanewal, Kot Adu, Leah, Multan and Shujaabad areas.

Letter of intent issued. The scheduled date for completion is November, 1963.

20 Supply and Erection of 228 miles of 11 kV lines in Chakwal and Sargodha areas.

Letter of intent issued. The scheduled date for completion is December, 1963.

21 Supply and erection of 11 kV distribution lines in Peshawar, Chiniot, Chunian, Jhang, Kamalia, Sumandri, and Shorkot areas.

Letter of intent issued. The scheduled date for completion is December, 1963.

RENOVATION

22 Contracts for the supply of power transformers to be utilized in Peshawar, Mardan, Nowshera, Sialkot, Gujranwala, Lyallpur, Sargodha, Montgomery and Lahore under the renovation scheme have been awarded and all material has been received at site.

23 Contracts for the supply of distribution transfomers to be utilized in 9 towns mentioned above have also been awarded, and all material ordered has been received at site.

SUPPLY OF MATERIAL ONLY

24 Contract for the supply of power transformers for Rawalpindi, Jhelum and Khairpur has been awarded Sixty per cent of the equipment has been received and the balance is on the way.

25 Contract for the supply of aluminium conductors, insulated aluminium conductors and cross-arms etc. for different towns mentioned uhder item No. 21 has been awarded and all the material ordered has been received at site.

26 Contract for the supply of copper wire and line hardware material has been awarded and the equipment has been received at site.

27 Contract for supply of power transformers and voltage regulators has been awarded and the entire material ordered has been- received at site.

28 Contract for supply of cross arms has been awarded and the entire material has been received at site.

Cost

The revised cost of the Secondary Transmission and Distribution Scheme is Rs 286.2 million. The increase of Rs 80 million over the original estimate is due to the enlarged scope of the scheme and rising cost of materials.

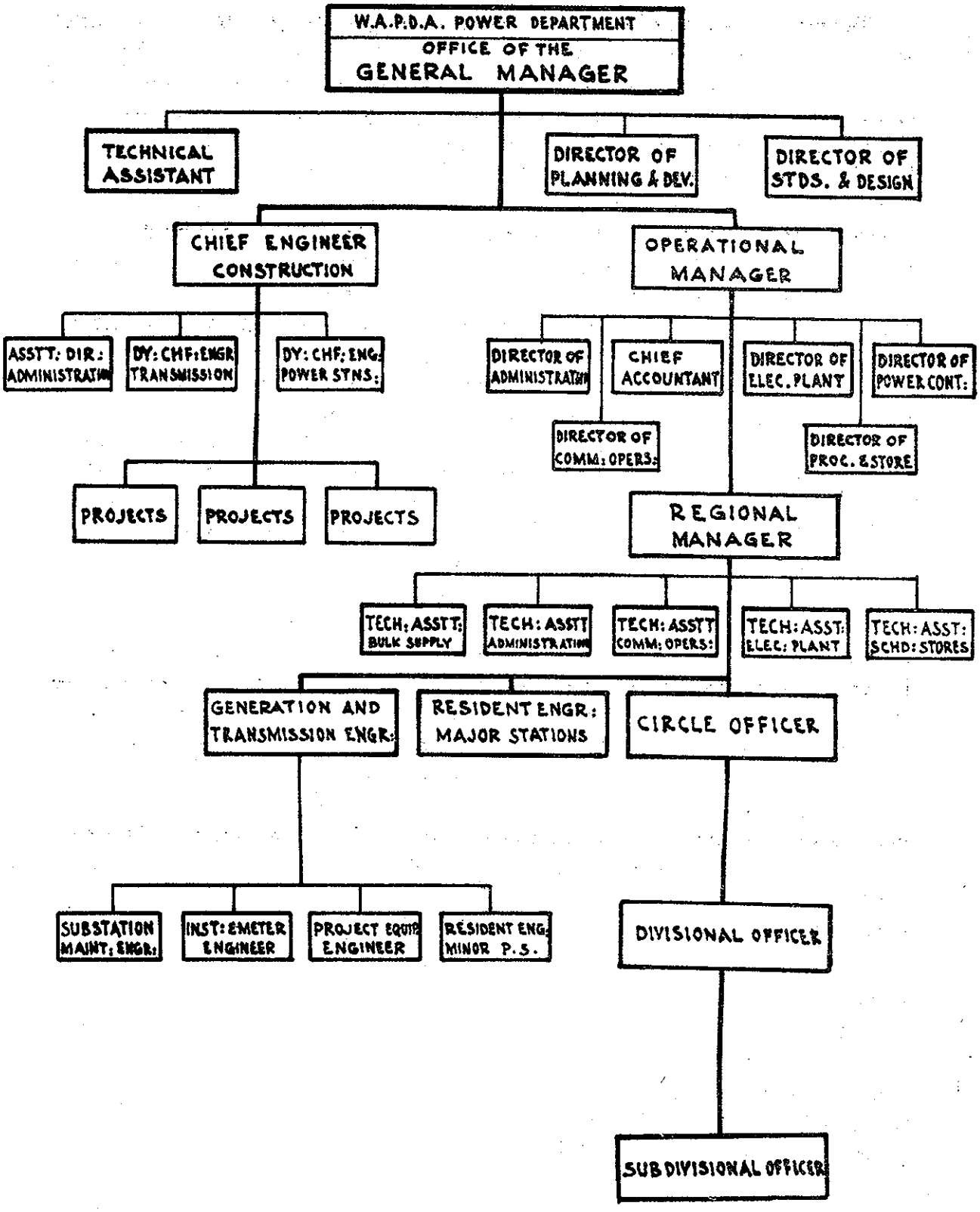
The upto date-expenditure is Rs 115.7 million.

ADMINISTRATION AND REORGANISATION

The rapid expansion of Wapda's activities relating to the generation, transmission and distribution of electricity made it increasingly difficult for the Power Wing to cope efficiently with the growing volume of work with the organisational set up as it existed at the time of the transfer of the Electricity Department from the control of the West Pakistan Government to Wapda in 1959. The department had evolved as a branch of the then omnibus Public Works Department and although expected to work on commercial lines was never organised on a commercial basis. Operations lacked the drive, initiative and the responsiveness of a business enterprise; the department's accounting followed the general pattern of government accounting and did not adequately reflect the strcitly commercial aspect of the year to year operations; the purely managerial aspects of the power system's operation were generally considered as of secondary importance; the system had aged and deteriorated but no in-built arrangement existed in the department for the orderly engineering and the large scale renovation and augumentation which the system demanded; through sheer lack of demarcation of functional responsibilities, most of them requiring specialised knowledge, the plant was inadequately maintained and this in time was affecting the efficiency of the service; with the expansion of the system, an increase in demand and an increase in the number of consumers more focal points of authority to dispose off routine day-to-day matters were necessary but decentralisation of authority had not kept pace with system needs; and a huge construction programme was ahead of the department but in the absence of an adequate construction organisation it was ineffectively looked after by the over-worked operational divisions. In short, the department generally lacked the structure, outlook and orientation of a progressive and responsive commercial organisation. A preliminary reorganisation of the department was introduced soon after its transfer to the Authority. At the same time arrangements were set in train for a detailed study of the organisation and system, and their respective strong and weak points with a view to evolving a new organisational set-up which besides meeting the demand would prove adequate for the foreseeable future. As a result of these studies, and availing of the experience of public utilities in other parts of the world, a new organisational set-up was devised and introduced in early 1962. Further details of the new organisation are given in the annexures.

Under the new organisation the Power Wing is headed by a General Manager under whom there are two functional heads: Operational Manager and Chief Engineer (Construction). The General Manager co-ordinates the work of the Construction and Operations branches. He directs the entire operation of the Authority's electric power systems in all their phases of planning, design, construction, maintenance and operation. This includes overall co-ordination and control, long-term planning and development, budget preparation and administration, revenues and

POWER WING ORGANIZATION



expenditures, public and employee relations, commercial operations, construction survillance and all other factors associated with the efficient and profitable working of the Power Wing.

The jurisdiction of the Power Wing is divided into four regions with a Regional Manager in control of each. The Regional Manager is responsible for the overall operation of Wapda's power system in his respective geographic region. He maintains proper relations with the public and governmental departments, and industrial and other consumer groups. He administers the budgetary procedure, revenue assessment and realization, promotion of energy use, construction of distribution facilities entrusted to him, maintenance and operation of the equipment placed in his charge, augmentation and renovation of works and all other activities connected with the efficient management and operation of the system. All the generation, transmission and distribution facilities installed in his region come under his responsibility except that the loading of generators, use of main transmission lines and the setting up of protective relays will be under the charge of Director (Power Control), who is directly attached to the Operational Manager.

The Chief Engineer (Construction) is incharge of the Development Branch of the Power Wing. He is responsible to the General Manager for administrating the construction programme for all major generation, transmission and distrubtion projects approved by the Authority and any other work specifically assigned to him. With the help of consulting engineers, where necessary he prepares specifications and tender documents and carries out adjudication of the bids received for placing orders with the approval of the competent authority. He is assisted by Deputy Chief Engieer (Power Stations) and Deputy Chief Engineer (Transmission and Distribution) who, as their designations imply, are responsible for generation and transmission and distribution schemes respectively.

This re-organization was introduced in February 1962 and in the short period of 4 months improvement is already becoming noticeable. The basic idea behind the new set up is to stress the management aspect of power operations and to delegate powers down the line so that consumers problems are handled nearer home, delays are avoided and the consumer utility relation no longer remains altogether impersonal and detached. It is confidentally hoped that as soon as conditions have stablized and the various charges created have been duly filled the functioning of the Power Wing will come upto all modern standards.

OPERATIONS BRANCH

With the reorganization of the Power Wing, the management and operation of the electric supply facilities in various zones has been placed under four Regional Managers each exercising more or less autonomous authority in his own jurisdiction. The work of the Regional Managers is co-ordinated by an Operational Manager who thus functions as the head of Operations Branch. The four regions are geographically located as under:

(i) **North Region with headquarters at Peshawar**

This region covers the civil divisions of Peshawar, Dera Ismail Khan and a part of Rawalpindi.

(ii) **East Region with headquarters at Lahore**

This region covers the civil divisions of Lahore, and a part of Rawalpindi.

(iii) **West Region with headquarters at Multan**

This region covers the civil divisions of Multan, Bahawalpur and Sargodha.

(iv) **South Region with headquarters at Hyderabhd**

This region covers the civil divisions of Hyderabad, Kalat and Khairpur.

The experience gained during the few months since reorganization has given indications that the delegation of responsibilities will lead to more operational efficiency. Reference to the head office have been reduced and closer contacts are being established between the consumers and the operations staff.

The Operations Branch carries out its activities with funds allocated to it under the head *Distribution of Power in West Pakistan*. Some of the main items on which these funds are spent are listed below:

i) To maintain all works, including power stations, transmission and distribution lines, sub-stations, consumers' service connections, repairs and testing, workshops and laboratories and communication and transport facilities.

ii) To pay for fuel costs.

iii) To meet all recurring and running expenses including a 4 per cent return to the Government on the capital invested by it.

iv) To meet all establishment charges.

v) To procure stores for use in giving new connections, augmentation, renovation and extension of distribution works.

vi) To modernize the equipment in power stations, grids and distribution sub-stations.

vii) To procure workshop and testing equipment to meet the growing needs of the system.

The variety and scope of the above charter shows that without adequate funds the performance of the Operations Branch is bound to be adversely affected. The efficiency of the Branch has to be measured against the facilities provided to it. There has unfortunately been an inadequacy of funds in the past, particularly in foreign exchange with which stores are procured from abroad.

In spite of this handicap the Operations Branch has made progress in several directions as reported in the chapter entitled *Operational Record*. With the funds mentioned above the Operations Branch undertakes the installation of small generating sets, the extensions of high tension lines, installation of high tension sub-stations, extension and provision of low tension lines and all service mains to the consumers.

Augmentation and Renovation

As already mentioned earlier in the report the distribution system in some of the large towns of West Pakistan has deteriorated through age. The section relating to the Secondary Transmission and Distribution Project has already described the efforts being made to augment and renovate the distribution systems in Lahore, Montgomery, Lyallpur, Gujranwala, Sialkot, Peshawar, Nowshera and Mardan. For work to be carried out under the Secondary Transmission and Distribution Project in these towns Wapda has provided for special staff under the Construction Branch. Augmentation and renovation, however, is a continuous process and the Operations Branch has been carrying on this work in cases of urgent need in the towns mentioned above and in other towns not covered by the renovation programme under the Secondary Transmission and Distribution Project.

During the year under report more than 100 miles of high and low tension lines, 62 out-door stations of an aggregate capacity of 12,000 kVa, 10 in-door stations of an aggregate capacity of 53,000 kVa were installed by the Operations Branch to augment the existing facilities in the grid area.

In the Upper and Lower Sind zones the generating capacity was augmented by about 900 kw with the installation of additional diesel sets at the following undertakings:

Station	Installed Capacity		Increased Capacity
	1960-61	1961-62	
Larkana (Upper Sind) ..	1266 kw	1866 kw	600
Tharushah (Upper Sind) ..	319 kw	519 kw	200
Kandkot (Upper Sind) ..	40 kw	120 kw	80
Shujawal (Upper Sind) ..	40 kw	65 kw	25
Total ..	1665 kw	2570 kw	905

In addition to the above, augmentation of the distribution system was carried out in Hyderabad town and some of the smaller towns. An 11 kV ring was laid around

Hyderabad and the capacity of the distribution system was increased by converting the feed of certain areas from 3.3 kV to 11 kV.

Lines with 11 kV capacity were also laid in the Upper Sind area connecting Kambar, Ratodero and Naudero with the Larkana diesel station. These lines are at present under test and are expected to be energized in the next few months.

During the year Wapda was authorized to run parallel distribution lines in Thatta, Gambat, Tando Adam and Shahdadpur where private electric supply undertakings are functioning.

Village Electrification

A scheme for the electrification of 5,000 villages was approved by the Government last year. An application had also been made to DLF for the financing of this scheme. During this year Wapda was required to submit a revised application based on a yearly phased programme. Another application was consequently prepared covering 500 villages to be electrified during the year. The reaction of the DLF to this application is awaited.

In the meantime the electrification of villages has been going with funds alloted under *Distribution of Power in West Pakistan*. The total number of villages electrified during the course of the year was 241. The demand for supply of power to villages is increasing daily but the activity in this field is restricted due to the limitation of funds. It is hoped that on the maturity of the loan from DLF or any other financing agency it will be possible to increase the pace of the programme.

Electrification of New Capital

A request was received from the Capital Development Authority for the electrification of the new capital at Islamabad. Commonwealth Associates have been appointed as consulting engineers to prepare a scheme which will be presented to the Capital Development Authority. After the design of the system is approved, the works will be carried out under a financial agreement to be settled between Wapda, Capital Development Authority and the Government.

Technical Personnel

With the system growing day by day the requirement of qualified engineers and technicians goes on increasing correspondingly. The work of the Power Wing is frequently handicaped for want of suitably qualified and experienced personnel. The number of engineers being turned out by the universities for the present is insufficient to fulfill the requirements of the country. Many of the posts which have to be filled by qualified engineers are presently manned by non-qualified subordinates who are promoted on the basis of their practical experience. This, in turn, leaves a void in the ranks of upper subordinates. Here again the existing institutions in the country providing facilities for the education of this class of personnel are not turning out adequate numbers. The shortage of trained and qualified staff is therefore adding to the difficulties of the Power Wing.

Training

In view of the problems created by the shortage of experienced and qualified personnel Wapda has set up an Institute for Training. For the present this Institute caters for the training of sub-station operators and linemen. It is intended in the near future to expand the Institute to cover the training of line superintendents as well as sub-divisional officers.

Tariff

On assuming charge of the Electricity Department Wapda immediately proceeded to reexamine the tariff structure. An expert was loaned to Wapda by the French Government who after working for nearly 4 months prepared a tariff structure taking into account the past, present and future development of the system. His recommendations were further examined by the Power Wing and by the Authority and the new tariff structure was adopted with some modifications to the proposal made by the French expert. In the revised tariff the supply rates to the general consumers and small industries were considerably reduced The guiding principle in fixing the new power rates was the relevant clause in the Wapda Act saying, "The rates at which the Authority shall sell power shall be so fixed as to provide for meeting the operating costs, interest charges and depreciation of assets, the redemption at due time of loans other than those covered by depreciation, the payment of any taxes, and a reasonable return on investment."

In the Southern region, the supply was being given at different rates in different towns. In order to bring the rates on a uniform level as far as possible, the tariff applicable in the main grid area was introduced with slight modifications. This has afforded a considerable relief to the consumers of the area. Wapda also recommended to the Government that the duty imposed on the consumers of electricity be dispensed with. This has since been done thus bringing the consumers in the Southern region at par with those of the main grid area.

Power Commission

The Government of Pakistan has set up a Power Commission with following terms of reference:

(a) To determine the power requirements of East and West Pakistan for the next 10 years and beyond and to make recommendations regarding sources of generation of power, including nuclear, to meet the requirements.

(b) To conduct a comprehensive examination of the power rates obtaining both in East and West Pakistan for commercial and domestic uses and to make recommendations regarding their rationalization with particular reference to cheap supply of power to boost production in different parts of the country, taking into consideration the special needs of under-developed areas.

(c) To suggest revision of Electricity Rules, 1937, consistent with reasonable safety requirements and designed to achieve economies in investments in transmission and distribution lines etc. so as to bring down power cost.

(d) To recommend agencies for generation, transmission and distribution of power in the light of local conditions.

(e) To examine whether there is need for a permanent organization preferably one in each Province, to supervise matters relating to distribution of power and fixation of power rates.

(f) To consider whether power should be supplied at a low rate in order to encourage industrialization, and the capital involved amortised through other means, such as taxation on industrial products.

(g) To make any other relevant recommendation.

The General Manager (Power) is a nominated Member of the Commission. Full co-operation is being given to the Commission by Wapda. The points of view of the Authority on various issues raised by the Commission have been expressed in its answers to the Questionnaire issued by the Power Commission. Further expression of opinion is made through the General Manager or by communications directly exchanged between the Authority and the Chairman of the Commission. Wapda's answers to some of the more important questions formulated by the Power Commission are given in the annexures that follow.

WAPDA'S ANSWERS
TO THE POWER COMMISSION QUESTIONNAIRE

Question 1.—To what extent and under what circumstances, should generation, transmission and distribution of electric *power, be in the public and private sectors?* Please give reasons.

Answer. (1) In considering the answer to this question certain basic postulates should be recognised.

(a) *the generation, transmission and distribution of power are not separate,* mutually exclusive activities any one of which can be undertaken as a profitable human endeavour in the absence of and without regard for the other. They are integral links of one chain designed to place electrical energy (power) at the service of man.

(b) the supply of power is not an end by itself; it is a means to an end—the end, among others, being to provide an infra structure for the economy.

(c) for a developing economy or for that matter for a healthy growth in a free economy anywhere it is essential that the transferable or service cost of the social overhead (infra structure) capital is kept at the minimum possible.

(d) the field of power supply (generation, transmission and distribution taken collectively) is one of the most sensitive to economies resulting from the scale of size and operation obtained by operating interconnected systems (grid operation) linking up all types of generation and reaching the ultimate consumer. This in turn involves large capital outlays with disproportionately low expectancy of investment returns.

(e) grid operation is a highly technical and intricate activity and can best be undertaken, particularly in conditions of shortage of technical talent, under undivided, unitary direction.

(2) Proceeding from these considerations a large electric power concern usually represents a fully integrated unit consisting of generation, transmission and distribution and it is most difficult to think of one part of such an integrated system being operated under one management and the other parts under another management, although such operation may be possible.

(3) A large integrated power system also represents and requires an exceedingly large capital investment over a period of many years and its earning power per unit of investment is far less than that of any other type of industry, such as textiles, sugar, oil, metals or other common industries where annual earnings are high in relation to invested capital.

(4) It is for these reasons that private sources of capital funds, particularly in developing countries where capital formation is still in its infancy and where other investment opportunities are large and more remunerative are not readily attracted to an investment

of this kind. Government remains as the only certain source of capital and Government of course, has a direct interest and responsibility in furnishing this capital.

(5) In West Pakistan the principal source of power for the balance of this century at least will be from hydro plants located on rivers which are used for irrigation as well as power purposes. The entire production of electric power from these rivers is so intimately associated with irrigation and flood control for the public welfare that it is difficult, if not impossible, to disassociate one from the other.

(6) Of considerable importance in considering public versus private ownership of any portion of an electric power system is the fact that a suitable profit margin must be maintained if such investments are to be made attractive to private investors. While publically owned and financed systems must also be operated in a solvent manner, the margin of earning can be much smaller.

(7) It is true that many foreign electric power systems are completely financed and operated by private investors in an efficient manner and with a suitable profit margin. Almost without exception, however, these privately operated systems were started at the very beginning of the use of electricity itself. At that time the investments required were very small in keeping with the small use of electricity. Electric rates were high and profits also were high, and right from the start, and from a small beginning, these privately owned systems enjoyed favourable rates. They grew as the use of electricity grew and capital was always available from earnings. This is not the situation in West Pakistan today where all kinds of modern power using equipment and devices are available where there is every encouragement to use electricity to the fullest, where the highest degree of continuity of service is desired and where low rates are expected. Private capital cannot be attracted to such a situation and, if it were, would very likely be unable to meet the conditions as is amply demonstrated by the history of electric power development in this country since independence.

(8) The situation of private ownership of electric power system in under developed countries is well illustrated in Latin America. In many of these countries, notably Mexico and Columbia private interest have until recently owned and operated entire systems or major portions of them. However, in recent years the incompatible requirements of large new investments, superior service, high operating costs and low rates have made it absolutely impossible to raise capital funds from private sources. Accordingly, many large electric power systems have now changed to public ownership.

(9) The experience of the British is also of interest. Many years ago Britain was served by a great many small power companies—each supplying a very small area and each having its own particular standards and methods of supplying electricity, with voltages and even frequencies—varying widely. Although this situation was corrected many years ago when public power was established to relieve situation, it is illustrative of a situation which could develop when many small publicly operated systems, or portion thereof, should become well established.

(10) Even in the U.S.A. where traditions of private enterprise are the strongest and where the private sector is both technically and financially fully competent to instal the required generating, transmission and distribution facilities and where at the political plan all public sector policies of government aimed at creating a welfare state or giving a New or Fair Deal are scrutinised for their supposed "non-violent Marxism" content the wind of change from private to public ownership would seem to have started blowing stronger and stronger. Starting with less than 1 per cent of all electrical utilities in the

country in 1933 the Federal Government was by mid 1953 by far the largest single producer of electrical power. It had invested $ 2.3 billion in power facilities and was supplying practically all the electric power in Tennessee and was major supplier in Alabama, Mississipi, Washington, Oregon, Montana, California, Arizona and Nevada. It produced power in 22 states and was selling it in these and 5 other states. Federal projects authorised and under construction for completion in 1960 at a total cost of 10 billion dollars were expected to triple the 1953 capacity. These figures are exclusive of the appropriations to the Federal Rural Electrification Administration for generating, transmission and distributing facilities which as of June 1953 totalled over $ 2.7 billion.

(11) Finally, in privately operated systems working purely from a profit motive there is a tendency to maximise profits by serving only the large population areas. There is a reluctance to supply small towns and villages where the investment is very high in relation to revenue. While publicly owned systems, expected to operate in a solvent manner, face the same problem, there is a greater possibility of their serving less profitable areas by pooling and utilising these profits from the highly remunerative load centres for the benefit of the not so remunerative areas.

Question 2.—Do you think that electric power stations should be established by agencies in the public sector in the first instance and then handed over to private sector? Is private sector in Pakistan prepared to take over power generating stations established by agencies in the public sector and if so, on what terms and conditions?

Answer. Although the building of industrial plants by the public sector and their later transfer to the private sector has been by and large successful and of great importance in expanding West Pakistan's industrial productivity, this same procedure does not have a similar application and will not be valid for large electric power systems. These systems constitute completely integrated units which must be operated as such "from generation to utilization". Much of this question has been answered in question 1 but, it can be added, that the integration of generation, transmission and distribution represents a highly technical operation and is sufficiently difficult even when under a single ownership. Dividing it into two or more ownerships makes the problem increasingly difficult and probably excludes the high degree of efficiency which can be made inherent in single ownership operation.

There is also another aspect of this question which seldom receives its rightful consideration but is worthy of serious attention. In a large integrated system there is usually a much greater opportunity for technical training and advancement than there is in the smaller systems or portions thereof, it is difficult to obtain proper "know-how" and to secure higher levels of advancement in the smaller systems.

Question 3.—If you think bulk of electric power should be generated by agencies in the public sector, do you recommended that distribution should be left to private sector or should distribution also be handled by agencies in the public sector? Please discuss any other alternatives on this subject, if any, in answer to this question.

Answer. Many of the answers to Question, 1 and 2 have a direct bearing on this Question but, of greatest importance in any of these answers, is the importance of maintaining an integrated and unified operating system. Public ownership of generation and transmission, private ownership or any type of ownership which involves a second party is not

deemed to be as desirable as single ownership. In Britain, local area boards (public bodies again) purchase power from a central generation and transmission (grid) system. Such is the case in a few other countries also. However, the actual degree of success of such operations is difficult to assess although, at the very best there is certain to be some duplication of effort. It should be mentioned that the investment in any distribution system represents at least one half of the total investment in any completely integrated power system. This can be a sizeable sum and, therefore, problems associated with securing capital funds, and the profit motive also, will always be of considerable concern.

Question 4.—Would it be advisable to encourage the formation of cooperatives, local bodies and similar organisations to buy electric power in bulk and handle distribution in the areas falling within their jurisdiction?

Answer. The suggestion in Question 4 is the same as that used by the British and commented upon in the answer to question 3. It is believed that in the case of Wet Pakistan, where single ownership operation is in general use throughout the Wapda Grid area, it would be unfortunate now to devise local organizations of any kind to distribute the electric power now available from the grid system. If these local bodies are to be the same local governmental units as now exist, it is believed that this would introduce many new difficulties which do not now exist. A large majority of service interruptions in any electric power system can be ~~treated~~ traced to the local distribution facilities and a large number of skilled personnel are required to handle them. It is believed that local governmental agencies are sufficiently concerned with the problems associated with Government itself to preclude their being burdened with problems of a highly technical and difficult nature. In addition as mentioned earlier the investment in the distribution portion of an electric power system is probably more than half of the total plant investments, which makes the problem of financing rather too formidable for local bodies or cooperatives.

Question 5.—Please state whether private foreign investment in the electric power industry should be encouraged and if so, in what segments and on what terms?

Answer. In the first paragraph of Question 1, reference is made to the fact that earnings on investments in electric power systems are far less than for other types of industry. Even in the more lucrative fields of industry, it has not been possible to attract in adequate numbers foreign investors who usually expect guaranteed profits of an amount which a public utility can hardly bear. In the Sui Gas fields, foreign investors have been attracted by giving them a guaranteed profit on their investment with the result that our gas prices are perhaps the highest in the world.

Question 7.—As most of the power projects in Pakistan have to be financed out of foreign loans obtained under specified terms and conditions of repayment which may not permit supply of electricity at rates considered reasonable by you, do you think the rates should be subsidised? If so, what form of direct or indirect subsidy would you recommend?

Answer. It is the duty of Wapda to supply electricity at the lowest possible cost consistent with good service. If the production costs of power from projects financing by foreign loans are not sufficiently low to permit the sale of electricity to consumer at rates considered reasonable, Wapda's overhead cost and arrangements for generation of course being satisfactory, then it would be the duty of Government to decide whether subsidies would not be appropriate. Where the foreign financing is in the form of grants, but be-

cause of the peculiar conditions of the grant the cost of the completed project is not competitive with world prices there would be a strong case for the government to treat the grant as grant and not charge it to the capital value of the project at least to the extent of difference between the cost of the completed project and world prices. It is believed that the electric power industry should operate on a commercial basis leaving a modest percentage of profit to maintain its solvency—with due and appropriate allowances being made for all operating expenses. Such expenses should include debt service, depreciation allowance and other appropriate overhead charges as well as reserves for emergencies. For reasons of economic or social policies government may decide to help a particular type of industry or class of service or a particular region. In such a case government should authorise separate funds for such a subsidy for credit to the electric system operations, rather than provide a concealed and indirect subsidy by requiring, against the cannons of commercial propriety, the electric system to undergo a loss on the particular type of supply.

Question 8.—Are you in favour of uniform electricity rates applicable to different classes of consumers throughout the country on an all-Pakistan basis irrespective of location and resources of generation of power?

Answer. It is believed that it would be impractical to try to establish uniform rates throughout all of Pakistan; uniform rates are practical only when applied to users served from a completely integrated power system. The rates in any isolated system depend entirely upon the economics of the particular system and cannot be "Averaged out" for several systems, where situations are likely to be dissimilar. Uniform rates between West Pakistan and East Pakistan are any how out of the question.

Question 9.—Do you suggest that there should be uniformity of rates applicable to different classes of consumers, at least on a provincial basis or do you think there is justification for different rates in different regions of a Province? Please state full reasons.

Answer. As stated in the answer to Question 8, it is believed that uniform rates are applicable to users served from a common grid system. It is also believed that uniformity applies with reference to the different classes of users. The philosophy which underlines electric tariffs recognizes that service to any user involves a fixed cost plus a variable cost. The fixed cost is based upon the investment required to serve a particular class of user while the energy cost represents fuel, maintenance and operating expense. The investment per unit of demand varies appreciably for difference classes of users. On the other hand, it varies only slightly between users of any given class and it is believed that their inclusion in a single rate is fair and equitable. As previously stated, there may be justification for different rates in different regions where these regions are isolated and are not supplied from a common grid.

Question 11.—Do you agree that Electricity Act 1910 and the rules framed thereunder as adopted in Pakistan, need amendments and modifications? If so, please suggest changes with reasons thereof.

Answer. It is agreed that the Electricity Act 1910 and the rules framed thereunder and adopted in Pakistan need amendments and modifications are badly needed. During recent years there have been very extensive developments in the design of electric power system, the use and application of materials and equipment, the amount of electricity generated and used and service requirements in general. It seems quite certain that new economies can be achieved without jeopardising safety of the public if the rules of 1910 are revised.

Amendments to these rules are now being undertaken by a sub committee of the Power Commission which has recently been formed for this express purpose.

Question 12.—Since the business of generation, transmission distribution and sale of electric energy involves an essential service to the public, do you favour the establishment of a Statutory Body or Bodies with powers to watch the interest of consumers and to regulate all business practices relating to electricity supply industry including the fixation of electricity rates?

Answer. It is understandable that some agency of the government might be desired to watch the interests of consumers and to regulate business practices, including rates, in cases where electric power systems are privately owned and operated purely for private profits. However, where the electric power systems are owned by government and are operated on behalf of the government by an agency, statutory or otherwise, of government such a regulatory body is neither necessary, nor even desirable. As long as the electric power system remains in the public sector and is operated within the framework of procedures and policies already established by government there is no need for such a regulatory body. Besides electric power there are several other "essential services" to the public, but where such services are owned operated by Government or Government sponsored and controlled agencies the need for other agency to safeguard the interests of the consumers has not arisen and should not arise. The actions of all public agencies are in ultimate analysis the actions of the government; government also in ultimate analysis is the protector of interests of all sections of the society. There is no chance, therefore, of any public agency perpetuating anything inequitable or against the interests of the public, be it in regard to tariffs or matters of a general nature, because government is always in a position to intervene and adjust such matters in the best interests of the public. It should be noted that even the institute of Electric Inspector of government created to safeguard the interest of public was justified only in conditions of 50 years ago when electric power supply was envisaged to remain in private hands. Today and in today's conditions it is merely a relic of the 1910 Act and would appear, but perhaps for the existence of a few private electric supply undertakings, altogether reduntant.

Question 19.—Can you suggest methods of improving the load factor of power stations such as linking together complementary generating and consumption areas, diversification of consumption and development of demand during off-peak hours for irrigation, domestic, commercial and industrial purposes?

Answer. The load factor of the Wapda system has been very good in comparison with the load factor of similar systems throughout the world. The highest load factor in recent years was 73% in 1958. The load factor dropped noticeably (to 58%) in 1960 because of the addition of generating capacity and the abandoning of load shedding but it is now on the increase and reached 60% in 1961. Maintaining a high load factor is the desire of every major electric power company and Wapda is encouraging the use of off-peak loads as much as possible. This is evident by the off-peak pumping rate which is available for tube-well installations.

Question 23.—What are your present arrangements for the proper maintenance of your equipment, including generation, transmission and distribution? Do you consider these arrangements as adequate and satisfactory? If not, what measures would you suggest for improvement?

Answer. Although the proper maintenance of equipment in any electric power system

is essential to satisfactory operation, few systems throughout the world probably have the maintenance programmes that they desire. Such is the case in the Wapda Grid System area which as for as maintenance is concerned including renovation, modernization and replacements suffers from a lack of funds particularly foreign exchange and lack of adequately trained staff at the junior levels. At the principal generating stations there is adequate staff of maintenance employees specially trained abroad or as under studies to foreign experts on the jobs and the maintenance of these plants is good. There is however a distinct lack of maintenance personnel in major transmission and distribution sub-stations. Special training programmes are now in progress and efforts are being made to augment them. It would be necessary and steps are being taken to that end, to train suitable technicians in foreign countries also as training for the use of the complex of equipment which is an integral part of more efficient system operation cannot efficiently be arranged within the country. There is also currently a serious lack of communications throuhgout the grid area. Carrier communication is now being installed throughout the grid, and on completion of the programme in hand during the current year the situation is expected to improve greatly. Good maintenance programmes also depend greatly upon the availability of proper and often specialised equipment and many of these facilities are lacking. An adequate central electrical laboratory where all testing facilities can be coordinated is greatly needed. A scheme put up by Wapda for establishing a Research and Test Laboratory has recently been approved by government and work will be taken in hand on it as soon as funds are made available in the coming financial year.

Question 24.—What is the average cost per mile of a single and a double circuit transmission distribution line of voltages of 11 KV and above in your area of supply?

Answer. The cost of overhead transmission and distribution lines varies widely and it is difficult to deal in average costs. Costs vary greatly depending upon the nature of the terrain, cost of rights of way, type of circuit and arrangement, and the size of the conductor itself. However, the following costs appear to be typical for lines recently constructed:

		Cost per mile	
		Single Circuit	Double Circuit
		Rs.	Rs.
1.	11 KV Line with Bare Copper conductor No. 5 S.W.G.	16,000	28,000
2.	11 KV Line with Alluminium conductor	11,000	20,000
3.	33 KV Line with A.C.S.R. Conductor (0.1 sq. in. Copper equivalent)	25,000	40,000
4.	66 KV Line with A.C.S.R. Conductor (0.1 sq. in. Copper equivalent)	35,000	50,000
5.	132 KV Line with A.C.S.R. (0.125 sq. in. Copper equivalent)	60,000	75,000
6.	220 KV line with A.C.S.R. conductor (0.4 sq. in. Copper equivalent)	1,00,000	1,70,000

Note: 1) The above costs are based on the rates of material and labour prevailing during 1961.

2) Steel Tubular, poles have been used for 11 & 33 KV and Lattice Steel Structures for voltages above 33 KV.

3) The above costs do not include the cost of special foundations in waterlogged and hilly arears.

Question 31. What is the anticipated maximum demand of power year wise during the next ten years and beyond in your supply areas? Please state whether projected demand has been based on actual market surveys or on some other basis. If possible, give the break up of the demand in Proforma XIII for each of the five classes of consumers referred in Question 20.

Answer. Although the estimated maximum annual demands now being used for the Wapda grid system are given in detail in Proforma XIII, it should be stated that a complete and comprehensive power market survey is now being conducted by Wapda and will be completed in 1962. From this Survey will be determined for each Division.

(a) The potential demand in 1962.

(b) The demand in 1962 if all electrified loads had been supplied from a common grid system.

(c) The estimated demand in 1964.

(d) The estimated demand in 1967.

In 1959 an interim power market survey was made for the grid area. The demands included herewith are those agreed upon in February 1961 with representatives of the Central Government.

Question 32.—How do you propose to meet the projected demand during the next ten years and beyond? Please give the details of the schemes and the stage at which they stand.

Answer. New generating capacity required to meet the power needs through 1970 has been the object of a thorough study both by Wapda and its consultants.

Question 35.—Have you experienced a shortage of trained manpower to run and maintain the power stations, transmission and distribution lines? Please give an estimate of your requirements of trained manpower and estimated availability under each category during the next five years.

Answer. A shortage of trained manpower, both amongst officers and subordinates has either been or is likely (with the expansion in hand) to be experienced in all departments of power system operations. An estimate of the requirements and personnel available are indicated herewith.

Requirements and availability of personnel during next five years (Power Wing) Wapda.

	Engineers		Technicians skilled and semi skilled	
Years	Requirements	Availability	Requirements	Availability
1961—62 ..	50	20	460	100
1962—63 ..	40	20	460	150
1963—64 ..	40	20	460	150
1964—65 ..	40	20	460	150
1965—66 ..	40	20	460	150
Total ..	210	100	2300	700

Question 36.—If you foresee any shortage of manpower, do you have any programme of training in and outside Pakistan? Have you taken full advantage of training facilities offered under Colombo Plan and other Technical Assistance Programmes? What difficulties, if any, have you experienced?

Answer. Knowing that Wapda is or will soon be faced with a shortage of manpower, a programme of training for engineers and technicians has been formulated. Use has been made of the Colombo Plan and to some extent other Technical Assistance Programmes, the serious difficulty in expediting these programmes is the fact that almost two years are required between the initiation of any programme and the time when it materializes due to various channels through which it has to pass.

Question 37.—Have you any budgetary provision for financing research in the problems of power generation, transmission and distribution? What percentage of your development funds for the projects can you spare for research?

Answer. In considering the answer to this question, care should be taken to distinguish between "Research" and the normal problems of electric power system operation which are associated with the use of highly technical laboratory equipment. Much laboratory equipment of a precision type is needed for the day-to-day operation of a power system and the use of such equipment is sometimes improperly referred to as "research". For this reason, no budgetary provision has been made for financing what could be termed "research" in the problems of power generation, transmission and distribution. However, funds are provided annually for electrical testing and for various types of laboratory work associated with system operations. Recently the Government of Pakistan has approved a plan for the establishment of a research and testing laboratory which will cost Rs. 47,00,000. It is expected that this laboratory will be completed during the Second Five Year Plan and about Rs. 5,00,000 a year will be made available for carrying out the work associated with its operation.

Question 39.—What in your view, should be the criteria for electrification of rural areas on an economic basis? How many unelectrified towns and villages in your area would meet these criteria?

Answer. Wapda has already established criteria for the electrification of rural areas. It is that all villages which have a population of 1000 or have 200 pucca houses should be electrified in the course of next 5 years or so. In accordance with this rule, about 8753 villages would be electrified. Priority will be given to those villages which happen to be located near existing or proposed lines. Special consideration will also be given to villages which are near a line built principally to supply power to tubewells.

Some rural electrification is also possible (and undertaken) as part of the normal distribution programme. An ordinary supply line to a factory or other large consumer can most conveniently be and is often utilised to give power to hamlets and villages on the way.

Question 40.—Are there any unelectrified towns and villages in your supply area which are beyond the economic reach of central power supply? if so, please mention their approximate number.

Answer. It is most difficult to answer this question as stated in as much as Wapda believe there is no such thing as "economic reach" of central power supply unless the

central supply system is assumed to be something static. What is beyond economic reach today, comes within economic reach the next day when the system is expanded in a planned and orderly manner. Within the economic reach however there will be uneconomic loads which are not picked up unless they become economical or the system revenues are adequate to absorb the losses and it is considered in the general interest of the economy to pick them.

Question 42.—What is the average cost of electrifying a typical village in each supply area? Please give a general break up of the cost against major items. How can the cost of electrification of rural areas be reduced?

Answer. It is difficult to determine the average cost of electrifying a typical village so that the cost can be meaningful or useful. However such an average cost has been determined to be Rs. 60,000 which is further sub-divided as follows:—

1.	Cost of transmission line	Rs.	24,000.00
2.	Cost of pole mounted sub-station	Rs.	6,000.00
3.	Cost of distribution lines	Rs.	20,000.00
4.	Cost of service line and material	Rs.	10,000.00

It is believed that the cost of electrification of rural areas can be kept to a minimum by such practices as (a) a proper and economic plan for power supply for an entire area, (b) adequate and proper construction standards, (c) standardization of materials which will permit their repetitive use for all programmes, (d) the use of a minimum number of types of material and equipment (e) an orderly and realistic construction schedule (f) availability of materials as the construction schedule requires, (g) adequate construction tools and equipment, and (h) well trained and supervised construction forces—measures which are all receiving attention.

Question 44.—What are the electricity rates applicable to the different classes of consumers in villages at present? Should individual consumers receive metered service or should they be charged at a flat rate?

Answer. The electricity rates applicable to the different classes of consumers in villages at present are the same as those being charged to electricity users in towns and cities.

It is strongly recommended that all individual users should receive metered service and that flat rates should be permitted only in cases of emergency. Unmetered service is most objectionable from the point of view of any electric power system because (a) there is no record of the amount of kwh used and this must be estimated for record purposes, (b) it is almost impossible to limit the use of electricity to that provided in the flat rate, and (c) there is no incentive to be economical in the use of electricity and it is invariably wasted.

Question 45.—What is the total hydro-electric potential in East and West Pakistan separately? What is the basis of the estimate? What part of the total hydro potential is economically exploitable? Please furnish a list of the feasible projects showing the expected generating capacity, the capital cost involved, the cost of generation per kwh and the period of construction in Proforma XVII.

Answer. Estimates of the total hydro-electric potential in West Pakistan vary from 10 million to 30 million kw, with the later figure being recognized as reasonable. (See appen-

dix). It is impossible to say what portion of the 30 million kw would be economically justified because economic conditions change from year to year and no one can say what the investment costs will be in the decades ahead. Obviously, if fuel costs increase, greater investment costs in hydro projects will be justified. On the other hand if new low costs fuels are discovered in the years to come, then a lesser amount of hydro power will undoubtedly be justified. It can be stated with certainty however that the total power needs of the province (with the exception of some areas in Baluchistan where the demand will be almost negligible) for the balance of the century (with possible exception of some firming up capacity) can be met by "economically exploitable hydro potential."

Question 61.—Do you think electric power should be generated wherever possible with the help of wind power, solar energy and tidal waves? Would you suggest an intensive research programme for harnessing power from these sources?

Answer. It is believed that electric power should be generated from sources which have already proved to be economical and in the public interest. Obviously, this precludes for the time being the generation of power using wind, solar energy or tidal waves for the reasons that none of these sources has yet proved to be comparable with sources which are economically available. In a country like Pakistan where funds for new power plants must be borrowed from outside sources, until such time as the economy makes capital funds available, it would appear imprudent to make substantial investments in experimental projects whose hope for success can, at best, be only questionable. The exploitation of the new sources of energy is already receiving a good deal of attention abroad and considering the limitations of funds and technical talent in the country it would perhaps be in the interest of the country to watch and await, and avail the result of these researches rather than embarking on ab initio fundamental research except possibly in fields where we have a distinct advantage over others.

Question 67.—In view of the overall shortage of power and the limited natural resources for generation of power in the country, should nuclear power stations be established where economically feasible and competitive? What priority should be given to the nuclear power programme in the country?

Answer. From answers to the previous questions it will be noted that any overall shortage of power will not be caused by "limited natural resources". There is adequate hydro potential in West Pakistan for the power requirements of the next 3 or 4 decade—even if the country's power demand would double every 10 years. With reference to nuclear power stations, it would be logical to build them if they were economically feasible, could compete with other types of generation using the lowest cost fuels, were in the public interest, if they utilised nuclear fuels of a kind which would be available in the country in sufficient quantities for many years in the future, and that adequately trained technical staff would be available. Apparently, it would be most difficult to satisfy all of these conditions. Until nuclear power plants can be built at a much lower cost than at present and until such time as the cost of nuclear generation becomes predominantly in favour of nuclear plants, the programmes for now generating plants now in progress should continue.

Question 72.—What measures by way of improvement in the working of your supply system etc. would you suggest to reduce the existing rates in your supply areas. Please give full reasons.

Answer. In most electric power system the largest part of the cost of producing electricity consists of the fixed charges on the investment required to serve the users. This is particularly true in any system which received the most of its power from hydro generation. Obviously, one way to reduce electric rates would be to reduce investments in the power system itself. It is quite unlikely that investments in new hydro plants will be much less than those in the past because of rising costs of material, equipment and labour. However more than one half of the investment in an electric power system is in the transmission and distribution portions, both of which have great possibilities for cost reduction. Wapda recognises that there are always opportunities for reduction in investment in the transmission and distribution system and is mindful that the constant review of design and construction practices offers many opportunities for cost reduction. These can be realised to their fullest when proper recognition is given to (a) standardized patterns of power supply to towns and cities, (b) complete standardization of transmission and distribution materials, (c) adequate warehousing of construction materials and equipment, (d) a complete and carefully prepared set of overhead line construction standards, (e) complete standardization of substations with respect to size, equipment, design and construction with the full use of out-door equipment, and many other items which offer cost investment savings and service improvement as well. Constant surveillance of these and other similar items make the possibility of reduced costs in transmission and distribution system a reality. This is a continuing function and is always present in any well operated electric power system.

Question 73.—Do you think it is possible to classify industrial and agricultural consumers and to supply electric power to each class at different rates without affecting the overall financial working of your power supply undertakings?

Answer. Industrial and agricultural users are already separately classified and are being charged at different rates. It is believed that this is a very proper procedure and is in line with rate making policies in electric power companies throughout the world, where rates are established for each distinct class of users so that each class will be properly charged in accordance with its use of the electric power system. This is a fundamental policy in rate making.

Question 74.—Do you recommend writing down the cost of aided power projects to reduce raets? If so, to what extent?

Answer. The writing down of the cost of aided power projects is recommended, but only to the extent that such costs are in excess of the cost of comparable projects completed on free competition basis.

Question 76.—By working on a "no profit-no-loss", what average rates of electric power for different classes of consumers can be adopted in your supply area?

Answer. This is a question of fundamental policy for government to decide whether it expects any publicly owned electric power system to operate on a profit or loss or on "no profit no loss" basis. It was stated in answer to question No. 7 that the electric power industry should operate on a commercial basis leaving a modest percentage of profit to maintain its solvency with due and appropriate allowances being made for all operating expenses such as debt service, depreciation allowance and other appropriate overhead charge as well as reserves for emergencies. This would be the correct policy to follow. Aside from policy, working on strict "no profit no loss" basis will create many practical difficulties. In a system which is expanding at a rapid rate it is most difficult to determine the exact rates which are necessary to produce a "no profit no loss" situation. The unit

costs of electricity decreases with increased use and it is most difficult to determine a "break even" point sufficiently in advance so that various rates schedules can be adjusted to produce just the right amount of revenue. Further, there is always the possbility of a bad year or some catastrophic event which will have a very adverse effect on yearly revenues. These factors—and others make it impractical if not impossible for each year to be a "no profit no loss" year. It is believed, however, that this status can be approached or, in fact, realized by a proper study of trends, and their skillful use over a period of years. This would result in the changing of rate schedules at longer intervals than would be the case if year-to-year adjustments were attempted, which, that is to say, rate adjustments, at short intervals are not desirable anyhow.

POWER WING REORGANISATION

General Manager

Acting under the jurisdiction of the Authority through its Chairman, directs the entire operation of the Authority's electric power systems in all their phases of planning, design, construction, maintenance and operation. This includes overall co-ordination and control, long-term planning and development, budget preparation and administration, revenues and expenditures, public and employee relations, commercial operations, construction survillance and all other factors associated with the efficient and profitable operation of the electric power systems.

Director of Planning and Development

Under the direction of the General Manager, assembles, verifies and approves all annual budgetary programmes for maintenance, operation and construction; directs the preparation of system power supply studies and long-range programmes for additions to the generation, transmission and distribution system; reviews construction expenditures and plant investments; reviews all major programmes with respect to policy and performance; reviews all progress reports and recommends action as required; conducts load surveys and makes long-range load forecasts, and otherwise acts as adviser to the General Manager on budgets, planning and technical considerations.

Director of Design and Standardization

Under the supervision of the General Manager, conducts studies and research for the purpose of establishing, publishing and maintaining standards for construction, maintenance and operation, including the preparation of transmission and distribution standards and specifications, materials, standards and specifications, standardized practices and procedures together with forms and techniques for outlining their proper and efficient use.

Secretary to General Manager

Acts as Secretary to the General Manager with respect to administrative affairs and preparation and disposal of administrative cases, also miscellaneous administrative duties as assigned, including appointments, administrative files and records.

Technical Assistant to General Manager

Acts as an assistant with respect to engineering and other technical affairs, condenses and summarizes data and reports, collects and assembles technical information, and otherwise relieves the General Manager of such details as can be readily accomplished by a technical assistant.

Operational Manager

Under the jurisdiction of the General Manager, is responsible for the overall operation and maintenance of the electric power system of the Authority, including generation, transmission, distribution and sale of power in all its ramifications, including planning, maintenance, operation and miscellaneous plant additions, procurement and stores, personnel, public relations, commercial operations and inter-Regional administration.

Director of Electric Plant

Under the general direction of the Operational Manager, reviews and approves maintenance programmes prepared at the Regional level, including maintenance methods and procedures for generating plants, transmission lines, distribution lines, sub-stations and facilities associated therewith; reviews and approves budgetary programmes covering miscellaneous additions to generation, transmission and distribution plant; arranges for plans and specifications as reqiured, indicating the appropriate construction organization; furnishes technical services to the Regional Offices as requested, including electrical calculations, equipment application, short circuit studies and other items associated with maintenance and operation of the electric power system.

Director of Power Control

Acting for the Operational Manager, directs the operation of the grid system power supply to the distribution, systems, including scheduling load anticipation and economic assignment of generating units, scheduled outages and emergency operation of generators, transmission lines and sub-stations; also recording, tabulating and publishing operating statistics; planning, operating and maintaining the tele-communications system; supervising, calibrating and maintaining all protective relay facilities on the transmission system.

Director of Administration

Under the supervision of the Operational Manager, prepares and administers the budget for maintenance, operation and miscellaneous plant addition; also directs the recruitment, training, transfers, assignments, salary schedules, working conditions, performance and efficiency of all personnel under supervision of the Operational Manager; and otherwise carries out operational assignments of a general nature as directed.

Director of Commercial Operations

Under the general direction of the Operational Manager, directs the preparation and application of tariffs, billing and collection policies and procedures, preparation and publication of statistical data and information; determines policies and procedures regarding unauthorized energy use; formulates customer relations policies and promotes the sale and use of energy; and undertakes assignments of a commercial and public relations nature as are delegated to him by the Operational Manager.

Director of Procurement and Stores

Under the supervision of the Operational Manager, directs the procurement of all materials, equipment, and supplies for the maintenance and plant additions for the electric system in accordance with approved requisition; outlines the procedure associated with enquiries, tenders, purchase orders, shipments, receipts, expediting and inspection of materials; handles all contracts for materials, supplies, and fuels; at the direction of the Operational Manager establishes such centralized purchasing procedures as may be necessary for the flow of materials, supplies and equipment to Regional warehouses to be established as directed, supervises inventory control originating in the Regional Offices, formulates policies associated with the safety and security of stores.

Chief Accountant

Under the general direction of the Operational Manager, supervises the operation of the General Accounting Department and handles all accounting functions, including general book keeping, accounting procedures, methods, statistics, routine expenditure reports for maintenance, operation and plant additions; prepares accounting forms and procedures for all operating departments; establishes payroll methods, and otherwise performs all related accounting functions.

Regional Manager

Under the general jurisdiction of the Operational Manager, is responsible for the overall operation of the electric power system in a geographic region with respect to maintaining proper and satisfactory relations with the public, with governmental departments, bureaus, and agencies, with city, town and village officials and with industrial regional groups. In addition, through appropriate staff officers and department heads, the Regional Manager shall administer all details concerned with budgetary procedures, promotion of energy use, revenues and disbursements, employee relations, and the maintenance and operation of all property equipment, and facilities with the exception of those operating details concerned with the loading and scheduling of generators, transmission lines and sub-stations and the maintenance and operation of their protective relays. In addition, the Regional Manager shall be responsible, through appropriate assistants and personnel, for the maintenance, operation, extension, renovation and design of the distribution systems, including distribution sub-stations, lines, transformers and services to customers to be conducted in accordance with overall policies established as a part of a standardization programme designed to improve and expedite maintenance and construction and insure the efficient use of men, materials, and machinery.

Technical Assistant—Electric Plant

Under the direction of the Regional Manager, prepares all budget recommendations; prepares plans, specifications and studies as required, reviews and approves work orders plans, specifications, and material and equipment requisitions at the Regional level; arranges for construction by appropriate forces and provides technical services as required. In addition, under the direction of the Director of Power Control, directs the operation and maintenance of the tele-communications system and directs the calibration and maintenance of protective relays and customers' metering equipment. Also, prepares the budget for the electric distribution system for review and approval and directs the preparation of detailed designs in accordance with established standards.

Technical Assistant—Administration

Acting for the Regional Manager, recruits personnel and makes transfers and assignments; establishes training programmes; reports on performance and efficiency; supervises the general accounting at the regional level, arranges for office supplies and facilities, and otherwise carries out assignments of a general nature as directed.

Technical Assistant—Commercial Operations

Acting for the Regional Manager, interprets tariffs for Regional applications, outlines and directs activities associated with the sale of power, including marketing and sales promotion; directs activities relating to unauthorized use of energy; directs billing and collection procedures; handles customer relations and public relations at the Regional level and other assignments of a commercial nature.

Technical Assistant—Schedules and Stores

Acting for the Regional Manager, prepares schedules for all programmes associated with maintenance and miscellaneous plant additions and follows progress of this work; also supervises store room operations, including handling requisitions, inventory control and flow of stores within the Region, also safety and security of stores.

Chief Engineer—Construction

Responsible to the General Manager for administering the construction programme for all major generation, transmission, sub-station and distribution projects approved by the Authority and other specifically assigned to the Construction Department, including formulating, negotiating and allocating construction contracts, preparing contract conditions and documents, the overall review and approval of plans and specifications, purchasing equipment and materials not contractor furnished, coordinating construction schedules, expediting construction progress, checking conformance with plans and generally representing the interests of the Authority in all phases of major projects, operating through recognized staff officers and personnel of the Authority, the contractor, the design engineers and consultants.

Deputy Chief Engineer—Power Station Construction

Under the supervision of the Chief Engineer, Construction, actively supervises the field construction programme for power stations and other assignments, meets regularly with contractors, construction superintendents, engineers, contract administrators, and other construction personnel for the purpose of forcefully prosecuting construction programmes, acts for the Chief Engineer in matters requiring day-to-day decisions in the field, continuously advises the Chief Engineer regarding progress or problems which require executive attention, and otherwise represents the Chief Engineer as required to insure the completion of power station construction in accordance with plans specifications and contracts.

Deputy Chief Engineer—Transmission and Distribution Construction

Under the supervision of the Chief Engineer, Construction, actively supervises the field construction programme for transmission lines, sub-stations, distributions systems and other assignments, meets regularly with contractors, construction superintendents, engineers, contract administrators, and other construction personnel for the purpose of forcefully prosecuting construction programme, also acts for the Chief Engineer in matters requiring day-to-day decisions in the field, continuously advises the

Chief Engineer regarding progress or problems which require executive attention, and otherwise represents the Chief Engineer as required to insure the completion of transmission line, sub-station and distribution system construction in accordance with plans specifications and contracts.

Director of Administration (Construction)

Under the supervision of the Chief Engineer, Construction, performs administrative duties associated with budgeting and disbursement of construction funds, assist with personnel administration, prepares and distributes progress reports, handles routine relations with other departments of the Authority, and otherwise performs administrative duties assigned by the Chief Engineer, Construction.

FINANCIAL STATEMENTS

Balance Sheet for Indus Basin Project

Balance Sheet for Water Wing

Balance Sheet for Machinery Pool Organization

Operating Account for Machinery Pool Organization

Balance Sheet for Power Wing

Revenue Account for Power Wing

INDUS BASIN PROJECTS WING

BALANCE SHEET AS AT 30TH JUNE, 1962

Expenditure on projects			386,551,270
Unallocated expenditure			5,848,595
Administrative fixed assets: Cost	90,821		
Less: Accumulated depreciation	12,383		78,438
Advance to consultants			2,842,733
Other advances, loans and debtors			536,117
At bank and in hand			14,027,476
Due from other Wings of the Authority			44,405,065
		Rupees	454,289,694
Creditors and credit balances			17,077,520
Advances from Government of Pakistan			140,073,137
Grant from Government of Pakistan			900,000
Funds received from the Indus Basin Development Fund			296,239,037
		Rupees	454,289,694

WATER WING

BALANCE SHEET AS AT 30TH JUNE, 1962

ASSETS

Projects Under Construction & Under Investigation		
Gudu Barrage : Expenditure to 30-6-1961	12,54,73,018	
Expenditure during the year	10,68,11,449	23,22,84,467
Other Projects: Expenditure to 30-6-1961	12,37,66,225	
Expenditure during the year	5,11,24,504	17,48,90,729
Unallocated expenditure		3,20,763
Investment in printing press		12,44,682
Expenditure on housing		1,01,53,929
Administrative fixed assets: Cost	34,86,491	
Less: Accumulated depreciation	6,75,018	28,11,473
Debtors, advances and deposits		48,63,169
At bank and In hand		39,17,729
	Rupees	43,04,86,941

LIABILITIES

Loans from Agency for International Development, U.S.A.		3,70,41,443
Provincial government loans		12,26,15,552
Provincial government advances for Gudu Barrage		19,04,29,443
Central government advances		11,25,824
Bank overdrafts		1,85,93,718
Sundry creditors and credit balances		1,08,33,647
Due to other Wings of the Authority		4,98,47,314
	Rupees	43,04,86,941

MACHINERY POOL ORGANIZATION

BALANCE SHEET AS AT 30TH JUNE, 1962

LIABILITIES		
LIABILITY IN RESPECT OF ASSETS TAKEN FROM:		
Irrigation Department	110,570,073	
Warsak & Shadiwal Projects	35,952,554	
Gudu Barrage Project	21,256,245	
Indus Basin Projects	10,187,998	
Other WAPDA Projects	6,002,868	183,969,738
LOANS:		
Provincial Government	23,225,448	
United Kingdom	5,250,977	
Irrigation Department	55,126,869	83,603,294
CURRENT LIABILITIES		
Trade creditors	7,434,225	
Accrued charges	1,406,068	
Interest on loans	9,549,421	
Repair & maintenance charges payable	3,000,000	21,389,714
	Rupees	**288,962,746**
ASSETS:		
FIXED ASSETS:		
Cost	139,893,750	
Less: Accumulated depreciation	29,999,697	109,894,053
Equipment in transit	8,206,278	118,100,331
INVENTORIES:		
In hand	110,334,118	
In transit	8,805,148	
In process	5,530,202	124,669,468
DEBTORS:		
Accounts receivable:		
Irrigation Department	14,390,771	
G. M. Barrage excavation	11,046,962	
WAPDA	1,236,561	
Others	2,379,645	29,053,939
Deposits & prepayments	32,075	
Inter-Office debits awaiting adjustment	2,182,467	31,268,481
CASH AND BANK BALANCES		1,058,095
OPERATING ACCOUNT:		
Adverse balance to 30-6-1961	15,530,423	
Less: Surplus for the year	1,664,052	13,866,371
	Rupees	**288,962,746**

MACHINERY POOL ORGANIZATION

OPERATING ACCOUNT FOR THE YEAR ENDED 30TH JUNE, 1962

Workshop Operations:			
REVENUE		29,802,277	
LESS: EXPENSES:			
Work in process 1-7-1961	4,382,571		
Labour	5,462,460		
Stores consumed	14,543,780		
Shop equipment maintenance costs	538,139		
Other workshop expenses	2,905,794		
Depreciation	300,638		
Work in process 30-6-1962	(5,530,202)	22,603,180	7,119,097
Rental Equipment Operations:			
REVENUE		29,551,661	
LESS EXPENSES:			
Repair & other expenses	9,097,896		
Depreciation	21,724,686	30,822,582	(1,270,921)
G. M. Barrage Excavation:			
REVENUE		12,933,992	
LESS EXPENSES:			
Salaries & allowances	732,037		
Repair including labour & spares	3,865,180		
Fuel, oil & grease	2,053,841		
Wages	650,156		
Other expenses	310,203	7,611,417	5,322,575
Inventory Sales:			
REVENUE		4,253,930	
LESS: COST:		3,867,209	386,721
Miscellaneous Revenue			2,836,165
Cash Discount Earned			608,622
Gross Surplus before charging administration expenses & interest			15,082,259
Administration Expenses			
M. P. O.	2,695,124		
Consultants	629,582		
WAPDA	585,631	3,910,337	
Interest		9,185,727	
Expenditure on Jamshoro Training School		322,143	13,418,207
Balance			
Being surplus for the year carried to balance sheet		Rupees	1,664,052

POWER WING

BALANCE SHEET AS AT 30TH JUNE

		1960		1961		1962
FIXED ASSETS:						
Estimated depreciated value of assets taken over on 1st April, 1959			32,23,16,464		32,23,16,464	32,23,16,464
Capital expenditure & estimated value of assets acquired thereafter:						
Construction by the Operations Branch ..			6,26,19,201		11,24,64,062	17,17,39,683
Construction by Power Development ..			—		5,59,82,000	25,02,14,385
Warsak			—		—	26,00,00,000
			38,49,35,665		49,07,62,526	1,00,42,70,532
Deduct: Accumulated Depreciation ..			1,15,99,118		2,39,97,434	4,67,58,592
			37,33,36,547		46,67,65,092	95,75,11,940
Add: Capital Works in Progress ..			19,99,06,741		29,27,03,245	31,60,81,429
Total Fixed Assets ..			57,32,43,288		75,94,68,337	1,27,35,93,369
CURRENT ASSETS:						
Stock and Stores		6,38,89,555		6,67,12,569	6,79,44,164	
Consumers bills receivable		78,40,234		1,02,11,581	1,35,58,356	
Other debts and advances		85,02,398		77,02,971	1,69,26,420	
Due from Government on current transactions		39,93,599		27,55,393	18,86,191	
Wapda Water Wing		5,05,23,787		(54,51,025)	2,05,25,528	
Cash at bank, and in hand		1,48,94,781		1,62,05,716	1,24,71,635	
		14,96,44,354		9,81,37,205	13,33,12,294	
LESS: CURRENT LIABILITIES:						
Sundry creditors & credit balances ..		5,52,11,965		4,31,52,067	3,71,84,028	
Employees' funds		—		3,79,840	22,36,440	
Deposits		37,00,962		38,07,761	91,20,342	
		5,89,12,927		4,73,39,668	4,85,40,810	
Net Current Assets			9,07,31,427		5,07,97,537	8,47,71,484
TOTAL NET ASSETS	Rupees		66,39,74,715		81,02,65,874	1,35,83,64,853
SOURCE OF FINANCE:						
Debentures			—		—	5,00,00,000
Loans from Agency for International Development			1,71,48,654		5,37,86,750	9,85,05,648
Provincial Government Loans			54,52,27,200		63,02,13,998	72,69,11,998
Central Government Loans			7,42,04,239		7,42,04,239	33,42,04,239
German Loans			—		—	6,67,52,000
Consumers' & Employees' Security Deposits ..			1,69,25,934		1,90,91,830	2,12,02,627
Accumulated Surplus			1,04,68,688		3,29,69,057	6,07,88,341
	Rupees		66,39,74,715		81,02,65,874	1,35,83,64,853

POWER WING

REVENUE ACCOUNT FOR THE YEAR ENDED 30TH JUNE

		1960	1961	1962
EARNINGS:				
Sale of energy		7,41,73,511	9,30,28,133	11,69,23,893
Bank interest		3,22,724	1,60,523	47,804
Commission on Government collections		68,005	69,895	16,250
Miscellaneous receipts		1,05,598	3,60,307	2,98,237
	Rupees	7,46,69,838	9,36,18,858	11,72,86,184
EXPENDITURE:				
Cost of power purchased		16,89,039	91,33,896	—
Generation cost		1,81,18,607		85,18,260
Transmission cost		59,95,995	2,13,85,880	18,00,664
Distribution cost		41,19,320		1,46,18,415
Establishment		91,36,468	1,03,31,424	89,62,091
Consultants fee		60,795	65,679	66,000
Depreciation		1,04,16,133	1,23,98,315	2,33,90,000
Interest		1,52,00,000	1,78,03,295	3,21,11,480
		6,47,36,357	7,11,18,489	8,94,66,900
Surplus		99,33,481	2,25,00,369	2,78,19,284
	Rupees	7,46,69,838	9,36,18,858	11,72,86,184